Nguyen Duc Thang

2700 ANIMATED MECHANICAL MECHANISMS

With

Images,
Brief explanations
and YouTube links

Part 4
Mechanisms for various industries

Renewed on 31 October 2017

This document is divided into 4 parts.
Part 1: Transmission of continuous rotation
Part 2: Other kinds of motion transmission
Part 3: Mechanisms of specific purposes
Part 4: Mechanisms for various industries

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.

Author's information:

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- Mechanical engineer, 1969, Hanoi University of Technology, Vietnam
- Doctor of Engineering, 1984, Kosice University of Technology, Slovakia
Job history:
- Designer of small mechanical engineering enterprises in Hanoi.
- Retirement in 2002.
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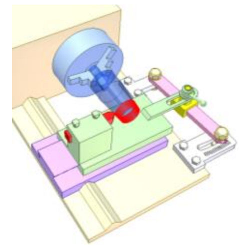
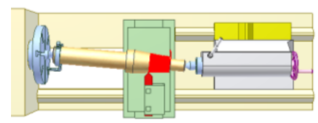
26. Mechanisms for shaping products

26.1. Mechanisms for machine tools

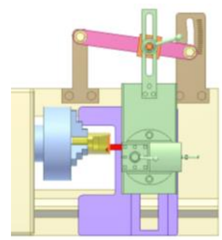
Tapered turning attachment 1
http://youtu.be/fm7uZqS3Oy0
The green slider carries red tool and yellow slider which has revolution joint with the green slider and prismatic joint with pink taper ruler. When the violet power-fed carriage moves along the axis of rotation of the blue work, the tool moves along a line parallel to the ruler to create cone surface on the work.



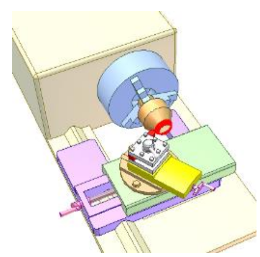
Tapered turning by offsetting of the tailstock
http://youtu.be/z3iYhKFPHKc
This method more suited for shallow tapers.
Approximately the set-over S = L.sinα
L: distance between the blue centers
α: half of taper angle



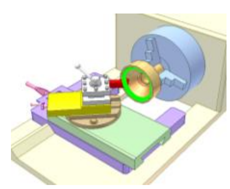
Tapered turning attachment 2
http://www.youtube.com/watch?v=9OcQW3Wc1eE
The green slider carries red tool and orange slider which has revolution joint with the green slider and prismatic joint with pink taper ruler. When the violet power-fed carriage moves along the axis of rotation of the yellow work, the tool moves along a line parallel to the ruler to create inner cone surface on the work.



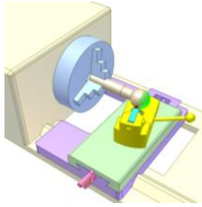
Tapered turning by using the compound slide 1
http://youtu.be/4LET_jHIZvM
The brown base of the yellow compound slide is turned an angle α (half of taper angle of cone surface to be created) and then fixed. This makes the tool moves along a line that creates an angle α with the axis of rotation of the orange work when turning the compound slide screw.
The green cross slide and the violet carriage are fixed during operation.



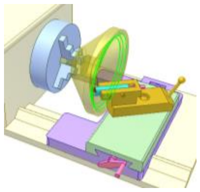
Tapered turning by using the compound slide 2
http://youtu.be/ysiVGfX4p_4
The brown base of the yellow compound slide is turned an angle α (half of taper angle of inner cone surface to be created) and then fixed. This makes the tool moves along a line that creates an angle α with the axis of rotation of the orange work when turning the compound slide screw.
The green cross slide and the violet carriage are fixed during operation.



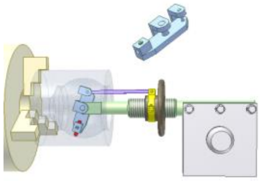
External spherical turning
http://youtu.be/PhM5rsGChTk
Axis of the revolution joint between the yellow tool post and the green slider must intersect axis of rotation of the work. If not, the created surface is toric, not spherical.



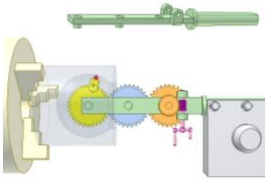
Internal spherical turning 1
http://youtu.be/f0IYSAXJyBs
Axis of the revolution joint between the orange tool post and the green slider must intersect the axis of rotation of the work.



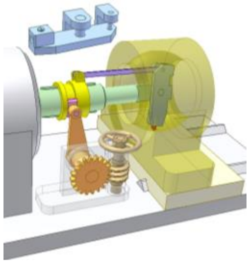
Internal spherical turning 2
http://youtu.be/aopSStktT8k
Move the lathe carriage to set initial position: center of internal spherical surface of the work must lay on the axis of the revolution joint between the blue tool post and the green bar.
Turn brown nut to move red tool in circular trajectory.



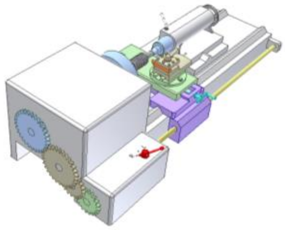
Internal spherical turning 3
http://youtu.be/f1MGCo5dgiQ
Move the lathe carriage to set initial position: center of internal spherical surface of the work must lay on the axis of the revolution joint between the yellow tool post and the green bar.
Turn pink crank to move red tool in circular trajectory.



Internal spherical turning 4
http://youtu.be/wnW_KJjWDig
Move the lathe carriage to set initial position: center of internal spherical surface of the work must lay on the axis of the revolution joint between the blue tool post and the green bar.
Turn brown wheel to move red tool in circular trajectory.

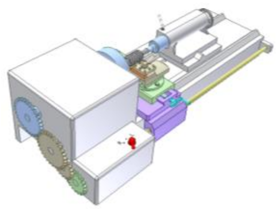


Turning right hand thread
https://youtu.be/VGekTGYw1Zg



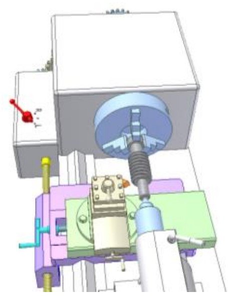
Red lever position determines right or left hand thread to be turned. It changes rotation direction of the yellow lead screw in relation with the rotation direction of the blue chuck.
Gears represent the gear train that determines the lead of the thread to be created.
Device for changing rotation direction of the yellow lead screw in relation with the blue chuck is not shown. It may be of this one:
http://youtu.be/Hc22Jqs8FhY
Device (electrical or mechanical) for reversing rotation direction of the chuck is not shown.

Turning left hand thread 1
https://youtu.be/ShwgiTEdWQs



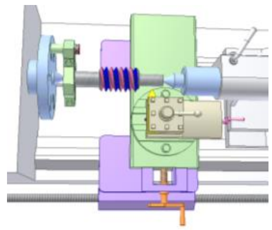
The tool (in orange) is clamped upwards. The blue chuck turns counterclockwise during cutting stroke (apart from the chuck) of the violet carriage.
Red lever position determines right or left hand thread to be turned. It changes rotation direction of the yellow lead screw in relation with the rotation direction of the chuck.
Gears represent the gear train that determines the lead of the thread to be created.
Device for changing rotation direction of the yellow lead screw in relation with the blue chuck is not shown. It may be of this one:
http://youtu.be/Hc22Jqs8FhY
Device (electrical or mechanical) for reversing rotation direction of the chuck is not shown.

Turning left hand thread 2
https://youtu.be/GI3e-Mm7KuI



The tool (in orange) is clamped downwards. The blue chuck turns clockwise during cutting stroke (towards the chuck) of the violet carriage.
Red lever position determines right or left hand thread to be turned. It changes rotation direction of the yellow lead screw in relation with the rotation direction of the chuck.
Gears represent the gear train that determines the lead of the thread to be created.
Device for changing rotation direction of the yellow lead screw in relation with the blue chuck is not shown. It may be of this one:
http://youtu.be/Hc22Jqs8FhY
Device (electrical or mechanical) for reversing rotation direction of the chuck is not shown.

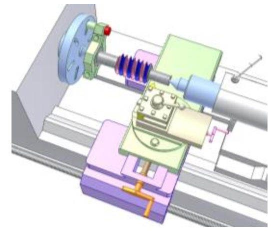
Turning multiple start thread 1
https://youtu.be/OWjX14CoRC8



Grey workpiece has two start thread, one start is in blue, the other in pink. The video shows cutting the pink start then the blue one.
Displace the compound slider (in brown) to shift from one start to the other. The displacement is L/N.
L: lead of the thread
N: number of starts. Here N = 2.

Turning multiple start thread 2

https://youtu.be/LOCAPIlFqBo



Grey workpiece has two start thread, one start is in blue, the other in pink. The video shows cutting the blue start then the pink one.

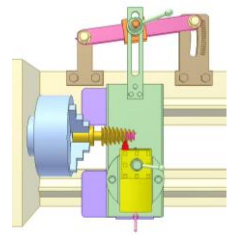
To shift from one start to the other: pull the red pin, turn the workpiece A deg. and release the pin.

A = 360/N.

N: number of starts. Here N = 2.

Taper thread turning 1

http://youtu.be/hIs4UHUUZdA

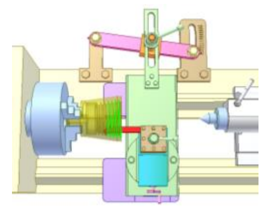


Thanks to the tapered turning attachment the tool moves along a line that creates an angle α (half of taper angle) with the axis of rotation of the yellow work.

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

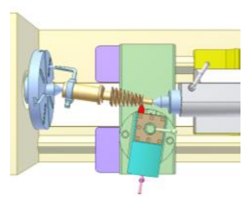


The green slider carries red tool and cyan slider which has revolution joint with the green slider and prismatic joint with pink taper ruler. When the violet power-fed carriage moves along the axis of rotation of the yellow work, the tool moves along a line parallel to the ruler to create inner taper 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.sinα

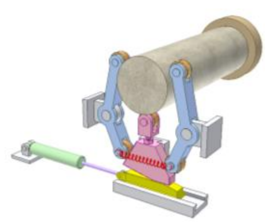
L: distance between the blue centers

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.

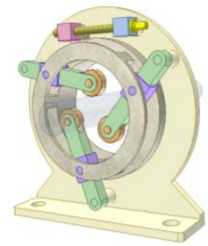
Rest 1

https://youtu.be/qDoS_kIj7-s

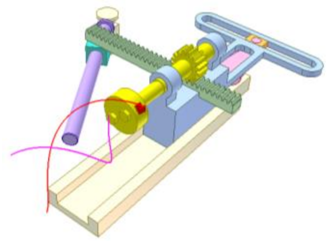


Thanks to green cylinder, yellow wedge moves pink vertical slider, two blue levers and brings orange rollers into contact with brown workpiece. Thus the workpiece is supported during the cutting process. The wedge moves back for removing the workpiece.

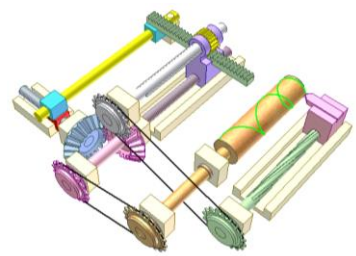
Rest 2
https://youtu.be/e_WrfATp5zM
Combination of four coulisse mechanisms.
Pink nut has revolute joint with brown round frame.
Blue screw bearing has revolute joint with the base.
Use the yellow screw to center and support the work (in glass).



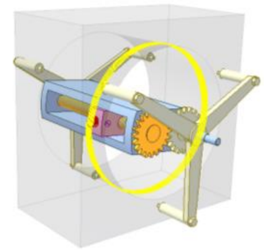
Making internal helix groove 1
https://youtu.be/pK9w8fyrVNI
Input: pink crank that moves blue slider (carrying green rack) via sine mechanism.
Green rack has traversal motion due to cyan slider moving on violet oblique runway.
The yellow shaft translates and rotates at the same time and its two cutters trace two helixes.
Helical lead L = Pi.D/tan(β)
β: oblique angle of the violet runway.
D: pitch diameter of the yellow gear.
Disadvantage: tools contact workpiece during return stroke.



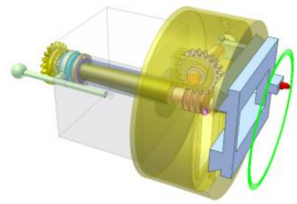
Making helix groove of variable lead 1
https://youtu.be/1lx7H9Q05l0
Input: orange shaft carrying workpiece.
Violet slider carrying green rack moves longitudinally thanks to pink screw.
Red slider has traversal motion thanks to blue screw and turns yellow bar.
Yellow bar makes green rack move in traversal direction and the latter turns yellow gear that has sliding key joint with grey shaft.
Green screw turns irregularly makes pink tool post moving irregularly to create helix groove of variable lead.
Two black closed lines represent chains of two chain drives.



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.

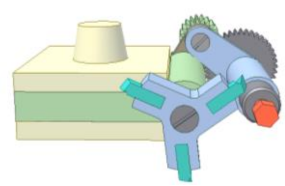


Device for facing bulky work on a lathe 1
https://youtu.be/9fCmW16W16s



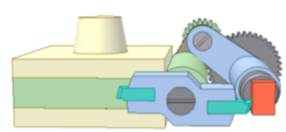
This is a design of engineer T. V. Thong, Hanoi, Vietnam, in 1963.
Work (not shown) is fixed to lathe cross slide.
Yellow body is fixed to lathe spindle through its tape-tail.
Pink worm has revolution joint with the body.
Violet nut - worm wheel, which is in mesh with the worm, can rotate around cross axis of the body and around the worm.
Orange cross screw, which is in mesh with internal thread of the nut - worm wheel, is fixed to blue slider carrying red cutter.
Cyan clutch controlled by green shifter has sliding key joint with the worm.
Brown half clutch is fixed to lathe base (stationary).
Yellow half clutch is fixed to yellow gear that receives motion from lathe feed gearbox.
When the lathe spindle rotate (not shown its transmission train) the red cutter moves following Archimedean spiral for facing the work.
The separation distance T of Archimedean spiral can be adjusted by selecting speeds or directions of the yellow gear and positions of the cyan clutch.
The video shows how T is increased: at first, the cyan clutch is at right position, the worm is immobile, then the cyan clutch is at left position, the worm rotates together with the yellow gear.
It is possible to adjust radial position of the cutter by turning the orange screw when keeping the nut - worm wheel immobile.
Positioning device of the green shifter is not shown.

Making hexagon on a lathe
http://www.youtube.com/watch?v=3Kzk3_uzRAg



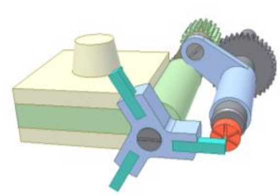
The tool shaft rotates twice faster than the workpiece shaft.
For details see:
http://meslab.org/mes/threads/13831-Gia-cong-luc-lang-tren-may-tien

Making rectangle on a lathe
http://www.youtube.com/watch?v=yr0VVtuPAlE



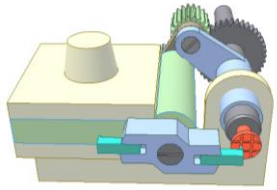
The tool shaft rotates twice faster than the workpiece shaft.

Making face slots on a lathe 1
http://www.youtube.com/watch?v=KsMbm2mB7KI

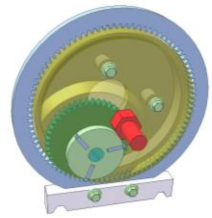


The tool shaft rotates twice faster than the workpiece shaft.

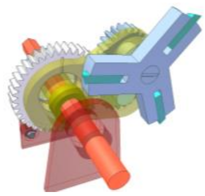
Making face slots on a lathe 2
http://www.youtube.com/watch?v=xQ_eQ2naSFc
The tool shaft rotates twice faster than the workpiece shaft.



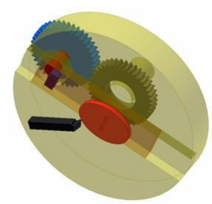
Device for making hexagon on a lathe
http://www.youtube.com/watch?v=XJb-kKOVBqU
The tooth number of the fixed gear is double the one of the satellite gear.



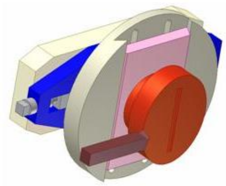
Device for making hexagon on a lathe
http://www.youtube.com/watch?v=AwkDB0ThXG8
The tooth number of the fixed gear is double the one of the satellite gear.
The processing length is not limited.



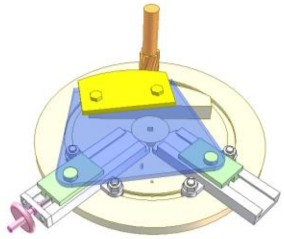
Device for turning ellipse 1
http://www.youtube.com/watch?v=TjaBYsAlwGc
Beside rotation, the workpiece has radial linear motion of sine law.
For details, see
http://meslab.org/mes/showthread.php?p=101930%23post101930



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

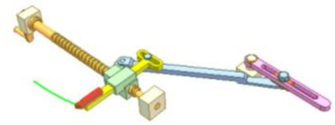


Cutting curve of large radius 1
https://youtu.be/ExnMxNQCTD8
It is an application of ellipse mechanism (two green sliders and a blue conrod). A grounded point traces on the conrod a curve, a portion of which has large radius. For full curve see the green one shown in
http://youtu.be/M3hlMN--gAg



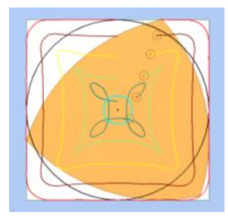
Yellow workpiece is fixed to the conrod at the said portion.
The obtained profile is not absolutely circular.
Angle between two grey runways can be adjusted for various radii of the profile.

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.

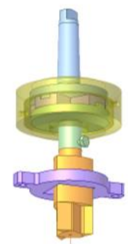


Wood hand screw drill
http://youtu.be/uBZWXZKDCDM
Press on the button, move the green grip up and down to rotate the red bit.

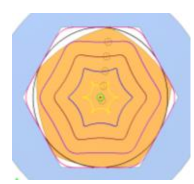
Drilling square holes 1a
http://www.youtube.com/watch?v=BnvT45CjD-E
Reuleaux triangle rotates inside a square.
Loci of various points on the triangle are shown.
The red locus is the section of the drilled square hole.
Its corners are rounded.
An inscribed round hole of the square hole must be predrilled.



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”

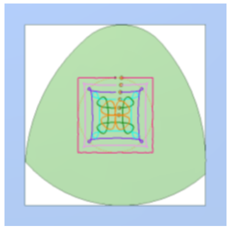


Drilling hexagon holes 1a
http://www.youtube.com/watch?v=oe8e-N3VusI
Reuleaux pentagon rotates inside a hexagon.
Loci of various points on the pentagon are shown.
The red locus is the section of the drilled hexagon hole.
Its corners are rounded.
An inscribed round hole of the hexagon hole must be predrilled.



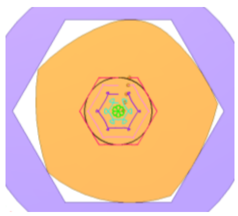
Drilling hexagon holes 1b
http://www.youtube.com/watch?v=_5OgWbMH8D8
Device for drilling hexagon hole of rounded corners based on the principle shown in "Drilling hexagon holes 1a"

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.



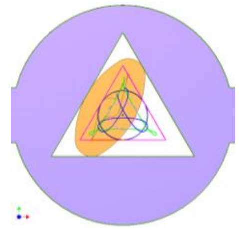
Drilling square holes 2b
http://www.youtube.com/watch?v=pT1H_cPYGAE
Device for drilling square holes of rounded corners based on the principle shown in "Drilling square holes 2a"

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.



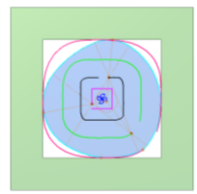
Drilling hexagon holes 2b
http://www.youtube.com/watch?v=W16f-qCXVkM
Device for drilling hexagon holes of sharp corners based on the principle shown in "Drilling hexagon holes 2a"

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.



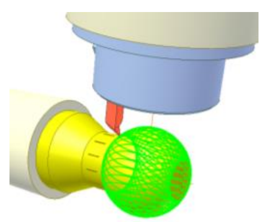
Drilling triangle holes 1b
http://www.youtube.com/watch?v=LNCHxxbMXEU
Device for drilling triangle holes of sharp corners based on the principle shown in "Drilling triangle holes 1a"

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.

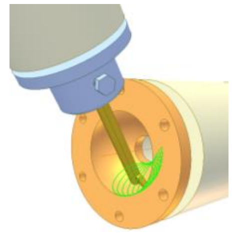


Making sphere on a milling machine 1
http://www.youtube.com/watch?v=BJtxfl_LKio
Workpiece is clamped in a dividing head's chuck and rotated by hand.
Tool is clamped in an arbor that allows it to be regulated radially.
For details see:
http://meslab.org/mes/threads/12255-Gia-cong-mat-cau-loi-tren-may-phay-thuong

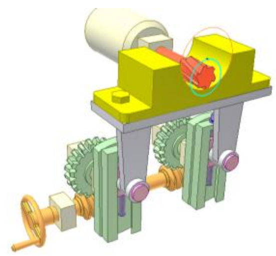
Making sphere on a milling machine 2
http://youtu.be/tx6b17qeOtg
Machining convex asymmetric sphere surfaces.
Workpiece is clamped in a dividing head's chuck and rotated by hand.
Tool is clamped in an arbor that allows it to be regulated radially. Axes of the workpiece and the arbor must be intersecting. The tool point position in relation with the workpiece decides dimension of the machined sphere surface.



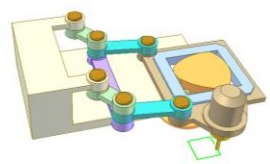
Making sphere on a milling machine 3
http://youtu.be/F22IBTB3cxY
Machining concave sphere surfaces.
Workpiece is clamped in a dividing head's chuck and rotated by hand.
Tool is clamped in an arbor that allows it to be regulated radially. Axes of the workpiece and the arbor must be intersecting. The tool point position in relation with the workpiece decides dimension of the machined sphere surface.



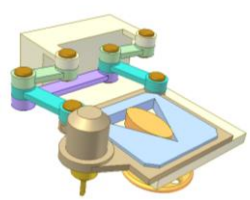
Jig for milling inner cylindrical surface
http://youtu.be/Vyqg7p_7HeE
The yellow work is clamped to the grey conrod of a parallelogram mechanism and has round translational motion.
Radius of inner cylindrical surface to be created is Rw (orange circle). Locus of center of the orange circle is the green 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.



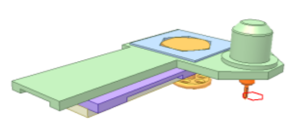
Milling square with Reuleaux polygon
http://www.youtube.com/watch?v=DoKT2fR9Rms



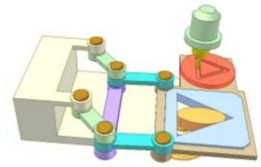
Milling triangle with Reuleaux polygon 1
http://www.youtube.com/watch?v=LOr-lb7E2YM



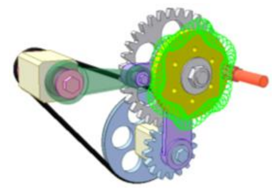
Milling hexagon with Reuleaux polygon
http://www.youtube.com/watch?v=_9j8mVfTS6M



Milling triangle with Reuleaux polygon 2
http://www.youtube.com/watch?v=4TlYYzs17B0

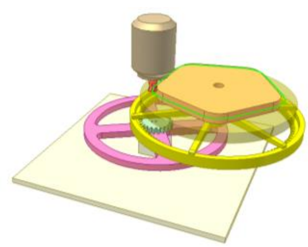


Milling profile 1
http://youtu.be/kPA6xngrYE8



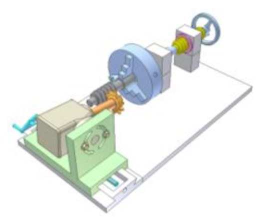
Input is pink shaft having an eccentric.
Red cutter creates profile on yellow work that is fixed to grey gear shaft. Transmission ratio from pink pulley to the grey gear shaft is 6 so the created profile of star shape has 6 wings. The wing is not symmetric because the grey gear shaft rotates irregularly.
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.

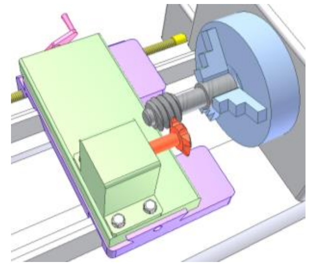
Milling thread 1
https://youtu.be/HtfEVziOrak



Threads of the grey workpiece and the yellow guiding screw have the same hand and lead. Pink nut is stationary.
Angle between orange cutter rotary axis and the one of the workpiece is equal to (90 – A) deg.
A: helix angle of the thread to be cut.
This mechanism is applied for light cutting forces.

Milling external thread on a lathe 1

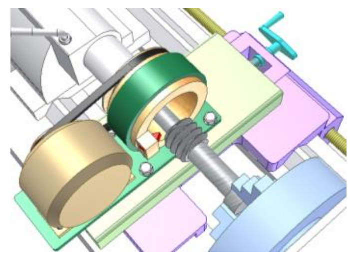
https://youtu.be/wLpSoXimXpc



Green motor block of red cutter is fixed to green cross slide. The latter can slide on violet longitudinal slide, which moves synchronically with blue chuck: L mm in one revolution of the chuck. L is thread lead of the grey work.
Cross motion of the green slide (thanks to pink screw) alters the radial distance from the red cutter to the work.
The cutter rotates very fast to create the thread surface.
Because the thread lead angle is small, no need to set the angle between cutter axis and the work axis.
The video shows a working cycle (up-milling method):
Cutter moves in – work rotates and cutter moves longitudinally to cut thread – work stops and cutter moves out – work rotates in reverse direction and cutter moves to its initial position.

Milling external thread on a lathe 2

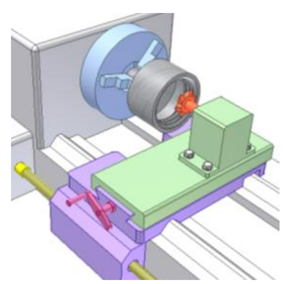
https://youtu.be/4jLlqTLxuow



Green bearing of orange rotary tool post is fixed to green cross slide. The latter can slide on violet carriage, which moves synchronically with blue chuck: L mm in one revolution of the chuck. L is thread lead of the grey work.
There is always an eccentricity between the rotary tool post and the work. Use the cyan screw to alter the eccentricity thus the distance from the red cutter to the work.
The cutter rotates very fast thanks to brown motor to create the thread surface.
Because the thread lead angle is small, no need to set the angle between rotary axis of the tool post and the work axis.
The video shows a working cycle (down-milling method):
Cutter moves in – work rotates and cutter moves longitudinally to cut thread – work stops and cutter moves out – work rotates in reverse direction and cutter moves to its initial position.

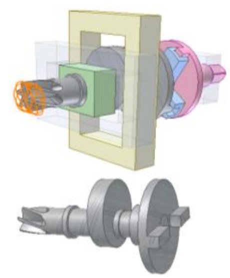
Milling internal thread on a lathe

https://youtu.be/i4EfNkPJreo

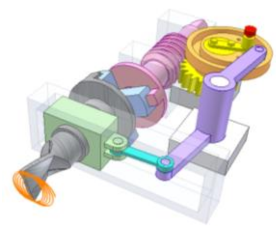


Green motor block of red cutter is fixed to green cross slide. The latter can slide on violet longitudinal slide, which moves synchronically with blue chuck: L mm in one revolution of the chuck. L is thread lead of the grey work.
Cross motion of the green slide (thanks to pink screw) alters the radial distance from the red cutter to the work.
The cutter rotates very fast to create the thread surface.
Because the thread lead angle is small, no need to set the angle between cutter axis and the work axis.
The video shows a working cycle (down-milling method):
Cutter moves in – work rotates and cutter moves longitudinally to cut thread – work stops and cutter moves out – work rotates in reverse direction and cutter moves to its initial position.

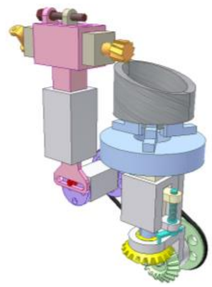
Milling the mortise 1
https://youtu.be/7NBElkQAXjk
Input: pink shaft.
Grey spindle is connected to the input via an Oldham coupling.
An eccentric fixed to the spindle slides in yellow frame.
The end mill must have as many as possible flutes to get smooth mortise.
This mechanism has not been verified in practice.



Milling the mortise 2
https://youtu.be/0qyEQxH2wUc
Input: pink shaft.
Grey spindle is connected to the input via an Oldham coupling.
An eccentric groove cam (in orange) is fixed to yellow worm wheel makes the spindle bearing slide horizontally.
Adjust angular position of the cam and the wheel by the red positioning pin to get various lengths of the mortise.
This mechanism has not been verified in practice.

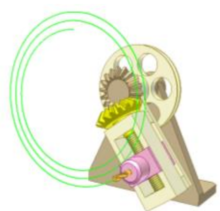


Milling sinus profile of an end cam
https://youtu.be/bm8MlZJbJ3E
Orange cutter shaft is driven by a motor via a Cardano joint (not shown).
Green input shaft is driven by another motor (not shown).
Violet crank shaft and pink slider of traversal slot create a sinus mechanism.
The violet crank shaft receives motion via a chain drive represented by the black cable. Thus the grey workpiece (an end cam) rotates and the cutter moves up down synchronically to create the sinus profile on the cam. Here the chain transmission ratio i = 1. If i = 2, the cam will be of two sinus profiles.

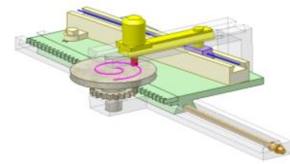


Brown screw is for adjusting horizontal position of the cutter in accordance with cam diameter.
Cyan screw is for moving the workpiece up down.
Front disk of the violet crank shaft has several holes (for the red pin), distances of which to rotary axis of the crank shaft are different. Each hole is for a particular height of the sinus profile.

Device for milling Archimedean spiral groove 1
http://youtu.be/6gnsM7u8_1c
Combination of bevel gear satellite drive and nut-screw one.

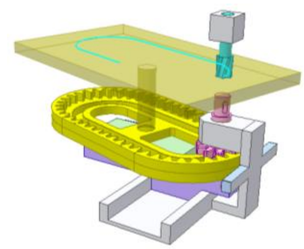


Device for milling Archimedean spiral groove 2
https://youtu.be/qXD4b4A2bQA



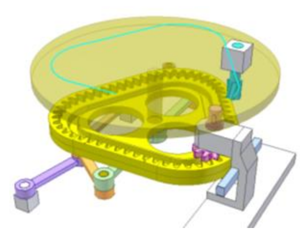
Move green slider carrying a rack that turns grey shaft to mill an Archimedean spiral groove on the work (not shown) fixed to the grey shaft.
Violet and yellow sliders are connected together by a revolute joint.
Adjust oblique angle α of the popcorn runway to get various constant distances of the Archimedean spiral. If α = 0 the spiral turns into a circle.
This device can be considered as a mechanism for converting a straight line (in blue) in a Castesian coordinate system into an Archimedean spiral (in pink) in polar coordinate system.

Milling profile 2a
http://youtu.be/hXexjgkVnOE



Yellow oval gear engages with a pink input pinion rotating around fixed axis.
Lower end of the pinion is a pin sliding in an oval groove.
The groove center closed curve is shaped by offsetting the rolling curve of the oval gear. The offset is equal to pitch radius of the pinion.
The oval gear has planar motion, 3 degrees of freedom: 1 rotation and 2 translations. The rotation is guaranteed by its revolution joint with green upper slider. The two linear motions are possible thanks to the green upper slider and violet lower slider. Here prismatic joints should be of ball-type linear guideway to ease the motion.
Function of the blue ruler is to assist guiding the oval gear.
The workpiece is mounted on the yellow table fixed to the oval gear.
Blue curve is locus of the center of an end mill (mounted coaxially with the pinion) on the table surface. It is exact copy of the groove center curve.
Change shape of the oval gear for other loci. However it is not easy to create such gear.
This video was made on request of a YouTube user. The mechanism was purely created on computer and needs to be verified in practice.

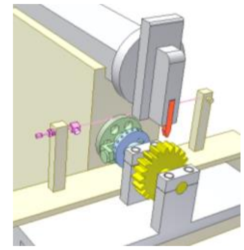
Milling profile 2b
http://youtu.be/HmNNPJySZ8w



It differs from mechanism shown in “Milling profile 2a” only in replacing the violet lower slider of two prismatic joints with a double parallelogram mechanism.
Blue curve is locus of the center of an end mill (not mounted in line with the pinion) on the table surface. It is similar to center closed curve of the groove in which lower end of the pinion slides.
This video was made on request of a YouTube user. The mechanism was purely created on computer and needs to be verified in practice.

Cutting gear on the shaper 1

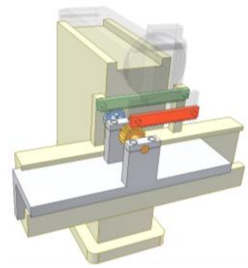
http://youtu.be/W69m2cDaqvY



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

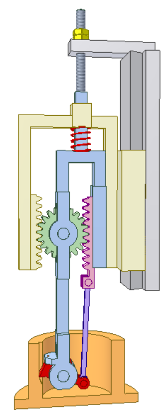
http://youtu.be/wkSI6H0-9XE



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.

Slotting a blind slot

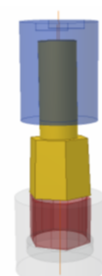
http://youtu.be/mfGWx8IAlmA



Input: popcorn main slider.
The main slider pushes blue slider move down through red spring. At the end of the slot cut on orange workpiece, yellow nuts stop the blue slider, the main slider continues going down and turns red tool out of the slot via gear rack drive and violet conrod.
There is no need of relief cut at the workpiece bottom.

Rotary broaching 1

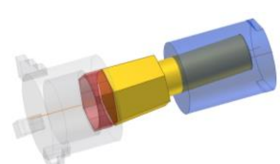
http://www.youtube.com/watch?v=J2OAISkHHbI



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

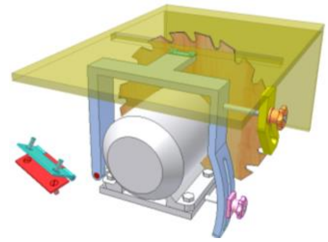
http://www.youtube.com/watch?v=VcEhmpkMVrM



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.

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.

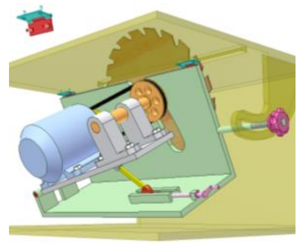
The mechanism is applied for light duty saw machines.

This video is a simulation of the machine in

http://woodgears.ca/homemade_tablesaw/index.html

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.

