Nguyen Duc Thang

3200 ANIMATED MECHANICAL MECHANISMS

With

Images,
Brief explanations
and YouTube links

Part 4

Mechanisms for various industries

31 March 2020

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.

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Job history:
- Designer of small mechanical engineering enterprises in Hanoi.
- Retirement in 2002.
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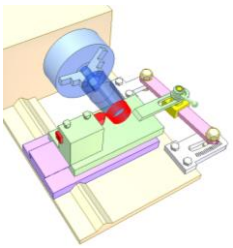
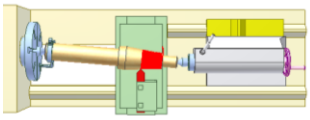
26.1. Mechanisms for machine tools

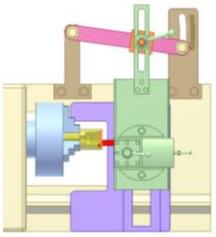
Tapered turning attachment 1
http://youtu.be/fm7uZqS3Oy0
The green slider carries red tool and yellow slider which has revolution joint with the green slider and prismatic joint with pink taper ruler. When the violet power-fed carriage moves along the axis of rotation of the blue work, the tool moves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



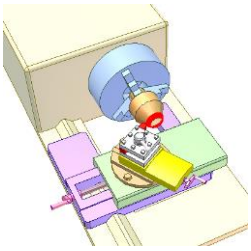
Tapered turning by offsetting of the tailstock
http://youtu.be/z3iYhKFPHKc
This method more suited for shallow tapers.
Approximately the set-over S = L.sinα
L: distance between the blue centers
α: half of taper angle



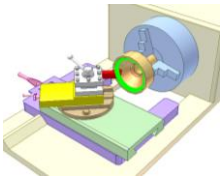
Tapered turning attachment 2
http://www.youtube.com/watch?v=9OcQW3Wc1eE
The green slider carries red tool and orange slider which has revolution joint with the green slider and prismatic joint with pink taper ruler. When the violet power-fed carriage moves along the axis of rotation of the yellow work,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



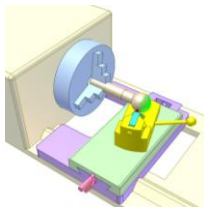
Tapered turning by using the compound slide 2
http://youtu.be/ysiVGfX4p_4
The brown base of the yellow compound slide is turned an angle α (half of taper angle of inner cone surface to be created) and then fixed. This makes the tool moves along a line that creates an angle α with the axis of rotation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

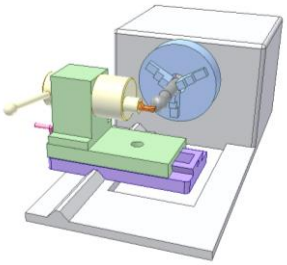
Axis of the revolution joint between the yellow tool post and the green slider must intersect axis of rotation of the work. If not, the created surface is toric, not spherical.



Turning balls using boring head

https://youtu.be/fdEiWtz3wW4

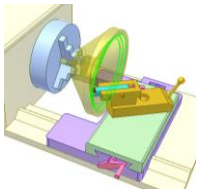
Turn popcorn boring head to create external spherical surface of the grey work.
Rotary axis of the head and rotary axis of the work intersect at a right angle.
Distance A between the orange cutter tip and rotary axis of the head is equal to radius R of the ball to be cut.
For more about the boring head see:
https://youtu.be/fdEiWtz3wW4
See ball turning in practice
https://youtu.be/CswdaiwZyQc



Internal spherical turning 1

http://youtu.be/f0lYSAXJyBs

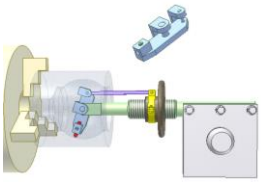
Axis of the revolution joint between the orange tool post and the green slider must intersect the axis of rotation of the work.



Internal spherical turning 2

http://youtu.be/aopSStktT8k

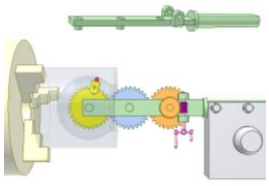
Move the lathe carriage to set initial position: center of internal spherical surface of the work must lay on the axis of the revolution joint between the blue tool post and the green bar.
Turn brown nut to move red tool in circular trajectory.



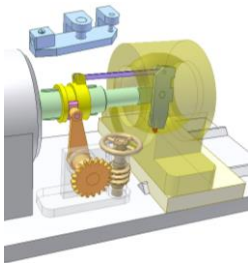
Internal spherical turning 3

http://youtu.be/f1MGCo5dgiQ

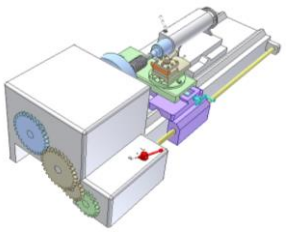
Move the lathe carriage to set initial position: center of internal spherical surface of the work must lay on the axis of the revolution joint between the yellow tool post and the green bar.
Turn pink crank to move red tool in circular trajectory.



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:
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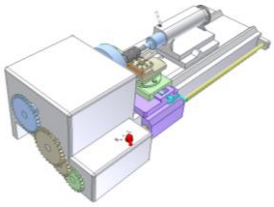
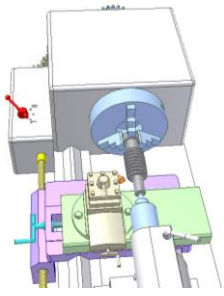
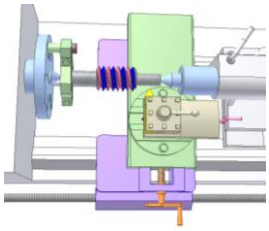


Turning left hand thread 2
https://youtu.be/GI3e-Mm7KuI
The tool (in orange) is clamped downwards. The blue chuck turns clockwise during cutting stroke (towards the chuck) of the violet carriage.
Red lever position determines right or left hand thread to be turned. It changes rotation direction of the 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

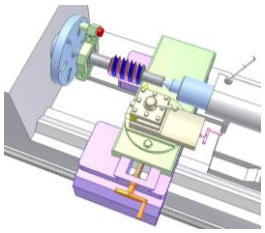
https://youtu.be/OWjX14CoRC8



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

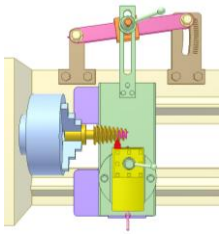
https://youtu.be/LOCAPIlFqBo



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

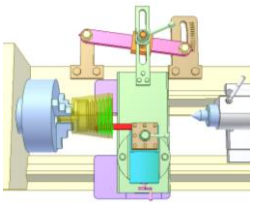
http://youtu.be/hIs4UHUUZdA



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

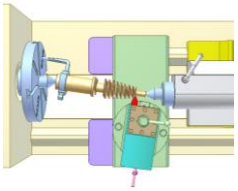
http://youtu.be/8yX4Q78QO6M



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.

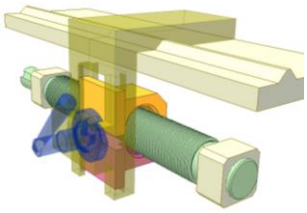
Taper thread turning 3

http://youtu.be/ttK0LNuwQTk

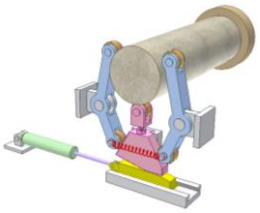


Thanks to tailstock offsetting the tool moves along a line that creates an angle α (half of taper angle) with the axis of rotation of the orange work.
This method more suited for shallow tapers.
Approximately, the set-over S = L.sinα
L: distance between the blue centers
α: half of taper angle
The lathe 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.

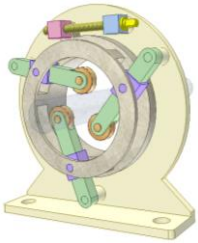
Half nuts for lathes
http://www.youtube.com/watch?v=yqYd2-52R5U
The haft nuts get engaged with the leadscrew by the blue slot face cam. The mechanism is used for turning threads.



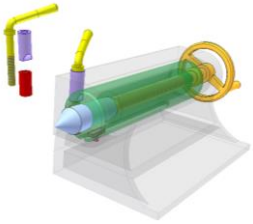
Rest 1
https://youtu.be/qDoS_kIj7-s
Thanks to green cylinder, yellow wedge moves pink vertical slider, two blue levers and brings orange rollers into contact with brown workpiece. Thus the workpiece is supported during the cutting process. The wedge moves back for removing the workpiece.



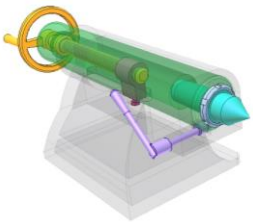
Rest 2
https://youtu.be/e_WrfATp5zM
Combination of four coulisse mechanisms.
Pink nut has revolute joint with brown round frame.
Blue screw bearing has revolute joint with the base.
Use the yellow screw to center and support the work (in glass).



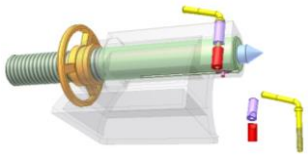
Lathe tailstock 1
http://youtu.be/pgsJJI5-zow
Use the yellow lever to release or tighten the green spindle.
Turn the orange screw to move the spindle that has a hole with internal thread. At right end position of the spindle, the screw pushes the blue center for its removing.



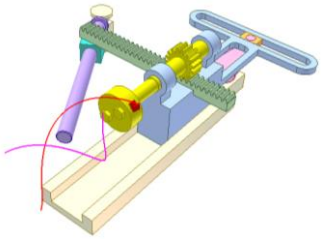
Lathe tailstock 2
http://youtu.be/gGVdUasdM9A
Use the violet lever (eccentric) to release or tighten the green spindle.
Turn the orange screw to move the spindle. The pink nut is fixed to the tailstock house. The blue round nut is for removing the center.



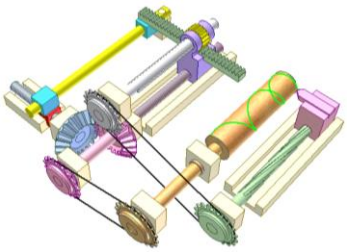
Lathe tailstock 3
http://youtu.be/Sf-WVtx5mio
Use the yellow lever to release or tighten the green screw-spindle.
Turn the orange nut-wheel to move the spindle.



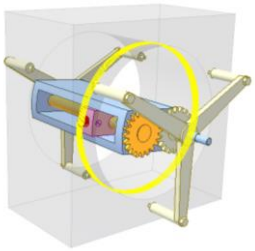
Making internal helix groove 1
https://youtu.be/pK9w8fyrVNI
Input: pink crank that moves blue slider (carrying green rack) via sine mechanism.
Green rack has traversal motion due to cyan slider moving on violet oblique runway.
The yellow shaft translates and rotates at the same time and its two cutters 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.



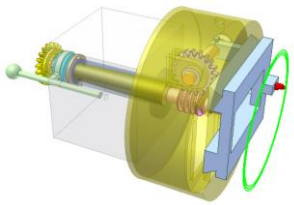
Making helix groove of variable lead 1
https://youtu.be/1lx7H9Q05l0
Input: orange shaft carrying workpiece.
Violet slider carrying green rack moves longitudinally thanks to pink screw.
Red slider has traversal motion thanks to blue screw and turns yellow bar.
Yellow bar makes green rack move in traversal 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.

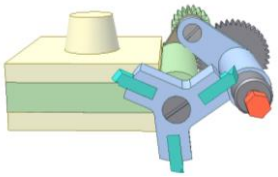
The separation distance T of Archimedean spiral can be adjusted by selecting speeds or directions of the yellow gear and positions of the cyan clutch.

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



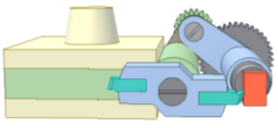
http://www.youtube.com/watch?v=3Kzk3_uzRAg

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

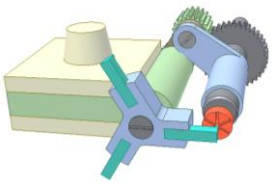
Making rectangle on a lathe



http://www.youtube.com/watch?v=yr0VVtuPAlE

The tool shaft rotates twice faster than the workpiece shaft.

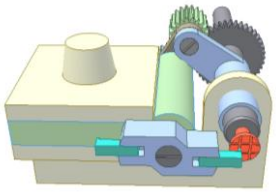
Making face slots on a lathe 1



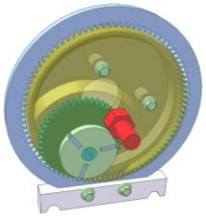
http://www.youtube.com/watch?v=KsMbm2mB7KI

The tool shaft rotates twice faster than the workpiece shaft.