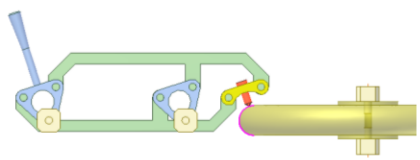
The mechanism is applied for light duty saw machines.

This video is a simulation of the machine shown in

http://woodgears.ca/reader/pekka/tablesaw.html

Device for Correcting Grinding Wheel

http://youtu.be/yLGqlwvKinY



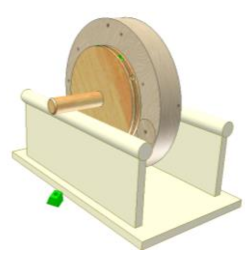
This combination of two parallelogram mechanisms enables the tool point to describe a circular-arc curve.

The yellow link rotates around a virtual axis.

It is used when the arrangement of fixed bearings for the virtual axis is impossible.

Grinding wheel equilibration 1

http://youtu.be/NQxPukE9y48



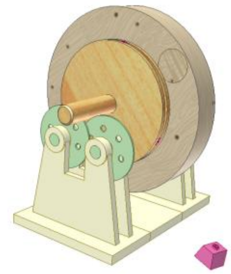
Grinding wheel assembly is laid on two horizotal shafts.

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

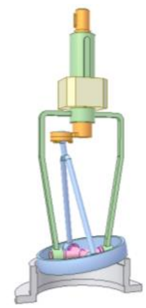
http://youtu.be/p6tEpwW9gJ4



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).

Mechanism for lapping a hole 1

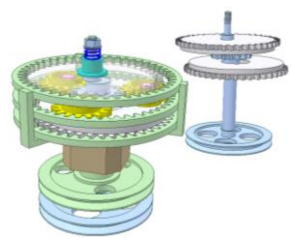
http://youtu.be/w9BlgeqKKHY



Mechanism has two inputs: rotation of orange shaft and translation of green frame. Blue wobbling lap with abrasive powder help increase hole surface quality of grey fixed work. Joint between the blue lap and orange shaft: spherical (revolution one is possible).
The mechanism can be mounted on a upright drilling machine.
The same wobbling motion can be seen in ceilling fans:
http://youtu.be/YFyX6fxkvpA

Lapping machine 1

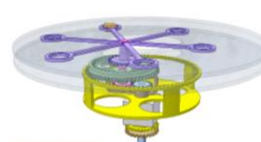
https://youtu.be/TS5HRfeykCk

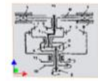


Pink workpieces are slapped between two grey disks.
Input 1: green pulley to which green gears are fixed.
Input 2: blue shaft of blue gear.
Blue shaft has two eccentric portions on which two grey gears with slapping disks rotate. The upper grey gear can move axially a little.
The grey gears engage with green lower and upper internal gears.
So blue, grey and green (upper and lower) gears create a planetary drive.
Yellow gears are in mesh with the central blue gear and green middle internal gear.
So blue, yellow and green (middle) gears create a planetary drive without a carrier.
Height of the yellow gears is slightly smaller than the one of the workpieces.
Blue spring forces upper slapping disk toward the lower one.
Yellow gears and workpieces have complicated planar motion which can be set by adjusting input speeds.

Lapping machine 2

https://youtu.be/x5NDE1mhphU

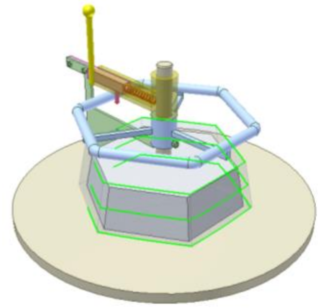




It is a combination of two planetary gear mechanisms (see the sketch).
Orange workpieces (here only one is shown) are moved by violet separator and slapped between two transparent grey slapping disks.
The upper disk is forced down by springs (not shown).
Input 1: yellow cylinder to which an external and an internal gears are fixed.
Input 2: brown carrier to which a gear is fixed.
Input 3: blue shaft to which a gear is fixed.
Various motion rules are applied for the three inputs to get desired motion of the workpieces.

Making concrete planters 1

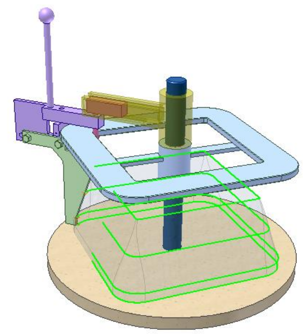
https://youtu.be/Jx6prfwPZhw



Pink slider reciprocates in a groove of yellow arm. Its pink pin is forced toward the blue guide by spring (in red).
When turning the yellow arm the green sweeper creates outside surface of the planter (in glass).
Profiles traced by points on the green sweeper may not similar to the guide profile due to the distance from them to the guide profile (in plan view). Refer to:
https://youtu.be/owLo-gXPJnA
So set the guide profile as close as possible to the product surface (in plan view).
The planter corners will be shaft if the pink pin radius is equal to inner corner radius of the guide profile.

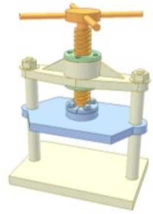
Making concrete planters 2

https://youtu.be/-3pq-4zL0oI

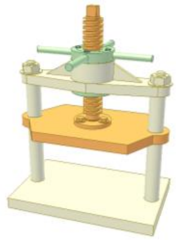


The pink slider reciprocates in a groove of the yellow arm. Its pink pin is always in contact with the blue guide inner profile.
Violet part is pivoted on the pink pin.
A surface of the violet part is always in contact with the guide outer profile (distance from the pink pin to the surface is equal to the guide width).
When turning the violet part the green sweeper creates outside surface of the planter (in glass), a right square frustum in this case.
The green sweeper has complicated motion: successive translation and rotation. This motion helps to create variable fillets on the frustum edges.
The mechanism may be applied in following video:
https://www.youtube.com/watch?v=FQ8QDukqb0M&t=0s

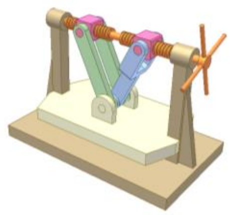
26.2. Mechanisms for machine presses



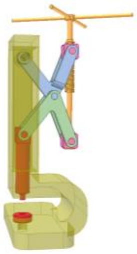
Manual screw press 1
http://www.youtube.com/watch?v=GrK5bhJjex4
The green nut is fixed. The orange screw is rotated and translated.



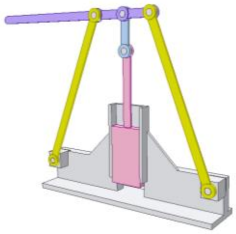
Manual screw press 2
http://www.youtube.com/watch?v=-DAtwJzmFdM
The green nut is rotated. The screw is translated.



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.

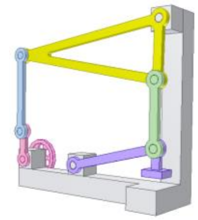


Manual screw press 4
http://www.youtube.com/watch?v=S7OIx_liVqY
A combination of slider-crank mechanism and nut-screw one gives a high mechanical advantage.
The orange screw is rotated. The pink nuts are translated. Both move slightly in vertical plan.

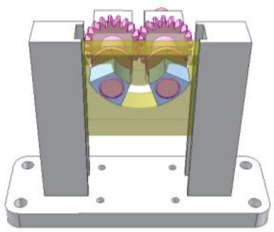


Manual press of 6-bar linkage
https://youtu.be/Cttpe_Sjqxk
Input: violet lever.
Length of yellow bars: a
Length of blue bar: 0.211a
Length of violet bar: 0.19a + 0.19a
Distance between two startionary bearings: 1.105a

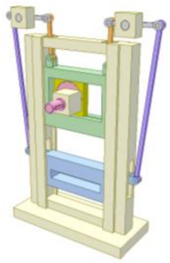
Press of double toggle action
https://youtu.be/BmlXyM375Y0
Input: pink crank.
When the crank and blue bar are vertical, they together with green and yellow bars create a parallelogram.
The double toggle action (when the pink crank, the blue bar are in line and green bar, yellow bar are in line) gives a strong working force.



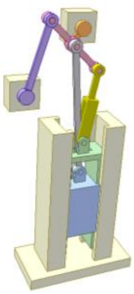
Press of two cranks
https://youtu.be/fWMW1GZCrUo
It is used for large die of sheet metal product.
The press has two pink cranks, two blue conrods and one yellow slider. Blue conrods are of unfamiliar shape because their lengths are smaller than their revolute joint dimensions.



Press of two coaxial sliders 1
https://youtu.be/IGEpDTy84QE
Input: pink eccentric shaft.
Upper and lower sliders move oppositely thanks to two slider crank mechanisms of grey common crank on each side.
This mechanism can be used for compressing grain materials from both sides.
In one side compression materials near immobile side are not compressed as tightly as the ones near mobile side.

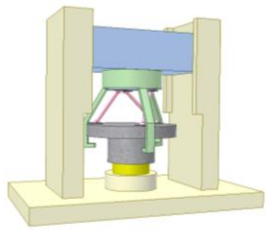


Press of two coaxial sliders 2
https://youtu.be/RWKVFREANYU
Input: orange crank.
Slider-crank mechanism of greey conrod moves blue inside slider.
Mechanism of violet and pink bars, yellow conrod moves green outside slider.
This mechanism can be used for deep drawing of sheet metal.

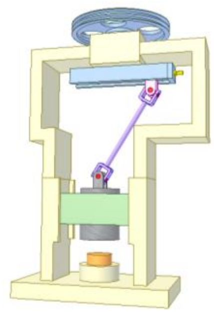


Press using spatial slider crank mechanism
http://www.youtube.com/watch?v=613_NYKz68I

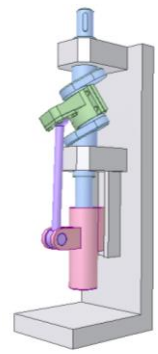
Forging with twisting 1
https://youtu.be/kkpg8go09yU
Grey hammer is connected to blue press slider via pink conrods and spherical joints.
The hammer after blowing yellow forged part has also twisting motion that is required for some forging operations.
Relation between vertical force and torque applied on the work depends on oblique angle of the conrods. This relation can be set by adjusting axial position of the green stopper.



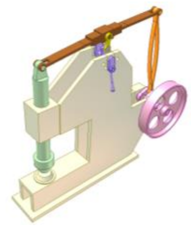
Forging with twisting 2
https://youtu.be/qbJI5w8j8B8
Grey hammer has revolute joint with green slider.
It is connected to blue press shaft via violet conrods of double Hook joints. There is an offset E1 between the blue shaft and the grey hammer. There is also distance E2 between upper Hook joint of the conrod and the blue shaft axis.
The hammer compresses and twists orange forged part at the same time. Twisting is required for some forging operations.
The video shows using yellow screw to adjust the distance E2 to get various stroke lengths of the green slider.



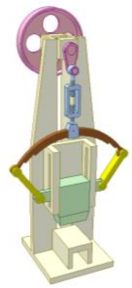
Press of spatial slider crank mechanism
https://youtu.be/hRFNR7AEnF8
Input: blue crank.
Output: pink slider.
The input rotary axis and the output sliding axis are coaxial.
Cylindrical joint between the pink slider and the blue crank is not necessary in term of kinematics.



Leaf spring hammer 1
http://youtu.be/ibmCejKObgM
The violet part is an eccentric shaft for adjusting stroke of the green slider.

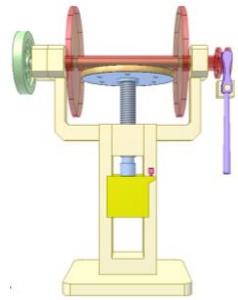


Leaf spring hammer 2
http://youtu.be/ZxoXAZEbYv4



Friction press 1

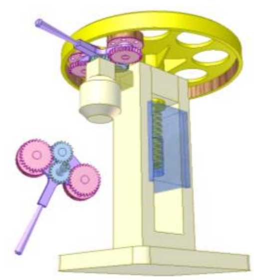
http://youtu.be/ixZ78JGV0RE



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

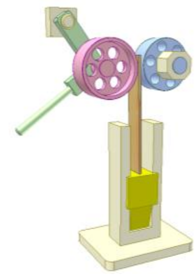
http://youtu.be/AQX6kVQK7OE



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

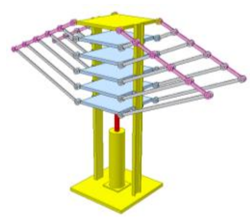
http://youtu.be/NUIdUT32OaY



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.

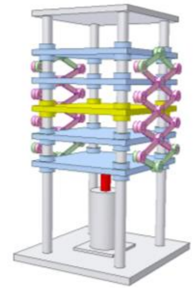
Multi-plate press 1

https://youtu.be/f42pobuVCuo

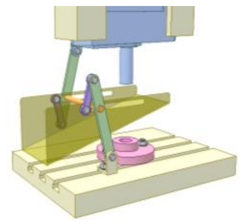


The combination of slider-crank mechanisms of commun cranks (in pink) ensures that the distances between blue plates, and thus product thicknesses are always equal.
The lowest blue plate moves 5 times faster than the uppest one.
Triangle proportionality theorem is applied here.
The press is used for wood chip products.
Disadvantage: occupation of large space on both sides.

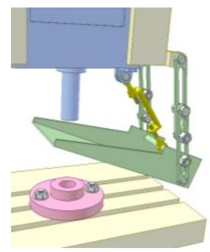
Multi-plate press 2
https://youtu.be/0s8X750MiVY
Scissor mechanism ensures that the distances between adjacent plates (blue or yellow) and thus product thicknesses are always equal.
The yellow stationary plate can be any other plate (except the lowest), however the needed piston stroke length will be different.
The press is used for wood chip products.



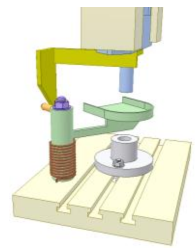
Mechanism for catching workpieces in presses 1
https://youtu.be/T7bYx_M8Iwg
The mechanism is used for case when the workpiece is jammed with the punch after being pressed and then removed at upper position of the blue slider (removing device is not shown). Yellow gutter catches the workpiece and guides it out of the pressing area. The gutter moves aside when the punch goes down.



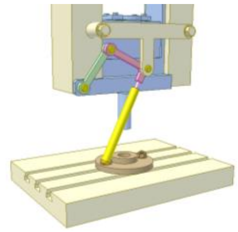
Mechanism for catching workpieces in presses 2
https://youtu.be/1PJ_9Ix0qcE
The mechanism is used for case when the workpiece is jammed with the punch after being pressed and then removed at upper position of the blue slider (removing device is not shown). Green gutter catches the workpiece and guides it out of the pressing area. The gutter moves aside when the punch goes down.
Blue slider, yellow conrod and green cranks to which the green gutter is fixed, create a slider crank mechanism.



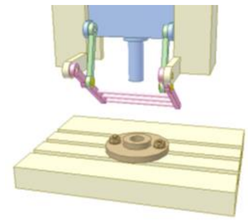
Mechanism for catching workpieces in presses 3
https://youtu.be/MZ81Q5UmuO0
The mechanism is used for case when the workpiece is jammed with the punch after being pressed and then removed at upper position of the blue slider (removing device is not shown).
Green gutter catches the workpiece when the punch goes up. The gutter moves to the back of the press when the punch goes down. The workpiece flies to a container thanks to its inertia.



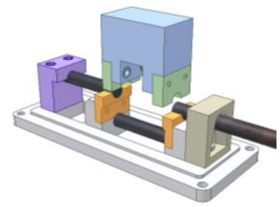
Injury prevention mechanism for presses 1
https://youtu.be/ElpPDZY8BPw
Yellow bar sweeps unwanted objects out of pressing area when the punch goes down to prevent injury for operator hands.
Pink crank, green conrod and blue slider create a slider crank mechanism.



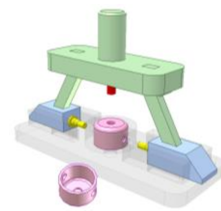
Injury prevention mechanism for presses 2
https://youtu.be/sLSGxmpuc_k
Pink frame sweeps unwanted objects out of pressing area when the punch goes down to prevent injury for operator hands.
Pink crank, green conrod and blue slider create a slider crank mechanism.



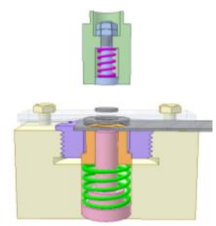
Cut-off die
https://youtu.be/OTVtrm5OVHU
Die for getting two blanks at the same time makes cutting faces rather perpendicular to bar axis (in black).
Violet and brown parts are for preventing the bar bending.



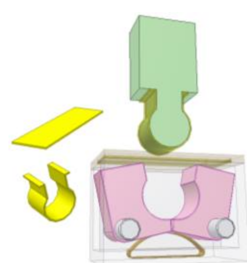
Wedge mechanism 9
http://youtu.be/uavruMk99v8
Piercing die. Vertical and horizontal holes are created at the same time by punches fixed on vertical and horizontal sliders.
The vertical wedges (in green) can be of rectangular section or circular one.



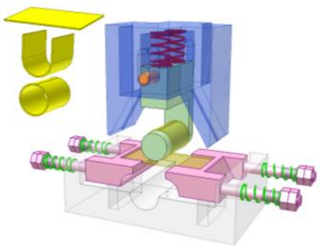
Die for making washers in a single punching stroke
https://youtu.be/_Np461igdGk
Green upper punch and violet die create outter circle of the washer.
Green upper punch and pink pin create inner circle of the washer.
Spring orange bush is for pushing the washer out of the violet die.
Spring blue pin is for pushing the washer inner scrap out of the green punch.
Glass runway helps removing the strip from the green punch.



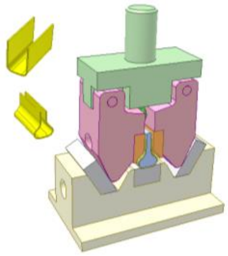
Bending die 1
https://youtu.be/O6ykFfYGpvU
Yellow workpiece before and after bending are shown on the left.
Green punch in its motion down first bends the workpiece into U-shape and at the end of punch stroke two pink dies create final shape of the workpiece.
Yellow transparent wokpieces in the die are shown only for illustrative purpose. Sorry for unabling to simulate the deformation in bending process.



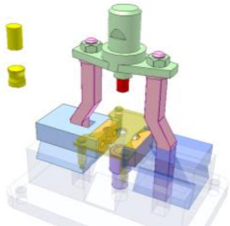
Bending die 2
https://youtu.be/eqKa2gv9Kx0
Yellow workpiece before and after bending are shown on the left.
Blue main slider of the press carrying green punch in its motion down first bends the workpiece into U-shape. Then the main slider pushes two pink dies to create final shape of the workpiece.
Yellow transparent wokpieces in the die are shown only for illustrative purpose. Sorry for unabling to simulate the deformation in bending process.



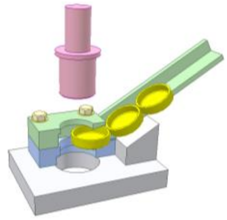
Bending die 3
https://youtu.be/QaDQHSdMq3E
Yellow workpiece before and after bending are shown on the left.
Two grey parts fixed on the base turn pink punches toward blue core when green punch support goes down to create final shape of the workpiece.
Yellow transparent workpiece in the die is shown only for illustrative purpose. Sorry for unabling to simulate the deformation in bending process.



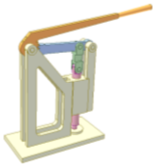
Stamping die 1
https://youtu.be/Cmk42XrtyAo
Yellow workpiece of soft metal before and after stamping are shown on the left. It is of undercut shape.
Green punch in its motion down first closes orange dies of two halves thanks to two pink wedges and then deforms the workpiece.



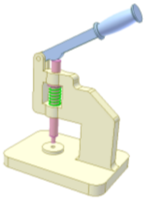
Automatic feeding for press 1
https://youtu.be/85THuzdZ3dY
The simplest way of automatic feeding: yellow workpieces come into pressing position due to the gravity.
Outer diameter of the workpiece is reduced after pressing.
The green and blue parts are cut off half for easy understanding.



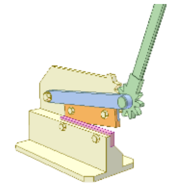
Hand punch machine 1
http://youtu.be/N9ni9wzh3gI
Combination of gear drive and slider-crank mechanism.



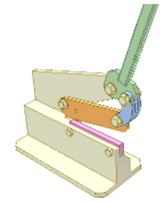
Hand punch machine 2
http://youtu.be/9xB4J91--8w
Disk cam and linear reciprocating follower.



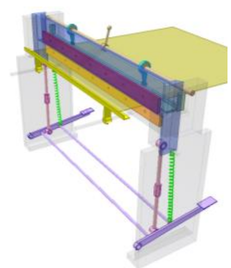
Hand shearing machine 1
http://youtu.be/tp4qFdWDkT8
A planetary gear is used.
Hand force is applied to the satellite gear. The other gear is fixed. The upper tool blade is fixed to the carrier.



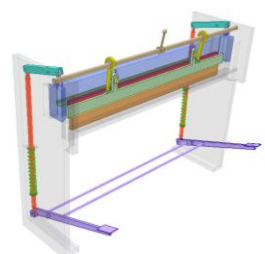
Hand shearing machine 2
http://youtu.be/zLLgQCJ4vSQ
A 4-bar linkage is used.
Hand force is applied to one crank. The upper tool blade is fixed to the other crank.



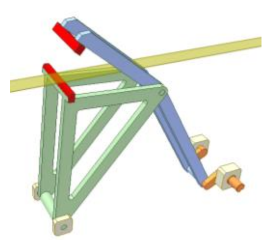
Foot shearing machine 1
http://youtu.be/GIcygJlH2BM
The blue slider carrying the red upper cutter is driven by a slider crank mechanism. The crank is the violet foot lever. The sheet is clamped before sheared by another slider crank mechanism of brown eccentric shaft. The orange lower cutter is fixed to the machine base. The red upper cutter has inclining cutting edge to reduce cutting force.



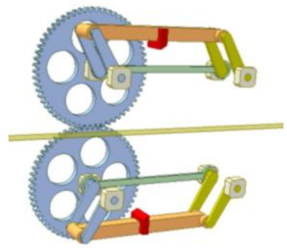
Foot shearing machine 2
http://youtu.be/pyGNgP6ZNvA
The blue slider carrying the red upper cutter is driven by a 6-bar mechanism. The sheet is clamped before sheared by a slider crank mechanism of brown eccentric shaft. The runway of the green slider is on the blue slider. The orange lower cutter is fixed to the machine base. The red upper cutter has inclining cutting edge to reduce cutting force.



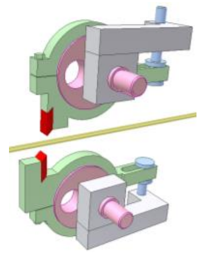
Web-cutting mechanism 2
http://youtu.be/Oe1erEBdHL8
This 4-bar linkage with an extended coupler can cut a yellow web at high speeds. The linkage is dimensioned to give the knife a velocity during cutting operation that is equal to the linear velocity of the web.



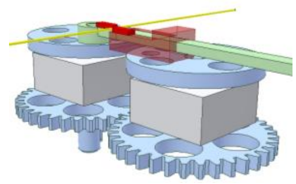
Web-cutting mechanism 1
http://youtu.be/VY8W3letECk
This parallelogram mechanism with knife on coupler can cut a yellow web at high speeds. The mechanism is dimensioned to give the knife a velocity during cutting operation that is equal to the linear velocity of the web. The green bars help the mechanism overcome its dead positions.



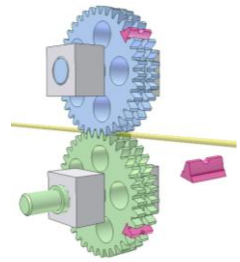
Web-cutting mechanism 3
https://youtu.be/oqXDVc3I3lE
Input: pink eccentric shafts rotating at the same velocity in opposite directions.
Red cutters have circular translating motion to cut yellow web.
Velocities of the web and the cutters at cutting point are about equal.



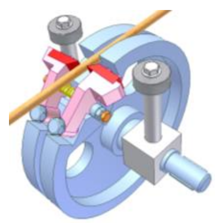
Wire-cutting mechanism 1
https://youtu.be/UDcTRTmfeio
Input: blue shafts rotating at the same velocity and in opposite directions.
Red cutters cut yellow wire that moves continuously. Velocities of the wire and the cutters at cutting point are about equal.



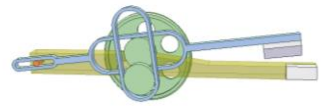
Wire-cutting mechanism 2
https://youtu.be/6pZLVvanekI
Input: green and blue shafts rotating at the same velocity and in opposite directions.
Pink cutters cut yellow wire that moves continuously. Velocities of the wire and the cutters at cutting point are about equal.
The mechanism is used for cutting steel of reinforced concrete.



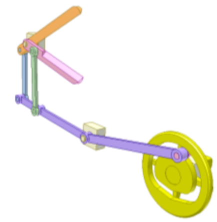
Wire-cutting mechanism 3
https://youtu.be/gIieZyEBeGA
Input: blue wheel carrying two reds cutters.
Orange wire is moved by other motion source (not shown).
The wire velocity and circular velocity of the cutters are the same.
Two pink cutter carriers are pushed aside by a yellow spring. Their rest positions are adjusted thanks to brown screws.
When the wheel rotates, two grey rollers force the cutter carriers to cut the wire.
Cutting length = Pi.2R
R: distance from the cutter to rotary axis of the blue wheel.



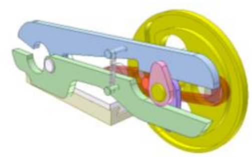
Mechanism for slicing machine
http://www.youtube.com/watch?v=F3hnQxzhZno



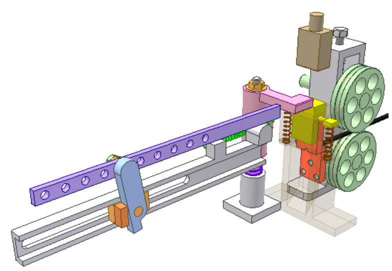
Cam-driven scissors 1
http://youtu.be/kOMxi0W2r3g



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.

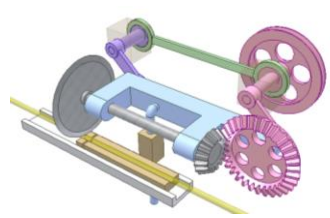


Cut-off machine
https://youtu.be/AXtKHnHlt0c
Brown punch reciprocates continuously. Its motion source is not shown. It never contacts yellow slider carrying red upper cutter.
Two green rollers rotate continuously. Their motion source is not shown. They advance black rod thanks to friction. The rod moves forward and pushes blue lever. This lever pushes the pink shim into the space between the punch and the yellow slider. The latter goes down to cut the rod.



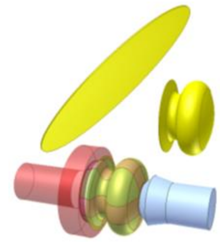
Adjust position of orange slider to get desired length to be cut for the black rod.
The red stopper on the orange slider limits angular motion of the blue lever.
When the rod contacts the blue lever, it may stop for a while and the green rollers slip on it.
Disadvantage: the length to be cut can not be large because of the longitudinal bending of the rod.

Mechanism for cutting cigarette rod
https://youtu.be/zZNTNADKNbs
Input: pink crank to which the large gear is fixed.
Output: grey shaft with the cutter that rotates around its own axis and at the same time has round translating motion in the vertical plane.
Pink and violet cranks, blue part create a parallelogram mechanism. Green conrod helps the mechanism overcome dead positions.

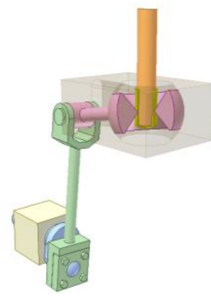


Brown slider acting as a supporting part when the cigarette rod (in yellow) being cut. The cutter and the slider speeds are about equal at cutting moment.
Device for moving the cigarette rod is not shown.

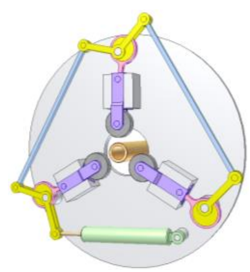
Spinning undercut objects
https://youtu.be/BjK2DxbHrYA
Red part represents a lathe spindle. Upper yellow parts are workpiece of disk shape and its final product.
A combined core is used for spinning objects of undercut
The video shows how to take out the combined core from the final product.



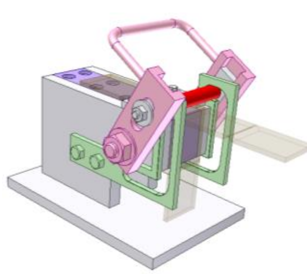
Wobbling die
http://youtu.be/5KZ_IHdsd50
Orange punch slowly pushes yellow workpiece through pink die for reducing outer diameter of the workpiece.
Fast wobbling motion of the die makes forming process easy.
Joint between the die and the base (sphere with a pin) gives the die 2 degrees of freedom.
Green conrod is connected to blue crank by spherical joint and to the die by revolution joint.
The workpiece and the die are cut off partly for easy understanding.
Workpiece feeding device is not shown.



Pipe diametric rolling
https://youtu.be/IJvLrdAhmQo
Three grey rollers are self-centering, move radially for reducing diameter of the orange pipe that rotates and moves axially.
Yellow crank-eccentrics, pink conrods and violet sliders create slider-crank mechanisms.
Blue conrods and yellow crank-eccentrics create parallelogram mechanisms that enables synchronic rotations of three yellow crank-eccentrics.
Green cylinder controls violet slider motion.
This mechanism can be used for cutting pipe, rolling or cutting external thread, self-centering clamping, …

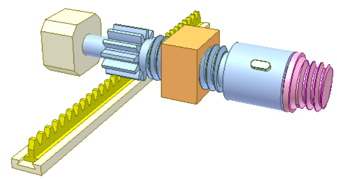


Manual bending U-shaped products 1
https://youtu.be/mjc02kb1eBE
It is for bending easy to dent, soft material.
Input: pink shaft to which runways for white sliders are fixed.
Red roller is pivoted on the sliders. The roller moves in slots of green guides.
The roller bends transparent blank to get U-shaped product (in yellow).
The video shows at first the bending schema, then the mechanism action to create the roller motion.

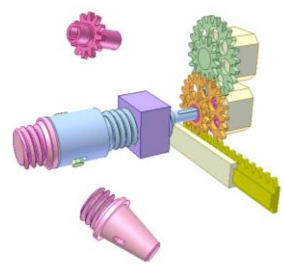


26.3. Mechanisms for molding machines

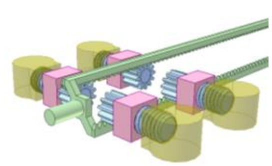
Mechanism for moving thread core of a plastic injection mould 1
http://youtu.be/7bVTvWGAdAA
Yellow rack is connected to the movable half mold.
When the movable half mold moves, the rack pinion drive and the screw drive (blue screw and orange fixed nut) make blue shaft carrying the pink thread core rotate 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.

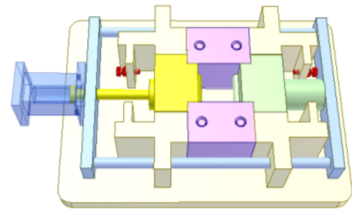


Mechanism for moving thread core of a plastic injection mould 3
https://youtu.be/ZESjsMQKmIs
Pink nuts are fixed to the mould.
Green racks are connected to an actuator.
The racks make blue gear thread cores rotate and translate. Thus the thread cores are removed from four plastic injection parts (in yellow).
The parts and the nuts have the same thread lead.



Mechanism for mould opening 1

https://youtu.be/vSEGVGXqV7A



The mould consists of four pieces: two violet fixed ones, green and yellow movable ones. The green and yellow pieces must go apart from each other for removing the undercut workpiece (not shown).

Only one cylinder controls their motions (instead of two in ordinary concept) thanks to its floating fitting.

The cylinder body and the green piece are fixed to blue frame that can translate in the base.

Yellow piston is fixed to the yellow piece.

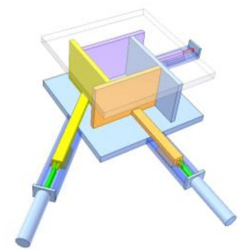
When the piston moves out off the cylinder, the yellow and green pieces come into contact with the violet ones, the mould is closed.

When the piston moves in, the yellow and green pieces come into contact with red screws of the base, the mould is opened. Stroke length of each movable mould piece cand be set by red screw.

The two violet pieces can become movable by the same way to create four movable piece mould.

2D compression for grain material

https://youtu.be/SI_iZ5CyPIA



Two blue cylinders perform the compression from two perpendicular directions.

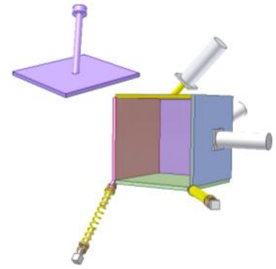
The mechanism has only one degree of freedom. Motions of two green pistons are interdependent.

Oblique angle of yellow slider determines edge ratio of the created rectangle.

It can be used also for 2D compression strength testing.

3D compression for grain material

https://youtu.be/lWFi3b51alo



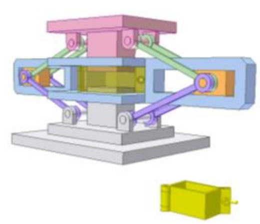
Three grey cylinders perform the compression from three perpendicular directions. The mechanism has only one degree of freedom. Motions of three pistons (blue, yellow and violet) are interdependent.

Oblique angles of yellow and violet pistons determine edge ratio of the created rectangular cuboid.

It can be used also for 3D compression strength testing.

Mould for up and down side compression

https://youtu.be/LyI56qhkq4U



Input: pink upper punch fixed to main slider of a press.

When the upper punch moves down, blue slotted bar, to which yellow mould is fixed, moves down with a half speed.

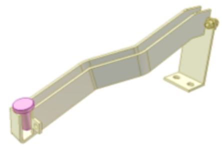
Although grey lower punch is immobile, in fact both punches move into the yellow mould of detachable structure.

27. Mechanisms for work manipulation

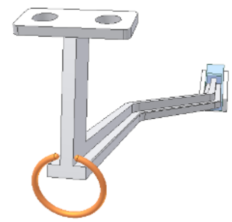
27.1. Feed ways

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.

Feed way 1
https://youtu.be/gHcV5h0YGBA
Pink workpieces move along feed way of U-shaped section due to the gravity.

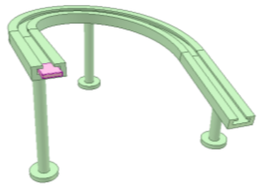


Feed way 2
https://youtu.be/R9s5TxC5Q84
Orange workpieces move along feed way of T-shaped section due to the gravity.



Feed way 3
https://youtu.be/WyYMSs3a2jM
Pink workpieces move along feed way of rectangular section due to the gravity.