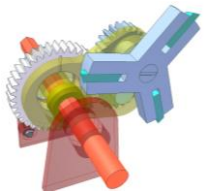
Making face slots on a lathe 2
http://www.youtube.com/watch?v=xQ_eQ2naSFc
The tool shaft rotates twice faster than the workpiece shaft.



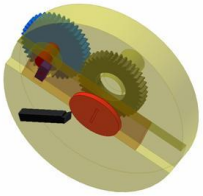
Device for making hexagon on a lathe
http://www.youtube.com/watch?v=XJb-kKOVBqU
The tooth number of the fixed gear is double the one of the satellite gear.



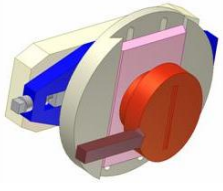
Device for making hexagon on a lathe
http://www.youtube.com/watch?v=AwkDB0ThXG8
The tooth number of the fixed gear is double the one of the satellite gear. The processing length is not limited.



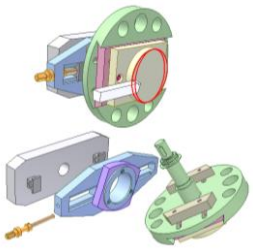
Device for turning ellipse 1
http://www.youtube.com/watch?v=TjaBYsAlwGc
Beside rotation, the workpiece has radial linear motion of sine law. For details, see
http://meslab.org/mes/showthread.php?p=101930%23post101930



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

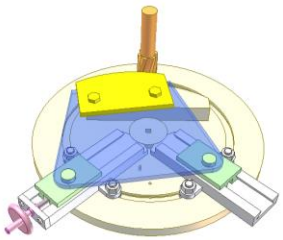


Device for turning ellipse 2b



https://youtu.be/lP2qxxoHCSI
Blue slider has prismatic joint with the base.
Violet part has revolution joint with the blue slider.
Pink slider has prismatic joint with green plate fixed to the lathe spindle.
Two brown bar have prismatic joint with the violet part.
Use orange screw to set the eccentricity E between the blue slider and the spindle axis.
The video shows the tool traces a circle on yellow work when E = 0 and an ellipse when E differs from 0.
Ellipse semi-major axis = distance between tool tip and the spidle axis.
Ellipse semi-minor axis = distance between tool tip and rotary axis of the violet part
This device is based on ellipse trammel mechanism:
https://youtu.be/tsAPaHrqKEA

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.

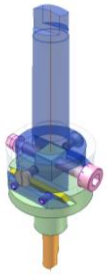
Nut-screw and bar mechanisms 5

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

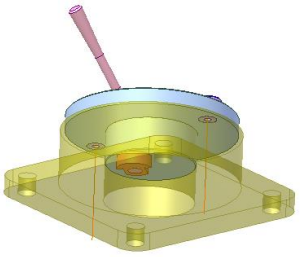
http://youtu.be/uBZWXZKDCDM
Press on the button, move the green grip up and down to rotate the red bit.

Boring head

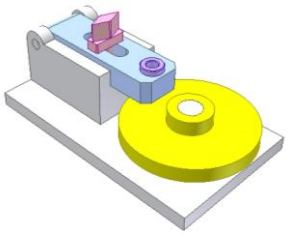


https://youtu.be/s-iD7LfifmA
Turn pink screw to set distance R between the orange cutter tip and rotary axis of the head. R is, namely, radius of the bored hole as shown in the video last scene.

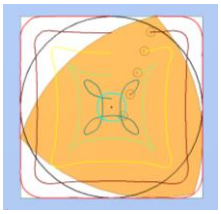
Clamping a drill bushing disk
https://youtu.be/6BmSQjbH40Y
Blue disk, to which two drill bushings (in violet) are fixed, is clamped with yellow workpiece thanks to pink eccentric cam.
This design is numbered as 1032 in the book “Mechanical Fixtures Tooling”



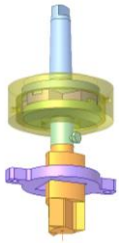
Clamping a drill bushing bracket
https://youtu.be/O19NmBg5yiM
Blue bracket, to which a drill bushing (in violet) is fixed, is clamped above yellow workpiece thanks to pink screw.
Turn the screw 90 deg. (for aligning it with the bracket slot) to release the bracket and flip the latter to free the space for removing and installing workpieces.
This design is numbered as 1036 in the book “Mechanical Fixtures Tooling”.



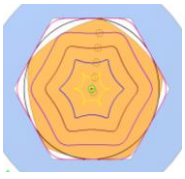
Drilling square holes 1a
http://www.youtube.com/watch?v=BnvT45CjD-E
Reuleaux triangle rotates inside a square.
Loci of various points on the triangle are shown.
The red locus is the section of the drilled square hole.
Its corners are rounded.
An inscribed round hole of the square hole must be predrilled.



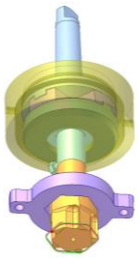
Drilling square holes 1b
http://www.youtube.com/watch?v=TioBY-JGI4I
Device for drilling square holes of rounded corners based on the principle shown in “Drilling square holes 1a”



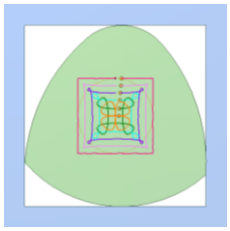
Drilling hexagon holes 1a
http://www.youtube.com/watch?v=oe8e-N3VusI
Reuleaux pentagon rotates inside a hexagon.
Loci of various points on the pentagon are shown.
The red locus is the section of the drilled hexagon hole.
Its corners are rounded.
An inscribed round hole of the hexagon hole must be predrilled.



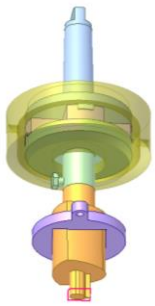
Drilling hexagon holes 1b
http://www.youtube.com/watch?v=_5OgWbMH8D8
Device for drilling hexagon hole of rounded corners based on the principle shown in "Drilling hexagon holes 1a"



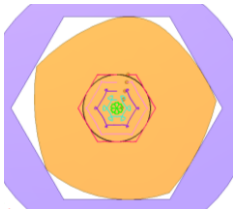
Drilling square holes 2a
http://www.youtube.com/watch?v=UvgfqSvKAOI
Reuleaux triangle rotates inside a square.
Loci of various points on the triangle are shown.
The red locus is the section of the drilled square hole.
Its corners are sharp.
An inscribed round hole of the square hole must be predrilled.
There are blade's points that trace knotty loci unfavorable for cutting.



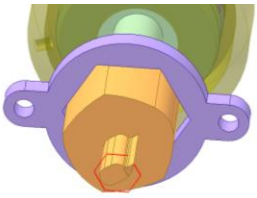
Drilling square holes 2b
http://www.youtube.com/watch?v=pT1H_cPYGAE
Device for drilling square holes of rounded corners based on the principle shown in "Drilling square holes 2a"



Drilling hexagon holes 2a
http://www.youtube.com/watch?v=4HVj89C1bxw
According to Barry Cox and Stan Wagon.
Reuleaux pentagon rotates inside a hexagon.
Loci of various points on the pentagon are shown.
The red locus is the section of the drilled hexagon hole.
Its corners are sharp.
An inscribed round hole of the hexagon hole must be predrilled.



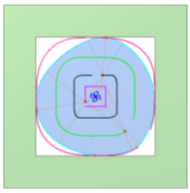
Drilling hexagon holes 2b
http://www.youtube.com/watch?v=W16f-qCXVkM
Device for drilling hexagon holes of sharp corners based on the principle shown in "Drilling hexagon holes 2a"



Drilling triangle holes 1a
http://www.youtube.com/watch?v=gGNC3ltLJK4
According to The Wolfram Demonstration Project.
An oval rotates inside a triangle.
Loci of various points on the oval are shown.
The red locus is the section of the drilled triangle hole.
Its corners are sharp.
An inscribed round hole of the triangle hole must be predrilled.

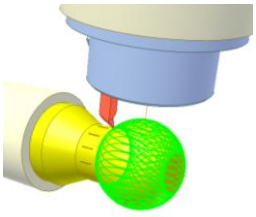
Drilling triangle holes 1b
http://www.youtube.com/watch?v=LNCHxxbMXEU
Device for drilling triangle holes of sharp corners based on the principle shown in "Drilling triangle holes 1a"

Irregular (scalene) Reuleaux triangle
http://www.youtube.com/watch?v=K1ZddTjkfc0
Irregular (scalene) Reuleaux triangle rotates inside a square.
Sketch of the Reuleaux triangle and loci of various points on the triangle are shown.

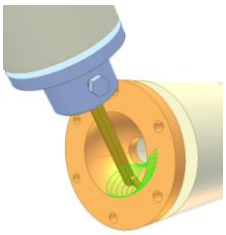


Making sphere on a milling machine 1
http://www.youtube.com/watch?v=BJtxfI_LKio
Workpiece is clamped in a dividing head's chuck and rotated by hand.
Tool is clamped in an arbor that allows it to be regulated radially.
For details see:
http://meslab.org/mes/threads/12255-Gia-cong-mat-cau-loi-tren-may-phay-thuong

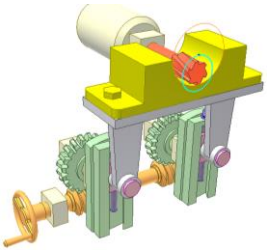
Making sphere on a milling machine 2
http://youtu.be/tx6b17qeOtg
Machining convex asymmetric sphere surfaces.
Workpiece is clamped in a dividing head's chuck and rotated by hand. Tool is clamped in an arbor that allows it to be regulated radially. Axes of the workpiece and the arbor must be intersecting.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



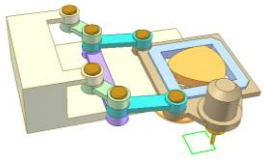
Making sphere on a milling machine 3
http://youtu.be/F22IBTB3cxY
Machining concave sphere surfaces.
Workpiece is clamped in a dividing head's chuck and rotated by hand.
Tool is clamped in an arbor that allows it to be regulated radially. Axes of the workpiece and the arbor must be intersecting. The tool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



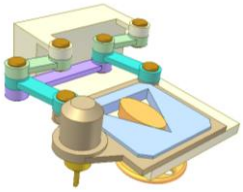
Jig for milling inner cylindrical surface
http://youtu.be/Vyqg7p_7HeE
The yellow work is clamped to the grey conrod of a parallelogram mechanism and has round translational motion.
Radius of inner cylindrical surface to be created is Rw (orange circle). Locus of center of the orange circle is the green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



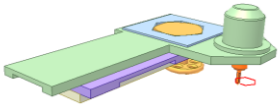
Milling square with Reuleaux polygon
http://www.youtube.com/watch?v=DoKT2fR9Rms



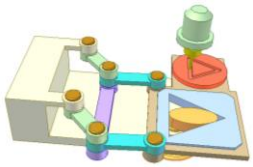
Milling triangle with Reuleaux polygon 1
http://www.youtube.com/watch?v=LOr-lb7E2YM



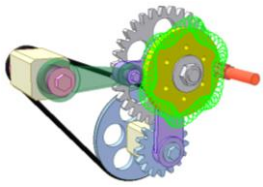
Milling hexagon with Reuleaux polygon
http://www.youtube.com/watch?v=_9j8mVfTS6M



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

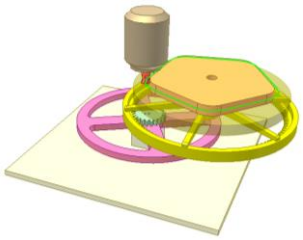


Milling profile 1
http://youtu.be/kPA6xngrYE8



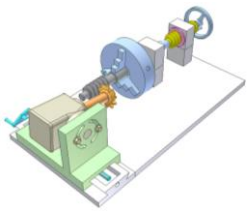
Input is pink shaft having an eccentric.
Red cutter creates profile on yellow work that is fixed to grey gear shaft. Transmission ratio from pink pulley to the grey gear shaft is 6 so the created profile of star shape has 6 wings. The wing is not symmetric because the grey gear shaft rotates irregularly.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

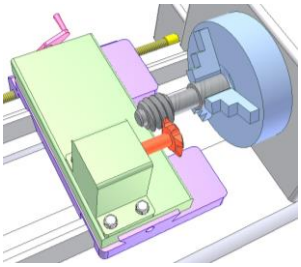
Milling thread 1
https://youtu.be/HtfEVziOrak



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

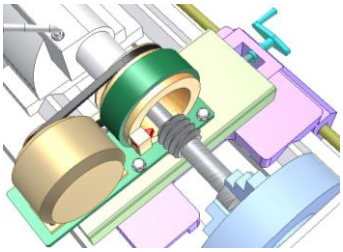
https://youtu.be/wLpSoXimXpc



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

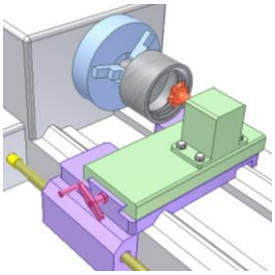
https://youtu.be/4jLlqTLxuow



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.

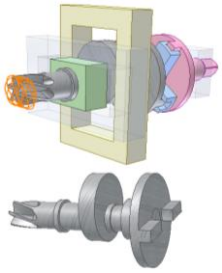
Milling internal thread on a lathe

https://youtu.be/i4EfNkPJreo

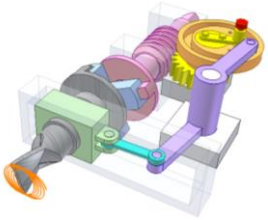


Green motor block of red cutter is fixed to green cross slide. The latter can slide on violet longitudinal slide, which moves synchronically with blue chuck: L mm in one revolution of the chuck. L is thread lead of the grey work.
Cross motion of the green slide (thanks to pink screw) alters the radial 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.

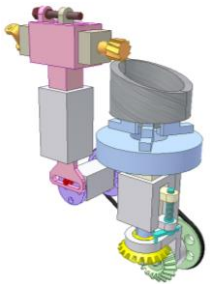
Milling the mortise 1
https://youtu.be/7NBElkQAXjk
Input: pink shaft.
Grey spindle is connected to the input via an Oldham coupling.
An eccentric fixed to the spindle slides in yellow frame.
The end mill must have as many as possible flutes to get smooth mortise.
This mechanism has not been verified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



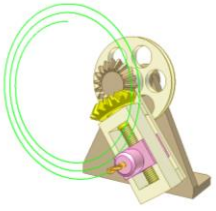
Milling the mortise 2
https://youtu.be/0gyEQxH2wUc
Input: pink shaft.
Grey spindle is connected to the input via an Oldham coupling.
An eccentric groove cam (in orange) is fixed to yellow worm wheel makes the spindle bearing slide horizontally.
Adjust angular position of the cam and the wheel by the red positioning pin to get various lengths of the mortise.
This mechanism has not been verified in practice.



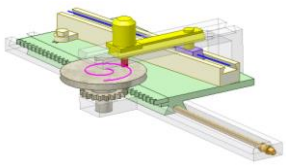
Milling sinus profile of an end cam
https://youtu.be/bm8MlZJbJ3E
Orange cutter shaft is driven by a motor via a Cardano joint (not shown).
Green input shaft is driven by another motor (not shown).
Violet crank shaft and pink slider of traversal slot create a sinus mechanism.
The violet crank shaft receives 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

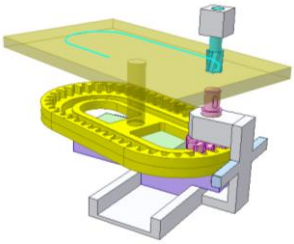
Move green slider carrying a rack that turns grey shaft to mill an Archimedean spiral groove on the work (not shown) fixed to the grey shaft.

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.

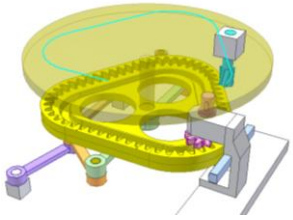
The workpiece is mounted on the yellow table fixed to the oval gear.

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



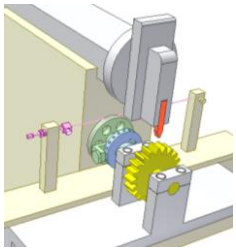
http://youtu.be/HmNNPJySZ8w

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.

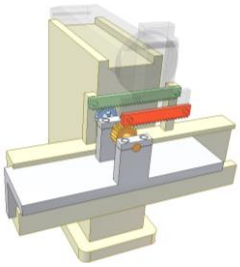
Blue curve is locus of the center of an end mill (not mounted in line with the pinion) on the table surface. It is similar to center closed curve of the groove in which lower end of the pinion slides.

This video was made on request of a YouTube user. The mechanism was purely created on computer and needs to be verified in practice.

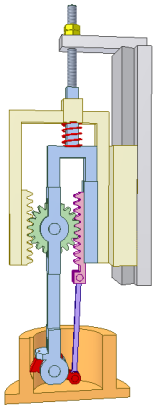
Cutting gear on the shaper 1
http://youtu.be/W69m2cDaqvY
The cable contact diameter of the green disk must be equal to the gear pitch diameter. The hole number on the blue disk is equal to the tooth number.
After completing a tooth slot to index the blue disk (fixed to the yellow workpiece) for cutting the next slot.
A gear-rack drive can be used instead of cable to avoid cable slipping.



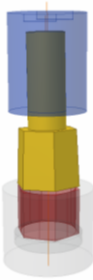
Cutting gear on the shaper 2
http://youtu.be/wkSI6H0-9XE
This method is applied only for gears of small module m and small tooth number Z. The tool is of rack shape. Indexing is not needed. Total displacement of the table carrying the workpiece must be more than π.m.Z.



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.

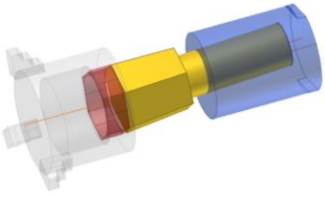
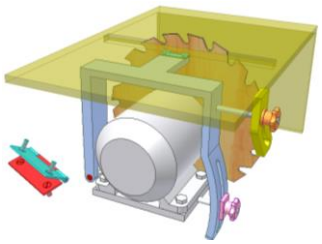


Table wood saw 1

http://youtu.be/J800VDgFpKk

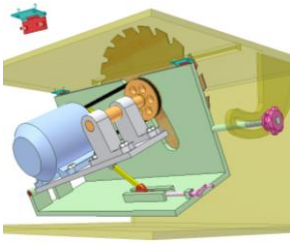


Motions for position adjustment of orange circular blade are shown:
- Up and down by using pink nut. The motor turns around red pin.
- Leaning by using orange nut

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

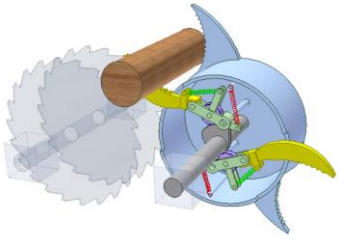


Motions for position adjustment of orange circular blade are shown:
- Up and down by using pink screw. The motor and blade shaft turns around red pin.
- Leaning by using pink nut

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

Wood saw machine

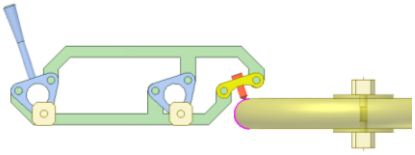
https://youtu.be/fVQrutXFdaY



It is an attempt to decode what happens inside the drum of the machine shown at:
https://yout`u.be/yDgWz4Wozjg
Input blue drum to which a pulley is fixed.
The grey cam shaft is stationary.
The wood is clamped between blue and yellow jaws under the action of the green springs.
The red springs maintain the contacts between violet rollers and the cam.
The wood is automatically released after being cut.

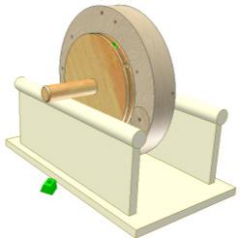
Device for Correcting Grinding Wheel

http://youtu.be/yLGqlwvKinY

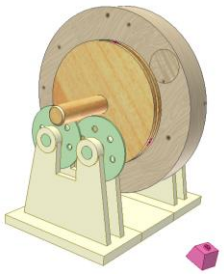


This combination of two parallelogram mechanisms enables the tool point to describe a circular-arc curve.
The yellow link rotates around a virtual axis.
It is used when the arrangement of fixed bearings for the virtual axis is impossible.

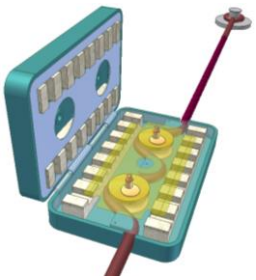
Grinding wheel equilibration 1
http://youtu.be/NQxPukE9y48
Grinding wheel assembly is laid on two horizotal shafts.
If the assembly is static imbalanced, the gravity turns it to the position at which the center of mass is below the assembly axis.
Move green contra-weights in circular dovetail groove of the assembly to upper positions and fixed them there for equilibrating, then test the assembly again.



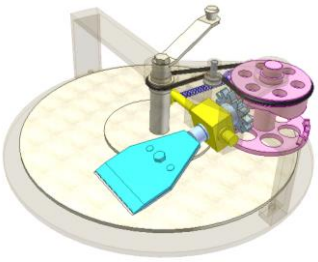
Grinding wheel equilibration 2
http://youtu.be/p6tEpwW9gJ4
Grinding wheel assembly is laid on four green idly rollers.
If the assembly is static imbalanced, the gravity turns it to the position at which the center of mass is below the assembly axis.
Move pink contra-weights in circular dovetail groove 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).



Razor blade sharpener 1
https://youtu.be/l-W3j7njmZU
This video was made based on:
https://www.youtube.com/watch?v=NuH-kdTcCas
Move the closed green box along strained rope to perform sharpening process. The razor is ground by four bars made of grinding material.
The bars are forced up by springs (not shown).
The razor blade plays role of a connecting rod of the parallelogram mechanism of two cranks (orange pulleys of eccentric short cylinders on which the blade is mounted). The pulleys rotate thanks to friction with the rope. The parallelogram mechanism can overcome its dead points because both pulleys are driven by the rope.
The video shows the razor blade motion when the box is open. In fact the box must be closed when working.

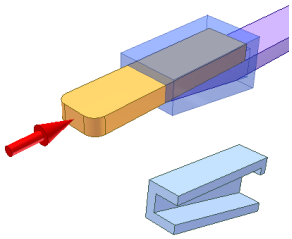


Razor blade sharpener 2
https://youtu.be/caGsV3GyDW8
This video is a guess for inside mechanism of the sharpener shown at
https://www.youtube.com/watch?v=UZNAVouDOY4
The razor blade is clamped between two blue jaws by a screw. Pink face cam is for raising the blade. Pink face gear is for flipping the blade.
In every three revolutions of the crank, two revolutions are for grinding one side of the blade, one revolution is for its flipping.
Transmission ratio between grinding disk and the pink shaft is 3.
Blue spring forces the blade on the grinding disk.



Wedge clamp for scraper tip

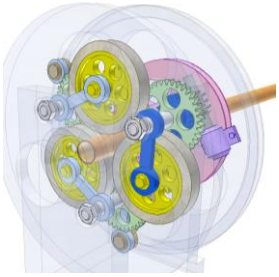
https://youtu.be/nYZL0R2VXPU



Orange scraper tip is clamped to violet blade of a power scraper thanks to wedge mechanism created by the blade and blue cover. Working load (red arrow) makes the clamping stronger.
A half-cut-off cover is also shown in first scenes of the video.
Apply force (green arrow) from behind the cover to remove the tip.
Wedge angle should be smaller than friction angle A for materials of contact parts. In case of steel with steel, clean and dry contact, friction coefficient = 0.4, A = 21.8 deg.
This concept is taken from US3147549 patent.

Tube polishing machine 1

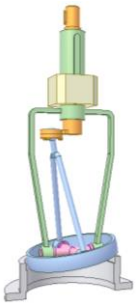
https://youtu.be/pmHiOBkC8N8



The polishing wheels receive high speed rotary motion from a motor via a belt drive (not shown), pink, green and yellow gears.
The house of the wheels receives low speed rotary motion from a motor via another belt drive (not shown). This motion is needed for polishing the tube periphery.
Orange tube is slowly advanced through three polishing wheels by feeding rollers (not shown). This motion is needed for polishing the tube length.
Last scenes of the video shows process of adjusting distance between the polishing wheels to compensate worn polishing material or to adapt various tube outer diameters. Violet motor controls angular position of dark blue crank via worm drive. The dark and light blue cranks are connected together by brown conrods (parallelogram mechanisms) thus the polishing wheels pivoted on the cranks move radially synchonically. Yellow gears roll on green gears during adjusting process. The adjusting process can be performed even without stopping the wheel rotation.
This video was made in attempt to guess the working principle of the machine shown at https://youtu.be/JxZl3wbIqW4

Mechanism for lapping a hole 1

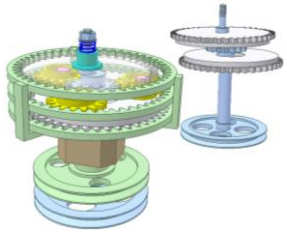
http://youtu.be/w9BlgeqKKHY



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

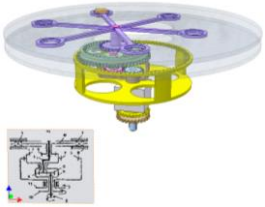
https://youtu.be/TS5HRfeykCk



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

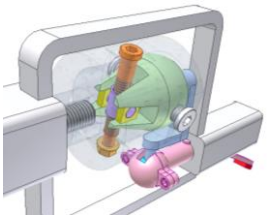
https://youtu.be/x5NDE1mhphU



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.