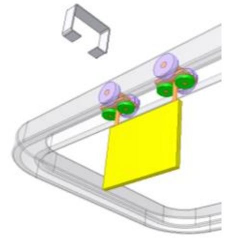
Feed way 4
https://youtu.be/4x-71gRTGNI
Pink workpieces move along feed way of rectangular section due to the gravity.



Feed way 5
https://youtu.be/9BhZqv7rgK0
Orange workpieces move along helical feed way of rectangular section due to the gravity. Various part shape are possible: balls, rollers, rectangular boxes.
Advantage: small space for large quantity of reserved parts.

Curved rail and roller slider

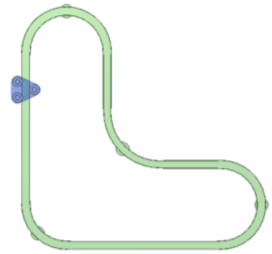
https://youtu.be/cLn4-eE8-SY



Violet rollers bear the weight of moving parts.
Green rollers are for guiding.
Yellow part is connected to the sliders via revolute joints.
Drive source is not shown.

Curved linear rail with 3-wheeled carriage

https://youtu.be/ZmF8mov2HZE



A 3-wheeled carriage moves along a rail consisting of straight, convex, concave and transitional portions.
To maintain a continuous gapless contact between the wheels and the rail, the widths of the portions are not the same.
They are larger at convex portions, smaller at concave portions in comparison with the widths of straight portions. The differences depend on wheel diameter, radii of convex and concave portions.
The transitional portions where the wheels may lose the contact should be very short.
See a real mechanism:
https://www.youtube.com/watch?v=xZV033ioljU

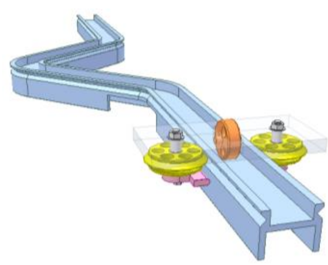
Curved linear rail with 4-wheeled carriage

https://youtu.be/KyD9Y7R19jQ

A 4-wheeled carriage moves along a rail consisting of convex, concave and straight portions.
The wheels are mounted on pink bars that have revolute joints with the carriage base. It ensures a continuous gapless contact between the wheels and the rail.

Zig-zag rail with 3-wheeled carriage

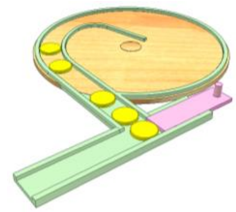
https://youtu.be/MLj6xHSi4PU



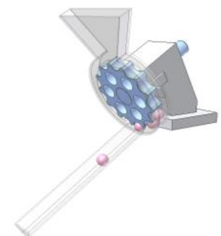
Input: orange wheel. It pushes the carriage thanks to friction force.
Yellow wheels and pink plates help the carriage change moving direction.
The pink plates are fixed to the carriage frame.
Pay attention to the removing portions of the runway wall at it inner corners.
The yellow wheel radius is equal to the runway profile radius at its inner corners.
This mechanism has just been created on the computer. It needs to be verified in practice.

27.2. Workpiece arrangement

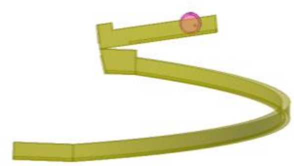
Lining up mechanism 1
https://youtu.be/x4P8sSUuNNA
Yellow workpieces of disk shape on orange rotary table are arranged in line thanks to centrifugal and friction forces.
Pink pushing bar will move them one by one to processing position (not shown).



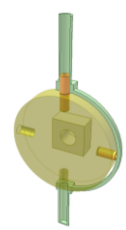
Lining up mechanism 2
https://youtu.be/grZWmiU0-ZI
Pink workpieces of ball (or roller) shape from the funnel are arranged in line thanks to blue gear rotor and the gravity.
There must be a vibration device for the funnel to prevent workpiece jam.



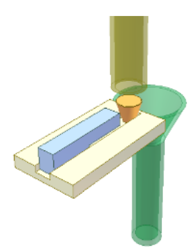
Part orientation 1
http://youtu.be/1Au-1clVp2A
This device makes the orange part to change its orientation after running haft-circle runway.



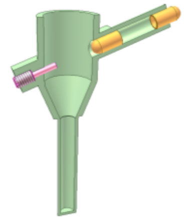
Part orientation 2
http://youtu.be/cXkOMI_Jd1Y
This device changes the orientation of the orange parts: from bottom down in the upper tube to bottom up in the lower tube. The yellow disk rotates interruptedly by an appropriate mechanism (not shown).
The device also has function of part separating.



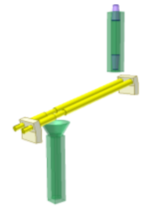
Part orientation 3
http://youtu.be/0-USznSJAtw
This device makes the orange parts to drop with large bottom down regardless of their initial orientation in the upper tube. The blind slot in the yellow plate is a key detail.



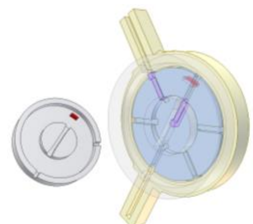
Part orientation 4
http://youtu.be/blv09DJr70Q
This device makes the orange parts to drop with closed bottom down regardless of their initial orientation in the upper tube. The pink screw is a key detail.



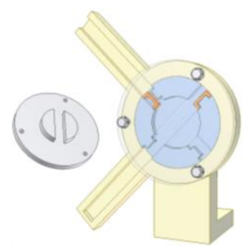
Part orientation 5
http://youtu.be/yCa2j8d8KyE
This device makes the violet parts to drop into the lower tube with small bottom down regardless of their initial orientation in the upper tube. The yellow shafts rotate with tendency to push up the parts to avoid their jam.



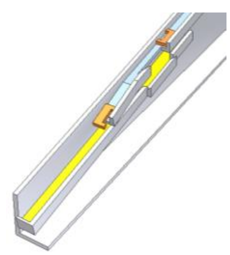
Part orientation 6
https://youtu.be/daHP7dkagas
This device makes the violet parts enter the lower runway with their head down regardless of their initial orientation in the upper runway.
The blue disk rotates interruptedly by an appropriate mechanism (not shown).
Key factor is the red portion on the grey/glass cover. It does not allow the part move down if the part head is in up position.



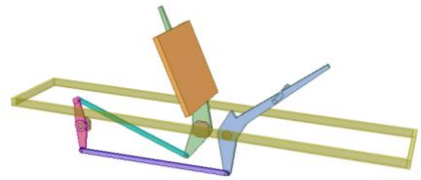
Part orientation 7
https://youtu.be/ed9Td2hUH2MThis device makes the orange parts enter the lower runway with their open sides pointing to the left regardless of their initial orientation in the upper runway.
The blue rotor rotates interruptedly by an appropriate mechanism (not shown).
Key factor is the protrusions in the grooves of the blue rotor. They do not allow the parts move down if their open sides point to the right.



Part orientation 8
https://youtu.be/hG5gSHFrlOw
This device makes orange parts enter yellow lower inclined runway with their open side pointing outside regardless of their initial orientation in blue upper inclined runway.
Key factor is the cut-off of the upper runway.

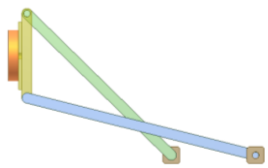


Flipping mechanism 1
http://www.youtube.com/watch?v=KCJa2zRWpwg



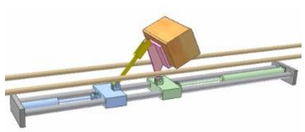
This mechanism can turn over a flat piece by driving two four-bar linkage from one double crank. The two flippers are actually extensions of the fourth member of the four-bar linkage.
Link proportions are selected so that both flippers rise up at the same time to meet a line slightly off the vertical 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



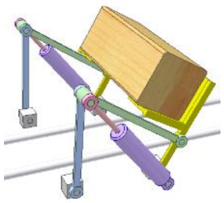
This is a four-bar linkage in which the orange workpiece fixed on the connecting rod is turned over (180 degrees).
Length of the connecting rod: 50
Lengths of the two cranks: 120 and 140
Distance between two fixed bearing houses: 50
The 180 deg. rotation of the workpiece corresponds the 90 deg. rotation of the blue crank.

Flipping mechanism 3
https://youtu.be/p5xSjYE69zM



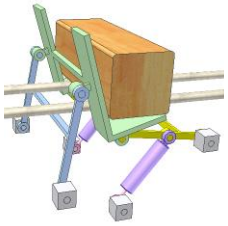
Yellow, pink and green links create a slider crank mechanism.
Thanks to green cylinder the pink conrod (length of which is shorter than the one of the yellow link) turns orange work 90 deg.
Blue piston is used for setting working position of the mechanism.

Flipping mechanism 4a
https://youtu.be/gd0izSF0IvI



Blue, green and yellow links create a 4-bar linkage.
Violet cylinder turns yellow crank 90 deg. but orange work can turns 180 deg. thanks to its inertia.

Flipping mechanism 5
https://youtu.be/3CAnTu6rsUc

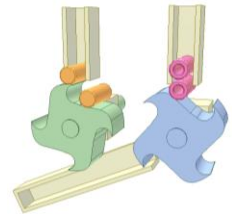


Blue, green and yellow links create a 4-bar linkage.
Thanks to violet cylinder the green conrod turns the work 90 deg.

Part mingling 1

http://youtu.be/jXPQxMRaq8I

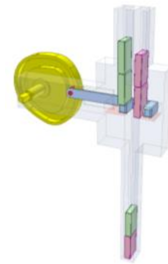
This device enables mingling two kinds of parts in an alternate order.
The rotors rotate in opposite direction.



Part mingling 2

https://youtu.be/jXzOK3W0DNI

This device enables mingling two kinds of parts in an alternate order.
The red plane surfaces on the base are slanting outward to prevent the parts from casual falling.

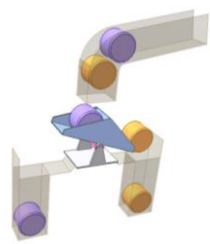


Part flow dividing 1

https://youtu.be/Dbj6Wz6dUfc

Incoming part (rollers) flow is divided into two ones thanks to blue pivot bucket.
Key factor:
- torque caused by the lowest part (in contact with the bucket) applied to the bucket must be larger than the one caused by upper parts.
- center of mass of the bucket must be higher than its rotary axis.

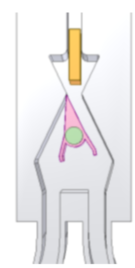
This mechanism can be used for grain material (dividing and dispensing).



Part flow dividing 2

https://youtu.be/gP7JZ1-fhNc

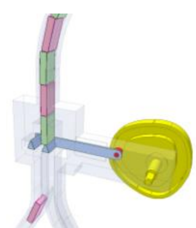
Incoming part (in orange) flow is divided into two ones thanks to pink pivot guide.
Key factor: center of mass of the guide must be higher than its rotary axis.
Disadvantage: There must be enough distances between successive parts in the flow (adding a separate device if necessary).



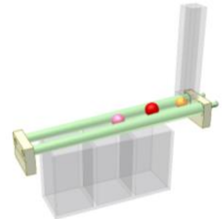
Part flow dividing 3

https://youtu.be/BInuMZ2ygX8

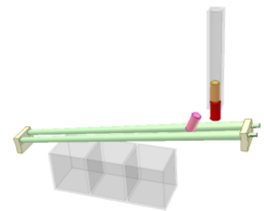
Incoming part (in pink an green)) flow is divided into two ones thanks to blue follower of yellow cam. The mechanism also acts as a separating device.



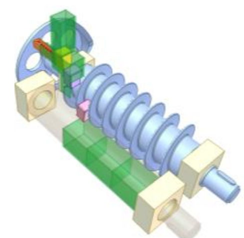
Part sorting 1
http://youtu.be/nKZX6EuvfiM
The balls are sorted on diameter. The first box receives smallest balls, the last box receives biggest ones.
The green conical shafts rotate in opposite direction with tendency to raise the balls.



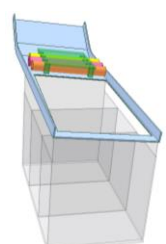
Part sorting 2
http://youtu.be/ZUM5xUA1GUQ
The rollers are sorted on diameter. The first box receives smallest rollers, the last box receives biggest ones.
The green conical shafts rotate in opposite direction with tendency to raise the rollers.



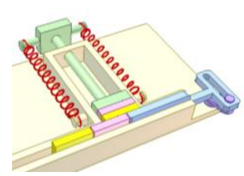
Part sorting 3
https://youtu.be/jYqbtcY2AHk
Axes of blue screw and glass shaft (both of cylindrical shape) are set in such a way to create a small angle.
They rotate in opposite direction with tendency to raise the parts of wegde shape (in yellow, pink and violet).
The parts are sorted on their width. The first green box receives smallest parts (in yellow), the last box receives biggest ones (in violet).



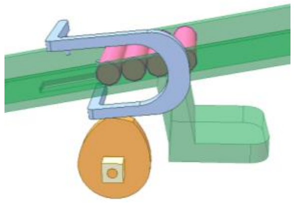
Part sorting 4
https://youtu.be/-UZfxI6amZM
The parts (in yellow, orange and pink) are sorted based on their lengths. They move on blue runway thanks to green belt (external teeth) of a belt drive (its two pulleys are not shown) and fall down into three boxes.
The first box receives shortest parts (in yellow), the last box receives longest ones (in pink).
The hole on the blue runway is of wedge shape.
The parts always contact the runway right wall due to the gravity.
This sorting way has not been verified in practice.



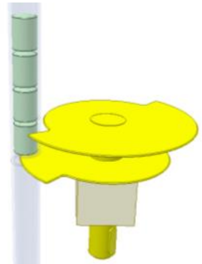
Feeder 1
https://youtu.be/9v4laaQrvQI
Workpieces (yellow and pink) are fed one by one.
Blue pushing bar is driven by a sine mechanism.



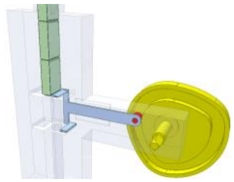
Part separation 1
http://youtu.be/qNftCnJGsvU
This device enables feeding parts one by one to the processing machine. The blue separator is driven by a cam.



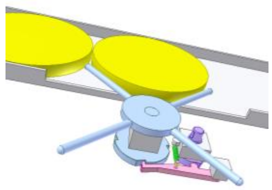
Part separation 2
https://youtu.be/lXx72T7qa10
This device enables feeding green parts one by one to the processing machine.



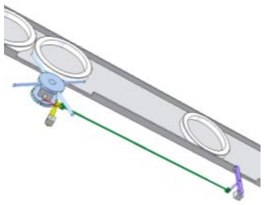
Part separation 3
https://youtu.be/DapbPNaIGVY
This device enables feeding green parts one by one to the processing machine. One part corresponds one cam revolution.



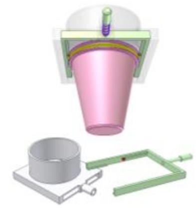
Part separation 4a
https://youtu.be/sYW_VbofOHU
Yellow parts tend to turn blue disk of 4 pins and to go down due to their weight.
Green spring forces pink pawl towards blue ratchet wheel to prevent the disk from rotation. Violet cam rotates continuously. In 1 revolution it pushes the pawl once to let the disk turn 90 deg. and one part go through.



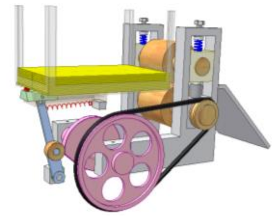
Part separation 4b
https://youtu.be/EJyhiQ52kWo
White parts tend to turn blue disk of 4 pins and to go down due to their weight.
Red spring forces pink pawl towards blue ratchet wheel to prevent the disk from rotation.
Once the part A overcomes the blue disk, the latter stops the next part B. The part A goes down and pushes violet lever to pull the pawl from the ratchet wheel to let the disk turn 90 deg. and the part B can go through.



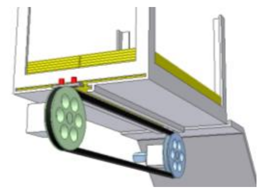
Paper cup dispenser
http://youtu.be/HWDkaef7mZE
Push and release the green slider to get cups one-at-a-time.
Red wedges on the green slider are for preventing the cup sticking.



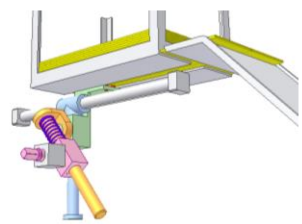
Card dispenser 1
https://youtu.be/0MAkTc2TJE4
Yellow cards in stack are dispensed one by one.
Input: pink cam shaft that gives green slider linear reciprocating motion via blue follower of a small roller. Red spring maintains contact of the roller and cam.
The lowest card is pushed by red pins (with the red spring force) of the slider into space between two orange rollers. The latters pull the card out by friction.
The clearance between the two rollers is set a little smaller than the card thickness.



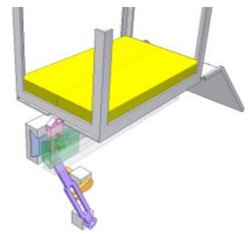
Card dispenser 5
https://youtu.be/QIkOO0tzhLY
Yellow cards in stack are dispensed one by one.
Input: blue pulley.
The lowest card is pushed by red pins fixed to the black belt.



Card dispenser 2
https://youtu.be/VxeP8Ayy1FQ
Yellow cards in stack are dispensed one by one.
Input: pink shaft that makes green slider translate following a rectangular trajectory. See also:
https://www.youtube.com/watch?v=Hbq9J_HJsTo
The lowest card is pushed by red pins.
Weakness: large velocity of the red pins at moment when they begin contact with the cards.

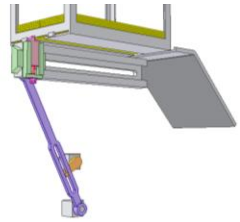


Card dispenser 3
https://youtu.be/99e2fo067sQ
Yellow cards in stack are dispensed one by one.
The lowest card is pushed by the pink slider.
Input: orange shaft that makes pink slider translate following a trapezoid trajectory. It is an application of mechanism shown at:
https://youtu.be/qtGZFapSnp8



Card dispenser 4

https://youtu.be/9KUnmu3SEck



Yellow cards in stack are dispensed one by one.
Input: orange shaft that gives green slider reciprocating linear motion.
The lowest card is pushed by pink vertical slider which has prismatic joint with green slider.
When the pink slider goes back, it descends a little due to the contact between its oblique plane with the lowest card. If there are only few cards in their stack, the pink slider pushes them up during back stroke.
Weakness: the pink slider may scratch lower surface of the card.

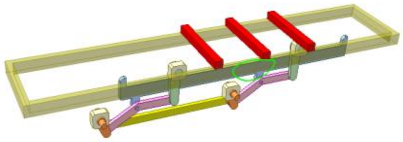
Grain material dispenser 1

https://youtu.be/OkMBfDeXxsQ

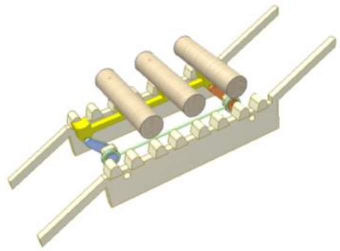
Input: yellow gear.
Material is supplied from the glass funnel to cylindrical containers on green disk. The container consists of green upper portion and yellow movable lower one. The material is released to the bag (not shown) on opposite side by opening container bottoms, which are controlled by pink face cam.
Rack drive of violet gear is used for setting the container capacity. Its positioning device after setting is not shown.
The video shows working process and container capacity adjusting (reducing) process.

27.3. Workpiece displacement

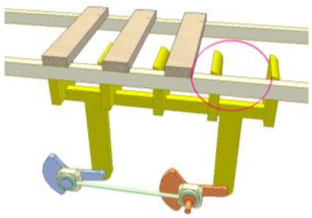
Transport mechanism 1
http://youtu.be/MeQOVyR9a-E
The blue transport has "egg-shape" motion that is used for moving the red works. It is the locus of a point on the pink 4-bar linkage's connecting rod. The yellow connecting rod used for uniting the orange cranks creates a parallelogram mechanism.



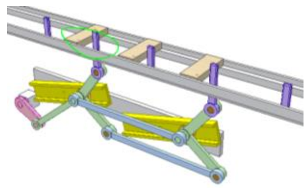
Parallel-link feeder 1
http://youtu.be/fK4sziwqOjo
A parallelogram mechanism is used for transporting the workpieces. The green bar helps the mechanism overcome its dead positions.



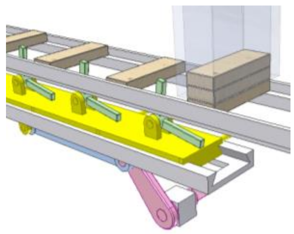
Parallel-link feeder 2
http://youtu.be/e3S_AldcqHI
A parallelogram mechanism is used for transporting the workpieces. The green bar helps the mechanism overcome its dead positions. The red circle is locus of a point on the yellow transporter



Transport mechanism 2
https://youtu.be/eH6tIjoNH0U
Input: pink crank.
Violet link pushes brown workpieces.
Green line is locus of a point on the violet link.
Green, blue and violet links create parallelogram mechanisms.
Yellow inclined runways make upper portion of the locus approximately horizontal.

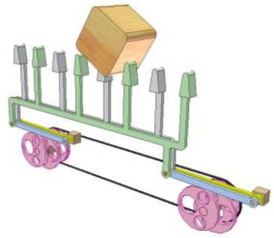


Transport mechanism 3
https://youtu.be/rO6A3DrJ71U
Input: pink crank.
Yellow slider carrying green pawls pushing brown workpieces.
The gravity tends to turn the pawls clockwise.



Transport mechanism 4

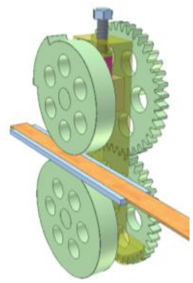
https://youtu.be/9oeiE2--Csc



Input: one of pink double cam (eccentric) shafts.
Black part represents a chain drive.
Green and blue links create a parallelogram mechanism.
Grey and yellow links create a parallelogram mechanism.
The parallelogram mechanisms are of the same size.
Orange work moves longitudinally and turns simultaneously.
Motion direction depends on initial position of the work, position of the parallelogram mechanisms and the input rotary direction.

Strip advancer 1

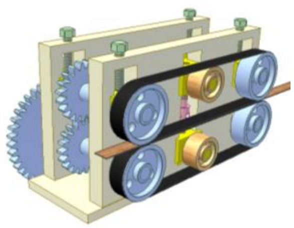
http://youtu.be/RaRESa4QS84



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.

Strip advancer 2

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.

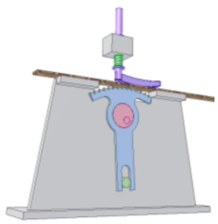
Mechanism for bar advancing 1

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.

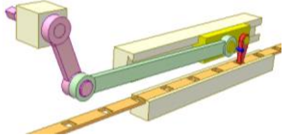
Fabric advancing mechanism

https://youtu.be/kyCaktO5Vic

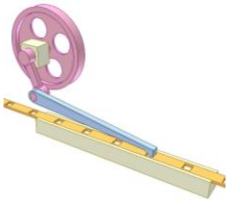


Input: pink eccentric.
It can be used for sewing machines.

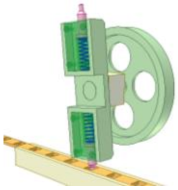
Mechanism for advancing perforated strip 1
http://youtu.be/UPkavC9eZPo
When moving to the right the red pawl is hold from rotation by the blue pin and pushes the orange strip to the right.



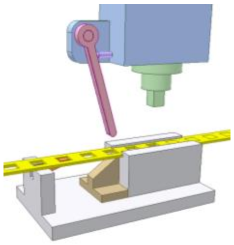
Mechanism for advancing perforated strip 2
http://youtu.be/-T14cCu-p7Y
When the pink crank rotates the blue long pawl pushes the orange strip to the right.



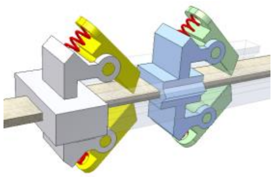
Mechanism for advancing perforated strip 3
http://youtu.be/MIBLtQEz4eE
The pink pins rotates together with the green double crank and can move along it, thus they can get into the strip holes and push it.



Mechanism for advancing perforated strip 4
https://youtu.be/SqOZT14RjCI
After being punched yellow strip is pulled to the left one pitch to prepare for the next punching.
Pink lever is forced towards violet stopper by a spring (not shown). When the lever goes down, brown cam pushes the pink lever to the left thus moves the strip.
Orange pawl prevents the strip from going back.

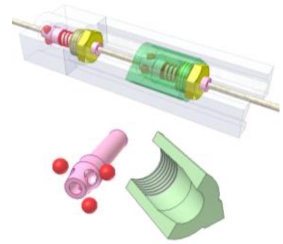


Strip advancer 2
https://youtu.be/OWIAdRdb5RI
It is a combination of two oneway linear clutches
The blue clutch (in the right) of two green knives linearly reciprocates (its motion source is not shown) and makes brown strip move to the right only.
The grey clutch (on the left) of two yellow knives is stationary and prevents the strip from moving to the left.
Red springs always force the knives towards the strip.



Wire advancer 1

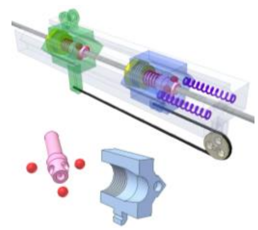
https://youtu.be/m5EQm5cDIYM



It is a combination of two oneway linear clutches
The green clutch (in the right) linearly reciprocates (its motion source is not shown) and makes the wire move to the right only.
The grey clutch (on the left) is stationary and prevents the wire from moving to the left.
Red springs always force the balls towards the wire.
Key factor:
tg(A/2) must be less than f1 and f2
A: vertex angle of the inner cone that are in contact with the balls.
f1, f2: coefficients of friction between the balls and the inner cones, between the balls and the wire respectively.
This mechanism was seen in paperclip making machines.

Wire advancer 2

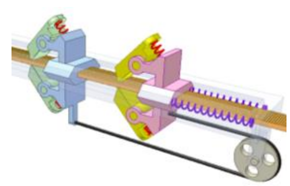
https://youtu.be/EJBVwq202X4



It is developed from mechanism "Wire advancer 1"
https://youtu.be/m5EQm5cDIYM
Green clutch (on the left) linearly reciprocates (its motion source is not shown). It makes the blue clutch move in opposite direction thanks to the cable drive.
Both clutches make grey wire move to the left when they move to the left. Thus the wire move continuously to the left.
So this mechanism converts reciprocating linear motion into continuous oneway one.
If the wire is the belt of a belt drive of two pulleys: linear reciprocating motion is converted into continuous oneway rotation of the pulleys.

Reciprocating linear motion into continuous oneway one

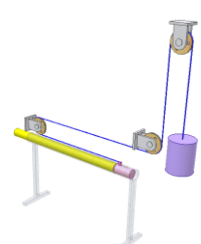
https://youtu.be/V-XMxIOIY0U



It is developed from mechanism "Strip advancer 2"
https://youtu.be/OWIAdRdb5RI
Blue clutch (on the left) linearly reciprocates (its motion source is not shown). It makes pink clutch (on the right) move in opposite direction thanks to the cable drive.
Both clutches make orange toothed bar move to the left when they move to the left. Thus the bar move continuously to the left.
So this mechanism converts reciprocating linear motion into continuous oneway one.
Red springs always force the knives (in green and yellow) towards the bar.
The mechanism can work even in case the bar is not toothed thanks to the friction.

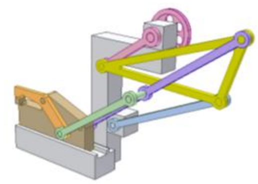
Mechanism for bar advancing 2

https://youtu.be/thevNijgu4g

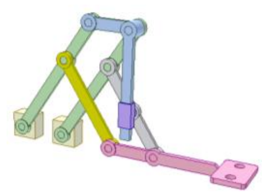


It is used in metal-cutting machine tools to create constant force (violet weight) for advancing works of bar shape (in yellow).

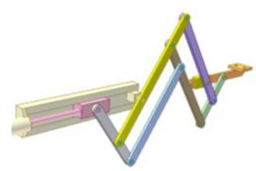
Feeding mechanism
https://youtu.be/g3-7bQWeL50
Input: pink crank.
Output: brown slider (bringing orange angular bar) that clamps a workpiece (not shown), moves it to the left, releases it there and returns to initial position.
The slider has two dwells at both ends of its stroke.
Length of pink crank: a
Length of blue bar: 2a
Length of violet bar: 0.42a + 2.58a
Dimenssion of yellow bar: 2.4a; 2a; 0,9a
Horizontal distance between two fixed bearing: 0.65a
Vertical distance between two fixed bearing: 1.47a



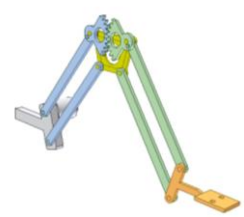
Linear manipulator 3
https://youtu.be/ivAQfdUT1ZM
Green and blue bars create a parallelogram mechanism.
Yellow, grey and pink bars create a parallelogram mechanism.
Green, grey and blue bars create an isosceles triangle.
Input: one of the green bars.
Pink bar (gripper support) moves linearly.



Linear manipulator 4
https://youtu.be/AKfC1RI9nsw
Blue, yellow, grey and brown bars create a parallelogram mechanism.
Brown, violet, yellow and green bars create a parallelogram mechanism.
Grey and yellow bars create an isosceles triangle.
Violet and green bars create an isosceles triangle.
Input: pink piston.
Orange bar (gripper support) moves linearly.

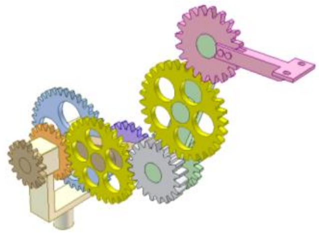


Linear manipulator 5
https://youtu.be/2ZY6liIIIHU
Blue bars and yellow plate create a parallelogram mechanism.
Green bars and yellow plate create a parallelogram mechanism.
Lengths of blue and green bars are equal.
Input: one of the blue bars.
Orange bar (gripper support) moves linearly.
This mechanism has the same working principle of the mechanism shown in
http://www.youtube.com/watch?v=4UpjmxQ3900



Planar manipulator 3

https://youtu.be/trtH7Id7HSA



Three inputs: brown, blue and orange gears.

Output: pink gripper support (fixed to pink gear) performing planar motion.

The video shows alternately:

1. Only brown assembly (gear and crank) turns, the pink support translates linearly along the line connecting centers of brown and pink gears.
2. Only blue gear turns, the pink support translates circularly around revolution joint of brown and green cranks.
3. Only orange gear turns, the pink support turns around its revolution joint with the green crank.
4. The three inputs turn back to their initial positions.

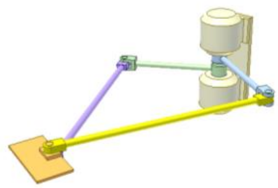
Transmission ratio between orange and pink gears: 1 (when brown and green cranks are kept immobile). Tooth numbers of orange, grey and pink gears are equal.

Transmission ratio between blue and green gears: 2 (when brown crank is kept immobile).

Advantage: actuators for the inputs are grounded (not shown).

Planar manipulator 1

http://youtu.be/CfKzBu-wDQo



The mechanism has two degrees of freedom.

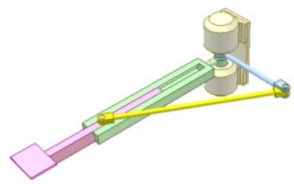
Orange plate performs planar motion.

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.

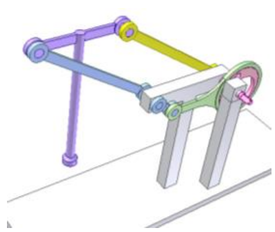
Features:

- 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.

Pick and place mechanism 1

https://youtu.be/AEXYQhxnQEM



Input: pink eccentric shaft rotating regularly.

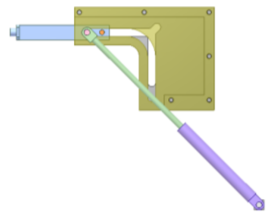
Violet conrod, blue and yellow rockers create a parallelogram mechanism.

The 4-bar mechanism (blue rocker, pink crank and green conrod) makes the parallelogram mechanism rockers oscillate near 180 deg.

The vacuum tool at the violet conrod end picks and places workpieces.

Pick and place mechanism 2

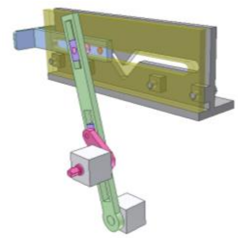
https://youtu.be/ukWPhCSAtrA



Green piston of violet cylinder makes pink pin of blue bar move along a slot on yellow plate. At the same time, orange pin of the blue bar moves along a slot on grey plate.
The mechanism can be used for the following scenario:
The blue bar moves down to pick a workpiece, moves up, turns left, moves to the left, releases the workpiece there and returns to initial position.

Pick and place mechanism 3

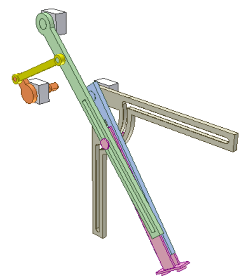
https://youtu.be/hOruQzm5v0Y



Input: pink crank rotating regularly makes pink pin of blue bar move along the slot of yellow plate. At the same time, orange pin of the blue bar moves along the slot of grey plate.
The mechanism can be used for the following scenario:
The blue bar moves to the left to pick a workpiece, moves to the right, turns 180 deg, moves to the right, releases the workpiece there and returns to initial position.

Pick and place mechanism 3a

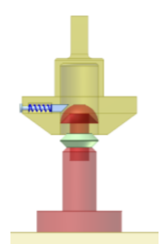
https://youtu.be/gZ6cNk7H-j8



Orange crank and yellow conrod makes green rocker oscillate.
Pink slider moves in dovetail slot of blue pivoted runway.
One pin of the slider moves in straight slot of the green rocker.
Other pin of the slider moves in slot of the brown stationary runway.
The curved portion of this slot is of an Archimedean curve. This portion can be replaced with a 45 deg. straight line but the simulation shows that the motion is not smooth.
The mechanism can be used for the following scenario:
The pink bar moves down to pick a workpiece, moves up, turns right 90 deg., moves to the right, releases the workpiece there and returns to initial position.

Grapple frees loads automatically 1

http://youtu.be/9lBBBTgeB-4

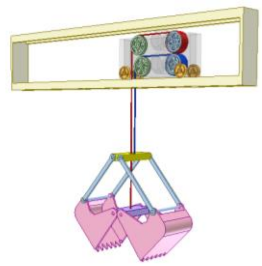


This self releasing mechanism is developed at Argone National Laboratory in Illnois, USA, to remove fuel rods from nuclear reactors. It is useful also where human intervention is hazardous or inefficient, such as lowering and releasing loads from helicopters.
There are 3 blue latches disposed around 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.