Scraping machine

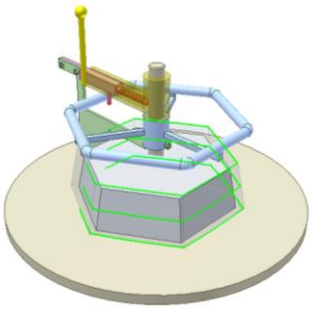
https://youtu.be/hiYRrA7hGP0



This mechanism converts rotary motion into reciprocating motion.
Input: grey shaft to which a head (in glass) is fixed.
Green bearing body pivoted on the head performs wobbling motion.
Blue crank having revolution joint with the green body via two brown ball bearings makes pink tool slider reciprocate. Joint between the blue crank and cyan ball is cylindrical.
Turn orange screw to move violet nut for setting stroke length L of the red tool. The video shows adjusting process to increase the angle A between the green bearing body and the head (in glass) for larger stroke length.
When A = 0 deg., L = 0.
This design is taken from patent US2940324.

Making concrete planters 1

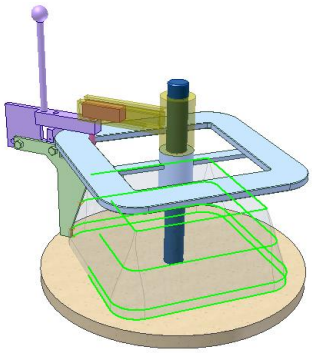
https://youtu.be/Jx6prfwPZhw



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

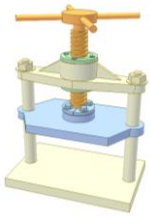
https://youtu.be/-3pq-4zL0oI



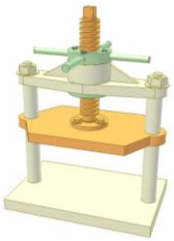
The pink slider reciprocates in a groove of the yellow arm. Its pink pin is always in contact with the blue guide inner profile.
Violet part is pivoted on the pink pin.
A surface of the violet part is always in contact with the guide outer profile (distance from the pink pin to the surface is equal to 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

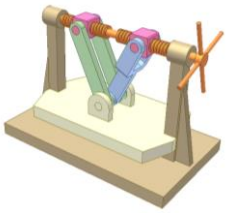
Manual screw press 1
http://www.youtube.com/watch?v=GrK5bhJjex4
The green nut is fixed. The orange screw is rotated and translated.



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

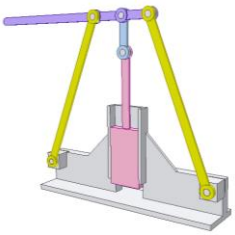


Manual screw press 3
http://www.youtube.com/watch?v=nGiS4ZScxII
The orange screw has right hand and left hand threads with the same pitch and is rotated. The pink nuts are translated.



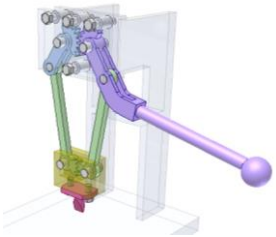
Manual screw press 4
http://www.youtube.com/watch?v=S7OIx_liVqY
A combination of slider-crank mechanism and nut-screw one gives a high mechanical advantage.
The orange screw is rotated. The pink nuts are translated. Both move slightly in vertical plan.

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

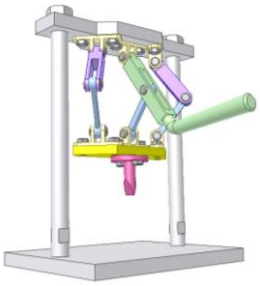


Nut cracker 1
https://youtu.be/8n_SSaZKUQs
Green parts represent two ball bearings.
See a real one in action:
https://youtu.be/IMcdid8wxxU

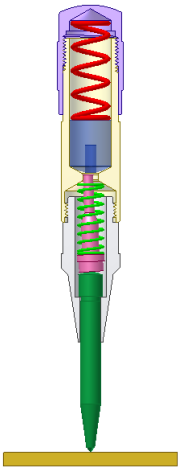
Press of gear-crank mechanism
https://youtu.be/yhBJxu50leY
Turn violet lever to make pink chisel move along absolutely straight line without any runway. The gaps between gear teeth must be kept as small as possible to reduce error in straightness of the chisel motion.
This design was made upon a YouTuber's request for oyster shucking tools.
The straightness of the chisel motion is influenced by:
- The gaps between gear teeth. It must be kept as small as possible.
- The symmetry of the links. So pay attention to gear position on every link.



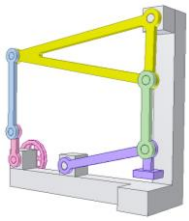
Press of Sarrus mechanism
https://youtu.be/a8_ryAgIXas
It is an application of Sarrus mechanism:
http://youtu.be/pQBJcgJe6t0
Turn green lever to make pink chisel move along absolutely straight line without any runway. For larger pressing force, reduce distance between two revolution joints of the green lever.
This design was made upon a YouTuber's request for oyster shucking tools.



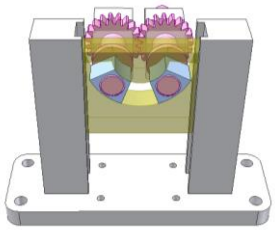
Automatic center punch 1
https://youtu.be/ZTRgO28WCgs
At initial position the pink pin is automatically set skewed. Its tip contacts the hammer (in blue) on the hammer face, slightly offset to the hammer hole.
When the tool body moves down, the hammer stays immobile and bears increasing force from red spring until the pink pin is pushed into alignment with center axis of the tool (when the pin tapered portion contacts narrow hole of the tool body). The hammer then can be launched down and strikes a blow on the pin to press the green punch on the workpiece.
There are several ways to make the pin skewed at initial position. Here the bottom face of the pin is made not perpendicular to the pin axis.



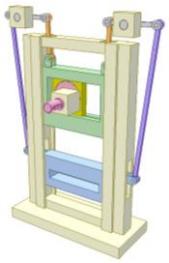
Press of double toggle action
https://youtu.be/BmlXyM375Y0
Input: pink crank.
When the crank and blue bar are vertical, they together with green and yellow bars create a parallelogram.
The double toggle action (when the pink crank, the blue bar are in line and green bar, yellow bar are in line) gives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



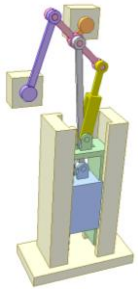
Press of two cranks
https://youtu.be/fWMW1GZCrUo
It is used for large die of sheet metal product.
The press has two pink cranks, two blue conrods and one yellow slider. Blue conrods are of unfamiliar shape because their lengths are smaller than their revolute joint dimensions.



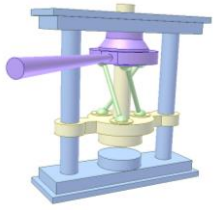
Press of two coaxial sliders 1
https://youtu.be/IGEpDTy84QE
Input: pink eccentric shaft.
Upper and lower sliders move oppositely thanks to two slider crank mechanisms of grey common crank on each side.
This mechanism can be used for compressing grain materials from both sides.
In one side compression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



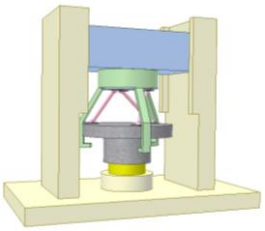
Press of two coaxial sliders 2
https://youtu.be/RWKVFREANYU
Input: orange crank.
Slider-crank mechanism of greey conrod moves blue inside slider.
Mechanism of violet and pink bars, yellow conrod moves green outside slider.
This mechanism can be used for deep drawing of sheet metal.



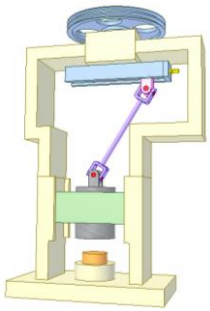
Press using spatial slider crank mechanism
http://www.youtube.com/watch?v=613_NYKz68I



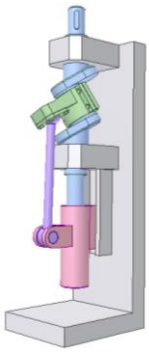
Forging with twisting 1
https://youtu.be/kkpg8go09yU
Grey hammer is connected to blue press slider via pink conrods and spherical joints.
The hammer after blowing yellow forged part has also twisting motion that is required for some forging operations.
Relation between vertical force and torque applied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



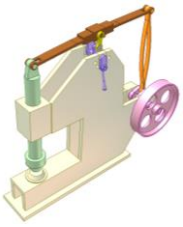
Forging with twisting 2
https://youtu.be/qbJI5w8j8B8
Grey hammer has revolute joint with green slider.
It is connected to blue press shaft via violet conrods of double Hook joints. There is an offset E1 between the blue shaft and the grey hammer. There is also distance E2 between upper Hook joint of 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.



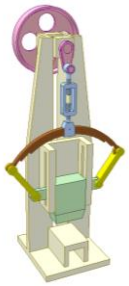
Press of spatial slider crank mechanism
https://youtu.be/hRFNR7AEnF8
Input: blue crank.
Output: pink slider.
The input rotary axis and the output sliding axis are coaxial.
Cylindrical joint between the pink slider and the blue crank is not necessary in term of kinematics.



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

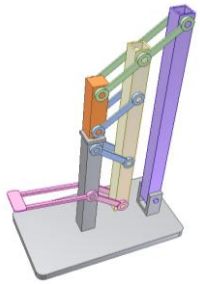


Leaf spring hammer 2
http://youtu.be/ZxoXAZEbYv4



Pedal hammer

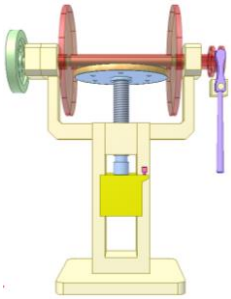
https://youtu.be/bOjl815Vd9w



Pink bars, lower blue bars and yellow bar create a parallelogram mechanism. Green bars, upper blue bars and yellow bar create another parallelogram mechanism. The orange hammer head moves along a vertical approximately straight line (no need of a runway).
This design is taken from page 6, Newsletter of New Jersey Blacksmiths Association, August 1998
http://www.njblacksmiths.org/archive/njba32a.pdf

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.

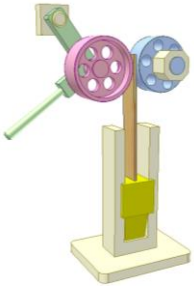
Friction press 2

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).

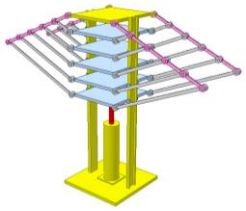
Drop hammer

http://youtu.be/NUIdUT32OaY

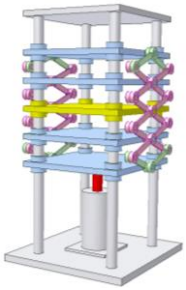


Input: the blue roller.
The pink roller idly rotates on the green lever.
The yellow slider has plank tail that is in contact with the two rollers.
Up and down motion of the yellow slider is controlled by the green lever that causes the pressure at contact places of the plank.

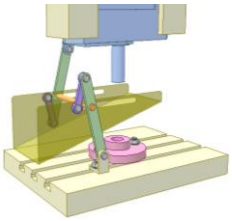
Multi-plate press 1
https://youtu.be/f42pobuVCuo
The combination of slider-crank mechanisms of commun cranks (in pink) ensures that the distances between blue plates, and thus product thicknesses are always equal.
The lowest blue plate moves 5 times faster than the uppest one.
Triangle proportionality theorem is applied here.
The press is used for wood chip products.
Disadvantage: occupation of large space on both sides.



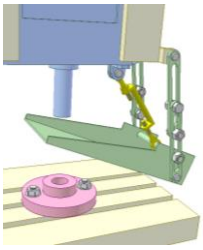
Multi-plate press 2
https://youtu.be/0s8X750MiVY
Scissor mechanism ensures that the distances between adjacent plates (blue or yellow) and thus product thicknesses are always equal.
The yellow stationary plate can be any other plate (except the lowest), however the needed piston stroke length will be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



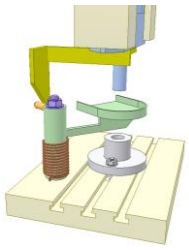
Mechanism for catching workpieces in presses 1
https://youtu.be/T7bYx_M8Iwg
The mechanism is used for case when the workpiece is jammed with the punch after being pressed and then removed at upper position of the blue slider (removing device is not shown). Yellow gutter catches the workpiece and guides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



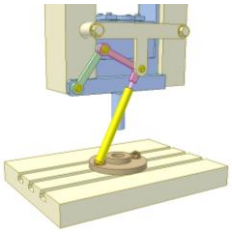
Mechanism for catching workpieces in presses 2
https://youtu.be/1PJ_9Ix0qcE
The mechanism is used for case when the workpiece is jammed with the punch after being pressed and then removed at upper position of the blue slider (removing device is not shown). Green gutter catches the workpiece and guides 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.



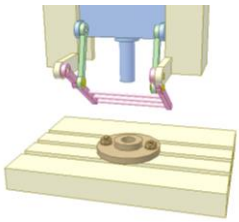
Mechanism for catching workpieces in presses 3
https://youtu.be/MZ81Q5UmuO0
The mechanism is used for case when the workpiece is jammed with the punch after being pressed and then removed at upper position of the blue slider (removing device is not shown).
Green gutter catches the workpiece when the 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.



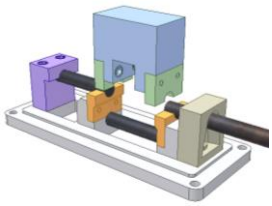
Injury prevention mechanism for presses 1
https://youtu.be/EIpPDZY8BPw
Yellow bar sweeps unwanted objects out of pressing area when the punch goes down to prevent injury for operator hands.
Pink crank, green conrod and blue slider create a slider crank mechanism.



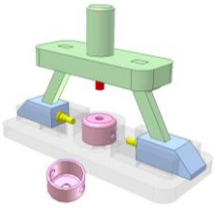
Injury prevention mechanism for presses 2
https://youtu.be/sLSGxmpuc_k
Pink frame sweeps unwanted objects out of pressing area when the punch goes down to prevent injury for operator hands.
Pink crank, green conrod and blue slider create a slider crank mechanism.



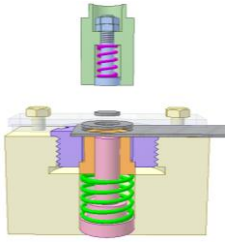
Cut-off die
https://youtu.be/OTVtrm5OVHU
Die for getting two blanks at the same time makes cutting faces rather perpendicular to bar axis (in black).
Violet and brown parts are for preventing the bar bending.



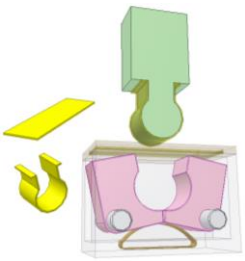
Wedge mechanism 9
http://youtu.be/uavruMk99v8
Piercing die. Vertical and horizontal holes are created at the same time by punches fixed on vertical and horizontal sliders.
The vertical wedges (in green) can be of rectangular section or circular one.



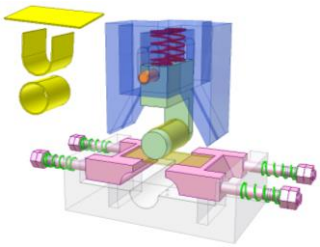
Die for making washers in a single punching stroke
https://youtu.be/_Np461igdGk
Green upper punch and violet die create outter circle of the washer.
Green upper punch and pink pin create inner circle of the washer.
Spring orange bush is for pushing the washer out of the violet die.
Spring blue pin is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



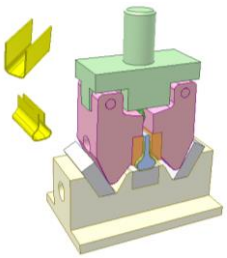
Bending die 1
https://youtu.be/O6ykFfYGpvU
Yellow workpiece before and after bending are shown on the left.
Green punch in its motion down first bends the workpiece into U-shape and at the end of punch stroke two pink dies create final shape of the workpiece.
Yellow transparent wokpieces in the die are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



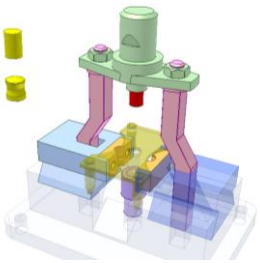
Bending die 2
https://youtu.be/eqKa2gv9Kx0
Yellow workpiece before and after bending are shown on the left.
Blue main slider of the press carrying green punch in its motion down first bends the workpiece into U-shape. Then the main slider pushes two pink dies to create final shape of the workpiece.
Yellow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



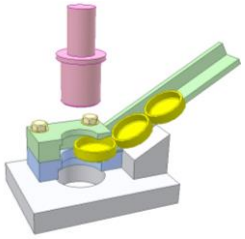
Bending die 3
https://youtu.be/QaDQHSdMq3E
Yellow workpiece before and after bending are shown on the left.
Two grey parts fixed on the base turn pink punches toward blue core when green punch support goes down to create final shape of the workpiece.
Yellow transparent workpiece in the die is shown only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



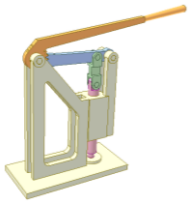
Stamping die 1
https://youtu.be/Cmk42XrtyAo
Yellow workpiece of soft metal before and after stamping are shown on the left. It is of undercut shape.
Green punch in its motion down first closes orange dies of two halves thanks to two pink wedges and then deforms the workpiece.



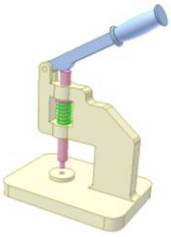
Automatic feeding for press 1
https://youtu.be/85THuzdZ3dY
The simplest way of automatic feeding: yellow workpieces come into pressing position due to the gravity.
Outer diameter of the workpiece is reduced after pressing.
The green and blue parts are cut off half for easy understanding.



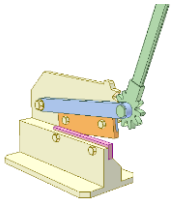
Hand punch machine 1
http://youtu.be/N9ni9wzh3gI
Combination of gear drive and slider-crank mechanism.



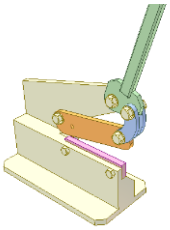
Hand punch machine 2
http://youtu.be/9xB4J91--8w
Disk cam and linear reciprocating follower.



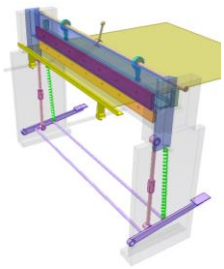
Hand shearing machine 1
http://youtu.be/tp4qFdWDkT8
A planetary gear is used.
Hand force is applied to the satellite gear. The other gear is fixed. The upper tool blade is fixed to the carrier.



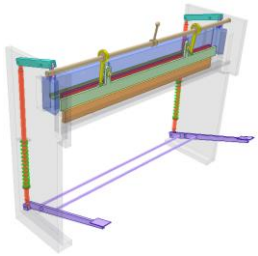
Hand shearing machine 2
http://youtu.be/zLLgQCJ4vSQ
A 4-bar linkage is used.
Hand force is applied to green crank. The upper tool blade is fixed to the orange rocker crank.



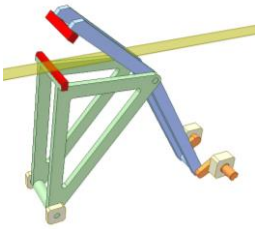
Foot shearing machine 1
http://youtu.be/GIcygJlH2BM
The blue slider carrying the red upper cutter is driven by a slider crank mechanism. The crank is the violet foot lever. The sheet is clamped before sheared by another slider crank mechanism of brown eccentric shaft. The orange lower cutter is fixed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



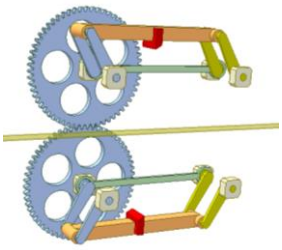
Foot shearing machine 2
http://youtu.be/pyGNgP6ZNvA
The blue slider carrying the red upper cutter is driven by a 6-bar mechanism. The sheet is clamped before sheared by a slider crank mechanism of brown eccentric shaft. The runway of the green slider is on the blue slider. The orange lower cutter is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



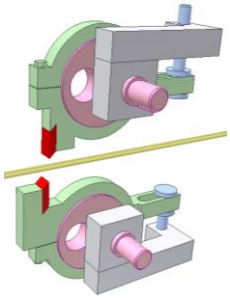
Web-cutting mechanism 2
http://youtu.be/Oe1erEBdHL8
This 4-bar linkage with an extended coupler can cut a yellow web at high speeds. The linkage is dimensioned to give the knife a velocity during cutting operation that is equal to the linear velocity of the web.



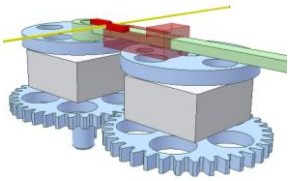
Web-cutting mechanism 1
http://youtu.be/VY8W3letECk
This parallelogram mechanism with knife on coupler can cut a yellow web at high speeds. The mechanism is dimensioned to give the knife a velocity during cutting operation that is equal to the linear velocity of the web. The green bars help the mechanism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



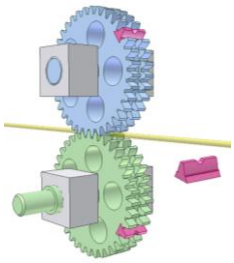
Web-cutting mechanism 3
https://youtu.be/oqXDVc3I3lE
Input: pink eccentric shafts rotating at the same velocity in opposite directions.
Red cutters have circular translating motion to cut yellow web.
Velocities of the web and the cutters at cutting point are about equal.



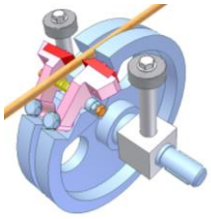
Wire-cutting mechanism 1
https://youtu.be/UDcTRTmfeio
Input: blue shafts rotating at the same velocity and in opposite directions.
Red cutters cut yellow wire that moves continuously. Velocities of the wire and the cutters at cutting point are about equal.



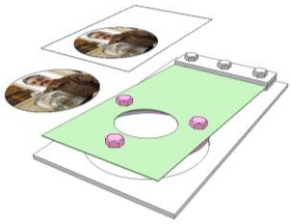
Wire-cutting mechanism 2
https://youtu.be/6pZLVvanekI
Input: green and blue shafts rotating at the same velocity and in opposite directions.
Pink cutters cut yellow wire that moves continuously. Velocities of the wire and the cutters at cutting point are about equal.
The mechanism is used for cutting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



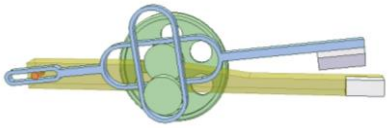
Wire-cutting mechanism 3
https://youtu.be/gIieZyEBeGA
Input: blue wheel carrying two reds cutters.
Orange wire is moved by other motion source (not shown).
The wire velocity and circular velocity of the cutters are the same.
Two pink cutter carriers are pushed aside by a yellow spring. Their rest positions 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.



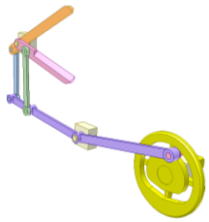
Cut-off die for paper
https://youtu.be/Pix4MLichyk
Pink donut punch is fixed to green plate that is made of thin spring sheet.
The paper is placed on white die plate. It is centered thanks to lines traced on the paper and the die (not shown).
Blow the green plate using a rubber hammer to get a picture from the paper.
Several papers can be cut with one blow.
Picture profiles may differ from circular one.



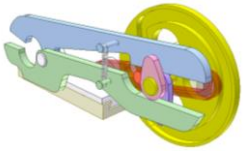
Mechanism for slicing machine
http://www.youtube.com/watch?v=F3hnQxzhZno



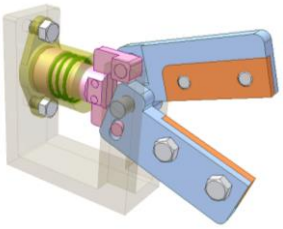
Cam-driven scissors 1
http://youtu.be/kOMxi0W2r3g



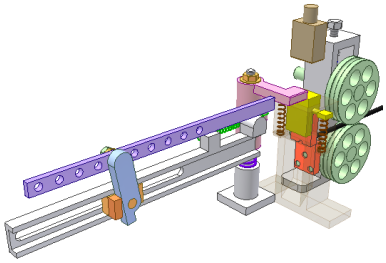
Cam-driven scissors 2
http://youtu.be/Qx0UItGXFRQ
The yellow grooved cam moves sciccor's pivot through the red rod. The upper and lower blades oscillate due to the violet and pink cams that are fixed to the yellow cam.