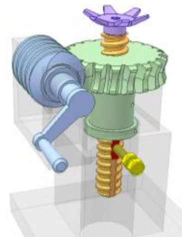
Crane bucket
http://youtu.be/ySAYljiSvKc



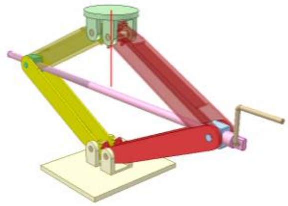
The blue cable is used for bucket moving up and down.
The red cable is used for bucket opening or closing.
Pay attention to the fact that the red cable must move when the bucket moves up and down to keep closing or opening state of the bucket.
Mechanism for moving the trolley is not shown.
To increase 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.

27.4. Lifting mechanisms

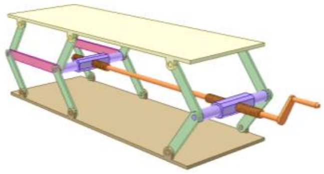
Nut-screw and worm jack
http://youtu.be/kp-dNLE8pMI
Combination of nut-screw and worm mechanisms gives the jack a high mechanical advantage.



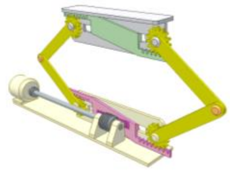
Gear and linkage mechanism 3c
http://youtu.be/78T8ufcyGjY
This jack is a combination of linkage, gear drive and nut screw one. The green disk moves along an absolutely straight line, its top plane is always horizontal.



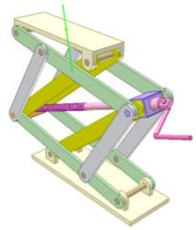
Double parallelogram mechanism 4
http://www.youtube.com/watch?v=nd8MWd1rz88
Raise or lower the table by turning the orange screw that has right hand and left hand threads with the same pitch.



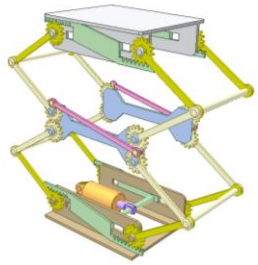
Lifting mechanism 1a
http://youtu.be/vCm01leXh30
A nut portion is created on the lower rack and receives motion from a motor via the grey screw.



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/vCm01leXh30
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.



Lifting ratchet rack mechanism
https://youtu.be/15YDH4bsFuE
Move green lever up down to lift the load (not shown) hung on the yellow hook.

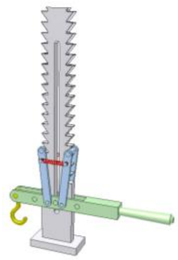
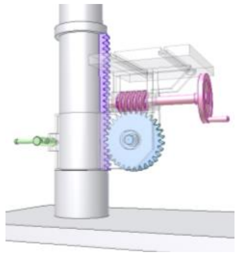
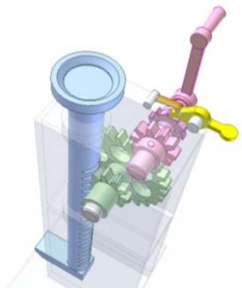


Table lifting mechanism for upright drilling machines 1
https://youtu.be/5QMYR2QcaD8
Turn pink shaft for raising or lowering the table.
The gravity can not move the table down because of the pink worm self-locking.
The table is turnable around the machine post.
Use green screw to fix the table after adjusting.
Blue gear is a helical one that engages with violet rack of oblique teeth.

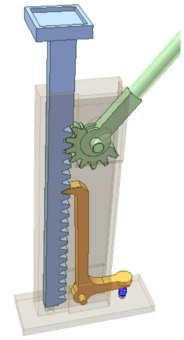


Rack-pinion jack 1
https://youtu.be/-RK_iuu6-Dg
Turn pink crank clockwise to move blue rack up.
Pink ratchet wheel and yellow pawl prevent the rack from falling down.
Push the pawl to bring it out of contact with the ratchet wheel and let the rack move down slowly by holding the crank.



Rack-pinion jack 2

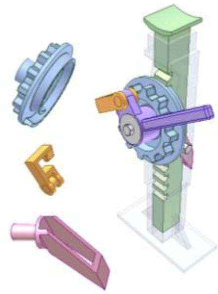
https://youtu.be/kkIAJJwb2GU



When turning green lever clockwise, its gear sector pushes the blue rack up.
When turning green lever counterclockwise, gear force pushes the gear sector out of contact with the rack so the latter is kept immobile thanks to orange pawl. Blue spring forces the pawl towards the rack.
Axle of the green gear sector moves in a curved groove.
To lower the rack keep the gear sector out of contact with the rack and turn the pawl clockwise.
This video was made based on US patent 964905, 1909.

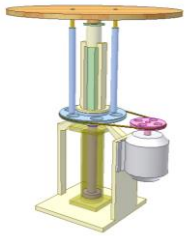
Archimedean spiral jack

https://youtu.be/QJblbD7pB6g



Blue ratchet wheel has Archimedean spiral rib that engages with green rack. Parameters of the spiral must be chosen to maintain the self-locking transmission.
Angular reciprocating motion of violet crank makes green rack move up or down, subject to angular position of orange pawl.
The video shows:
- The rack moves up.
- The rack moves down.
- The rack moves down fast (falls) when the pink axle is pulled out and the blue wheel does not contact the rack.

This video was made based on US patent 963206, 1910.



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

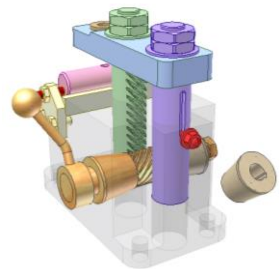
http://youtu.be/GhtIc-rLfbE

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.

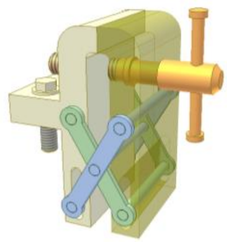
28. Clamping mechanisms

28.1. Mechanisms for clamping workpieces

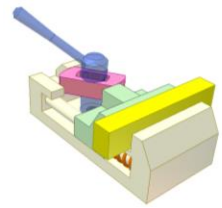
Drilling jig 1
http://youtu.be/rUDF2cTRwbk



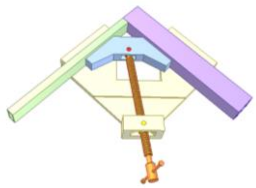
This jig is for drilling a hole on pink work.
The work is located thanks to a V-block and red stopper. The work is clamped by blue plate having brown drill bushing.
The orange gear shaft has two cones that are located in cone holes of the base. The cone angle is around 11 deg.
The shaft can move axially 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).



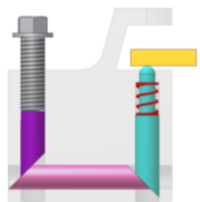
Nut-screw and bar mechanisms 4
http://youtu.be/IDvID90NT-A
Vice without runway.



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.

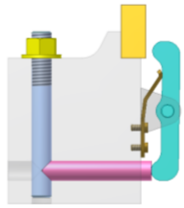


Angular Vice
http://youtu.be/Z2hujRfjv0U
Revolute joints for the red bush and the yellow nut of the screw enable clamping bars of different sizes.

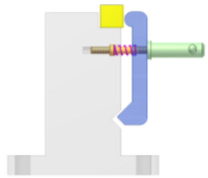


Wedge mechanism 11
http://youtu.be/Q9feu8j4OZ0
Double wedge mechanism.
Device for clamping workpiece (in orange).

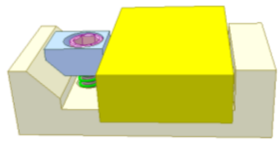
Wedge mechanism 12
http://youtu.be/QXXe8tCdO1g
Device for clamping workpiece (in orange).



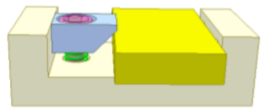
Wedge mechanism 25
http://youtu.be/LKYEhscIjHc
The wedge portion at lower end of the blue lever helps create vertical force component (friction) to press down the yellow workpiece (beside the horizontal one).



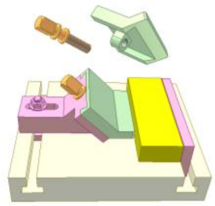
Wedge mechanism 26
http://youtu.be/fjdgmyK-WT8
The blue wedge helps create at the same time vertical (friction) and horizontal force components for clamping the workpiece.



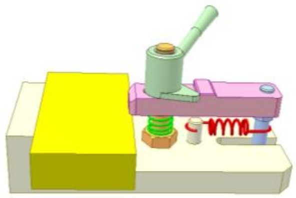
Wedge mechanism 27
http://youtu.be/pzj_AdvYZ7c
The blue wedge helps create at the same time vertical and horizontal force components for clamping the workpiece.



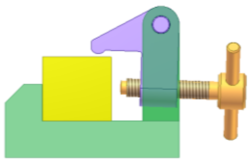
Machine tool fixture 5
http://youtu.be/H1utvZAUbUA
The green slider moves obliquely and creates at the same time vertical (friction) and horizontal force components for clamping the yellow workpiece.



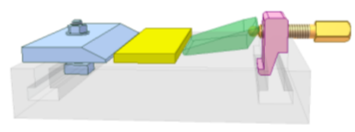
Machine tool fixture 1
http://youtu.be/F25gI0luThM
Turn the green cam-nut to tighten or release the workpiece and to clear space for its removing. Adjust positions of the green nut and the blue screw for adapting to the workpice's thickness.



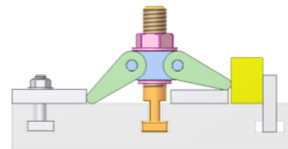
Machine tool fixture 2
http://youtu.be/geLVsyj88so
At the same time vertical and horizontal force components for clamping the yellow workpiece are created.



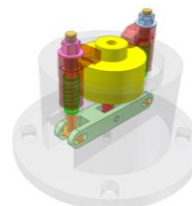
Machine tool fixture 3
http://youtu.be/JXT47Kpr8K0
It is used for clamping workpieces of small thickness.



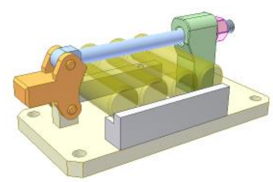
Machine tool fixture 4
http://youtu.be/BRkf-bi6_zM



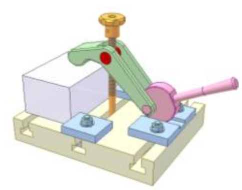
Machine tool fixture 9
http://youtu.be/B69K_33kapg
Turn the pink nut to clamp the yellow workpiece at two points.



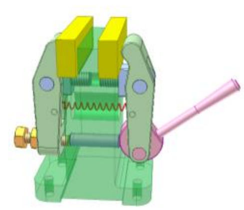
Machine tool fixture 17
http://youtu.be/C-EqQPTgXXQ
Multi-piece clamping.
Turn the pink nut to tighten or release the yellow cylindrical workpieces.



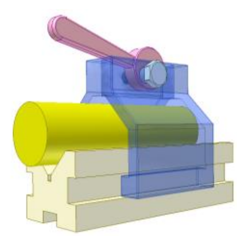
Machine tool fixture 6
http://youtu.be/RZIIRs0WWcw
The helix joint between the orange screw and the red pin-nut adapts the fixture to various thickness of workpieces.



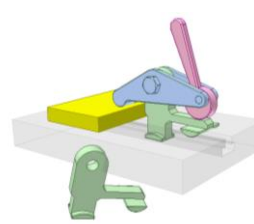
Machine tool fixture 10
http://youtu.be/Gq-Fe8A6ur0
The violet flowing pin enables firm clamping two yellow workpieces.



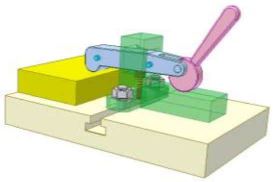
Machine tool fixture 12
http://youtu.be/rRajZ1XBzaY



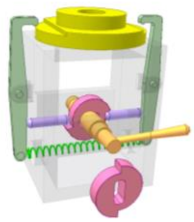
Machine tool fixture 13
http://youtu.be/H5W4arrmCPE
The green column is inserted into the table's T-slot. Its fixing to the table happens at the same time with the workpiece clamping.



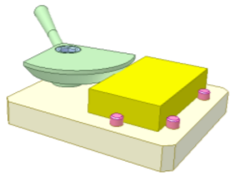
Machine tool fixture 14
http://youtu.be/ip7SyiZd7h4
The blue lever can move back to clear space for removing the yellow workpiece. The contact surfaces of the blue lever and the workpiece must be rough enough for the mechanism's good performance.



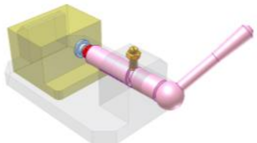
Machine tool fixture 8
http://youtu.be/wNckTzjwn4E
The pink double eccentric cam has a prismatic joint with the orange lever shaft. It enables firm clamping the yellow workpiece at two points.



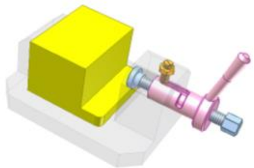
Machine tool fixture 11
http://youtu.be/_cPwqgrKJ-E
The green eccentric with a chamfer creates 3 force components including the down one to press the yellow workpiece toward locating elements.



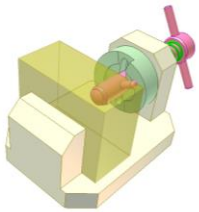
Machine tool fixture 15
http://youtu.be/5CWgcpLynnM
The pink lever can move back to clear space for removing the yellow workpiece. The clamping head's position can be adjusted by the red screw.



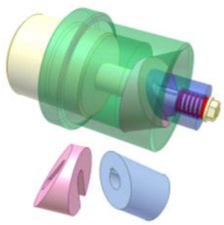
Machine tool fixture 16
http://youtu.be/_d2u8TEBMug
Use the blue screw to clamp or release the yellow worpiece.
Use the pink lever to move the pink nut for clearing space for removing the workpiece.



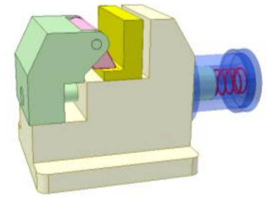
Machine tool fixture 7
http://youtu.be/L3Z5D3Ntor8
The green face cam is fixed. Push and turn the pink pin to tighten the workpiece. Turn the pink pin to release the workpiece. The cam slot and spring pushes back the pink pin quickly to clear space for removing the workpiece.



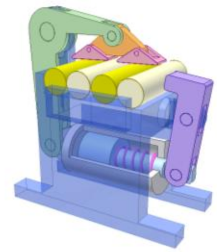
Wedge mechanism 16
http://youtu.be/oXIYX4AwXT0
Double wedge mechanism.
The green input slider and the blue output one move in opposite directions. The pink wedge moves perpendicularly to them
This mechanism can be applied for rotating clamping device.



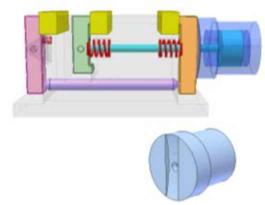
Machine tool fixture 19
http://youtu.be/0LukQCbXexY
Adding a pink bar that has a revolution joint with the green movable jaw enables clamping the workpiece from top side and left side simultaneously.
The movable jaw is fixed to the piston of a hydraulic cylinder.



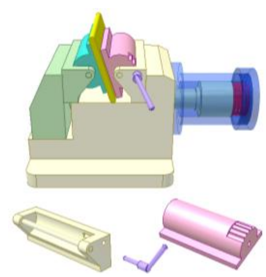
Machine tool fixture 20
http://youtu.be/U9fi2DJrIZY
Floating cylinder enables clamping 4 workpieces from top side and right side simultaneously.



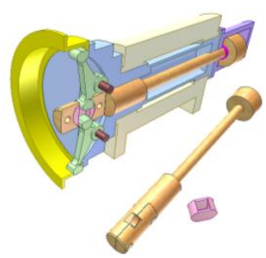
Machine tool fixture 21
http://youtu.be/fzz7-g6Qr1o
Floating cylinder enables clamping 3 workpieces simultaneously.
To clamp: Pressure fluid enters left space of the piston.
To unclamp: Pressure fluid enters right space of the piston.
Each workpiece has its vertical datum plane positioned directly to the base (to get better machining accuracy).
The orange bar has a revolution joint with the blue cylinder.



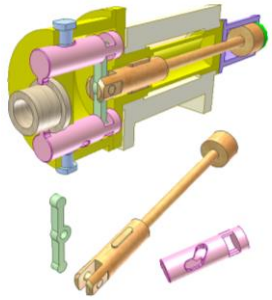
Machine tool fixture 22
http://youtu.be/9f1NolQBM94
A way for clamping a workpiece at an angle or clamping workpiece of non parallel planes.
Pink bar has revolution joint with the base. Its tilting angle is fixed by violet pin.



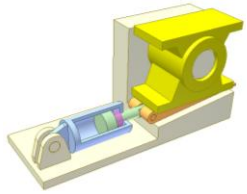
Machine tool fixture 23
http://youtu.be/YURD5Jf34EQ
Clamping a workpiece (in yellow) for lathes by a hydraulic cylinder (in violet).
In unclamping position green levers turn back and give space for mounting or removing the workpiece.
Revolution joint between pink cushion and orange piston is needed to compensate dimension error of the workpiece.
Most parts of the mechanism are cut off half for easy understanding.



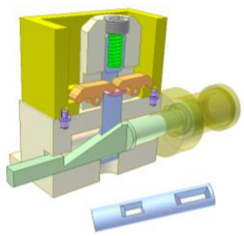
Machine tool fixture 24
http://youtu.be/UX5pEuTJGrY
Clamping a workpiece (in brown) for lathes by a hydraulic cylinder (in violet).
In unclamping position pink pins turn a little (thanks its helical groove) and give space for mounting or removing the workpiece.
Revolution joint between green arm and orange piston is needed to compensate dimension error of the workpiece.
Most parts of the mechanism are cut off half for easy understanding.



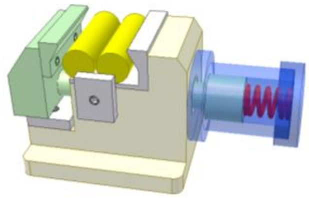
Machine tool fixture 25
http://youtu.be/ksDw--3vuhc
Clamping a workpiece (in yellow) by a hydraulic cylinder (in blue).
Orange wedge having revolution joint with green piston slides on the base. The cylinder has revolution joint with the base.



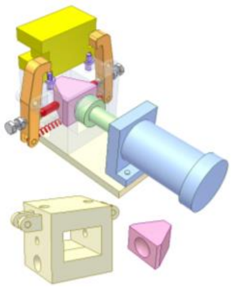
Machine tool fixture 26
http://youtu.be/OxDQFP5uAYo
Clamping a workpiece by a hydraulic cylinder through a wedge and two orange levers.
In unclamping position orange levers turn back and give space for mounting or removing the workpiece.
Revolution joint between pink cushion and blue vertical shaft is 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.

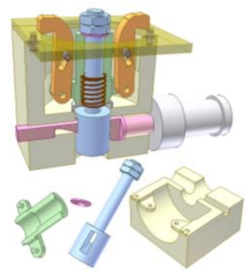


Machine tool fixture 28
http://youtu.be/nwEsGuGf6wQ
Clamping a workpiece (in yellow, cut off half for easy understanding) by a hydraulic cylinder through a wedge and two orange levers. Two violet pins are for positioning the workpiece.
In unclamping position orange levers turn back and give space for mounting or removing the workpiece.
Spherical joint between the wegde and the green piston rod is needed to compensate dimension error of the workpiece.



Machine tool fixture 29

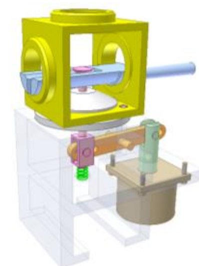
http://youtu.be/VPxWWgFwRQo



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

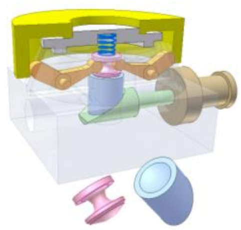
http://youtu.be/xbQECJ3byeg



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

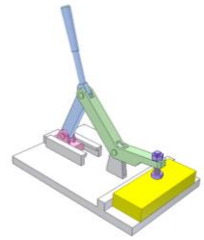
http://youtu.be/QtFkUqAtxr0



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.

Machine tool fixture 32

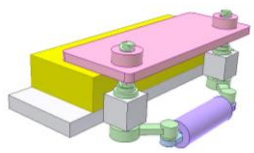
https://youtu.be/yrA0PYOvISw



Turn blue lever to clamp or unclamp yellow workpiece.
At clamping position blue bar is nearly perpendicular to sliding line of pink slider so the mechanism gets into self-locking state. Force applied to the workpiece can not loosen it.

Machine tool fixture 33

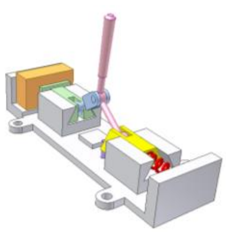
https://youtu.be/X9CdVrwSSGo



Violet cylinder controls the clamping of yellow workpiece.
Threads of two green cranks are opposite-handed.
It is suitable for long workpieces.

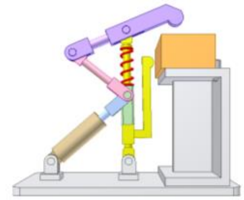
Machine tool fixture 34

https://youtu.be/W_H5g4ve6Aw

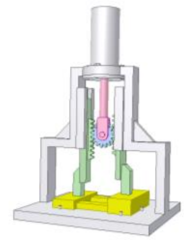


Pink lever controls the clamping of orange workpiece.
Red spring creates clamping force.

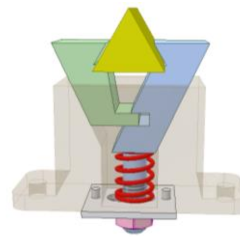
Machine tool fixture 35
https://youtu.be/2aVcRENbAjc
Brown cylinder controls the clamping of orange workpiece in both horizontal and vertical directions.



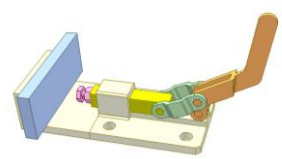
Machine tool fixture 36
https://youtu.be/ATsA3ra2mzg
Grey cylinder of pink piston controls the clamping of yellow workpiece at two points of different levels thanks to differential rack gear drive.



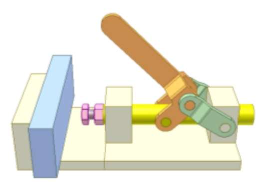
Wedge fixture 1
https://youtu.be/BrBVOdpJw5E
Turn pink nut for clamping or releasing yellow bar of equilateral triangle section.



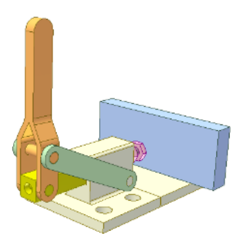
Toggle clamp 1b
http://youtu.be/lpjHsMKISB0
Toogle clamp using slider-crank mechanism.
Green conrod and orange crank come into toggle by an extension of each other.
The clamping force is applied to the crank.



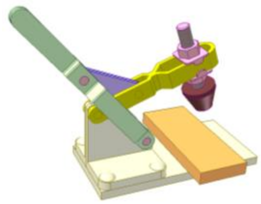
Toggle clamp 1c
http://youtu.be/Pjdb0CAj4Bc
Toogle clamp using slider-crank mechanism.
Green bar and orange conrod come into toggle by an extension of each other.
The clamping force is applied to the conrod.



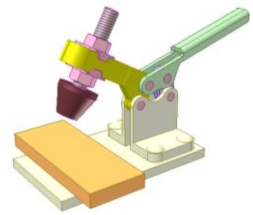
Toggle clamp 1d
http://youtu.be/cv8sqEfxCSs
Toogle clamp using slider-crank mechanism.
Green bar and orange conrod come into toggle by lining up on top of each other.
The clamping force is applied to the conrod.



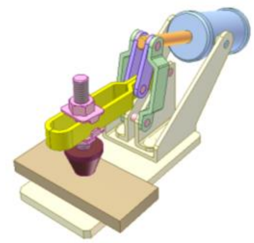
Toggle clamp 2a
http://youtu.be/Nmp_U-tkoH8
Toogle clamp using four bar linkage.
Green lever and violet conrod come into toggle by lining up on top of each other.
The clamping force is applied to the lever.



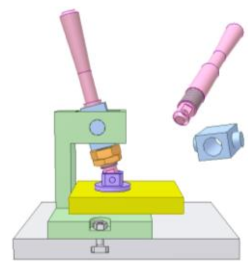
Toggle clamp 2b
http://youtu.be/lrL2_5tj1IE
Toogle clamp using four bar linkage.
Green conrod and violet lever come into toggle by an extension of each other.
The clamping force is applied to the conrod.



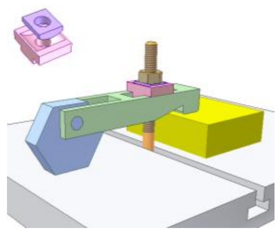
Toggle clamp 2d
http://youtu.be/ZtiW90wThO4
Toogle clamp using four bar linkage.
Violet conrod and green lever come into toggle by lining up on top of each other.
The clamping force of an air cylinder is applied to revolution joint between the violet conrod and the green lever.



Toggle clamp 3
https://youtu.be/qtH0nwc8zgU
Pink lever can slide in blue pivot bush (cylindrical or prizmatic joint).
Turn the lever clockwise, the lever and violet clamping head come into toggle when the upper orange nut contacts lower face of the blue bush to create large clamping force for yellow object.
Adjust orange nuts to adapt various height of the object.



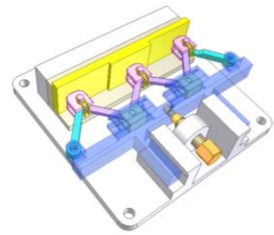
Machine tool fixture 38
https://youtu.be/ZzweJNcfR0c
The fixture can adapt to various heights of the clamped object (in yellow) thanks to various angular positions between the blue hexagon and the green clamp bar.
To change the position: release the brown nut, move up the clamp bar, turn the hexagon and tighten the nut.
Pink and violet parts ensure good contact between the nut and the possibly slanting clamp bar.
The motion of the yellow object implies the change of its height.



Machine tool fixture 42

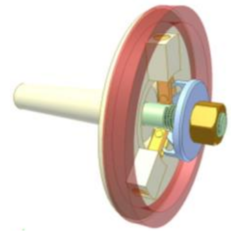
https://youtu.be/I5idxsmxhrk

Turn orange screw to clamp or release the yellow workpiece.
Green sliders have prismatic joints with blue slider.
It is applied for clamping a long plate of unhomogeneous thickness
More of pink clamping heads are possible.
Number of pink clamp heads = number of green sliders + 1
It can be used for multi-workpiece clamping fixture.



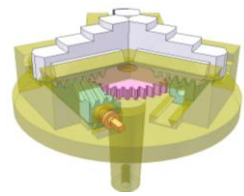
28.2. Mechanisms for clamping and centering workpieces

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.

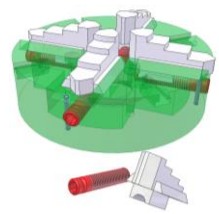


Three-jaw self-centering chuck 1
http://youtu.be/0ERIZeZhckw
Combination of bevel gear drive and spiral rack (scroll gear) mechanism.
Turn any one of the three blue bevel pinions for moving the jaws.

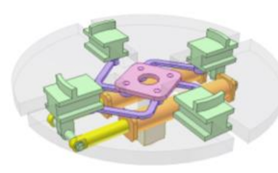
Three-jaw self-centering chuck 2
http://youtu.be/lPAfyZ5jCuA
Combination of screw-nut, gear-rack and rack-rack mechanisms.
Turn the sole orange screw for moving the jaws.



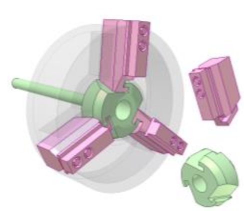
Four-jaw independent chuck 1
http://youtu.be/U_U0Cxrd_KE
Turn each red screw for moving the corresponsive jaw.



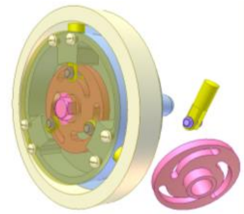
Four-jaw self-centering chuck 1
http://youtu.be/SEgw6hcujwk
An application of crank slider mechanism.
The pistons are connected to a green slider and the cylinders to opposite one. The cylinders can be connected to the rotary table in order to reduce pistons' displacement.
This chuck is used in tire mounting equipments.



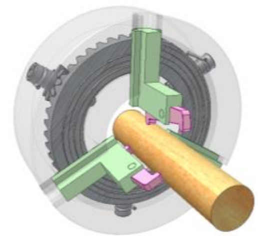
Three-jaw self-centering chuck 3
http://youtu.be/xUUeWQoY4CI
An application of the wedge mechanism.
The green rod is connected to a pneumatic cylinder (not shown) to get reciprocating motion.



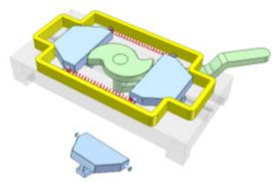
Three-jaw self-centering chuck 4
http://youtu.be/zzcj0-C6Njo
Turn the pink cam of three eccentric slots for clamping or releasing the popcorn workpiece. This chuck should be used only for operation of light cutting force.



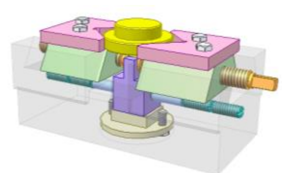
Self-centering chuck of six clamping points
https://youtu.be/nbaqSKBOkLQ
It is developed from the three-jaw self-centering chuck shown at
http://youtu.be/0ERIZeZhckw
A jaw lever (in pink) is pivoted on each green slider. Thus, the orange work (a stepped shaft) can be well centered and firmly clamped through six points.
See real chucks:
https://youtu.be/Gic4pCI9GuU



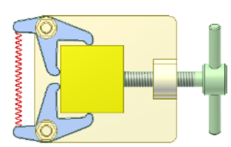
Self-centering fixture 1a
http://youtu.be/VQLBovXF9Uw
The green double eccentrics and two blue wedge-sliders center the yellow workpiece along transversal and longitudinal direction.



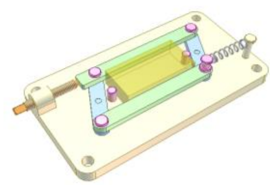
Self-centering fixture 1b
http://youtu.be/0kFUfX1m5aI
The orange screw having threads of right and left hand move the V blocks to center the yellow workpiece along transversal and longitudinal direction.
The blue pins anf screws (in lower part of the base) are used for adjusting the center position along longitudinal direction.



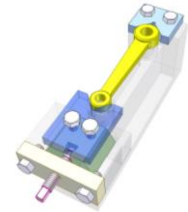
Self-centering fixture 2b
http://youtu.be/8UrBjWE96vc
Two symmetric V-shaped levers center the yellow workpiece along longitudinal direction.



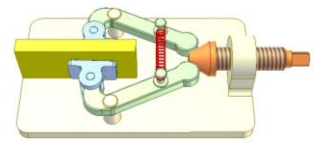
Self-centering fixture 2c
http://youtu.be/GzweOeQAiqM
The green connecting rods of a parrallelogram mechanism center the yellow workpiece along longitudinal direction.



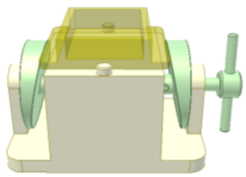
Self-centering fixture 2d
http://youtu.be/FpdSiDXOOCA
The V blocks (one is fixed, the other is movable) center the yellow workpiece along longitudinal direction.



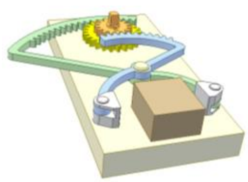
Translating cam mechanism 5
http://youtu.be/w8Hk3E5gfj0
Device for clamping workpiece (in yellow).
Wedge is the orange screw of cone head that has helical motion.



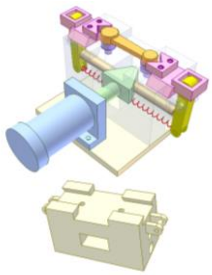
Self-centering fixture 2a
http://youtu.be/4tM1zNKiQPI
Two symmetric face cams center the yellow workpiece along longitudinal direction.



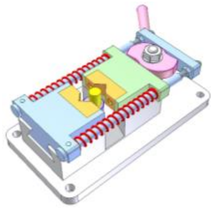
Self-centering fixture 4
http://youtu.be/lT49olsv-EU
Turn the block of orange and yellow gears to clamp brown work.
Two grey pads center the work along its longitudinal direction.
Condition for centering:
R1/R3 = R2/R4
(angle speeds of blue and green gears are equal)
Relation of gear pitch radia:
R4 = R1 + R2 + R3
R1, R2, R3 and R4 are pitch radius of the orange, yellow, blue and green gear respectively.



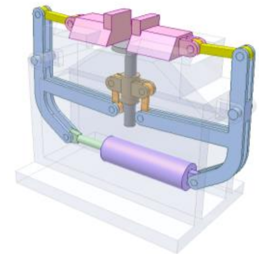
Self-centering fixture 5
http://youtu.be/L0BbQPfpMd0
Clamping a workpiece (in orange) by hydraulic cylinder through green wedge on the piston, two pins and two yellow levers.
Pink V blocks center the workpiece along its longitudinal direction.



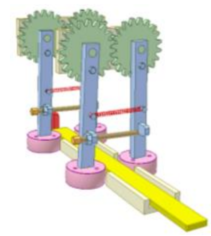
Self-centering fixture 1c
https://youtu.be/skZhoweAVqo
Pink cam lever controls the clamping process.
Red springs maintain the contact between the cam and fllowers.
It can be also used for a die of stamping undercut workpieces (soft metal).



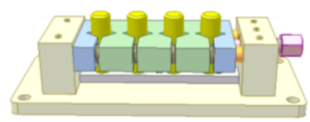
Self-centering fixture 6
https://youtu.be/42kmmozmp5U
Floating cylinder moves two pink jaws synchonically.
The slider-crank mechanisms of orange conrods bear inconsiderable load and ensure that displacements of the two jaws are equal.



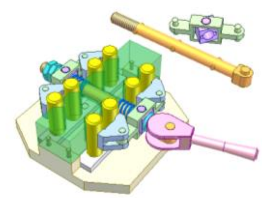
Self-centering fixture 3a
http://youtu.be/GF1Lw16lwco
The yellow running workpiece is centered along longitudinal direction when contacting with all the two pink roller couples. The fixture is used in a bamboo slitting machine. The red knife is stationary.



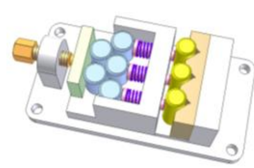
Self-centering fixture 4a
http://youtu.be/Oa5_0RAEbC0
Multi-piece clamping.
The V-blocks center the yellow worpieces along longitudinal direction. There are compression springs between the V-blocks.