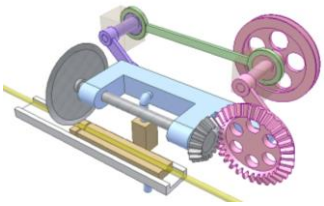
Machine scissors
https://youtu.be/1SAm-v7Mpso
Yellow cylinder controls the scissor blades via tangent mechanisms.



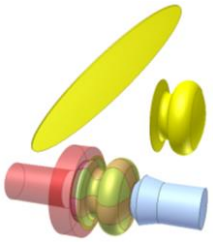
Cut-off machine
https://youtu.be/AXtKHnHlt0c
Brown punch reciprocates continuously. Its motion source is not shown. It never contacts yellow slider carrying red upper cutter.
Two green rollers rotate continuously. Their motion source is not shown. They advance black rod thanks to friction.
The rod moves 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.



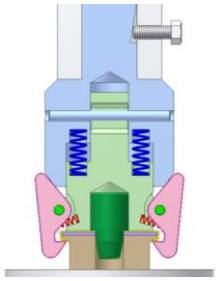
Mechanism for cutting cigarette rod
https://youtu.be/zZNTNADKNbs
Input: pink crank to which the large gear is fixed.
Output: grey shaft with the cutter that rotates around its own axis and at the same time has round translating motion in the vertical plane.
Pink and violet cranks, blue part create a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



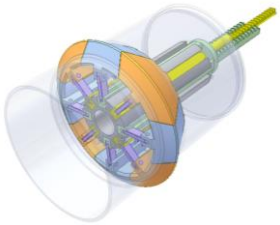
Spinning undercut objects
https://youtu.be/BjK2DxbHrYA
Red part represents a lathe spindle. Upper yellow parts are workpiece of disk shape and its final product.
A combined core is used for spinning objects of undercut
The video shows how to take out the combined core from the final product.



Crimping tool
https://youtu.be/-B-pIa0YrPw
Yellow part and violet disk are jointed with brown part by crimping.
The brown part is fixed to the base.
Transparent disk represents the yellow part before crimping.
Blue shank is fixed to grey spindle.
Green core can move up-down in the shank hole. Blue cross pin acts as a stopper for the core.
When the tool rotates and moves down, four pink jaws bend the yellow part to create the assembly.
The video last scene shows how the tool works supposing that the spindle doesn't rotate.

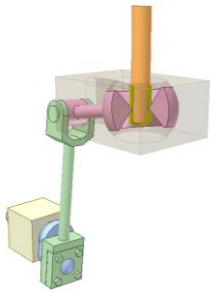


Expandable insert for belling plastic tubes 1
https://youtu.be/UobcIb4OR2w
This is a suggestion for the expandable insert used in belling machine:
https://www.youtube.com/watch?v=82m7Tf0p3gU
to create an annular groove on heat-softened end of a tube.
The insert ring consists of orange and blue inserts.
Each insert belongs to a parallelogram mechanism, the base of which (yellow or green sliders) can move axially. Springs that tend to turn violet bars forwards are not shown.
When the sliders move backwards, the inserts move inwards under the spring action.
When the sliders move forwards, the front violet bars collide with the front disk (in white) and move the inserts outwards, to set the inserts into a complete ring.
To hide the insert ring, the yellow slider moves backwards before the green one.
To expand the insert ring, the green slider moves forwards before the yellow one.
There are many ways to control these motions by only one actuator. A possible way is the mechanism shown at
https://youtu.be/sH_dAvX6byk



Wobbling die

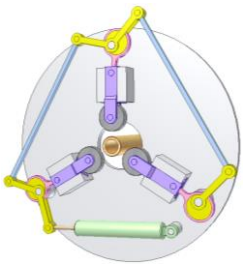
http://youtu.be/5KZ_IHdsd50



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

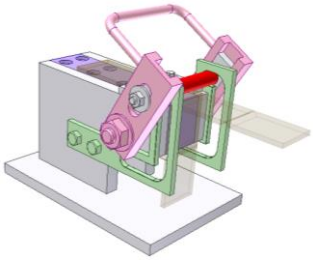
https://youtu.be/IJvLrdAhmQo



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

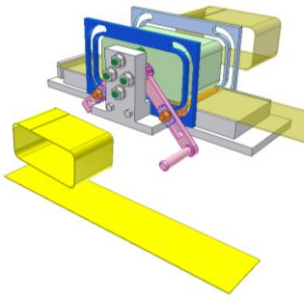
https://youtu.be/mjc02kb1eBE



It is for bending easy to bend, 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.

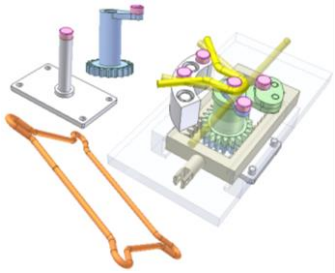
Manual bending O-shaped box

https://youtu.be/EzOtMeAe7TA



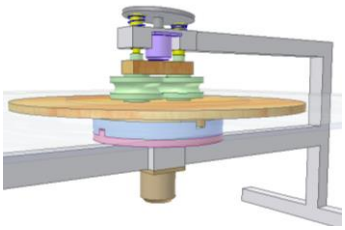
Insert yellow strip of soft material below fixed green core, turn pink crank for bending, push bent product out of the core.
Violet sliders move in the crank slots. Orange bending shafts move in slots of blue guides.
The light blue guide can be made quick detachable for easy removing the product.

Wire bending machine 1



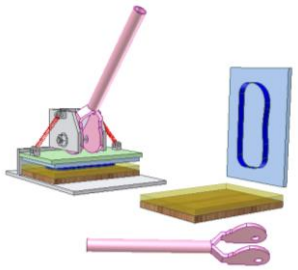
https://youtu.be/Zd_wiTx7mDk
Input: reciprocating frame of two racks (in beige). The motion source may be a hydraulic cylinder or an electric motor with suitable mechanical transmission.
The final product is shown in yellow color.
Its initial and intermediate shapes are shown in transparent yellow color.
It is used for making rectangular frames (in orange).
Download the video to see how
http://www.mediafire.com/file/kfl60yb4zj18d2g/WireFrameBend.mp4

Bending serpentine tube



https://youtu.be/nDGKm3klqSw
This video is an attempt to decode the mechanism shown at
https://www.youtube.com/watch?v=SKqb-6vf4pc
Brown step motor is for bending motion.
Bending motion is transmitted to orange bending plate via Oldham mechanism of blue cross groove disk.
Violet step motor is for controlling yellow pins.
The rollers are pivoted on the bending plate and supported by orange bridge.
The bending plate can rotate around one of the two yellow pins (around the pin that is inserted in the hole of one green roller).
The violet motor of grey oblique disk ensures that when one yellow pin is in the hole of one green roller, the other pin is not.
So the bending plate alternately rotates around two yellow pins.
Device for advancing tube after each bending is not shown.

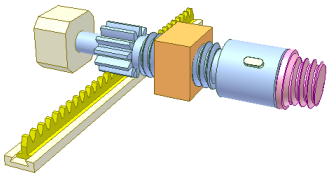
Hand press for cutting soles



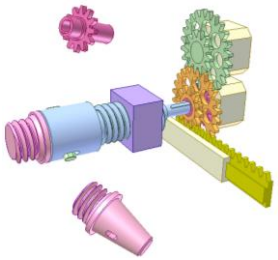
https://youtu.be/-po8vPTG7QE
Turn pink cam to move green plate down and force blue cutter on yellow soft material.
Runway for the green moving plate is omitted.
See a press in reality:
https://youtu.be/uGg49_z-ZCE

26.3. Mechanisms for molding machines

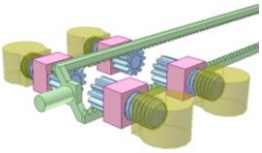
Mechanism for moving thread core of a plastic injection mould 1
http://youtu.be/7bVTvWGAdAA
Yellow rack is connected to the movable half mold.
When the movable half mold moves, the rack pinion drive and the screw drive (blue screw and orange fixed nut) make blue shaft carrying the pink thread core rotate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

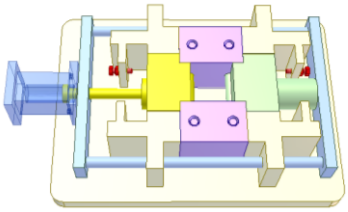


Mechanism for moving thread core of a plastic injection mould 3
https://youtu.be/ZESjsMQKmIs
Pink nuts are fixed to the mould.
Green racks are connected to an actuator.
The racks make blue gear thread cores rotate and translate. Thus the thread cores are removed from four plastic injection parts (in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



Mechanism for mould opening 1

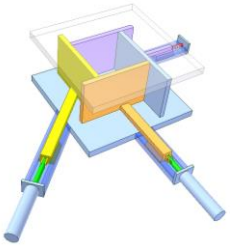
https://youtu.be/vSEGVGXqV7A



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

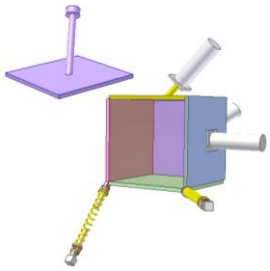
https://youtu.be/SI_iZ5CyPlA



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

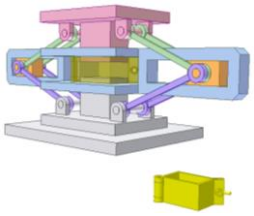
https://youtu.be/lWFi3b51alo



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



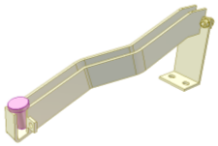
Input: pink upper punch fixed to main slider of a press.
When the upper punch moves down, blue slotted bar, to which yellow mould is fixed, moves down with a half speed.
Although grey lower punch is immobile, in fact both punches move into the yellow mould of detachable structure.

27. Mechanisms for work manipulation

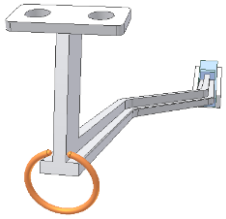
27.1. Feed ways

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.

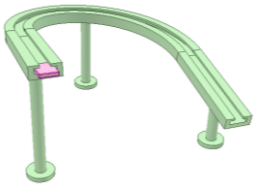


Feed way 2
https://youtu.be/R9s5TxC5Q84
Orange workpieces move along feed way of T-shaped section due to the gravity.



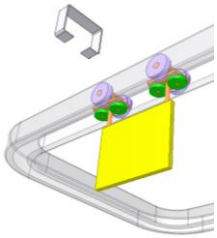
Feed way 3
https://youtu.be/WyYMSs3a2jM
Pink workpieces move along feed way of rectangular section due to the gravity.

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

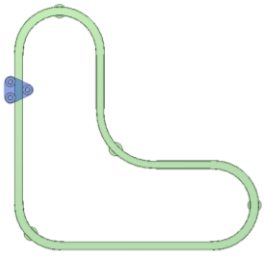


Feed way 5
https://youtu.be/9BhZqv7rgK0
Orange workpieces move along helical feed way of rectangular section due to the gravity. Various part shape are possible: balls, rollers, rectangular boxes.
Advantage: small space for large quantity of reserved parts.

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.

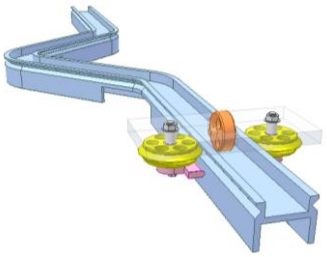


Curved linear rail with 3-wheeled carriage
https://youtu.be/ZmF8mov2HZE
A 3-wheeled carriage moves along a rail consisting of straight, convex, concave and transitional portions.
To maintain a continuous gapless contact between the wheels and the rail, the widths of the portions are not the same.
They 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



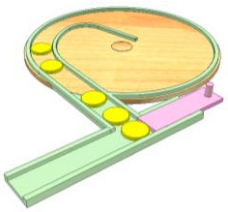
Curved linear rail with 4-wheeled carriage
https://youtu.be/KyD9Y7R19jQ
A 4-wheeled carriage moves along a rail consisting of convex, concave and straight portions.
The wheels are mounted on pink bars that have revolute joints with the carriage base. It ensures a continuous gapless contact between the 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.

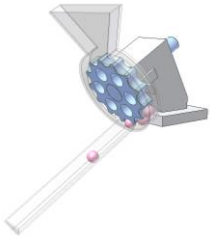


27.2. Workpiece arrangement

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).

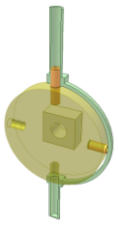


Lining up mechanism 2
https://youtu.be/grZWmiU0-ZI
Pink workpieces of ball (or roller) shape from the funnel are arranged in line thanks to blue gear rotor and the gravity.
There must be a vibration device for the funnel to prevent workpiece jam.

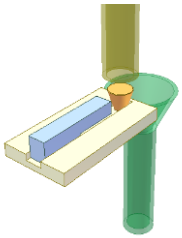


Part orientation 1
http://youtu.be/1Au-1clVp2A
This device makes the orange part to change its orientation after running haft-circle runway.

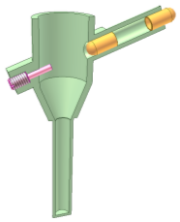
Part orientation 2
http://youtu.be/cXkOMI_Jd1Y
This device changes the orientation of the orange parts: from bottom down in the upper tube to bottom up in the lower tube. The yellow disk rotates interruptedly by an appropriate mechanism (not shown).
The device also has function of part separating.



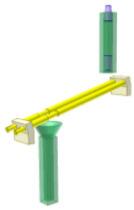
Part orientation 3
http://youtu.be/0-USznSJAtw
This device makes the orange parts to drop with large bottom down regardless of their initial orientation in the upper tube. The blind slot in the yellow plate is a key detail.



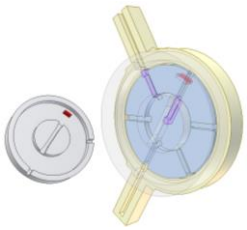
Part orientation 4
http://youtu.be/blv09DJr70Q
This device makes the orange parts to drop with closed bottom down regardless of their initial orientation in the upper tube. The pink screw is a key detail.



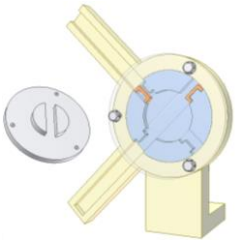
Part orientation 5
http://youtu.be/yCa2j8d8KyE
This device makes the violet parts to drop into the lower tube with small bottom down regardless of their initial orientation in the upper tube. The yellow shafts rotate with tendency to push up the parts to avoid their jam.



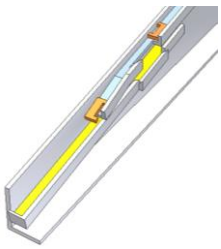
Part orientation 6
https://youtu.be/daHP7dkagas
This device makes the violet parts enter the lower runway with their head down regardless of their initial orientation in the upper runway.
The blue disk rotates interruptedly by an appropriate mechanism (not shown).
Key factor is the red portion on the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



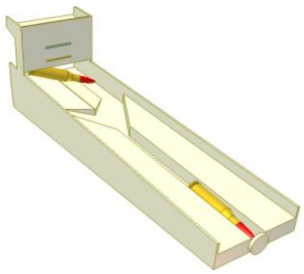
Part orientation 7
https://youtu.be/ed9Td2hUH2MThis device makes the orange parts enter the lower runway with their open sides pointing to the left regardless of their initial orientation in the upper runway.
The blue rotor rotates interruptedly by an appropriate mechanism (not shown).
Key factor is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



Part orientation 9

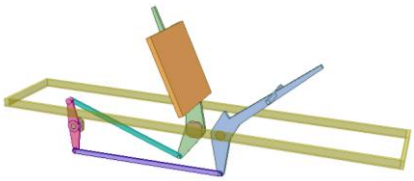


https://youtu.be/0zUDSkm2ze8

Cartridges of both possible orientations in input container fall and move down thanks to the gravity.
For a cartridge the sharp end (bullet, in red) is heavier than the other end (containing light propellant).
Suitable shapes of protrusions in the runway ensure that the red ends of output cartridges always point forwards.
Device for moving two green plates (for separating the cartridges) is not shown.
This concept may be applied for cartridge belt loader:
https://youtu.be/uB3lRVBs42w

Flipping mechanism 1

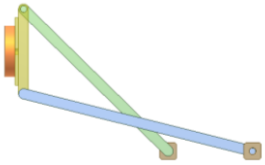
http://www.youtube.com/watch?v=KCJa2zRWpwg



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

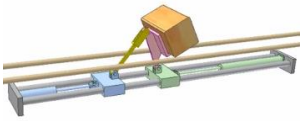
http://www.youtube.com/watch?v=bBWARLe2StQ



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.

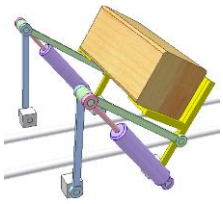
Flipping mechanism 3

https://youtu.be/p5xSjYE69zM

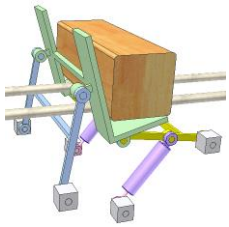


Yellow, pink and green links create a slider crank mechanism.
Thanks to green cylinder the pink conrod (length of which is shorter than the one of the yellow link) turns orange work 90 deg.
Blue piston is used for setting working position of the mechanism.

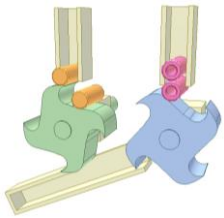
Flipping mechanism 4a
https://youtu.be/gd0izSF0IvI
Blue, green and yellow links create a 4-bar linkage.
Violet cylinder turns yellow crank 90 deg. but orange work can turns 180 deg. thanks to its inertia.



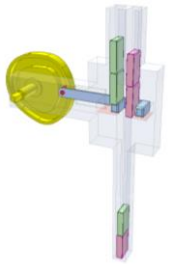
Flipping mechanism 5
https://youtu.be/3CAnTu6rsUc
Blue, green and yellow links create a 4-bar linkage.
Thanks to violet cylinder the green conrod turns the work 90 deg.



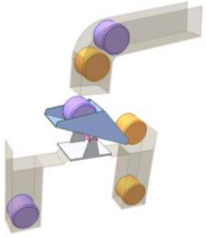
Part mingling 1
http://youtu.be/jXPQxMRaq8I
This device enables mingling two kinds of parts in an alternate order.
The rotors rotate in opposite direction.



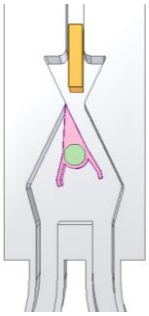
Part mingling 2
https://youtu.be/jXzOK3W0DNI
This device enables mingling two kinds of parts in an alternate order.
The red plane surfaces on the base are slanting outward to prevent the parts from casual falling.



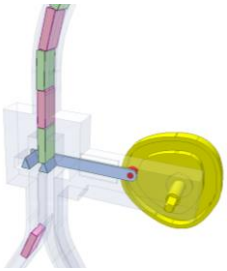
Part flow dividing 1
https://youtu.be/Dbj6Wz6dUfc
Incoming part (rollers) flow is divided into two ones thanks to blue pivot bucket.
Key factor:
- torque caused by the lowest part (in contact with the bucket) applied to the bucket must be larger than the one caused by upper parts.
- center of mass of the bucket must be higher than its rotary axis.
This mechanism can be used for grain material (dividing and dispensing).



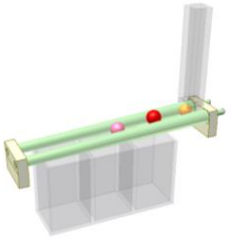
Part flow dividing 2
https://youtu.be/gP7JZ1-fhNc
Incoming part (in orange) flow is divided into two ones thanks to pink pivot guide.
Key factor: center of mass of the guide must be higher than its rotary axis.
Disadvantage: There must be enough distances between successive parts in the flow (adding a separate device if necessary).



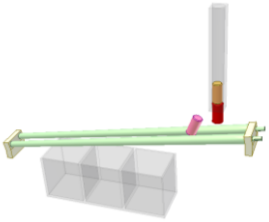
Part flow dividing 3
https://youtu.be/BInuMZ2ygX8
Incoming part (in pink an green)) flow is divided into two ones thanks to blue follower of yellow cam. The mechanism also acts as a separating device.



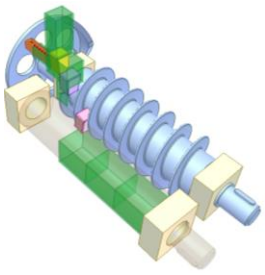
Part sorting 1
http://youtu.be/nKZX6EuvfiM
The balls are sorted on diameter. The first box receives smallest balls, the last box receives biggest ones.
The green conical shafts rotate in opposite direction with tendency to raise the balls.



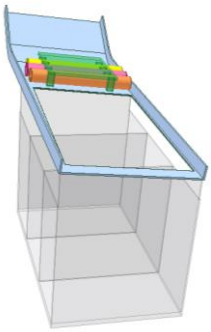
Part sorting 2
http://youtu.be/ZUM5xUA1GUQ
The rollers are sorted on diameter. The first box receives smallest rollers, the last box receives biggest ones.
The green conical shafts rotate in opposite direction with tendency to raise the rollers.



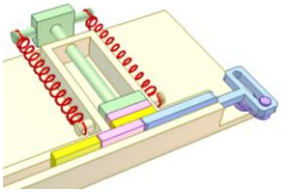
Part sorting 3
https://youtu.be/jYqbtcY2AHk
Axes of blue screw and glass shaft (both of cylindrical shape) are set in such a way to create a small angle.
They rotate in opposite direction with tendency to raise the parts of wegde shape (in yellow, pink and violet).
The parts are sorted on their width.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



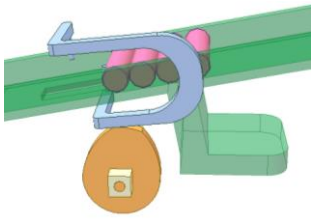
Part sorting 4
https://youtu.be/-UZfxI6amZM
The parts (in yellow, orange and pink) are sorted based on their lengths. They move on blue runway thanks to green belt (external teeth) of a belt drive (its two pulleys are not shown) and fall down into three boxes.
The first box receives shortest parts (in 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.



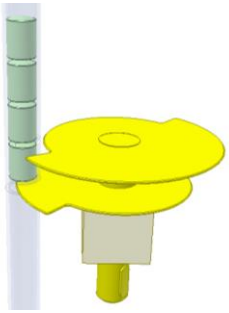
Feeder 1
https://youtu.be/9v4laaQrvQI
Workpieces (yellow and pink) are fed one by one.
Blue pushing bar is driven by a sine mechanism.



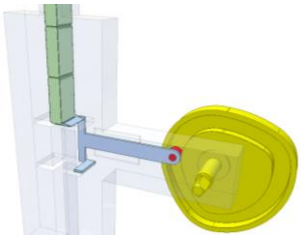
Part separation 1
http://youtu.be/qNftCnJGsvU
This device enables feeding parts one by one to the processing machine. The blue separator is driven by a cam.



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

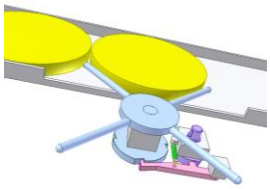


Part separation 3
https://youtu.be/DapbPNaIGVY
This device enables feeding green parts one by one to the processing machine. One part corresponds one cam revolution.



Part separation 4a

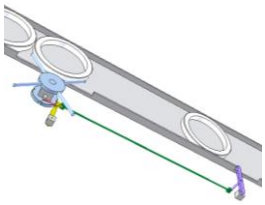
https://youtu.be/sYW_VbofOHU



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

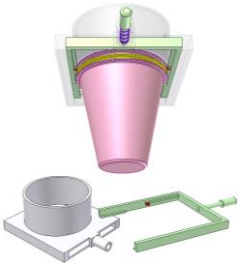
https://youtu.be/EJyhiQ52kWo



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

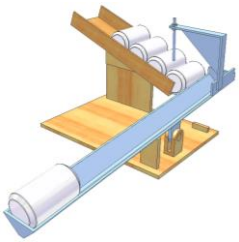
http://youtu.be/HWDkaef7mZE



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.