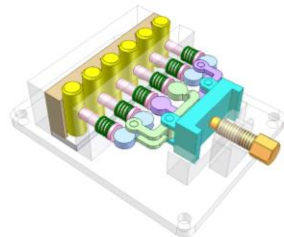
Machine tool fixture 18
http://youtu.be/HRxKJkVraLc
Multi-piece clamping.
Turn the pink lever to tighten or release the yellow cylindrical workpieces.



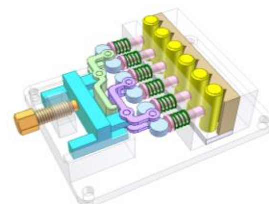
Machine tool fixture 39
https://youtu.be/H5d_S87Cx9k
Multi-piece clamping.
Turn orange screw to tighten or release yellow cylindrical workpieces.
This can be developed for clamping more than 3 workpieces.



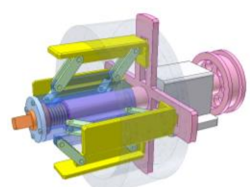
Machine tool fixture 40
https://youtu.be/5_mDB-g_0iE
Turn orange screw to clamp or release the yellow workpieces.
It is applied for clamping six cylindrical workpieces or a long plate of unhomogeneous thickness
Distance between two adjacent workpieces is 2a.
Length of the violet bar: 5a/3 + 10a/3
Length of the green bar: 5a/3 + 10a/3
Distance between revolution joints of the cyan slider: 14a/3
Such dimensions make clamping forces rather equal.



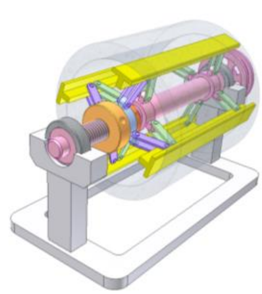
Machine tool fixture 41
https://youtu.be/YUYdnTIrlaE
Turn orange screw to clamp or release the yellow workpieces.
It is applied for clamping six cylindrical workpieces or a long plate of unhomogeneous thickness
Distance between two adjacent workpieces is 2a.
Length of the violet bar: a + 3a
Length of the green bar: 2a + 4a
Distance between revolution joints of the cyan slider: 5a
Such dimensions make clamping forces rather equal.



Self-centering uncoiler 1
https://youtu.be/XhWc4V4Tlc8
Turn orange screw to move yellow bars radially for centering a coil (in glass). Then the coil is turned for uncoiling. A brake drum on the pink shaft end is for creating uncoil tension.
Here are applied ellipse mechanisms (yellow bars and blue hub, green conrods) to convert linear motion of the blue hub into linear motion of the yellow bars.
Parallelogram mechanisms are used for supporting yellow bars.
This uncoiler is for coils of small width.



Self-centering uncoiler 2
https://youtu.be/XDHO9JHlPzI
Turn orange nut to move yellow bars radially for centering a coil (in glass). Then the coil is turned for uncoiling. A brake drum on the pink shaft end is for creating uncoil tension.
Here is applied slider crank mechanism (green cranks, violet conrods and blue hub) to convert linear motion of the blue hub into rotary motion of the green cranks.
Parallelogram mechanisms are used for keeping yellow bars parallel to the pink shaft axis.
This uncoiler is for coils of large width.

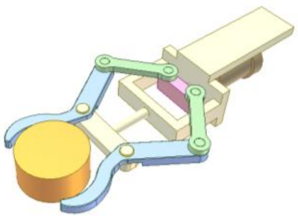


Machine tool fixture 37
https://youtu.be/sxOnMjMZFdM
An application of a slider crank mechanism: blue crank, green conrods, sliders: green pins sliding in slots of the base.
There is eccentric on each conrod. When turning the crank, these eccentrics center and clamp orange workpiece.

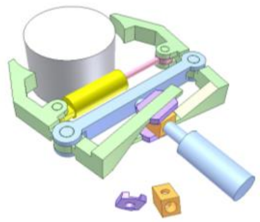
28.3. Gripper

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.

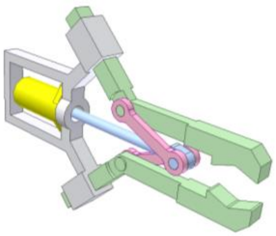
Robot gripper 2
http://youtu.be/YGlT0LtRzMw
A hydraulic or pneumatic cylinder opens and closes the jaws, permitting it to grasp and release objects.
Blue jaw, green conrod and pink slider create a slider crank mechanism.



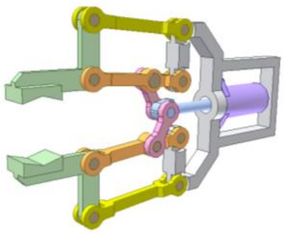
Robot gripper 3
http://youtu.be/oCVqapAj-7s
A hydraulic or pneumatic cylinder opens and closes the jaws, permitting it to grasp and release large objects.
Green jaw, violet swivel and orange slider create a tangent mechanism. There are revolution joints between violet swivels and orange slider.



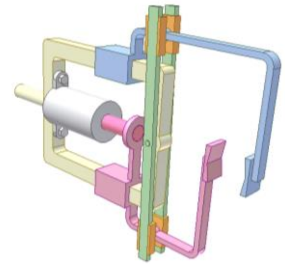
Robot gripper 4
http://youtu.be/CHyhQXoDI3I
A yellow cylinder opens and closes the jaws, permitting them to grasp and release objects.
Green slider, blue piston and pink conrod create an ellipse mechanism.



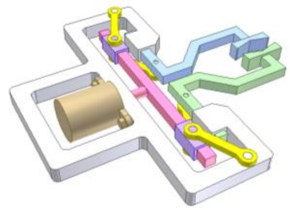
Robot gripper 5
http://youtu.be/95byfyaT3PQ
A violet cylinder opens and closes the jaws, permitting them to grasp and release objects.
Orange bar, blue piston and pink conrod create a slider crank mechanism.
Orange bar, yellow bar and green jaw create a parallelogram mechanism.



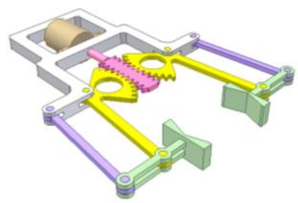
Robot gripper 6
https://youtu.be/Bpjr1slYxNQ
A grey cylinder opens and closes the jaws, permitting them to grasp and release objects.
Pink (or blue) slider, orange coulisse and green lever create a tangent mechanism.



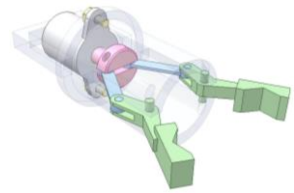
Robot gripper 7
https://youtu.be/pR_d4NTFNn4
A brown cylinder opens and closes the jaws, permitting them to grasp and release objects.
Pink slider, violet coulisse and yellow bar create a tangent mechanism.
Blue (or green) slider and two yellow bars create a slider crank mechanism.



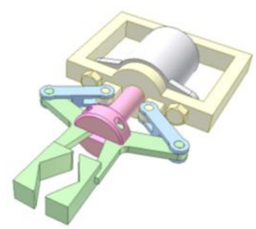
Robot gripper 8
https://youtu.be/ozP-yVZpv7s
A brown cylinder opens and closes the jaws, permitting them to grasp and release objects.
Yellow, violet and green links create a parallelogram mechanism.



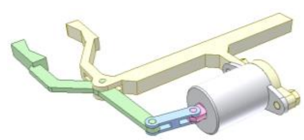
Robot gripper 9
https://youtu.be/shUN5VXV8mE
A grey cylinder opens and closes the jaws, permitting them to grasp and release objects.
Pink, blue and green links create a slider crank mechanism.



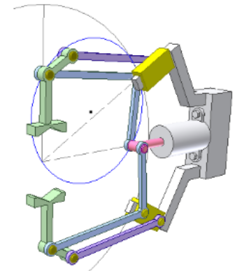
Robot gripper 10
https://youtu.be/pMAtl6MijSM
A grey cylinder opens and closes the jaws, permitting them to grasp and release objects.
Pink, blue and green links create a slider crank mechanism.



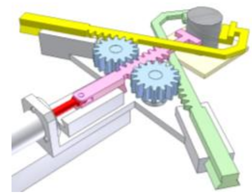
Robot gripper 11
https://youtu.be/Ggc24k6wErY
A grey cylinder opens and closes the green jaw to grasp and release objects.
Pink, blue and green links create a slider crank mechanism.



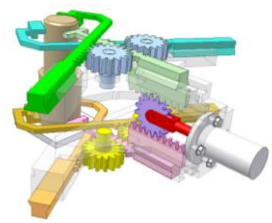
Robot gripper 12
https://youtu.be/YB4oSaCL0CY
A grey cylinder opens and closes the jaws, permitting them to grasp and release objects of large size range.
Yellow, violet, blue and green links create a parallelogram mechanism.
Green jaws linearly translate thanks to using mechanism of Cardano circles shown in “Straight line drawing mechanism 1b”:
https://youtu.be/aySMU4vkp-s



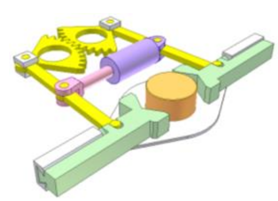
Rack self-centering fixture 1
https://youtu.be/03OCegpTRJY
Grey cylinder of red piston controls the fixture via gear rack drives.
Clamping planes of the three racks create a variable uniform triagular prism, center of its base is stationary.



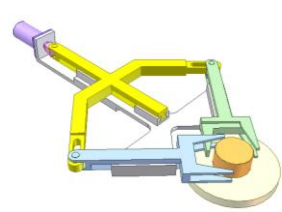
Rack self-centering fixture 2
https://youtu.be/5y70qOh7W1Y
Grey cylinder of red piston controls the fixture via gear rack drives.
Thanks to a differential rack gear drive (violet gear, pink and green racks) the clamping stepped shaft (in brown) can be realized at two different diameters.
It is a combination of two mechanisms shown in:
https://youtu.be/03OCegpTRJY
and
https://youtu.be/ATsA3ra2mzg
The mechanism has found application for manipulators.



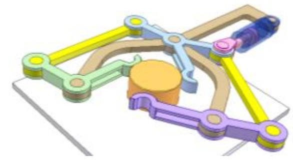
Gear self-centering gripper 1
https://youtu.be/yxnk1N3vARw
Violet cylinder of pink piston controls the gripper via yellow gear drive that moves two green jaws synchronically.



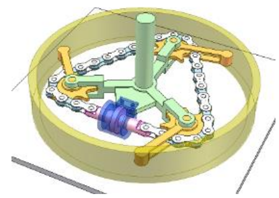
Wedge self-centering gripper 1
https://youtu.be/MCyK4QyVn5U
Violet cylinder of pink piston controls the gripper via yellow bar drive that moves two green and blue jaws synchronically. In fact the yellow bar and blue and green sliders create wedge mechanisms.



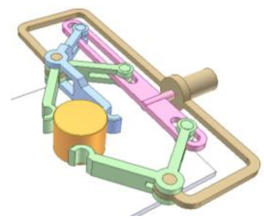
Bar self-centering gripper 1
https://youtu.be/wvwQ82y3vQs
Three jaws (blue, green and violet) pivoted on brown frame center and clamp orange work under action of blue cylinder. Centers of the jaw revolution joints with the frame are at vertices of an equilateral triangle. The center of the work is at the center of this triangle when clamped.
There are two parallelogram mechanisms of yellow conrods.



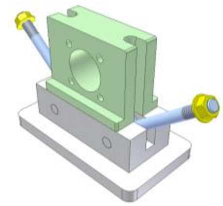
Chain self-centering gripper 1
https://youtu.be/uagWFJLj2EM
Blue fixed cylinder of pink piston controls the gripper via chain drive. Yellow work is clamped at its inner surface by three orange levers fixed to the sprockets.



Bar gripper 1
https://youtu.be/JEI1X0y-II4
Brown cylinder of pink piston controls the gripper.
Three jaws move synchronically to grip or release orange work thanks sine mechanisms (common pink slider and three levers).
When the orange cylindrical work is gripped, its axis is in vertical plane that contains the piston axis.

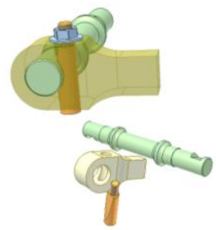


28.4. Mechanisms for clamping other objects



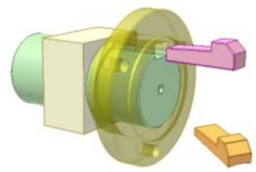
Quick release bearing
https://youtu.be/LN9Wtq5VGvU
Pivot bolts and slots on the bearing enable its quick release.

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.

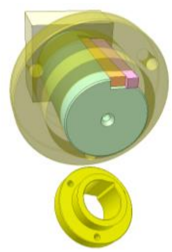


Wedge mechanism 20
http://youtu.be/fO-NIQ-YFmA
Bicycle bottom axle and crank joint.
The orange cotter pin plays role of a wedge. The prestress is added by rotating the blue nut.

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.

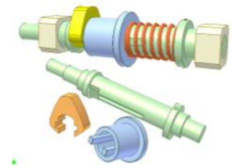


Wedge mechanism 22
http://youtu.be/6N0YcXU_0vc
Sunk taper key in strained joint.
The slopes on the pink key and on the yellow disk slot are equal.
Possible case for the taper key (in orange): no slot on the shaft and bottom surface of the taper key is cylindrical.

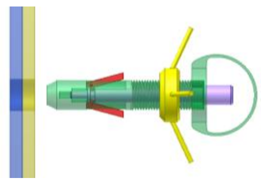


Wedge mechanism 23
http://youtu.be/qlPg8I8ZB1U
Tangential taper key in strained joint.
The slopes on two pink keys are equal.
If the green shaft is driving, the rotation direction must be clockwise.

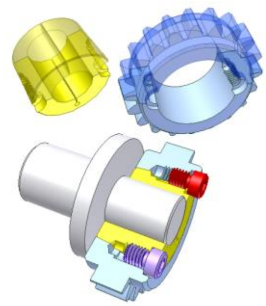
Quick changeable cam
http://youtu.be/TOi_2Xla5Xc
Move the blue sliding bush to free the cam for its change.



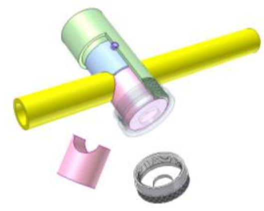
Fastener 1
http://youtu.be/wHIPzLIxdfI
Push the violet pin to retract the red wings.
Rotate the yellow nut to tighten the plates.
Pull the green ring to remove the fastener.
This NASA's invention is used for fasten things to a plate, back surface of which is inaccessible.



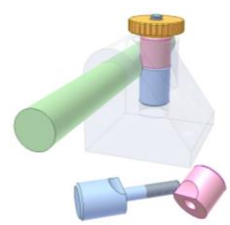
Fastener 5
http://youtu.be/8MnLVIU4Vuo
A way to fix a gear on a shaft thanks to a flexible split bush and two screws.
The bush has a tapered outer diameter.
The gear has a tapered inner diameter.
Only one hole among the two holes in the bush or in the gear is tapped.
Split tapped hole in the bush align 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.



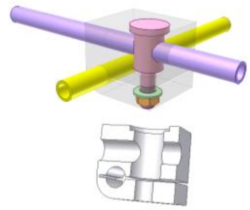
Fastener 2
http://youtu.be/6dSCQNG35Nc
Green tube and blue fixed jaw are fixed together.
Tight or release grey nut for clamping or repositioning yellow tube.
The green tube is cut off for easy understanding.



Fastener 3
http://youtu.be/ypf7OvwAJ8I
Tight or release orange nut for clamping or repositioning green bar.

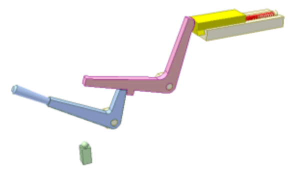


Fastener 4
http://youtu.be/abj9X8kSYP0



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.

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.

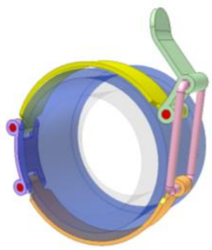
Table clamp
http://youtu.be/uzqd1rKp5qQ

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

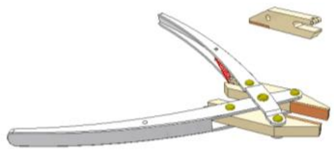
Toogle clamp using slider-crank mechanism.
Orange lever: crank. Green link: connecting rod. Yellow plate: slider.
The green link and the orange crank come into toggle by lining up on top of each other to hold the yellow plate firmly.
Red arrow represents resisting force.
The clamping force is applied to the crank.

Toggle clamp 2c
http://youtu.be/k9tMxQfo2zo

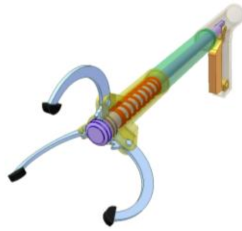


Toogle clamp using four bar linkage.
Green conrod and pink lever come into toggle by lining up on top of each other.
The clamping force is applied to the conrod.

Parallel jaw pliers 1
http://youtu.be/TbdkXOo0z94
Two back pins slide in the slots.
Conditions to get parallel clamping surfaces of the jaws:
1. For each jaw, distances to clamping surface from center line of the slot and from center of the hole are equal.
2. Center distances of the holes on the handle are equal.
Red springs tend to move the jaws apart from each other.

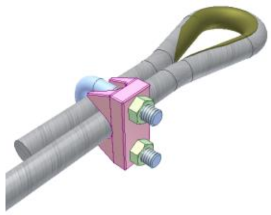


Grabber 1
https://youtu.be/ifNNnIT9jI4
Three blue claws of gear sector engage with violet rack of circular teeth.
Press orange trigger to grab an object.
Number of the claws can be 2, 3, 4 subject to shape of the object to be grabbed.

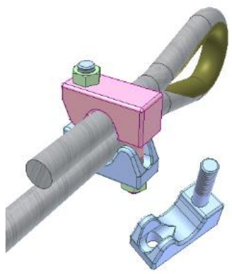


Grabber 2
https://youtu.be/An_B75JCyj8
Pull pink rod to grab an object.
This grabber can be considered as an application of slider crank mechanism of flexible links.
Slider: pink rod.
Cranks: blue bars.
Connection rods: green bars

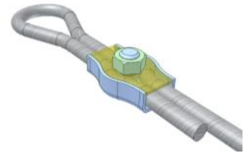
Wire rope clamp 1
https://youtu.be/_J7sBDyfd68



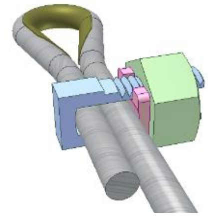
Wire rope clamp 2
https://youtu.be/Cd3XO3Ap5Lw



Wire rope clamp 3
https://youtu.be/e51o-ysFq8U



Wire rope clamp 4
https://youtu.be/IkxEpVTfQj8

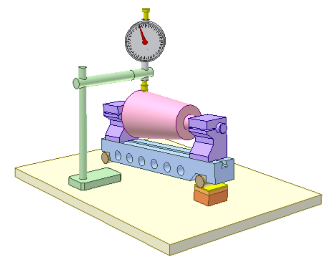


Wire rope clamp 5
https://youtu.be/kIDSC-qzsqE

29. Measurement and quality control

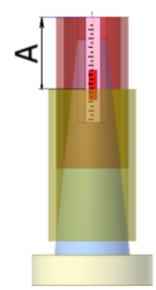
29.1. Geometry quality control

Male taper measurer 1
http://youtu.be/dduZx61R-eg



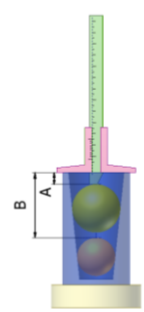
The taper to be measured is in pink color. It is mounted between two centres that are installed on a blue sine bar of two brown rollers. The rollers are always fixed to the bar.
Use slip gauge combination to make the highest generatrix of the taper parallel to the surface plate. The parallelism is checked by a dial indicator. Then
sinα = 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).
tanα = ((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
tanα = ((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)

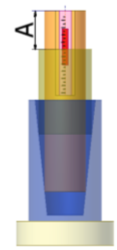
Female taper measurer 1
http://youtu.be/QiDu1k-6HUs



The taper to be measured is in blue color.
Use a depth gauge to get A and B dimensions
sinα = (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

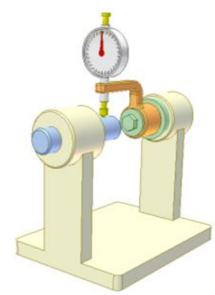
http://youtu.be/SvmRPrN7Zd4



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

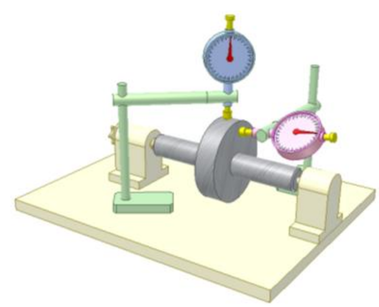
http://youtu.be/DkmLCIVo-1Y



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

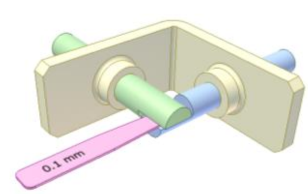
http://youtu.be/1JNCe9fwRUw



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

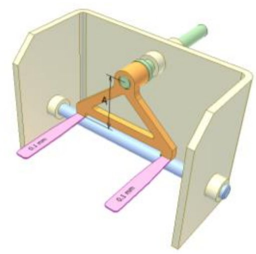


Ensure no gap between shafts and holes.
The flat portion of each shaft must contain shaft centerline. Insert a feeler gauge (as thick as possible) into the gap between the shaft flat portions to get the error in intersection (feeler gauge thickness). Turn the shafts 180 deg. if no gap appears.

Measuring distance between 90 deg. skew holes

http://youtu.be/bLfvIWlZZBc

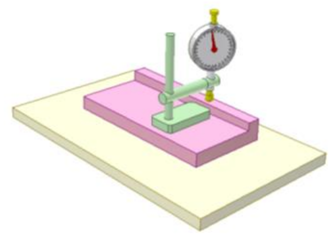
Ensure no gap between shafts and holes.
A is distance between the flat portions and the centerline of the orange part. It is determined according to allowed smallest value of the distance to be measured.
Insert two feeler gauges (of equal thickness and as thick as possible) into both gaps between the 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

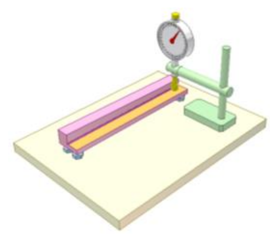
One plane is large enough for laying the indicator base.
Move the indicator set longitudinally to get values E1 and E2 at two points, distance between which is A.
Non-parallelism P = (E1-E2)/A
Using height gauge gives less accurate result.



Checking parallelism between two planes 2

http://youtu.be/YedyhVrmThk

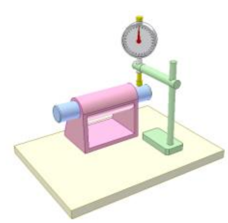
The planes are small so the indicator base can not be laid on one of them.
Make the orange plane paralell to the surface plate using the blue jack pins. Check the parallelism by the indicator, base of which moves on the surface plate.
Then check the parallelism of the pink plane to the orange one through its parallelism to the surface plate.



Checking parallelism between hole and bottom

http://youtu.be/OfmDN3FuWRs

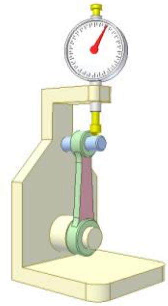
Insert a shaft into the hole to be checked.
Ensure no gap between shaft and hole.
Non-parallelism P = (E1-E2)/A
E1 and E2 are extremal values shown by the indicator at two measuring positions distance of which is A.



Checking parallelism between two holes

http://youtu.be/eEGu7azvNow

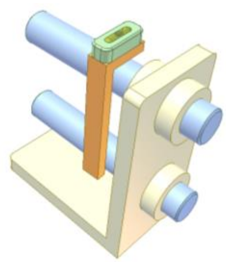
Insert a shaft into one hole of the green object.
Ensure no gap between shaft and hole.
Get the highest value E1 of the shaft at the measuring position.
Turn the object 180 deg.
Get the highest value E2 of the shaft at the measuring position.
Non-parallelism P = (E1-E2)/(A-B/2)
A: distance from indicator 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

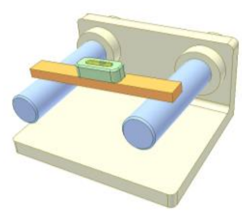
Insert two shafts into the holes to be checked. Ensure no gaps between shafts and holes.
Move the orange square of a spirit level along the shafts while keeping continuous contact between the shafts and the square.
The spirit level shows the error in parallelism between two holes in horizontal plane (not in vertical one).



Checking parallelism in vertical plane between two holes

http://youtu.be/svSkqNaTHBE

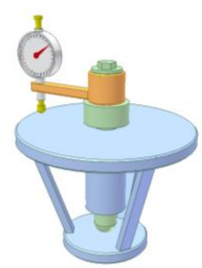
Insert two shafts into the holes to be checked. Ensure no gaps between shafts and holes. Move the orange bar of a spirit level along the shafts.
The spirit level shows the error in parallelism between two holes in vertical plane (not in horizontal one).
Another way for checking (without the orange bar):
Put the spirit level directly on each blue shaft (along its length) and compare two values shown by the spirit level.



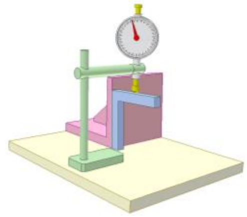
Checking perpendicularity between hole and face

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.

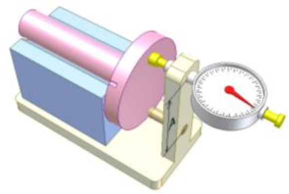


Checking perpendicularity between two surfaces
http://youtu.be/ZRvdzfM9lSo



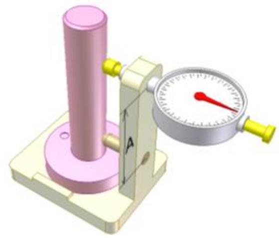
Bottom surface and vertical one of the pink object is checked for perpendicularity.
Use a blue square that is pressed against the vertical surface of the object, thus perpendicularity checking is turned into parallelism one.

Checking perpendicularity between face and centerline of a shaft 1
http://youtu.be/R7u0Af9dsIA



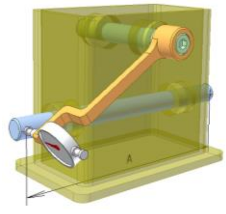
Turn the shaft several revolutions on the blue V-block while keeping a continuous contact between the shaft face and the brown pin (for example by setting the base inclined).
Get max and min values (E1 and E2) shown by the indicator.
Non-perpendicularity P = (E1-E2)/A
A: center distance of indicator 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.

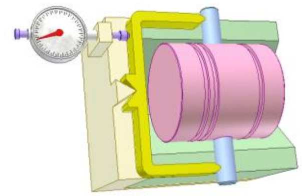
Checking perpendicularity between 90 deg. skew holes
http://youtu.be/VKfFRS0H3Wc



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

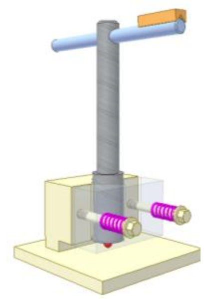
http://youtu.be/3TwxF7t4-_U



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

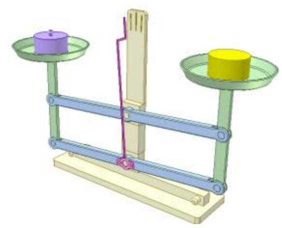
http://youtu.be/yr-MTaKDuis



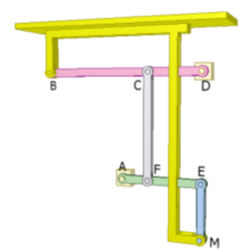
A blue round bar is inserted into the hole of of the grey shaft.
Ensure no gap there.
V-block and the shaft are arranged vertically.
Small error in verticality does not affect the checking result.
The shaft always contacts V-block thanks to two pink springs.
There is a red ball at the shaft bottom.
Checking 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.

29.2. Measurement

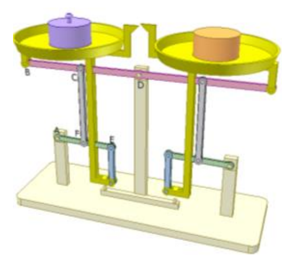
Two-pan balance 1
https://youtu.be/pSSpjnTNbIw
Parallelogram mechanisms are applied for this type of balances.
Disadvantage: there is error due to possible eccentricities between the masses and the pans.



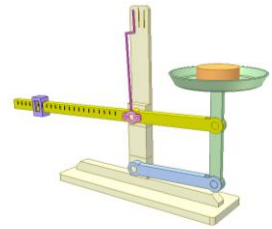
Vertical translating platform
https://youtu.be/cJIUVR_I7Z8
AE/AF= BD/CD
When pink and green bars are horizontal, grey and blue bars are vertical.
With small oscillating angle A of the pink bar, yellows platform is always approximately horizontal and move approximately vertically.
The video shows:
A = +/-10 deg.
Max inclined angle of the platform = 0.25 deg.



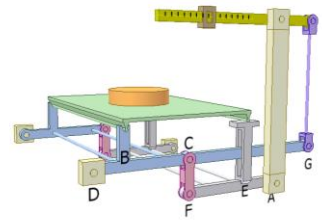
Two-pan balance 2
https://youtu.be/Ltw-dzul5DQ
AE/AF= BD/CD
Yellows pans are always approximately horizontal and move approximately vertically.
Possible eccentricities between the masses and the pans do not cause weighing error.
It is an application of mechanism shown in:
https://youtu.be/cJIUVR_I7Z8



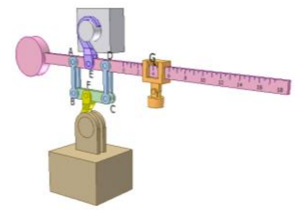
One-pan balance 1
https://youtu.be/cVqqOeCpiz0
Parallelogram mechanism is applied for this type of balances.
When no mass in green pan and violet slider is at 0 mark, yellow bar is horizontal.
Disadvantage: there is error due to possible eccentricities between the masses and the pans.



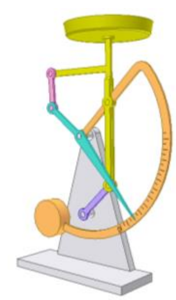
Platform weighing scale 1
https://youtu.be/0mZAjWJ1Q5M
AE/AF= BD/CD
Green platform has revolution joint with blue bar and cylindrical slider joint with grey bar.
When grey and blue bars are horizontal, pink and violet bars are vertical.
Green platform is approximately horizontal and moves approximately vertically when blue and grey bars oscillate with small angle.
Position of orange mass on green platform does not cause weighing error.



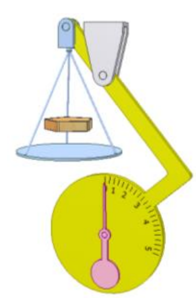
Differential steelyard
https://youtu.be/9nx_2kjVeJA
AE = ED; AB = DC; AD = BC
FC is longer than BF
ABCD: parallelogram
Move orange slider to make the pink beam horizontal. Final position of the slider shows the weight of object being weighed (in brown).
Q = G * EG / (2*(AE – BF))
Q: weight of the brown object.
G: weight of the orange counterbalance
(AE – BF) can be very small so Q can be very large while G and EG are kept the same of the ordinary steelyard.



One-pan balance 3b
https://youtu.be/tgLh4S3slYE
Orange, violet and yellow bars bars create a parallelogram mechanism.
When no mass in the yellow pan the blue hand points to 0 mark.
The graduation on the circular bar is nonlinear.

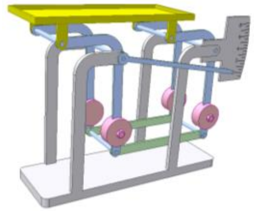


One-pan balance 4
https://youtu.be/-vzAsyUhRW8
When no mass in the blue pan, the pink hand points to 0 mark.
The video shows when the orange object is placed on the pan, the yellow bar rotates and the pink hand (always kept vertical due to the gravity) indicates the object weight.
The graduation on the dial is nonlinear.
Disadvantage: moving graduatied dial causes reading difficulty.



One-pan balance 2

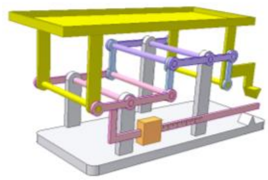
https://youtu.be/cjv2eX2UCXg



Two blue angular bars, yellow pan and green bars create a double parallelogram mechanism. Blue hand is fixed to the blue bar.
When no mass in the pan the hand points to 0 mark.

One-pan balance 3a

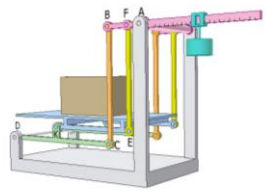
https://youtu.be/eQ8hhapy9U8



Pink graduated scale is fixed to pink bar. Move the orange sliding mass to get the scale horizontal. Position of the sliding mass shows the weight of the object placed on the yellow pan.
The video shows case when no object in the pan, the scale is horizontal because the sliding mass is set at 0 mark.

Platform weighing scale 2

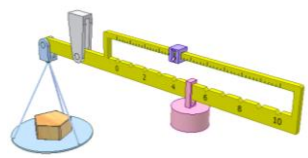
https://youtu.be/knYY26VdNnY



Move cyan sliding mass to get pink scale horizontal. Position of the sliding mass shows the weight of the object (in brown) placed on the blue platform.
KE = EF
DK / DC = FA / AB
The platform is always kept horizontal.

Steelyard of two graduated scales

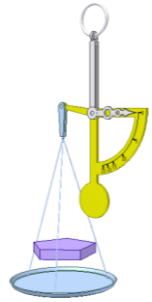
https://youtu.be/QpIalioR33E



Pink large counterweight position shows the rough value on the lower scale.
Move violet small counterweight to set adding value on the upper scale for exact weight of the orange object.

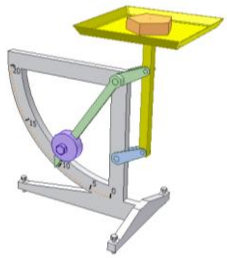
One-pan balance 5

https://youtu.be/juDyJ-8CssI

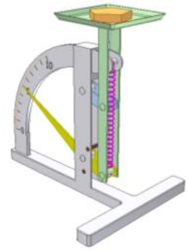


When no mass in the blue pan, the grey stationary hand points to 0 mark.
The video shows when the violet object is placed on the pan, the yellow bar rotates and the hand indicates the object weight.
The graduation on the dial is nonlinear.
This balance is used for light objects such as tea.

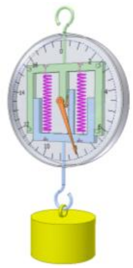
One-pan balance 6
https://youtu.be/4AuETQisTyE
When no mass in the yellow pan, the green hand points to 0 mark.
The video shows when the orange object is placed on the pan, the hand moves to indicate the object weight.
The graduation on the dial is nonlinear.
This balance is used for light objects.



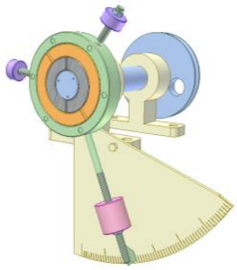
Spring scale 1
https://youtu.be/W-gxHZ5uahA
When no mass in green pan, yellow hand points to 0 mark.
The video shows when orange object is placed on the pan, the hand moves to indicate the object weight.
The graduation on the dial is linear.



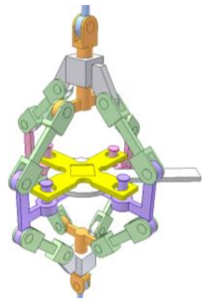
Spring scale 2
https://youtu.be/PKX84Eq1l6w
When no mass hung on blue hook, orange hand points to 0 mark.
The video shows when yellow object is hung on the blue hook, the hand moves to indicate the object weight.
The graduation on the dial is linear.



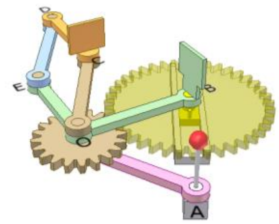
Friction torque measuring
http://www.youtube.com/watch?v=QQfhv9AuYuM
A simple method to measure friction torque M generated in revolution joint of the grey inner ring and the orange outer one. The grey ring is fixed on the blue shaft, the orange ring is fixed on the green hand assembly.
$M = PL\sin\alpha$
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.



Mechanism for 2D pulling test
https://youtu.be/UyJZVaCffVY
Yellow sample of four holes is pulled in 4 directions at the same time thanks to blue upper and lower pistons.
The blue components are two pistons of two cylinders (not shown). When the pistons go towards each other the pulling process starts.

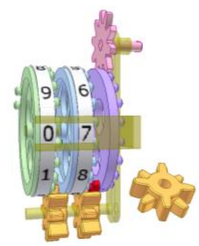


Mechanism for spectrometer



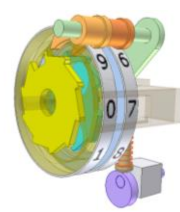
https://youtu.be/LCtKzzI-Pr4
Input: yellow slider to which large gear of Zy teeth is fixed.
Brown gear of Zb teeth is fixed to bar OC.
Zy = 2.Zb
OA = OB = OC = ED
OE = DC
Angle EOB of green link = 90 deg.
AB: sliding line of the yellow slider.
Red ball represents a light source.
Green rectangle represents a grating.
Orange rectangle represents a detector.
During motion always:
Angle AOB = angle BOC
AB = BC
Angle ACD = 180 deg.
If a mirror is placed at the green rectangle, the orange rectangle can catch the reflected ray of the incident ray coming from the red ball.

Mechanical odometer 1



https://youtu.be/UOhFri6FPrs
It is an application of the mechanism shown in:
https://youtu.be/HHLIT6__Brs
Input: pink pinion that makes violet pin gear rotate continuously.
One revolution of the violet gear makes the next blue pin gear rotate interruptedly one tenth of a revolution thanks to two pins on the left side of the violet gear and the first orange gear of 8 teeth. Four teeth of the orange gear are longer than the remainings. In combination with the outside diameter of the violet gear they keep the orange gear and the blue gear immobile when the above mentioned two pins are not in mesh.
The same process is applied to the motion transmission between the bue and green gears.
The video shows how the odometer works when the violet gear rotates from the 07^{th} to the 13^{th} revolution.

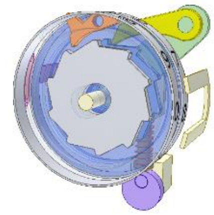
Mechanical counter 1



https://youtu.be/vyejpfe72rA
Input: green rocking lever driven by any motion source (violet cam and brown follower in this video). Two orange pawls are fixed together and have revolute joints with the green lever. They are forced toward their ratchet wheels by springs (not shown).
When blue ratchet wheel, to which unit digit dial is attached, completes 1 revolution, yellow ratchet wheel, to which ten digit dial is attached, turns 1/10 of a revolution. This happens because:
1. Distance from the pawl point to ratchet wheel axis for the right pawl is smaller than the one for the left pawl.
2. One tooth on the ratchetwheels is cut deeper than the remaining teeth.
The video shows counting process from 07 to 21.
Measure for positioning the ratchets and digit dials is not shown.

Mechanical counter 2

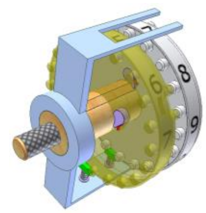
https://youtu.be/IoGnOz3YASw



Input: green rocking lever driven by any motion source (violet cam and brown follower in this video).
Yellow pawl moves blue unit digit dial attached to blue ratchet wheel.
Each stroke of the yellow pawl makes the blue dial turn 1/10 of a revolution.
Orange pawl is pivoted on the blue unit digit dial. A spring (not shown) forces the orange pawl to contact a small pin on the blue unit digit dial. So the orange pawl does not contact the grey ratchet wheel of the glass ten digit dial till the pawl contacts pink cam and makes the ten digit dial turn 1/10 of a revolution.
The video shows counting process from 08 to 28.
Measure for positioning the ratchets and digit dials is not shown.

Zero return device for mechanical counter

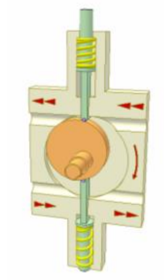
https://youtu.be/Vq0cMJB-6Rc



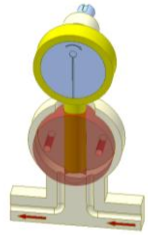
Nothing happens to digit dials when orange reset shaft turns clockwise.
So the dials can rotate anticlockwise when counting.
Once the reset shaft turns anticlockwise, thanks to its longitudinal groove and violet pawls on the dials, firstly the same digits on the dials are aligned and then the 0 digits are brought to the reading window.
The violets pawls are forced toward the shaft by red springs.
Green pawls are for positioning the dials.

30. Pumps and engines

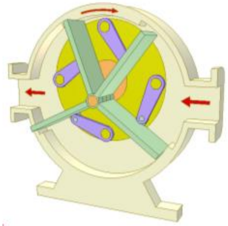
30.1. Pumps



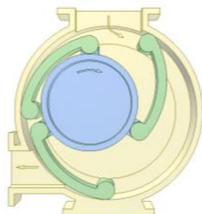
Pump with eccentric 1
http://www.youtube.com/watch?v=RVORJ91ELEE
The red arrows indicate the rotation direction of the eccentric shaft and the fluid moving direction.
The front half case is removed.



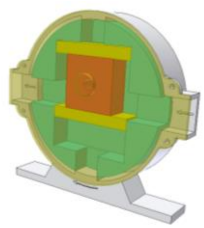
Pump with eccentric 2
http://www.youtube.com/watch?v=IvzHnE26P1o
The red arrows indicate the rotation direction of the eccentric shaft and the fluid moving direction.
The front half case is removed.



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.

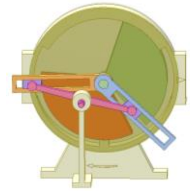


Pump with 4-bar mechanism 2
http://www.youtube.com/watch?v=YFb6tVo8rfg
The arrows indicate the fluid moving direction.
The front cover is removed.
An expanding cavity is created on the suction side and a decreasing cavity is created on the discharge side.

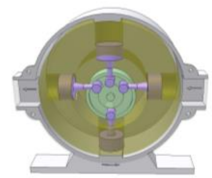


Pump with rotating square piston
http://www.youtube.com/watch?v=WiYK04vVPRY
Input: green disk.
Yellow slider slides in slot on the green disk.
Red piston slides in slot on the yellow slider.
The piston axle is fixed eccentrically on the yellow cover.
The arrows indicate the fluid moving direction.
The piston creates an expanding cavity on the suction side and a decreasing cavity on the discharge side.

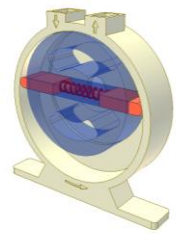
Pump with 4-bar mechanism 3
http://youtu.be/RSAyygL03po
The arrows indicate the rotation direction of the sectors and the fluid moving direction. Each sector is fixed with a coulisse.
The rotating sectors create an expanding cavity on the suction side and a decreasing cavity on the discharge side.



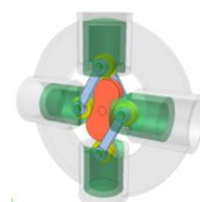
Pump with rotating cylinder
http://youtu.be/Bu7000931oQ
The arrows indicate the rotation direction of the yellow cylinder and the fluid moving direction. Green disk is fixed eccentrically on the case
The pistons create an expanding cavity on the suction side and a decreasing cavity on the discharge side.



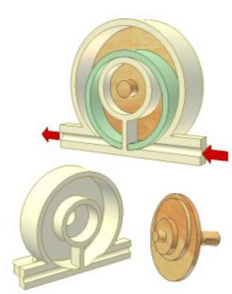
Pump with eccentric 3
http://www.youtube.com/watch?v=w8MDLutvcZo
The arrows indicate the rotation direction of the eccentric and the fluid moving direction.
The eccentric creates an expanding cavity on the suction side and a decreasing cavity on the discharge side. The front cover is removed.



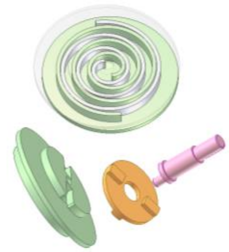
Cam mechanism of follower's planar motion 2
http://youtu.be/sJoL85j44Ro
The blue followers, connecting rods of ellipse mechanisms, have planar motion. This mechanism can be used for air compressors or engines.



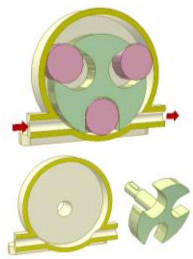
Pump with eccentric ring 1
http://youtu.be/LSkIEa4tjrk
Input: orange rotor.
Green ring is mounted eccentrically on the rotor.
A vertical wall of the base prevents the green ring from rotating.
There should be a soft contact (elastic seal) between the ring and the wall.
The arrows show fluid flows.
An 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.



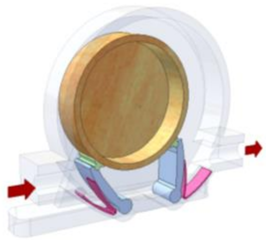
Scroll compressor
http://youtu.be/V5sXKMQWw9s
The grey disk with an Archimedean rib is fixed.
The green disk with the same rib receives motion from a pink eccentric shaft. Due to a Oldham mechanism with the orange disk the orientation of the green disk does not change during motion.
Suction place is 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.



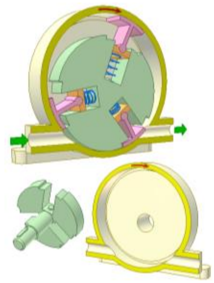
Pump with rollers 1
http://youtu.be/8AfzVEwOypQ
Input: green rotor that rotates eccentrically in the housing.
Three pink rollers can slide in the rotor slots.
Centrifugal forces push the rollers toward the interior cylindrical surface of the housing.
The arrows show fluid flows.
The pump is cut off half 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.

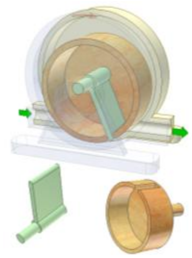


Pump with sliders 1a
http://youtu.be/S7qE55UJJXI
Input: green rotor that rotates eccentrically in the housing.
Orange sliders can slide in the rotor slots.
Pink sliders can slide in circular grooves of the housing.
There are revolution joints between orange sliders and pink ones.
It is an application 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

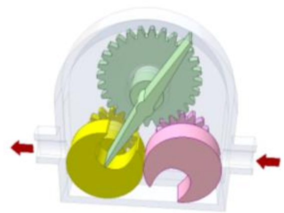
http://youtu.be/t5BQStcdqTo



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

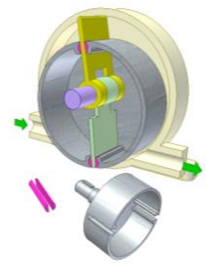
http://youtu.be/jtWM5zclqfw



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

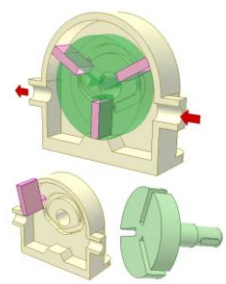
http://youtu.be/OiSO7FKtlTw



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

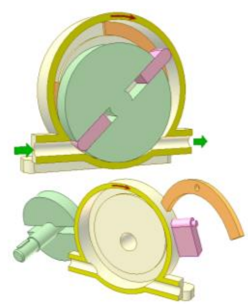
http://youtu.be/DHJiK1lfzNc



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.

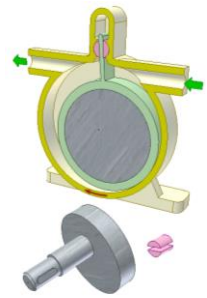
Pump with sliders 1b

http://youtu.be/4DtouBqxfSU

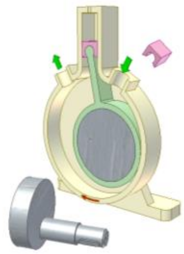


Input: green rotor that rotates eccentrically in the housing.
Pink sliders can slide in the rotor slots.
Orange sliders can slide in circular grooves of the housing.
There are revolution joints between orange sliders and pink ones.
It is an application of a coulisse mechanism where green rotor and pink sliders are the cranks.
The green arrows show fluid flows.
The pump is cut off half for easy understanding.

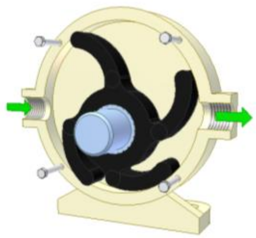
Pump with eccentric 5a
http://youtu.be/BoXO-7R51co
Input: grey rotor that rotates eccentrically in the housing.
Green conrod separates suction and discharge spaces of the pump.
The pink parts have revolution joints with the housing.
The arrows show fluid flows.
The pump is cut off half for easy understanding.



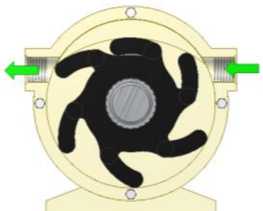
Pump with eccentric 5b
http://youtu.be/LJDs5Er6zJs
Input: grey rotor that rotates eccentrically in the housing.
Green conrod separates suction and discharge spaces of the pump.
The rotor, conrod and pink slider create a slider crank mechanism.
The arrows show fluid flows.
The pump is cut off half for easy understanding.



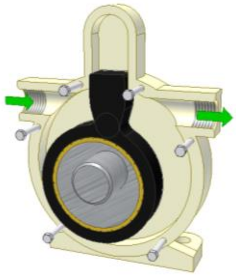
Flexible impeller pump 1a
http://youtu.be/JtQ-0ZYkH2c
Black rubber impeller, eccentrically rotating clockwise in the housing, transports fluid from inlet to outlet. The front half housing is removed for easy understanding.
Green arrows show fluid flow.



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.

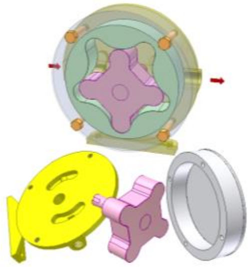


Flexible impeller pump 2
http://youtu.be/rV1cdVGnU5Y
Grey shaft rotates anticlockwise in the housing. Black rubber impeller having revolution joint with an eccentric of the grey shaft, transports fluid from inlet to outlet. The front half housing is removed for easy understanding.
Green arrows show fluid flow.



Trochoid gear pump

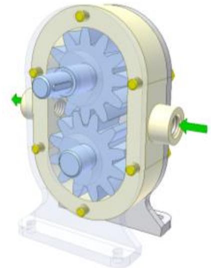
http://youtu.be/Xd3s5xEPSlA



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

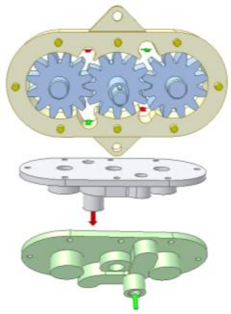
http://youtu.be/EPCI8poQAoI



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

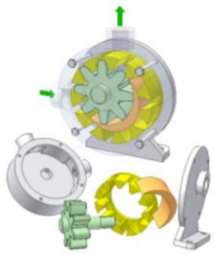
http://youtu.be/gp6SJiEsUu4



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.

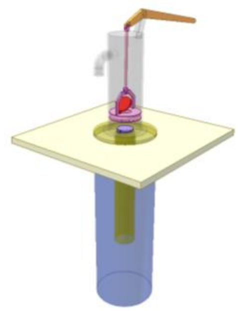
Cable drive 23

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

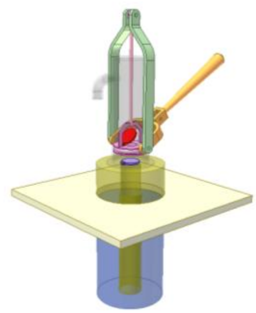
http://youtu.be/8xv21E7XKBU



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

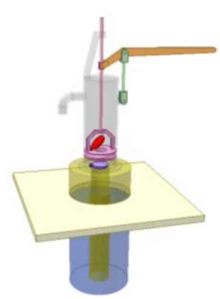
http://youtu.be/NtMlwYN7EeU



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

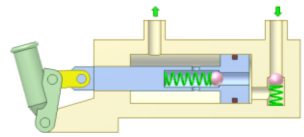
Hand water pump 2a

http://youtu.be/adMu9Yo0nCA

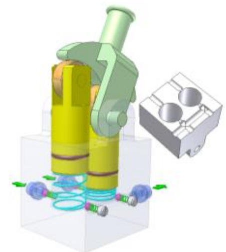


Slider crank mechanism converts oscilation of orange conrod to reciprocating translation of pink piston. Hand force is applied to the conrod.
Disk valves open and close automatically due to fluid pressure alteration in the space under the piston. When the piston moves up, the lower valve opens, the upper 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

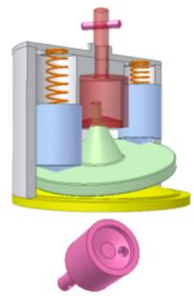
Hand piston pump 1
http://youtu.be/5a-UdttYEVs
Spring ball valves are operated automatically thanks to fluid pressure.
The arrows show fluid flows.
The cylinder and the piston are cut off half for easy understanding.



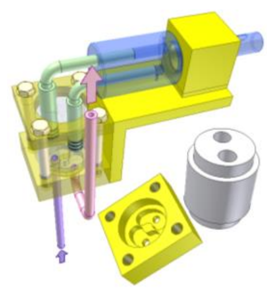
Hand piston pump 2
http://youtu.be/cVwOS5cd4Oo
Green double cam lever controls two pistons.
Spring ball valves are operated automatically thanks to fluid pressure.
The arrows show fluid flows.



Pump of wobbling disk
https://youtu.be/6IiZPe12yTg
Input: pink shaft of oblique hole for green disk trunnion.
The disk contacts with the cones of blue pistons and the cone of yellow bottom.
There are four cylinder holes, two of which can be seen. Inlet and outlet check valves are arranged on top of each cylinder.

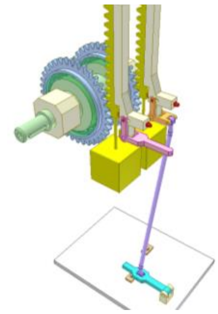


Pump of Hobson's joint
https://youtu.be/hhc2iTiWOHs
Input shaft: blue
Suction pipe: violet
Discharge pipe: pink
Two green pistons slide in the holes of white rotary cylinder.

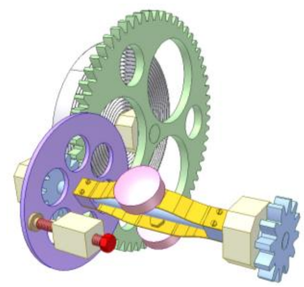


30.2. Engines

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.

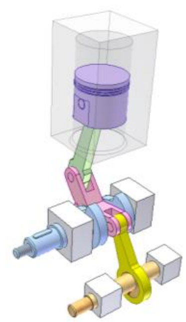


Speed control of spring motor
http://youtu.be/ehjgr3AYKvM
Orange leaf springs tend to get their neutral position and push violet flange to the left. Centrifugal forces of pink weights tend to move the violet flange to the right when the speed increases and cause the friction at the contact place between 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.



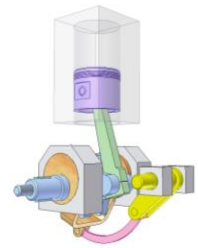
Flyball governor for flow control.
http://youtu.be/SiYEtnlZLSs
A water turbine spins the governor, which control the water flow, which feeds the turbine, creating a speed-regulated machine.
When the flow is too strong, the water turbine and the violet governor shaft rotates faster than the set velocity. By centrifugal force, the green arms regulates the orange valve to reduce the flow.

Variable compression ratio engine 1a
https://youtu.be/a9hYU2OnsfE
Angle position of orange control shaft is controlled by a motor (not shown).
When red arrow points down, volume of the combustion chamber is min, the compression ratio is max and vice versa.
This working principle is taken from Nissan VCR engine.
Infiniti VC-T engine has similar working principle using two 4-bar mechanisms for controlling the pink arm.



Variable compression ratio engine 2

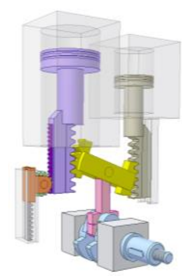
https://youtu.be/-Zg4HKXlXT4



Position of orange cradle of the blue crank shaft determines compression ratio of violet piston cylinder. It gives different volumes of the combustion chamber. There is an offset between the blue crank shaft and the cradle axes.
The position is controlled by yellow crank shaft connected to the cradle by pink conrod. A cylinder and rack-gear drive for turning the yellow crank shaft are not shown.
The video shows the shifting process from high compression ratio to low one and then back to high one.
Disadvantage: the output crankshaft axis position is variable.
This working principle is taken from Envera VCR 1.0 car engine.

Variable compression ratio engine 3

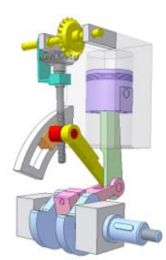
https://youtu.be/HVtKySd27sk



Position of brown piston determines compression ratio of violet piston cylinder. Low position makes volume of the combustion chamber small and the compression ratio high.
Green pinion and two small racks are for reducing the violet piston bending.
The structures for preventing the rotations of the violet and brown pistons are not shown.
This working principle is taken from Peugeot MCE-5 VCR-i car engine.

Variable compression ratio engine 4

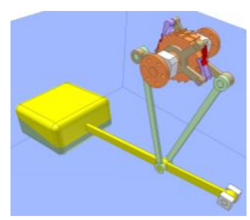
https://youtu.be/XJR0kK9HNHw



Position of orange circular slider determines compression ratio of violet piston cylinder. Low position gives high compression ratio and vice versa.
The position is controlled by yellow shaft via bevel gears and nut-screw drive.
Attention: piston stroke length is varied considerably when adjusting.

Wave motor

https://youtu.be/caZa4-CuM2w

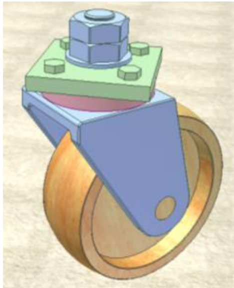


Waves raise yellow float and the latter falls due to its weight. These motions make orange output shaft rotate one way.
In this video the grey bearings are stationary. However they can be installed on another float (not shown). The distance between the two floats is chosen to be about equal to half of the wavelength. Thus the oscillation angle of the yellow bar can be increased. The second float also helps the motor adapt to variable sea level caused by the tide.
Several such motors are connected in series (coaxial connection of the orange shafts) to increase output power. The output rotation after being accelerated and evened out is transmitted to an electric generator.

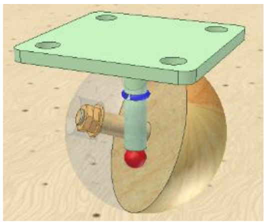
31. Transport measures, bridges

31.1. Vehicles

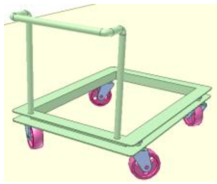
Swivel caster 1
https://youtu.be/9oE1LXboS-g
There are two revolution joints: vertical one between blue fork and green base, horizontal one between blue fork and orange wheel. Their offset distance is A.
When the caster is moved and the wheel is not facing the correct direction, the offset A will cause the wheel assembly to rotate around the axis of the vertical shaft to follow behind the direction of movement.



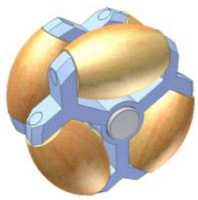
Swivel caster 2
https://youtu.be/5RWA_aAN5mQ
This is a structure embodiment of "Swivel caster 1", spherical wheel.
There are two revolution joints: vertical one between green base and glass hemisphere and slanting one between glass hemisphere and orange hemispherical wheel. Their offset distance is A. The glass hemisphere doesn't touch the floor.
When the caster is moved and the wheel is not facing the correct direction, the offset A will cause the wheel assembly to rotate around the axis of the vertical shaft to follow behind the direction of movement.



Swivel caster trolley
https://youtu.be/X_SdkZfDz1c
Four swivel casters ensure no drag because they are automatically adapted to the new moving direction of the trolley.

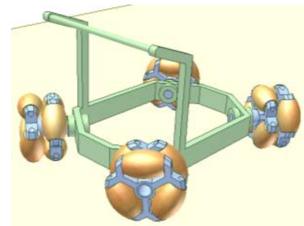


Motion of idly Omni wheel
https://youtu.be/x4wvNVovzJU
Angle between rotary axis of the orange rollers and rotary axis of the wheel is 90 deg. The roller profile is chosen in such a way that the distance from the contact point to the rotary axis of the wheel is constant. So the wheel looks like a round wheel on its side view.

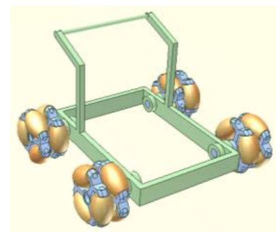


The video shows the wheel motion when the grey axle moves along:
1. X direction (perpendicular to the wheel axis): the rollers almost don't rotate.
2. Y direction (parallel to the wheel axis): the roller that contacts the ground rotates.
3. 45 deg. oblique direction: all the rollers and the wheel rotate.
Idly Omni wheels can be used for shopping trolleys (no need of swivel casters).

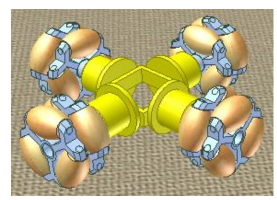
Omni wheel trolley 1
https://youtu.be/l4phSei5G8A
Four Omni wheels are mounted idly symmetrically on green frame. Pushing and rotating the trolley in different directions do not cause the drag of the wheels.
In the video the trolley alternately:
1. goes forward.
2. goes sideways
3. goes diagonally.
4. rotates



Omni wheel trolley 2
https://youtu.be/45X-w2fMF4c
Four Omni wheels are mounted idly symmetrically on green frame. Pushing and rotating the trolley in different directions do not cause the drag of the wheels.
In the video the trolley alternately:
1. goes forward.
2. goes sideways
3. goes diagonally.
4. rotates



Omni wheel car
https://youtu.be/bqMFxGBQYgw
Four Omni wheels are mounted symmetrically on yellow frame. Each wheel is driven by a separate motor, the rotation of which is programmable.
Various combination of the wheel rotations (velocities and directions) makes the car move in different directions.
In the video the car alternately:
1. goes forward.
2. goes diagonally.
3. goes sideways.
4. rotates

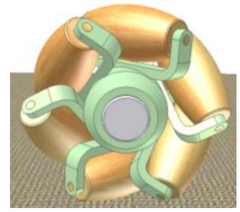


Motion of driven Mecanum wheel
https://youtu.be/3wXUAcVVUTk
Angle between rotary axis of the rollers and rotary axis of the wheel is 45 deg. At any moment the wheel contacts the ground via at least one point of one among the rollers.
The roller profile is chosen in such a way that the distance from the contact point to the rotary axis of the wheel is constant. So the wheel looks like a round wheel on its side view.

The video shows case when the wheel rotates clockwise. It moves forward and to the left.

Motion of idly Mecanum wheel

https://youtu.be/2tSaDV0_pvQ



Angle between rotary axis of the rollers and rotary axis of the wheel is 45 deg. At any moment the wheel contacts the ground via at least one point of one among the rollers.

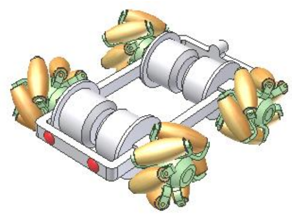
The roller profile is chosen in such a way that the distance from the contact point to the rotary axis of the wheel is constant. So the wheel looks like a round wheel on its side view.

The video shows how the wheel works when the grey axle moves along:

1. X direction (perpendicular to the wheel axis): the wheel rotates but the rollers almost don't rotate.
2. Y direction (parallel to the wheel axis): the rollers rotates, the wheel rotates.
3. 45 deg. oblique direction: all the rollers rotate but the wheel does not. The simulations with other values of oblique angle show that the rollers and the wheel rotate however.

Mecanum wheel car

https://youtu.be/KOYmIYRMmuU



Four Mecanum wheels are mounted symmetrically on grey frame. Each wheel is driven by a separate motor, the rotation of which is programmable.

Various combination of the wheel rotations (velocities and directions) makes the car move in different directions.

In the video the car alternately:

1. goes forward
2. goes sideways
3. goes diagonally
4. rotates

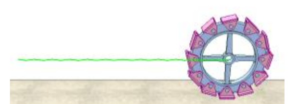
A problem for this car: hard to control the rollers rotation.

For example how to brake the car? When braking the four wheels (in green), the car does not stop due to its inertia and the rollers can idly rotate. So is it necessary to brake all rollers too? This problem also affects the direction change of a moving car.

So the car is suitable for low speed only?

Shoe wheel

https://youtu.be/OvlOGd_Ut4k



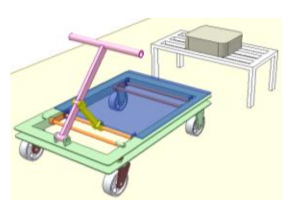
Pink shoes are connected to the blue wheel by revolution joints.

Green line is trajectory of the wheel center.

This wheel helps increase contact area with the ground in comparison with an ordinary wheel.

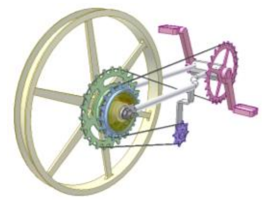
Lifting trolley

https://youtu.be/fpokkXh7f-U



Two orange cranks and blue desk create a parallelogram mechanism. When the green frame is kept immobile by foot, the blue desk can go up down by turning pink handle.

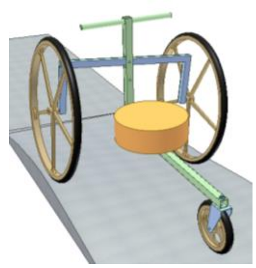
Retro-direct bike
https://youtu.be/INj6SWGRsMw



This provides a second gear ratio when pedalling backwards for climbing steep inclines.
A single chain (represented by the black line) wraps around pink chainring, violet idle sprocket and two sprockets (in blue and green). The two latters belong to two freewheels mounted in the same direction. The freewheel hubs are fixed to the bike rear wheel.
Only one freewheel is engaged at a time, while the other spins backward freely. Since the chain wraps around the second sprocket in the opposite direction to the first sprocket, the cyclist needs only to pedal backwards to engage it.
There is a small amount of out-of-line for the chain.
The video shows:
1. Pedalling forwards: the rear wheel turns forwards fast.
2. Stopping bicycle.
3. Pedalling backwards: the rear wheel turns forwards slow.
In fact it is the mechanism for converting two way rotation into one way rotation of different speeds..
Disadvantages:
- Noise when pedalling, because one of the two cogs is always freewheeling while the other drives the bike.
- It's not possible to position the pedals without lifting the rear wheel. That's because both pedalling directions are used.
- The bike will also refuse to be rolled backward. That's because both freewheels will engage and fight each other through the chain and the chainring.

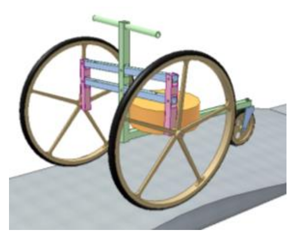
See a Retro-direct bike in action:
https://www.youtube.com/watch?v=P3Kvao07-eQ
See an Retro-direct embodiment of two chains, two chainrings:
https://www.youtube.com/watch?v=luQ3VRKZiN4
https://www.youtube.com/watch?v=MfxncSJTraU

Study of tricycle on uneven road 1
https://youtu.be/9JkoZ8RB-xg



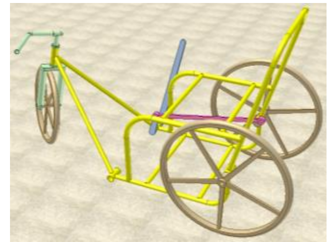
When rolling on an uneven road, green frame is kept always vertical in traversal plane (perpendicular to the vehicle motion direction) because center of mass of the green frame (with or without load (user weight)) is below its revolution joint with the blue bar.
It means that the seat is kept always horizontal in traversal plane.
Orange part represents the vehicle load.

Study of tricycle on uneven road 2
https://youtu.be/tJ7YWWV3K2U



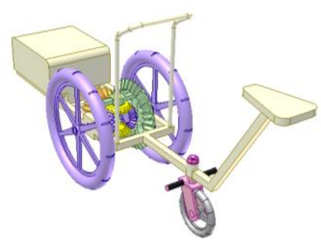
When rolling on an uneven road green frame, wheels of the vehicle are kept always vertical in traversal plane (perpendicular to the vehicle motion direction) thanks to:
1. Green, blue and pink bars create a parallelogram mechanism.
2. Center of mass of the green frame (with or without load (user weight)) is below its revolution joints with the blue bars.
It means that the seat is kept always horizontal in traversal plane.
Orange part represents the vehicle load.

Hand-powered tricycle 1
https://youtu.be/OSWw3ZvU8bY
It is driven via a four-bar linkage: blue lever, pink conrod and brown crank.
Way to overcome dead point at start: turn the right rear wheel.
Green bar is for turning the tricycle.



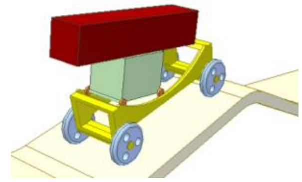
Hand-powered tricycle 2
https://youtu.be/cNcv4mKhHD4
It is driven via a four-bar linkage: blue lever, pink conrod and grey crank. Way to overcome dead point at start: turn the right rear wheel.
Violet steering wheel controls front wheel via spatial four-bar linkages. Orange conrods have spherical joints at their ends.
Centers of lower joints must be laid on axis of the revolution joint between the blue lever and the frame to eliminate angular oscillation of the green fork.
In fact one conrod is needed only. Two conrods help reducing their longitudinal compression but cause over constraint that is eliminated thanks to gaps in the joints and flexible deformations of the conrods.
Advantage: Propelling and turning the tricycle just by moving the violet wheel.
Disadvantage: there is small angular oscillation of the green fork when the tricycle is turning.

Steering motorized 3-wheel vehicle
https://youtu.be/RqKj5G9KIUA
It is for mini tractors used for agricultural works.
Input: orange gear receiving motion from an engine placed at front of the vehicle. It transmits rotation to two violet wheels via bevel gear differential.
The driver uses his feet to turn pink fork carrying small wheel to steer the vehicle while his hands are for controlling the engine and attached devices.
For the bevel gear differential see:
https://youtu.be/YjhzkV5Ya2k

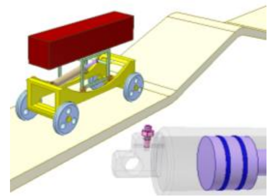


Twister car
https://youtu.be/BHxpqUgj3TQ
Other names of this toy: Rolling coaster car, Plasma car.
Only four orange wheels touch the ground.
Two violet wheels located at the front of the car do not touch the ground or spin: they are merely there for stability and safety in case the rider leans forward or drives into an elevated surface.
The car is propelled simply by rocking the pink steering wheel.

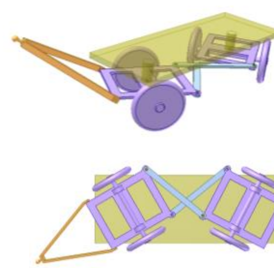
Coffin carrier 1
http://youtu.be/3Bp_Z3Kovxc
Circular runways of the yellow chassis enable to keep the coffin always horizontal regardless of sloping road provided that the carrier does not move too fast. The carrier is used in funeral homes.



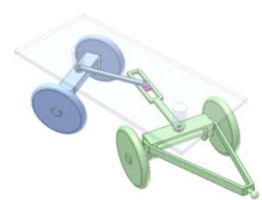
Coffin carrier 2
http://youtu.be/_vaAysAGf9g
Circular runways of the yellow chassis enable to keep the coffin always horizontal regardless of sloping road. The air cylinder is for damping, level of which is regulated by the pink screw.
The carrier is used in funeral homes.



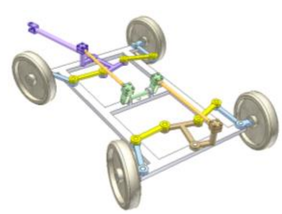
Mechanism for steering a 4-wheel trailer with small turning radius 1
http://www.youtube.com/watch?v=Dp-7uB0U-ow
An application of 4-bar mechanism.
It can work only when the gaps in the revolution joints of the connection rods are big enough.
In case of small gaps one of the two connection rods must be removed. However the remainder is easy to be buckled due to longitudinal compression.



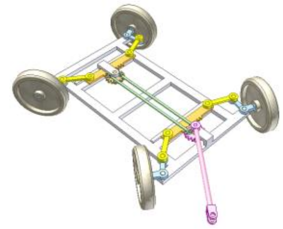
Mechanism for steering a 4-wheel trailer with small turning radius 2
https://youtu.be/FRy914PsV2s
An application of simple mechanism that reverses rotation between two shafts instead of a gear drive.
Disadvantage: Turning angles of the front wheel set and the rear one are not exactly equal.



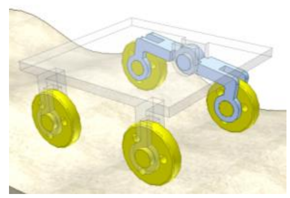
Mechanism for steering a 4-wheel trailer with small turning radius 3
https://youtu.be/sVEjb-YgjhQ
Combination of spatial and planar 4-bar linkages allows four wheels turn synchonically. Bar dimenssions are selected in such a way that the wheel turning centers are nearly concurrent.
Advantage: The quadrilateral created by contact points of four wheel with the ground (base area) almost is unchanged when turning.



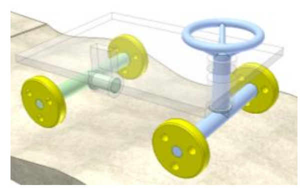
Mechanism for steering a 4-wheel trailer with small turning radius 4
https://youtu.be/1etaPtE6ELg
Combination of slider-crank mechanisms and gear-rack drives allows four wheels turn synchonically. Bar dimenssions are selected in such a way that the wheel turning centers are nearly concurrent.
Advantage: The quadrilateral created by contact points of four wheel with the ground (base area) almost is unchanged when turning.



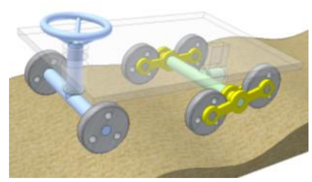
Four-wheel vehicle 1
https://youtu.be/RWWFW-Q5fAA
Unlike ordinary four wheel vehicles of no spring suspension, this ensures a permanent contact of all wheels with uneven roads. Forces applied to the chassis are not symmetrically.



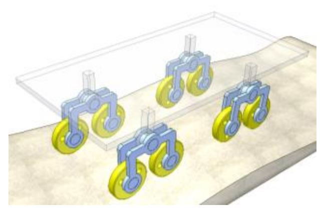
Four-wheel vehicle 2
https://youtu.be/y_RrPSHpbpM
Unlike ordinary four wheel vehicles of no spring suspension, this ensures a permanent contact of all wheels with uneven roads and the possibility of moving direction change.
Green shaft has revolution joint with the chassis.



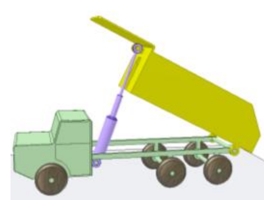
Six-wheel vehicle 1
https://youtu.be/Mix0fxVkL4Y
This ensures a permanent contact of all wheels with uneven roads and the possibility of moving direction change.
Green shaft has revolution joint with the chassis.



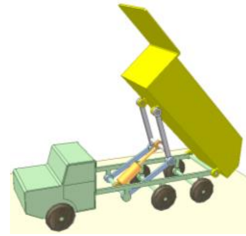
Eight-wheel vehicle 1a
https://youtu.be/FdEeKnodKhA
This does not ensure a permanent contact of all wheels with uneven roads.



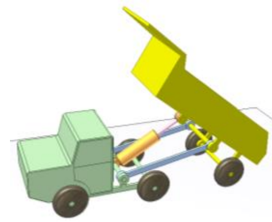
Dump truck 1
https://youtu.be/E52a1chWHkA
Yellow bed, violet cylinder and pistons create a coulisse mechanism. The bed can turn large angle thanks to using violet telescopic cylinder.



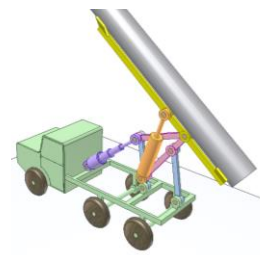
Dump truck 2
https://youtu.be/_Us-a_Wtffs
Yellow bed can turn large angle thanks to using six-bar linkage.



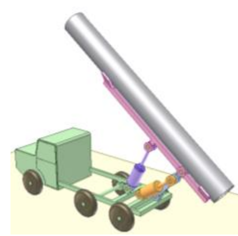
Semi dump trailer 1
https://youtu.be/Bai7WsAxdxo
Blue crank, yellow conrod (trailer bed) and rear wheels create crank slider mechanism (to some extent, because the wheel can be replaced with sliders).



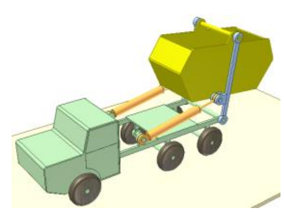
Pipe truck 1
https://youtu.be/gxJXT3bKygU
Blue and pink links create a parallelogram mechanism.
Orange cylinder turns the grey pipe 90 deg.
Violet cylinder translates the pipe.
Violet cylinder is of a double acting telescopic cylinder to increase motion range.
Pipe clamping device is not shown.



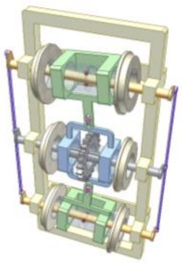
Pipe truck 2
https://youtu.be/iNT5vpnLtDw
Orange cylinder moves the grey pipe backward.
Violet cylinder turns the pipe 90 deg.
Pipe clamping device is not shown.



Container truck
https://youtu.be/r0ZUgWRzVYs
Application of coulisse mechanism which loads or unloads the yellow container for a truck.
The container can be removed from blue bars when it lays on the ground (removing device is not shown).

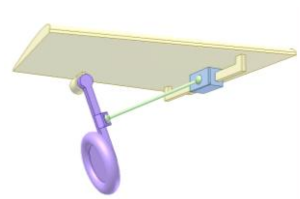


Drive for a locomotive
https://youtu.be/DzluEMFmjmY

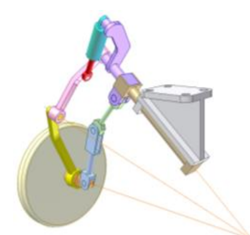


Three wheel sets of a locomotive are powered and can move in horizotal plane to adapt to the curves of the railway.
The green bearings of front and rear wheelsets pivot on the chassis.
The blue bearing of center wheelset can laterally displace thanks to key sliding joint on the grey center inner shaft. Blue and green bearings are connected together by pink sliders.
So when the locomotive enters a railway curve, the front green bearing turns and makes the blue bearing move laterally and the rear green bearing turns in opposite direction.
The grey center inner shaft receives motion from engine via grey gear fixed to the center wheelset and its key sliding joint and transfers the motion to orange front and rear inner shafts via parallelogram mechanisms. Angle between two cranks of each inner shaft differs from 0 and 180 deg. to eliminate dead positions of the parallelogram mechanisms.
The front and rear wheelsets receive motion via pin (in red) slot joints with the orange inner shafts.
It is Heywood design of 1877 with small changes for easy simulation:
http://www.douglas-self.com/MUSEUM/LOCOLOCO/heywood/heywood.htm

Airplane wheel retracting
http://www.youtube.com/watch?v=Te8UltGmcQQ
A spatial slider crank mechanism is used.



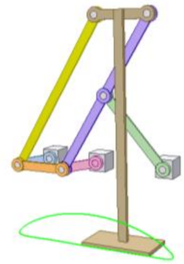
Retractable wheel
https://youtu.be/rMhivIhwKWE



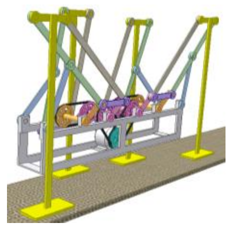
Cyan cylinder and red piston control the wheel retraction.
Violet, green and blue links create a planar bar mechanism.
Pink and yellow links create a spherical mechanism, their axes of revolution joints are concurrent.
Brown elastic torsion bar plays role of a buffer for torque load.

31.2. Walking machines

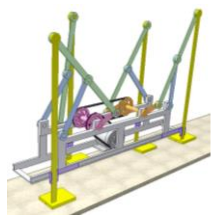
Linear translating motion 1
https://youtu.be/iQDq-5qMKzc
It is an embodiment of Chebyshev's Lambda Mechanism.
Input: pink crank rotating continuously.
Lengths of pink crank and blue bar: a
Length of green bar: 2.5a
Length of yellow bar: 5a
Length of violet bar: 2.5a + 2.5a
Length of orange and brown bars: b
Distances between stationary bearings: b + 2a
Green line is locus of a point on the brown bar.
The brown bar that has linear translating motion in a portion of its way can be used as legs in plantigrade machines.
The mechanism has purely revolute joints.



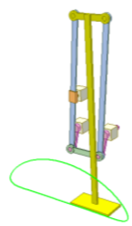
Chebyshev's plantigrade machine 1a
https://youtu.be/s76NNfQN9bI
Input: grey motor making pink and orange crank-shafts rotate regularly at the same velocity thanks to 4 timing belt drives. Pink and orange cranks are parallel.
Here there are four mechanisms shown at:
https://youtu.be/iQDq-5qMKzc



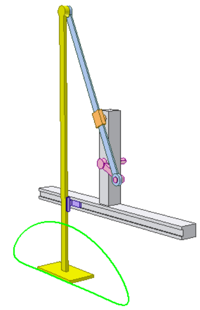
Chebyshev's plantigrade machine 1b
https://youtu.be/ISfVS4mDTKs
Input: grey motor making pink and orange cranks rotate regularly at the same velocity thanks to 2 timing belt drives. Pink and orange cranks are parallel.
Here there are four Chebyshev's Lambda Mechanisms, to which four yellow legs are connected by revolution joints. Violet sliders keep the legs always vertical. Using prismatic joints is the weakness of this machine but the legs are supported more steadier.



Linear translating motion 2a
https://youtu.be/DfFVOXHXgXI
It is an embodiment of mechanism shown at
https://youtu.be/VZSZTB_OLPs
Input: one of pink cranks rotating continuously.
Lengths of pink cranks : a
Length of blue bars: 6a
Distances between vertical stationary bearings: 1.5a
Green line is locus of a point on yellow bar.
There are two parallelogram mechanisms here.
The mechanism has 1 prizmatic joint besides revolution ones.
The yellow bar has linear translating motion in a portion of its way. Time for tracing straight portion is more than 1/2 of working period.
It can be used for plantigrade machines of 2 or 4 legs.

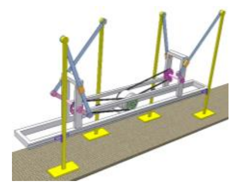


Linear translating motion 2b



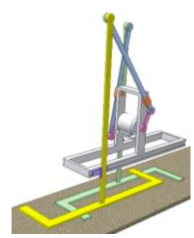
https://youtu.be/rZhC1aCkJW4
It is an embodiment of mechanism shown at
https://youtu.be/VZSZTB_OLPs
Input: pink crank rotating continuously.
Lengths of pink crank : a
Length of blue bar: 6a
Distances between vertical stationary bearings: 1.5a
Green line is locus of a point on yellow bar.
The mechanism has a 3 prizmatic joints and 4 revolution ones.
The yellow bar has linear translating motion in a portion of its way. Time for tracing straight portion is more than 1/2 of working period.
It can be used for plantigrade machines of 2 or 4 legs. See:
https://youtu.be/rZhC1aCkJW4
https://youtu.be/uGPKCq9RM6A

Bar plantigrade machine 1a



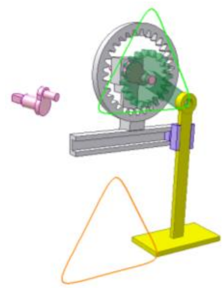
https://youtu.be/rZhC1aCkJW4
Input: grey motor making pink cranks rotate regularly at the same velocity thanks to 2 timing belt drives. Pink cranks are parallel.
It uses four mechanisms shown at
https://youtu.be/VZSZTB_OLPs

Bar plantigrade machine 1b

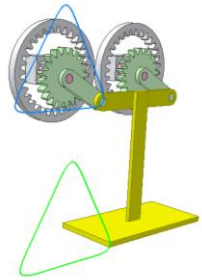


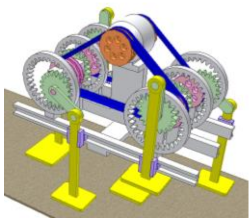
https://youtu.be/uGPKCq9RM6A
Input: pink shaft of two parallel cranks.
It uses four mechanisms shown at
https://youtu.be/VZSZTB_OLPs
U-shape of the legs maintains that the ground projection of center of mass of the machine is always in the leg area.

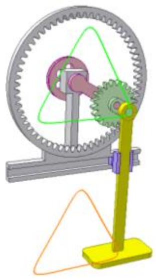
Gear linear translating motion 1a



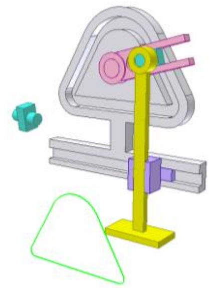
https://youtu.be/ym-pMkvr8aE
Input: pink crank.
Center of the pin on a green satellite pinion traces an equilateral triangle of rounded vertices.
Yellow vertical bar translates following the said triangle thanks to violet slider of two prismatic joints.
Internal gear: tooth number: 30; module: 3 mm
Pinion: tooth number: 20; module: 3 mm
Length of the pinion crank: 55 mm
Length of the pink crank: 15 mm
To draw a complete equilateral triangle the pink crank rotates 2 revolutions.
Time for tracing straight portion of the locus is nearly 1/3 of working period.
It can be used for plantigrade machines of 6 legs. See:
https://youtu.be/u21cYzWwFuQ

Gear linear translating motion 1b
https://youtu.be/3kZnchaXiJQ

Input: pink cranks.
Center of the pin on a green satellite pinion traces an equilateral triangle of rounded vertices.
Yellow vertical bar translates following the said triangle thanks to a parallelogram mechanism (two green cranks and yellow conrod).
Internal gear: tooth number: 30; module: 3 mm
Pinion: tooth number: 20; module: 3 mm
Length of the pinion crank: 55 mm
Length of the pink crank: 15 mm
To draw a complete equilateral triangle the pink crank rotates 2 revolutions.
Time for tracing straight portion is nearly 1/3 of working period.
It can be used for plantigrade machines of 6 legs similarly to
https://youtu.be/u21cYzWwFuQ

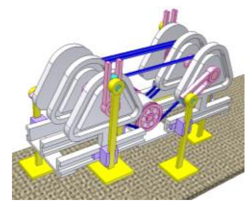
Gear plantigrade machine 1
https://youtu.be/u21cYzWwFuQ

Input: grey motor making three pink crank-shafts rotate regularly at the same velocity thanks to 3 timing belt drives. Angles between cranks of the coaxial crank-shafts are 120 deg.
Here there are six mechanisms shown at:
https://youtu.be/ym-pMkvr8aE
The machine motion is not very even because time on the ground of each leg is less than 1/3 of working period.

Gear linear translating motion 2
https://youtu.be/OPXL0uEw93U

Input: pink crank.
Center of the pin on green satellite pinion traces an equilateral triangle of rounded vertices.
Yellow vertical bar translates following the said triangle thanks to violet slider of two prismatic joints.
Internal gear: tooth number: 60; module: 3 mm
Pinion: tooth number: 20; module: 3 mm
Length of the pinion crank: 16.5 mm
Length of the pink crank: 60 mm
To draw a complete equilateral triangle the pink crank rotates 1 revolution.
Time for tracing straight portion is nearly 1/3 of working period.
It can be used for plantigrade machines of 6 legs similarly to
https://youtu.be/u21cYzWwFuQ

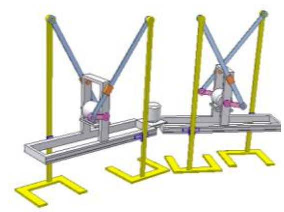
Cam linear translating motion
https://youtu.be/kUwZhcIzwAI
Input: pink crank rotating regularly.
A pin of cyan slider moving along grey cam slot.
Yellow bar has translating motion following the cam profile (green curve) that can be of any shape.
Here it is an equilateral triangle of rounded upper vertex. Time for tracing bottom straight portion is nearly 1/3 of working period.
The mechanism can be used for plantigrade machines of 6 legs.



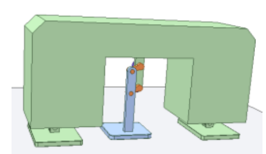
Cam plantigrade machine 2
https://youtu.be/P9H-hX26SmA
Input: grey motor making six pink crank-shafts rotate regularly at the same velocity thanks to 3 timing belt drives. Angles between cranks of the coaxial crank-shafts are 120 deg.
In this machine there are six mechanisms shown at:
https://youtu.be/kUwZhcIzwAI



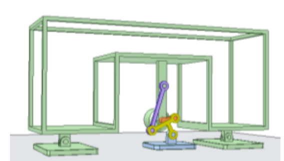
Bar plantigrade machine 1c
https://youtu.be/EyiWoa5fZws
It uses two mechanisms shown at
https://youtu.be/uGPKCq9RM6A
for studying how the plantigrade changes its moving direction.
Grey front and rear frames connected together by a revolution joint. Middle motor controls angle between them thus controls moving direction of the plantigrade.
Two other motors rotate at the same velocity.
Considerable lateral slipping of the legs is detected.



Walking mechanism 1
http://youtu.be/ZKNh4zbAY9M
Input: one among two orange cranks.
Blue foot and two orange cranks create a parallelogram mechanism.
The blue foot has circular translating motion.
This is applied for displacement of heavy equipments.

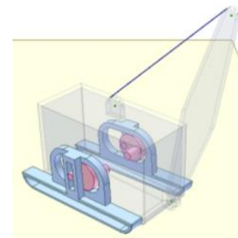


Walking mechanism 2
https://youtu.be/R5_1p5EPQWw
Input: orange crank.
Blue foot has revolution joint with yellow conrod of a 4-bar linkage.
This is applied for displacement of heavy equipments.



Walking mechanism 3

https://youtu.be/D4BFQKZ4zRg

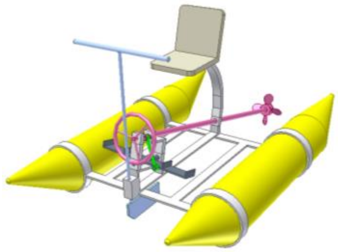


Input: two pink shafts.
Each shaft has two eccentric pins (one large, one small) that slide in two perpendiculat slots of the blue leg.
When the two shafts rotate in the same direction the machine moves straightly.
When one shaft stops the machine changes its moving direction.
This mechanism is applied for displacement of heavy machines.

31.3. Boats

Water bike 1a

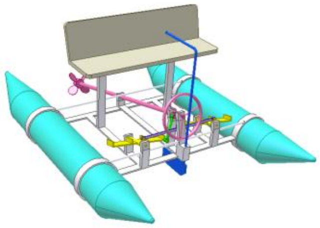
https://youtu.be/QB8ItKr5d94



It is a water bike for one person.
Four bar linkage (grey pedal, green conrod and pink crankshaft) is used to convert pedal oscillation into rotation of propeller like in foot powered sewing machines.
Turn the pink wheel clockwise a little at starting going forward if the linkage is in its dead position.
Blue handlebar is for controlling the blue rudder.

Water bike 1b

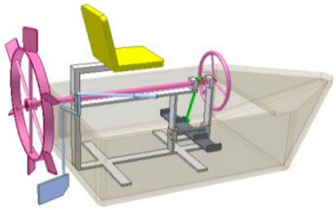
https://youtu.be/oMj7qbXiuZA



It is two person water bike.
Four bar linkage (yellow left pedal, green conrod and pink crankshaft) is used to convert pedal oscillation into rotation of propeller like in foot powered sewing machines.
Turn the pink wheel clockwise a little at starting going forward if the linkage is in its dead position.
Blue handlebar is for controlling the blue rudder.
Two yellow pedals are connected together by violet conrod creating a parallelogram mechanism.

Foot powered boat 1

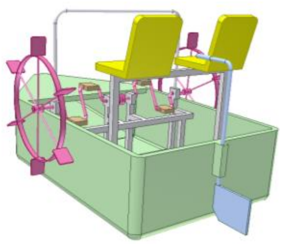
https://youtu.be/Hki0RPzBHjI



Four bar linkage (grey pedal, green conrod and pink crankshaft) is used to convert pedal oscillation into rotation of propeller like in foot powered sewing machines.
Turn the pink wheel clockwise a little at starting going forward if the linkage is in its dead position.
Blue handlebar is for controlling the blue rudder.
Only lower portion of the pink propeller is submerged in the water so the propeller thrust does not make the boat go straight. Use the blue rudder to keep the boat going straight. Adding a second coaxial propeller of opposite blade direction and opposite rotation direction can maintain the straight going however it is too complicated.

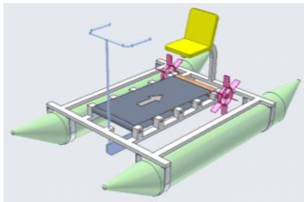
Foot powered boat 2

https://youtu.be/H8NPreucMHs

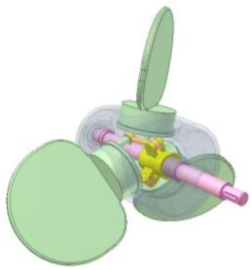


It is the simplest foot powered boat for two people.
Driving forces are directly applied to propeller shafts.

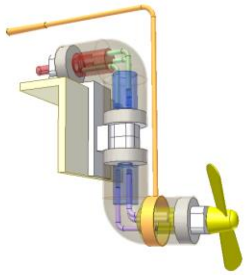
Walking on water device
https://youtu.be/SS3ZzKVV128
It is inspired by bicycle treadmills:
https://www.youtube.com/watch?v=Sg-KpT9RNXE
The walker steps on a slant conveyor belt and thus moves it. The belt makes the propeller shaft rotate thanks to friction.
It is possible for the walker to sit and move the belt.
Measures for belt tensioning and for pressing the propeller shaft to the belt are not shown.



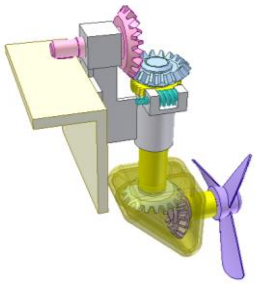
Pitch adjustment for boat propeller 2
https://youtu.be/TJip9Wde8ZI
Green blades are mounted on glass propeller hub by revolute joints.
The blades, orange conrods and yellow nut-slider create slider crank mechanisms.
Turn pink screw in relation with the hub for pitch adjustment.
Device for fixing the screw to the hub after adjustment is not shown.
The screw-nut drive can be replaced with hydraulic cylinder.



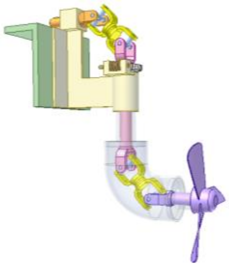
Azimuth thruster with Hobson's joints
https://youtu.be/OV1yZ75glCY
Two Hobson's joints replace two bevel gear drives of ordinary azimuth thruster.
Thrust direction is controlled by orange lever.



Azimuth thruster with bevel gear drives
https://youtu.be/F1K86mkk0J0
Engine torque is transmitted to propeller via two bevel gear drives.
Thrust direction is controlled via a worm drive.



Azimuth thruster with universal joints
https://youtu.be/GsLZrlFd_80
Engine torque is transmitted to propeller via two double cardan joints.
Angle between yellow shaft axes and vertical direction is 45 deg. That ensures a constant velocity transmission.
Thrust direction is controlled via a worm drive.



Passing river by its flow 1

http://www.youtube.com/watch?v=ctT6mFDlHJI

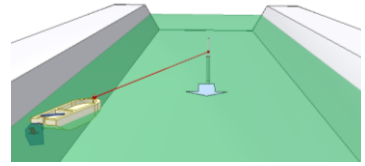


Illustration of movement 447 in the book "507 mechanical movements", 1908

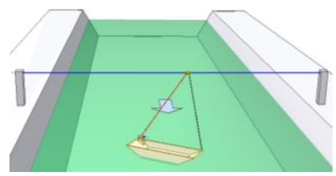
"This method of passing a boat from one shore of a river to the other is common on the Rhine and elsewhere, and is affected by the action of the stream on the rudder, which is carries the boat across the stream an the arc of a circle, the center of which is the anchor which is holds the boat from floating 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.

Passing river by its flow 2

http://youtu.be/xna9hjis_d8



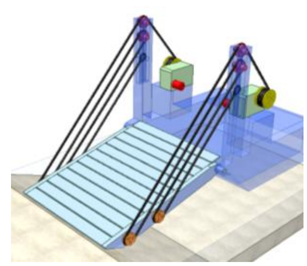
This method of passing a boat from one shore to the other is seen on the La Nga River in Vietnam. No motor, no human power.

Blue arrow shows the flow direction. Because the boat is set un-perpendicular to the stream, there is always a force portion pushing the boat to either shore.

Yellow slider with roller can move along blue runway.

Black cable of constant length has one end fixed to the slider and the other to the boat.

Red cable has one end fixed to the slider and the other to a windlass on the boat. Thus length of the red cable is adjusted for changing boat angle in relation with the stream (in combination with the stream action), i. e. changing motion direction of the boat.



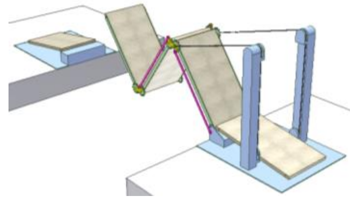
Cable mechanism for ferry slips

https://youtu.be/_UGAD6eFmwU

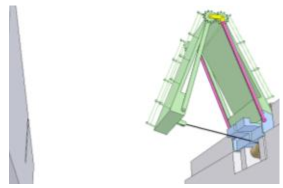
The blue bridge moves up down thanks to a cable mechanism.
The pulley system and reduction gear boxes (in green) help to reduce pulling force of two hydraulic motors (in red).
This animation was made according to a ferry slip seen at Cat Ba island, Vietnam, in September 2017.

31.4. Bridges

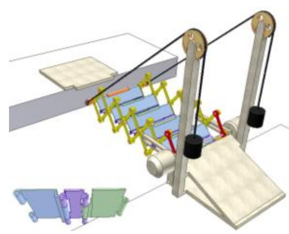
Folding bridge 1
https://youtu.be/8b4xKZv-pl0
The bridge is contracted by two windlasses.
It is stretched under gravity.
Gear forces are very large.
It is an application of the mechanism shown at:
http://www.youtube.com/watch?v=4UpjmxQ3900
See a related real bridge:
https://www.youtube.com/watch?v=E5BF3Lvmi_8



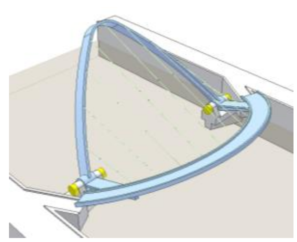
Folding bridge 2
https://youtu.be/JqcCHlzsm9g
The bridge is contracted by brown windlass.
It is stretched thanks to the gravity.
Blue stoppers on the right shore prevents the brigde from falling down at its stretching position.
Gear forces are very large.
Weakness: gap between bridge and the right shore that can be surmounted by placing a cover after stretching.
It is an application of the mechanism shown at:
http://www.youtube.com/watch?v=4UpjmxQ3900



Folding bridge 3
https://youtu.be/ob2z2VW7DhI
It is an application of scissors mechanism.
The bridge (for pedestrians) is stretched and contracted by two brown motors turning red bars.
Black weights are for balancing the bridge weight partly.
When stretched, bridge surface is formed by blue, violet and green plates (shown on lower left side). Their rotary axes are not in horizontal plane when stretched to avoid dead positions. It causes slits on the bridge surface and oscillation of the floor plates.
See a related design very elegant:
https://www.youtube.com/watch?v=7wVgcQ-yMi0
where it seems that the author does not pay attention to dead posiotions of the floor plates.

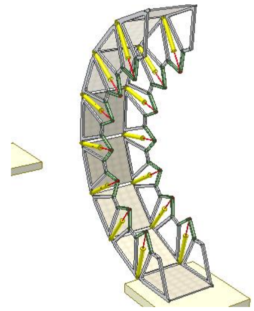


Tilting bridge
https://youtu.be/pQ_wR5dQVGw
It is an animation of Tilting Millennium Bridge, Newcastle, England.
The bridge rotation is controlled by yellow hydraulic motors.
Center of mass of the bridge is arranged to lay on the rotary axis to minimize torque needed for rotation.
See the real bridge:
https://www.youtube.com/watch?v=gk16C5Zgv4w



Rolling bridge

https://youtu.be/2yNamCnxdw4



It is an animation of the Paddington bridge, London.

The bridge consists of 8 spans of isosceles trapezoid shape.

A revolution joint (A) connects two adjacent spans.

Besides they are connected by two green conrods which are linked together by a revolution joint (B).

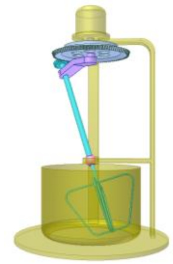
Yellow cylinder and red piston connect A and B.

7 pairs of hydraulic cylinders moving at the same speed roll and straighten the bridge.

At curled up pisition the brigde looks like a sculpture of octagonal shape on one side of the bank.

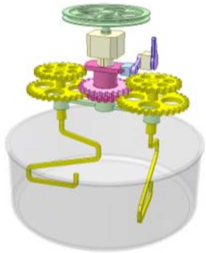
32. Mixing, stirring, crushing machines

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.

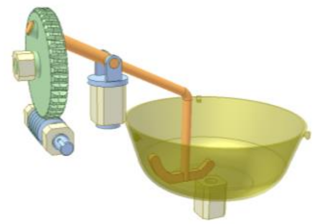


Mixing machine 4
http://youtu.be/6ktLcEOzY9o
Blue gear and violet worm are input links.

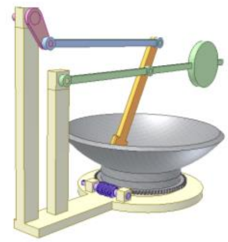
Mixing machine 5
http://youtu.be/iNl0R_26HSE
Blue gear and violet worm are input links.

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.

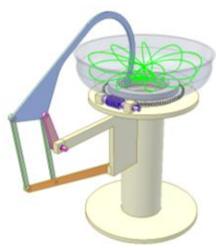
Dough-Kneading Mechanism
http://youtu.be/gYksowpfhFY
It is spherical 4R mechanism.
4R: 4 revolute joints.
Spherical: Joint center lines intersect at a common point.
The wobbling motion of the orange link is used to knead dough in the tank.



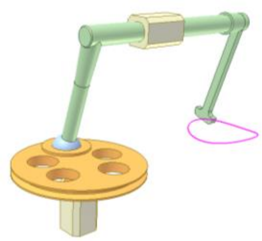
Stirring machine 1
https://youtu.be/a8gz7MvQ_qI
Input: pink crank and violet worm.
Revolution joint is located at center of spherical inner surface of grey container. Lower end of orange stirring bar is always in contact with the said surface under gravity. So practically the stirring mechanism is a 4-bar linkage (pink crank, green conrod and orange rocker).



Stirring machine
https://youtu.be/sZAlO0BdYLI
Input: pink crank and violet worm.
Green line is trajectory of stirring bar in relation with glass container.



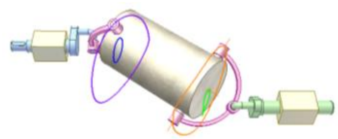
Agitator Mechanism
http://www.youtube.com/watch?v=aHEz0qNzyJ8
It is R-S-C-C space 4-bar mechanism.
R-S-C-C: Joint symbols from input to output joint.
R: revolute
S: sphere
C: cylinder
The output link rotates and translates, performs a twisting motion.



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.

Mixing machine 7

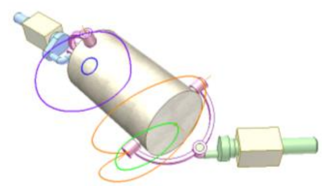
http://youtu.be/v_JZ3Q8pE1Y



Input: blue shaft.
Blue and green shafts are parallel offset.
Brown barrel has complicated motion.
Blue and green lines are loci of center points of the barrel end faces.
Orange and violet lines are loci of peripheral points of the barrel.
Strange things are:
1. In 1 rev. of the input, the peripheral points turn 1 rev. but the center points turn 2 rev.
2. In 1 rev. of the input, the green shaft turns 1 rev. but reciprocates four times.

Mixing machine 8

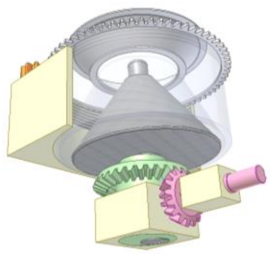
http://youtu.be/WdZ0JSi8mBc



Input: blue shaft.
Angle between blue and green shafts is 40 deg.
Brown barrel has complicated motion.
Blue and green lines are loci of center points of the barrel end faces.
Orange and violet lines are loci of peripheral points of the barrel.
Strange things are:
1. In 1 rev. of the input, the peripheral points turn 1 rev. but the center points turn 2 rev.
2. In 1 rev. of the input, the green shaft turns 1 rev. but reciprocates twice.

Cone crusher

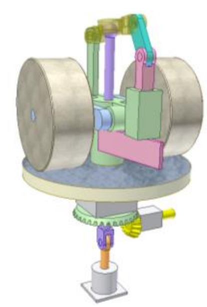
https://youtu.be/p7uIE_TYz4Y



Crushing material is loaded from above into space between inner (in grey) an outer (in glass) cones. The own axis of the inner cone creates a small angle with its rotary axis.
Orange pinion is for adjusting gap between the cones by moving up-down the outer cone via a nut-screw drive.
The video shows how to adjust the gap during the action of the crusher.

Vertical roller mill

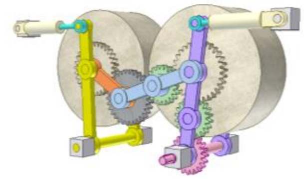
https://youtu.be/goOBCts7i7o



Material is loaded on grey disk from above. It is grinded under heavy rollers mounted on blue cranks that rotate around the vertical axis thanks to a bevel gear drive.
Pink plate (moved up-down by orange piston) is for removing product (powder) from the disk.
A possible design: the grey disk rotates, the blue cranks are stationary.

Roller crusher

https://youtu.be/ORIEY5M2kU0



Input: pink shaft.

Two brown crushing rollers rotate at the same velocity in opposite directions thanks to a system of bars and six gears that ensures proper gear engagement.

Roller positions and the gaps between the rollers are controlled by two hydraulic cylinders. The left one is for moving the left roller and vice versa.

Centers of the rollers move almost in the horizontal plane.

33. Agriculture machines

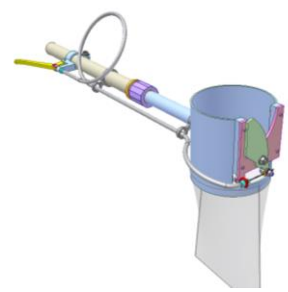
Fruit picker 1

https://youtu.be/daz4LKJQQ6Q

Violet conrod connects yellow lever and green cutter via revolution joints. Red helical spring keeps the cutters always open.
The distance from the control lever to the cutters can not be adjusted for this picker (the pole length is constant).
A picker of adjustable distance is of more complicated structure.
To catch falling fruits a bag (not shown) is attached under the cutters.
This picker is used for pruning small branches also.

Fruit picker 2

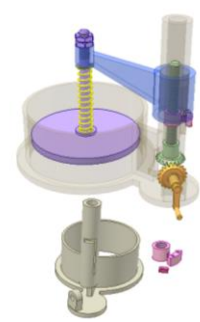
https://youtu.be/kSTHor87_i8



Motion of the green cutter is controlled by yellow lever.
The distance from the control lever to the cutters can be adjusted thanks to violet nut and orange flexible bush. See:
https://youtu.be/5U2Yns2J4IQ
Bowden cable mechanism makes the control possible at various distances. Violet spring keeps the cutters always open.
To catch falling fruits a bag is attached under the cutters.

Loading device of tea rolling machine

https://youtu.be/7AExAoGK1lc



It is an application of mechanism shown at:
https://youtu.be/uYUSwiRqH1Q
Pink nut of green screw has a rectangular pin that moves in L-shaped slot of the brown vertical tube.
Green screw is fixed to the green bevel gear.
Rotate orange gear counterclockwise to move blue arm up and to turn it aside for loading material into the large cylinder.
Do inversely for pressing down the material.
Blue arm can move vertically only when the nut pin is in vertical portion of the L-shaped slot.
Blue arm can move horizontally only when the nut pin is in horizontal portion of the L-shaped slot.
See a real device:
https://www.youtube.com/watch?v=g0-vYCYSrtE

Tea rolling machine

https://youtu.be/5A7nA9nPlVE

Input: pink pulley.

Three blue arms play role of a common conrod for three parallelogram mechanisms of pink and yellow cranks.

Violet lever is for opening green bottom window to take out the rolled tea.

See a real machine:

https://www.youtube.com/watch?v=g0-vYCYSrtE

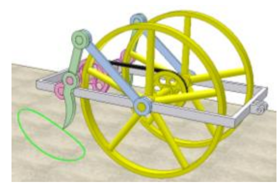
In this machine the damp tea leaves are rolled (wrapped around itself) to be formed into wrinkled strips. This rolling action also causes some of the sap, essential oils, and juices inside the leaves to ooze out, which further enhances the taste of the tea.

The blue device is for loading tea material. See:

https://youtu.be/7AExAoGK1lc

Tedder

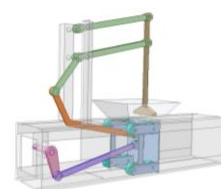
https://youtu.be/LtHSszwrz7M



The tedder is pulled by a tractor (not shown). Rotary motion of yellow wheels is transmitted to pink crank-shaft via a timing belt or chain drive. Pink crank, green conrod and blue bar create a four-bar mechanism. Complicated motion of green conrod lower ends (green curve) is used for tedding hay.

Mini hay baler

https://youtu.be/8UHmVVkDzzs



It consists of:

1. Slider crank mechanism. Pink crank receives motion from a engine and moves blue slider to compress the hay.

2. Parallelogram mechanism making brown bar move up-down to fill the hay into the space in front of the slider.

Orange bar connects two said mechanisms together.

This video was made on request of a YouTube viewer.

Related source:

https://www.youtube.com/watch?v=ETJDgAEoBtw&feature=youtu.be

34. Furniture

Folding chair 1
https://youtu.be/AM3Y_bU-8OA
It is an application of 4 bar linkage.
If yellow rear legs are considered as a stationary link so green front leg and blue seat are the rockers; pink link is the connecting rod.

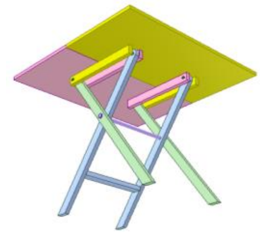
Folding chair 2
https://youtu.be/Ulu1h7u65UM
It is an application of 4 bar linkage.
If green rear legs are considered as a stationary link so pink link and blue seat are the rockers; yellow front legs are the connecting rod.

Folding chair 3
https://youtu.be/DVwjsFNy9dU
It is an application of slider crank mechanism.
If yellow rear legs are considered as a stationary link so front legs are the crank and brown seat is the connecting rod.
Pink pins slide along grooves of the yellow rear legs.

Folding table 1
https://youtu.be/2wWbrVpt4BY
It is an application of 4 bar linkage.

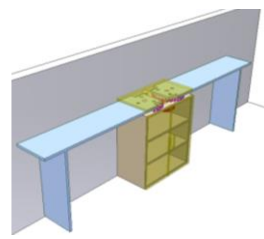
Folding table 2
https://youtu.be/6i3c7QYNIuA
During folding/unfolding process it is not closed kinematic chain.

Folding table 3
https://youtu.be/i428A_88ne0
It is an application of 4 bar linkage.

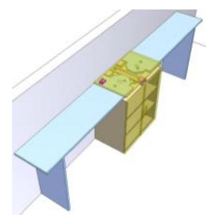


Folding table 4
https://youtu.be/JFYFs4cz_TU
During folding/unfolding process it is not closed kinematic chain.
This video was made based on:
https://www.youtube.com/watch?v=FtdaEFsvyQg

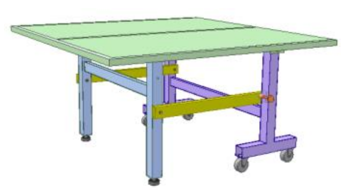
Shape transformable table 1a
https://youtu.be/EE_0Hr_jHR4
Pink gears are fixed to blue tables.
Red motor hidden in the cabinet turns the tables 90 deg. to get one of their two arrangements.



Shape transformable table 1b
https://youtu.be/UnL7yWInTNs
Green angular bars are fixed to blue tables.
Pink slider has a pin that slides in slots of the two green angular bars.
Red motor hidden in the cabinet turns the tables 90 deg. to get one of their two arrangements.



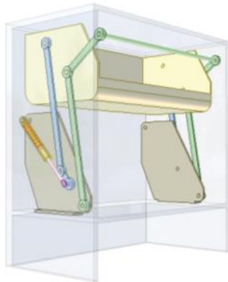
Folding ping-pong table1
https://youtu.be/nAh66UjQSfk



Raise left side of green panel to make it vertical.
The panel, violet front legs, blue rear legs and yellow bars create a parallelogram mechanism.
Adjust black screws to make the green panel horizontal.
Orange spring pin locks the panel at its vertical position. Pull the pin to unlock.

Pull down shelf 1

https://youtu.be/FdFmeAY8nmo



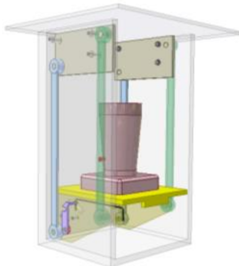
Beige base, yellow shelf and two rockers (in blue and green) create a parallelogram mechanism. Pull the green bar to get the shelf down. Spring cylinders equilibrate the mechanism.

This idea is taken from:

http://www.kesseboehmer.com/fileadmin/downloads/pdf/iMove-EN.pdf

Pull up shelf 1

https://youtu.be/mJGUocWFd4M



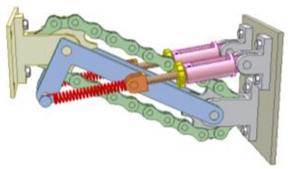
Beige base, yellow shelf and two rockers (in blue and green) create a parallelogram mechanism. Raise the shelf to its up position. Violet latch locks it there. Pull the black rod to unlock and lower the shelf.

This idea is taken from:

https://www.youtube.com/watch?v=FyUhV2nWWco

TV wall bracket 1

https://youtu.be/COZLfUvlu0Q

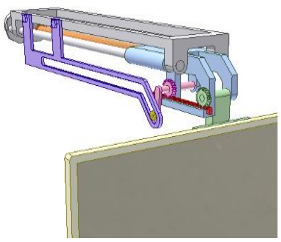


Instead of a parallelogram mechanism here a chain drive ensures that the TV direction is kept unchanged when it moves up down. The grey sprocket is stationary. The TV back is fixed to the other sprocket (in yellow).

Red springs equilibrate the mechanism. Positions of the spring pivots are the key factor. They should be defined during testing the mechanism to ensure that when spring force is increased, its lever arm for right revolution joint of the blue bar is reduced.

Mechanism for spreading a monitor

http://youtu.be/QAF4EligtPM



The monitor is hidden in a box (not shown). Orange screw powered by a motor moves blue slider. The green display support has revolution joint with the slider. Violet cam via pink crank, two pinions and a red rack turns the support 90 deg. at its forward position. The red rack moves in a runway of the blue slider only when the monitor is turning.

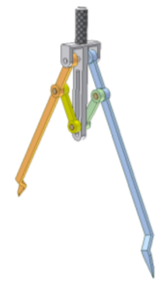
Using such second shaft for the pink crank is needed (instead of green shaft of the support). If not the violet cam will be protruded outside the box.

Replacement of gear-rack drive with parallelogram mechanism is possible provided its dead position is avoided.

35. Office appliances

Pair of compasses 1

https://youtu.be/KJqJb3I4IWg



It is a combination of two crank-slider mechanisms. Green and yellow bars play the role of conrods.

Blue and orange legs are coaxial and turn in opposite directions with the same velocity to ensure that the handle is always on the bisector of angle created by the legs.

See also:

http://youtu.be/CsEWqFHsx9g

Pair of compasses 2a

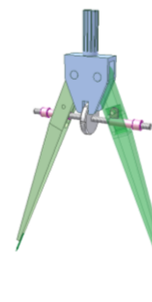
https://youtu.be/8Q07phTcFgE

Pink nuts have revolution joints with the legs. The screw has planar joint with the handle.

Turn screw of two opposite handed threads to alter distance between needle points. The legs are coaxial and turn in opposite directions with the same velocity to ensure that the handle is always on the bisector of the angle created by the legs.

Pair of compasses 2b

https://youtu.be/cOlsc64Xaao



Two green legs are not coaxial.

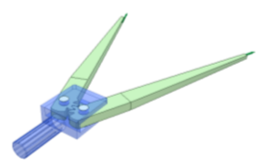
Pink nuts have revolution joints with green legs.

The screw has planar joint with the handle.

Turn screw of two opposite handed threads to alter distance between needle points. The mechanism ensures that the legs turn in opposite directions with the same velocity and the handle is always on the bisector of the angle created by the legs.

Pair of compasses 3

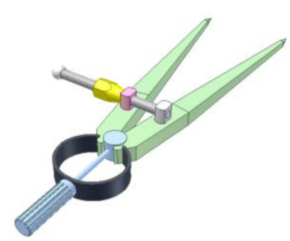
https://youtu.be/_AayprgIcgc



Two green legs are not coaxial. They are in gear engagement with each other thus turn in opposite directions with the same velocity to maintain that the handle is always on the bisector of the angle created by the legs.

Pair of compasses 4a

https://youtu.be/EpQl8o0sfV8

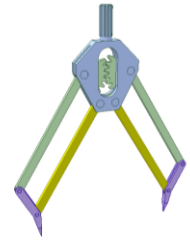


Blue handle has revolution joints with green legs. Circular spring (fixed to the handle and to the legs) always forces the legs move apart from each other. Pin part (bearing for grey screw) and grey part (fixed to grey screw) have revolution joints with the legs.

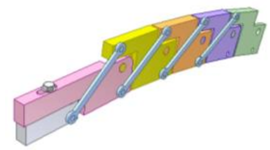
Turn yellow nut to alter distance between the leg points.

The mechanism ensures that the handle is always on the bisector of the angle created by the legs.

Pair of compasses 5
https://youtu.be/s-jp3tBTGjg
Gear engagement between green rockers ensures that blue handle is always on the bisector of the angle created by the green rockers.
Green and yellow rockers, violets conrod create parallelogram mechanisms that ensure violet points are always perpendicular to the drawing plane.

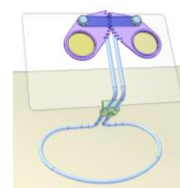


Chebyshev's ruler for drawing large radius arc
https://youtu.be/Cd6pqjsst-k
The orange part is connected to the yellow part by a revolution joint, to the violet part by another revolution joint. It is also connected to the pink part via blue conrod and to green part via another blue conrod.

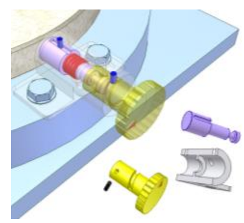


Move the pink part to get desired radius, tight the screw to fix the ruler and draw the arc.
The drawn arc consists of many line segments and is not smooth. To overcome that adding elastic bands on the ruler's upper and lower surfaces is recommended.

Table-Top Stereoscopic Viewer
https://youtu.be/WVL-DdOKq00
When adjusting for eye separation (turning violet parts around blue screws), the gear drive ensures that the two lenses stays equidistant from the centre.
See the product at:
http://www.tennants.co.uk/catalogue/Lots/117010.aspx



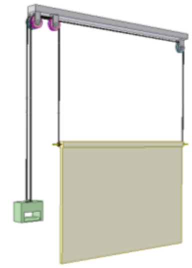
Paper scroller 1
https://youtu.be/EWqC8mdkrUI
Turn the yellow knob to get 3 working states.



1. The red arrow points to the left: the black pin on the knob prevents the violet shaft from contact with the disk so the latter can rotate free.
2. The red arrow points up: the black pin does not contact the violet shaft. The latter contacts the disk and brakes it with a sufficent friction force caused by red spring.
3. The red arrow points to the right: the black pin pushes the shaft towards the disk with large force so the disk can not rotate.

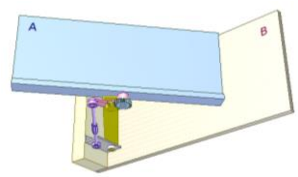
It is possible to make teeth on the outside cylindrical surface of the disk and the shaft end in shape of a pawl.
A paper scroller consists of two such mechanisms. By combination of their working states people can scroll paper fast, slowly for searching informations or keep it immobile for reading.
This mechanism was made on request of a YouTube viewer from Israel.

Counterbalance for board



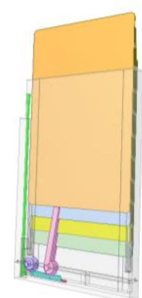
https://youtu.be/xTALILtw-GI
Each end of the black cable is fixed to the board.
One cable branch winds around blue pulleys.
The other winds around pink pulleys.
The green counter-weight, to which the cable is fixed, keeps the board immobile at set positions and not slanting during motion under gravity action.
This idea is taken from:
https://www.youtube.com/watch?v=Ly2Mq2gcyco

Mechanism for displaying two pannels



http://youtu.be/AAOihkueJLw
When yellow bar turns 90 deg. faces A and B are displayed towards the bisector of angle between them.
Yellow bar, violet bar and pink V-arm create a parallelogram mechanism. Yellow and blue gears have the same tooth number.
Yellow gear is fixed to yellow bar.
Blue gear is fixed to blue bar.
The mechanism can be applied for furniture cabinets or monitor supports.
Disadvantage: yellow and blue bars are not in line at open position.

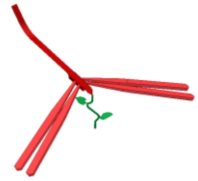
Credit card box



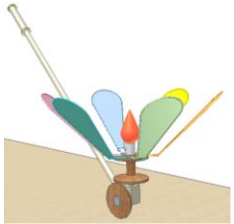
https://youtu.be/wMMzQT6m9DQ
Push green rod to raise the cards in a stair step manner.
Key factor: pink combined cams that are driven via rack-pinion drive.
The box bottom is detachable to ease the assembly.
Red spring brings the mechanism to initial position.
This video was made on request of a YouTube viewer.
Device for positioning the green rod (similar to the one used for ballpoint pens) is not shown. Its reference video:
https://www.youtube.com/watch?v=GjByJMGfUpY

36. Toys

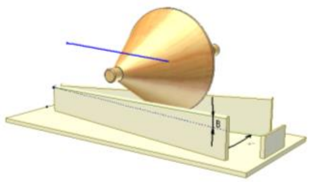
Inventor dragonfly
http://www.youtube.com/watch?v=iQEK0CuneTY
Stable balance. The center of gravity is lower than the fulcrum.



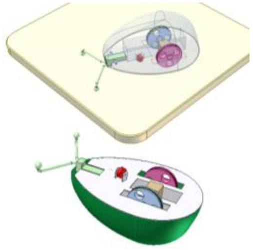
Toy rotation flower
https://youtu.be/G6bYNudeZV8
This toy is popular in Vietnam during Mid-Autumn Festival.
Push the toy on the road. Rotation of the horizontal roller is transmitted to the vertical one to which the flower is fixed. The friction force between the rollers is generated by gravity.
A candle is fixed to the vertical roller pivot.



Uphill roller
https://youtu.be/O7jj_lFWbCg
It was presented by William Leybourn in his book "Pleasure with Profit", 1694.
Under the gravity the roller moves to the right. It looks that it moves up along the inclined rails. In fact the roller center of mass moves down. Blue line is its trajectory.
Motion condition: tg(B) must be less than tg(A).tg(C)
A: vertex angle of the roller cone.
B: inclined angle of the rails
C: angle between the rails

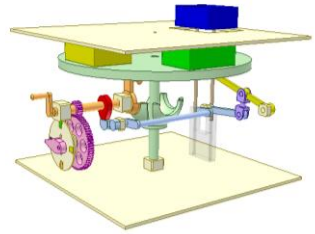


Unfallen beetle
https://youtu.be/G04TPKo1YQ0
Large pink wheel receives motion from brown motor.
Large blue wheel and small red wheel are idly mounted.
Green antenna has longitudinal revolution joint with the chassis. Violet pin is for restricting the antenna rotation.
When the antenna is on the plane surface, the beetle contacts the desk via 2 points of the antenna and 2 points of the large wheels. The beetle does not go straight on because only one wheel is driven.
Once a point of the antenna is out of the desk, the small wheel contacts the desk, becomes a guide wheel, and the beetle turns urgently to bring the antenna out point back to the desk. So the beetle never falls down.
This toy of spring motor was seen in Slovakia, in 1982.



Magic chest 1

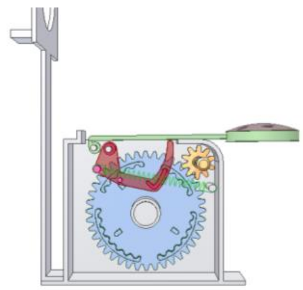
http://youtu.be/aJnnoExw77s



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.

Pie throwing game.

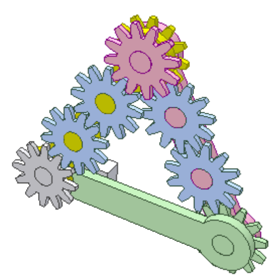
https://youtu.be/KcQzXsqfRKg



Game apparatus comprising a base supporting a vertical wall and a chin rest for a player (on the left). The wall has an opening facing the chin rest and an arm (in red) is pivotally supported on the base on the side of the wall opposite the chin rest. The arm is adapted to support a simulated pie. The player turns orange gear and the arm randomly swings upwardly to throw the pie through the opening in the vertical wall. The random happens due to the interaction of the arm of a pink curved rib and a pink pin with 4 internal gear segments of different notch numbers (4, 5, 6 and 7 in this video) and 4 rectangular pins fixed on blue gear.
Once the curved rib enters the notch, a click sounds (under action of the green spring). So in interval of two consecutive throwings may be 4, 5, 6, 7 clicks. It is extremely difficult to guess the number of clicks that will take place after the pie is released before it will be released again.
This video was made based on US patent 3488050, 1969
A video showing how to play
https://www.youtube.com/watch?v=jVSj1WUZ7Zk

Rolling rod of spur gears

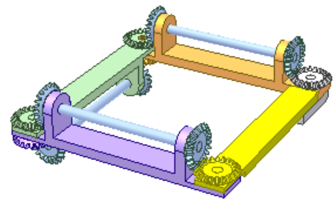
https://youtu.be/Dj--7y1GONA



Input: yellow bar.
All the gears have the same tooth number.
Blue gears rotate idly on yellow or pink bars.
The gears are fixed to the bar of their colour.
Grey gear is fixed to the grey base.
Angles between adjacent bars are kept equal to the input angle A during the motion.
If A = 120 deg., the three bars create an equilateral triangle.
If the bar number is n, the bars can create an equilateral polygon of n sides when A = 360/n.
Instead of spur gears other drive can be used provided that transmission ratio between grey and pink gears / yellow and green gears is -1.
This mechanism may be a solution for the London rolling bridge shown at
https://www.youtube.com/watch?v=2yNamCnxdw4

Rolling rod of bevel gears

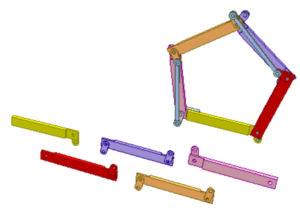
https://youtu.be/jKLM5_QOwOI



Input: orange bar.
All the gears have the same tooth number.
The gears are fixed to the bar of their colour.
Grey gear is fixed to the grey base.
Angles between adjacent bars are kept equal to the input angle A during the motion.
If A = 90 deg., the four bars create a square.
If the bar number is n, the bars can create an equilateral polygon of n sides when A = 360/n.
This mechanism may be a solution for the London rolling bridge shown at
https://www.youtube.com/watch?v=2yNamCnxdw4

Rolling rod of anti-parallelogram mechanisms

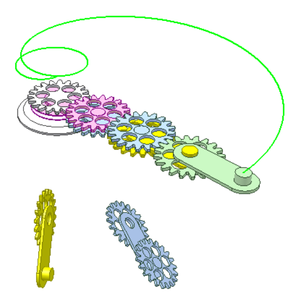
https://youtu.be/4E0GZ8XQyss



Input: pink bar.
All the short cranks of various colours have the same length.
Short cranks are fixed to the bar of their colour.
Two cranks and a blue conrod create an anti-parallelogram mechanism.
Grey crank is fixed to the grey base.
During motion angles between adjacent bars are not the same (with little differences).
In this video for closing the pentagon the pink input bar turns 76.5 deg. (not 360/5 = 72 deg) and the pentagon is not an equiangular one (103.5 or 115 deg., not 108 deg.).
A similar mechanism of three bars can be used for animation of the human finger.

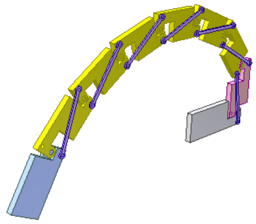
Gear whiplash

https://youtu.be/-E2pNGHip6U

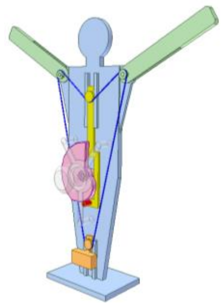


Input: pink gear crank.
System of gears and bars stretches and folds continuously when the input rotates.
White gear is stationary.
Blue gears are in mesh with white and green gears.
Pink gear is in mesh with yellow gear.
The stretching length can be increased by adding the gear-bars.
At particular positions various regular polygons are created (triangular and square in this video).
Green curve is the trajectory of a point on the green bar.
Instead of gear drives use cross belt or bevel gear ones to make the system less bulky.
This animation is adapted from:
https://www.youtube.com/watch?v=2NqpKzyLNk8

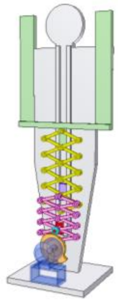
Rolling rod of bar mechanisms
https://youtu.be/P9XVfmChawA
Input: pink plate.
Angles between adjacent plates are not the same during motion.
In this video at the end position (the pink plate turns 90 deg.) as from the pink plate they are 141.75 / 151.53 / 157.14 / 160.85 / 163.50 / 165.50 and 167.06 deg.



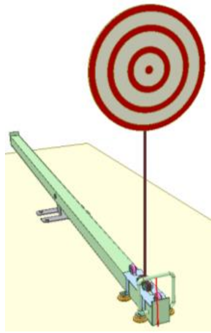
Hands up dummy 1
https://youtu.be/fe8pu1bo8mA
Input: pink cam driven by a motor (in glass).
Orange weight maintains contact between the cam and red pin of yellow follower.
Blue cable should be wound more than one revolution on green pulleys to increase friction torques.
The dummy is used in basketball training, made on request from a Youtuber.



Hands up dummy 2
https://youtu.be/LsHYy3xdSS0
Input: orange cam driven by a motor (in blue).
Thanks to double scissor mechanism (in pink and yellow) stroke length of green arms is very large, 20 times of the one of the cam follower (in red).
Gravity maintains cam and roller contact.
The dummy is used in basketball training, made on request from a Youtuber.
For more details of double scissor mechanism see:
https://youtu.be/zYfj9d2adqg

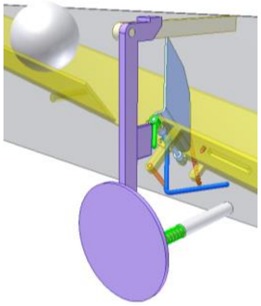


Dart cart
https://youtu.be/arXgx75icIU
This is a possible solution for the idea shown at:
https://sites.google.com/site/billyhasideas/home/dart-cart
Raise the green beam to bring the dartboard to far position (position for throwing the darts).
Lower the green beam to bring the dartboard to near position for taking back the darts.
Red arrows represent forces applied to the beam.
The blue cart moves due to gravity.



According to the game rules the distance between the front of the dartboard and the toeline is rather short (7 feet 9.25 inches, around 2.4 m), so is this idea really necessary? However the mechanism may find applications in other fields.

Mechanism for American TV show Top Shot



https://youtu.be/ufPPbVnoYgg
Grey balls are released one by one to roll down along a railway that consists of several sections connected together in zigzag shape.
Each section has a gate (hole) and its cover. The video shows only one section.
If the cover is open, the balls fall through the gate.
The contestant tries to hit violet round target for closing the gate to let the ball continue rolling in the railway to the final basket at the railway lower end. Winner is who gets most balls in the basket.
See the show at:
http://www.dailymotion.com/video/x1031yx_top-shot-s03e03-slug-it-out_sport
from 34th minute.
This video is made on request of a YouTuber, wjf213, who wants a mechanism purely mechanical.
When the red bullet hits violet target, a plate fixed to the target pushes green arm (fixed to the blue gate cover) to close the gate.
After passing the cover, the ball pushes the blue arm (fixed to the blue gate cover) to open the gate.
Red spring, creating snap action, keeps the cover firmly at its closing or opening positions.
At those positions axis of the revolute joint of the cover is not in the plane containing axes of the spring pins.
Two orange pins (one long, one short) are stoppers for the cover.
Green spring is for reducing oscillation of the target.

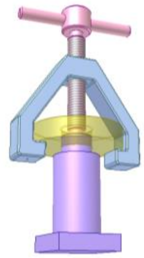
Multigear kinetic scupture

https://youtu.be/q8THK8q6cAw
Gears of two colors create squares during motion.
Input: the central gear.
The video was made based on:
https://www.youtube.com/watch?v=0_22x26qYPA

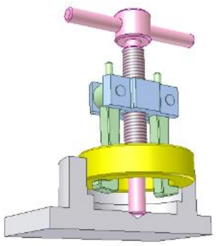
Sphere rotating around two perpendicular axes.

https://youtu.be/_AV5JinSviE
A kinetic scupture.
Input: blue shaft.
Large gear to which is fixed the sphere has revolute joint with the blue shaft. See the similar joint:
https://youtu.be/bx6Pn9XReg8
The sphere is driven via planetary bevel gear drive and spur gear one so it rotates around vertical and horizontal axes at the same time.
It is possible to hide the rim gear by attaching two flexible bands to the sphere groove walls.

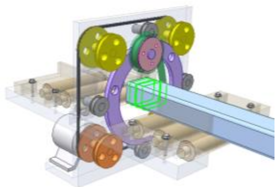
37. Unclassified mechanisms



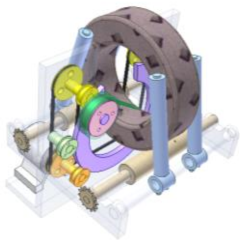
External puller 1
https://youtu.be/jn0RTUaaG90
It is an application of screw-nut drive for removing a disk (in yellow) out of a shaft (in violet). Hold the blue nut to prevent it from rotation at first stage of removing process.



Internal puller 1
https://youtu.be/KpgLyvXUVFw
It is an application of screw-nut drive for removing a bush (in yellow) out of a hole (in grey). Hold the blue nut to prevent it from rotation at first stage of removing process.

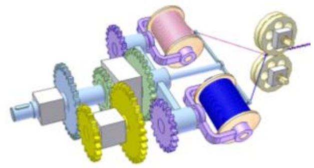


Wrapping machine for bar products
https://youtu.be/5B_NEMaa86E
Blue bar is wrapped with green foil.
Input: orange pulley of grey motor. Three yellow rollers receive motion via black belt.
Violet ring carrying a foil coil rotates on orange, yellow and grey rollers (friction drives).
The bar moves longitudinally thanks to brown rollers. The transmission for them is not shown.
See a real machine:
https://www.youtube.com/watch?v=P3eUWD1DQQs

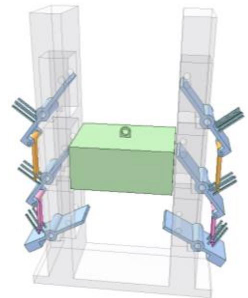


Wrapping machine for torus-shaped products
https://youtu.be/UknoNWF7xd0
The brown torus-shaped product is wrapped with green foil.
Input: orange pulley-roller of grey motor. Three other pulley-rollers receive motion via black belts.
Violet ring carrying a foil coil rotates on orange, yellow and green rollers (friction drives). The ring cut-off portion is for loading and removing the product.
The product rotates thanks to two long brown rollers. The transmission for them is not shown.
See a real machine:
https://www.youtube.com/watch?v=0bf2GOYkLv8

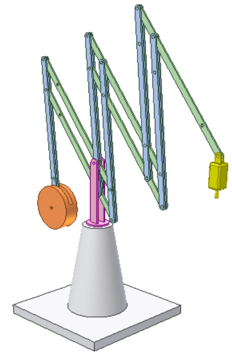
Cable braiding machine
https://youtu.be/UT0FR6VhdcM
Input: blue shaft, popcorn rollers.
It is an application of planetary gear drive.
The wires are pulled from their coils, twisted and braided into cable.



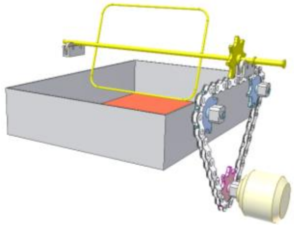
Storage rack 1
https://youtu.be/1F5V2wHBY5U
This rack allows loading and unloading goods in vertical direction. Blue levers prevent the contact of packages.
Blue levers of each level do not stop the package if there is no other package on the lower next level and vice versa.
Blue levers of each level do not prevent package go up if they are free of package.



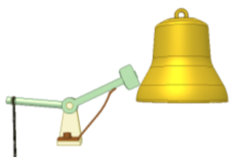
Counterbalance bar system
https://youtu.be/QlNrAMDR_qM
The operator can move the yellow tool up-down, radial inward-outward or turn it around the white base. The bar system of several parallelogram mechanisms is connected to the pink vertical fork by a horizontal axle. Orange counter weight ensures that torque around the axle caused by the gravity applied to the bar system is almost nil.
This idea is taken from:
https://www.youtube.com/watch?v=v4zkWWwHKBY



Roasting oven 1
https://youtu.be/JyrJ20f_C20
This oven for roasting ducks or chiken is popuplar in Vietnamese street markets.
Yellow roasting jack can be placed on or taken off from the oven at any time without stopping the chain drive.
Increase the bearing horizontal distance for more roasting jacks.

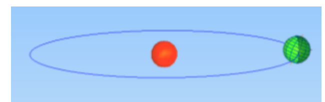


Hammer for striking bell 1
http://youtu.be/gT-QpjkZ6dA
Arrangement of hammer for striking bells. Spring below the hammer raises it out of contact with the bell after striking and so prevents it from interfering with the vibration of the metal in the bell.



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.

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