Can dispenser

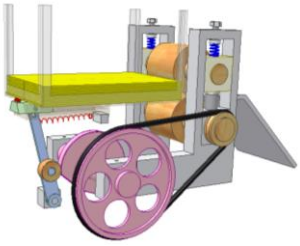
https://youtu.be/LlUPpo1pdiM



To get a can, move up the front end of the blue rail and then move it down. The gravity make the cans go down. While the first can rolls into the rail, the blue rod stops the rest cans.
For automatic operation use a disk cam actuating the rail.
This mechanism may be used in video
https://youtu.be/f9zS0cQe0aM

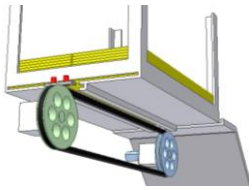
Card dispenser 1

https://youtu.be/0MAkTc2TJE4

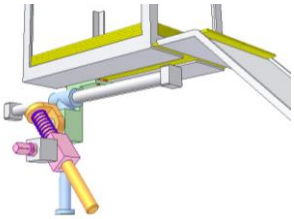


Yellow cards in stack are dispensed one by one.
Input: pink cam shaft that gives green slider linear reciprocating motion via blue follower of a small roller. Red spring maintains contact of the roller and cam.
The lowest card is pushed by red pins (with the red spring force) of the slider into space 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.

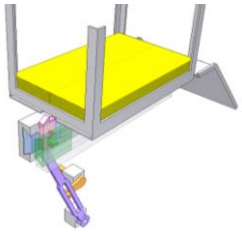
Card dispenser 5
https://youtu.be/QIkOO0tzhLY
Yellow cards in stack are dispensed one by one.
Input: blue pulley.
The lowest card is pushed by red pins fixed to the black belt.



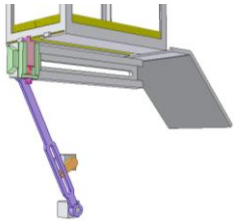
Card dispenser 2
https://youtu.be/VxeP8Ayy1FQ
Yellow cards in stack are dispensed one by one.
Input: pink shaft that makes green slider translate following a rectangular trajectory. See also:
https://www.youtube.com/watch?v=Hbq9J_HJsTo
The lowest card is pushed by red pins.
Weakness: large velocity of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



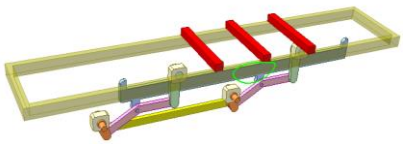
Card dispenser 4
https://youtu.be/9KUnmu3SEck
Yellow cards in stack are dispensed one by one.
Input: orange shaft that gives green slider reciprocating linear motion.
The lowest card is pushed by pink vertical slider which has prismatic joint with green slider.
When the pink slider goes back, it descends 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.



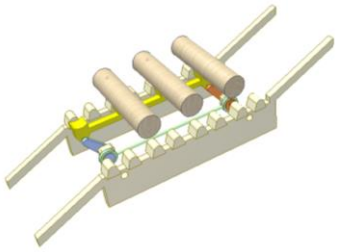
Grain material dispenser 1
https://youtu.be/OkMBfDeXxsQ
Input: yellow gear.
Material is supplied from the glass funnel to cylindrical containers on green disk. The container consists of green upper portion and yellow movable lower one. The material is released to the bag (not shown) on opposite side 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

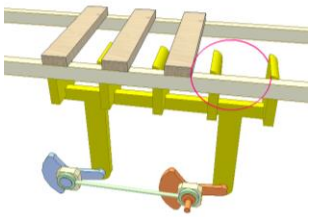
Transport mechanism 1
http://youtu.be/MeQOVyR9a-E
The blue transport has “egg-shape” motion that is used for moving the red works. It is the locus of a point on the pink 4-bar linkage’s connecting rod. The yellow connecting rod used for uniting the orange cranks creates a parallelogram mechanism.



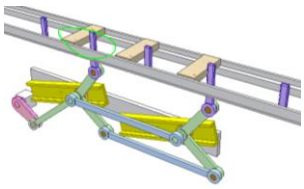
Parallel-link feeder 1
http://youtu.be/fK4sziwqOjo
A parallelogram mechanism is used for transporting the workpieces. The green bar helps the mechanism overcome its dead positions.



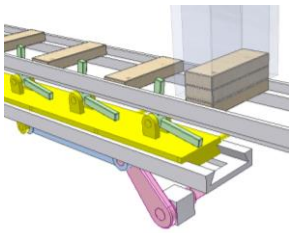
Parallel-link feeder 2
http://youtu.be/e3S_AldcqHI
A parallelogram mechanism is used for transporting the workpieces. The green bar helps the mechanism overcome its dead positions. The red circle is locus of a point on the yellow transporter



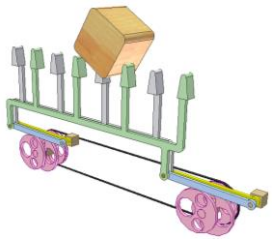
Transport mechanism 2
https://youtu.be/eH6tIjoNH0U
Input: pink crank.
Violet link pushes brown workpieces.
Green line is locus of a point on the violet link.
Green, blue and violet links create parallelogram mechanisms.
Yellow inclined runways make upper portion of the locus approximately horizontal.



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.

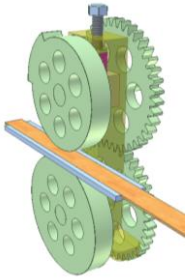


Transport mechanism 4
https://youtu.be/9oeiE2--Csc



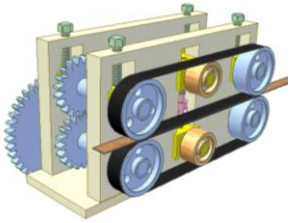
Input: one of pink double cam (eccentric) shafts.
Black part represents a chain drive.
Green and blue links create a parallelogram mechanism.
Grey and yellow links create a parallelogram mechanism.
The parallelogram mechanisms are of the same size.
Orange work moves longitudinally and turns simultaneously.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

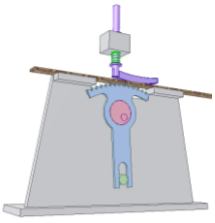


Input: the blue shaft of two gears.
Friction force between the black belts and the band moves it forward.
The belt tensioner consists of two orange rollers and a pink screw of right and left hand threads at its ends.

Mechanism for bar advancing 1
http://youtu.be/X7xW8_aRckM

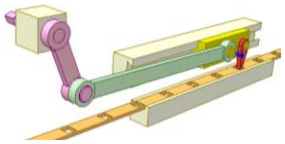
Friction forces caused by red springs move brown bar. Adjust angle position of lower roller to get various speeds of the bar. Max speed: when the two rollers are parallel.

Fabric advancing mechanism
https://youtu.be/kyCaktO5Vic

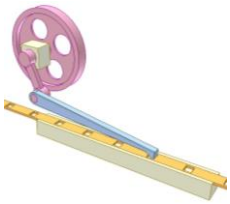


Input: pink eccentric.
It can be used for sewing machines.

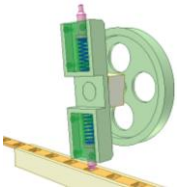
Mechanism for advancing perforated strip 1
http://youtu.be/UPkavC9eZPo
When moving to the right the red pawl is hold from rotation by the blue pin and pushes the orange strip to the right.



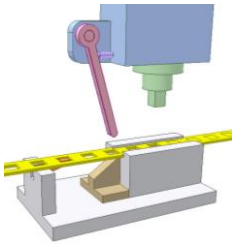
Mechanism for advancing perforated strip 2
http://youtu.be/-T14cCu-p7Y
When the pink crank rotates the blue long pawl pushes the orange strip to the right.



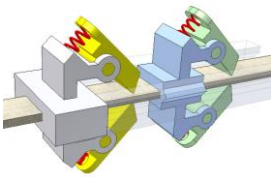
Mechanism for advancing perforated strip 3
http://youtu.be/MIBLtQEz4eE
The pink pins rotates together with the green double crank and can move along it, thus they can get into the strip holes and push it.



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.

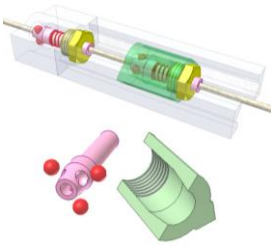


Strip advancer 2
https://youtu.be/OWIAdRdb5RI
It is a combination of two oneway linear clutches
The blue clutch (in the right) of two green knives linearly reciprocates (its motion source is not shown) and makes brown strip move to the right only.



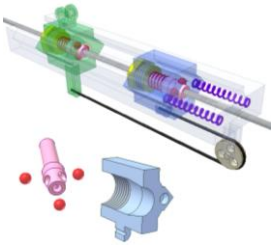
The grey clutch (on the left) of two yellow knives is stationary and prevents the strip from moving to the left.
Red springs always force the knives towards the strip.

Wire advancer 1



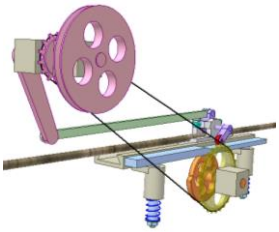
https://youtu.be/m5EQm5cDIYM
It is a combination of two oneway linear clutches
The green clutch (in the right) linearly reciprocates (its motion source is not shown) and makes the wire move to the right only.
The grey clutch (on the left) is stationary and prevents the wire from moving to the left.
Red 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



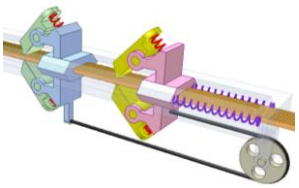
https://youtu.be/EJBVwq202X4
It is developed from mechanism “Wire advancer 1”
https://youtu.be/m5EQm5cDIYM
Green clutch (on the left) linearly reciprocates (its motion source is not shown). It makes the blue clutch move in opposite direction thanks to the cable drive.
Both clutches make grey wire move 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.

Two length wire advancer



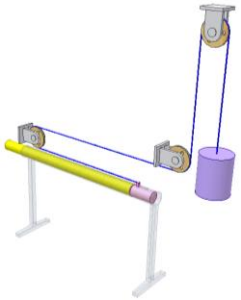
https://youtu.be/-N3u60KCAww
This advancer give two advancing lengths (L1 and L2) alternately.
White slider linearly reciprocates thanks to pink input crank and green conrod. Violet part and two blue screws are set to ensure that the wire can move only when the slider is pulled.
When the blue bar is at its lower position, the advancing length is max (L1). The red roller doesn’t touch the blue bar.
When the blue bar is at its upper position, the advancing length is L2, L2 is shorter than L1, because the high portion of the blue bar raises the red roller and make the violet bar do not contact the wire in a part of the slider pulling stroke.
Orange cam receiving rotation from the pink crankshaft controls motion of the blue bar via a chain drive. Its transmission ratio is 2.
Device for keeping the wire immobile (maybe a wire straightener), when it is not pulled, is not shown.
This video is an attempt to decode the advancer of the machine shown at
https://youtu.be/ACsbK-02kZk

Reciprocating linear motion into continuous oneway one



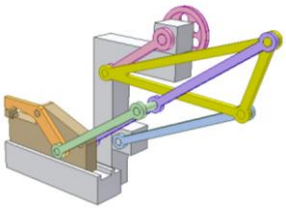
https://youtu.be/V-XMxIOIY0U
It is developed from mechanism “Strip advancer 2”
https://youtu.be/OWIAdRdb5RI
Blue clutch (on the left) linearly reciprocates (its motion source is not shown). It makes pink clutch (on the right) move in opposite direction thanks to the cable drive.
Both clutches make orange 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



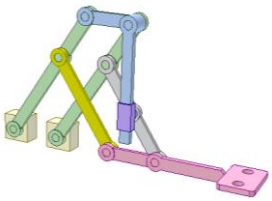
https://youtu.be/thevNijgu4g
It is used in metal-cutting machine tools to create constant force (violet weight) for advancing works of bar shape (in yellow).

Feeding mechanism



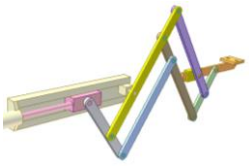
https://youtu.be/g3-7bQWeL50
Input: pink crank.
Output: brown slider (bringing orange angular bar) that clamps a workpiece (not shown), moves it to the left, releases it there and returns to initial position.
The slider has two dwells at both ends of its stroke.
Length of pink crank: a
Length of blue 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

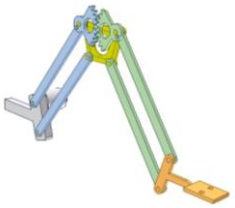


https://youtu.be/ivAQfdUT1ZM
Green and blue bars create a parallelogram mechanism.
Yellow, grey and pink bars create a parallelogram mechanism.
Green, grey and blue bars create an isosceles triangle.
Input: one of the green bars.
Pink bar (gripper support) moves linearly.

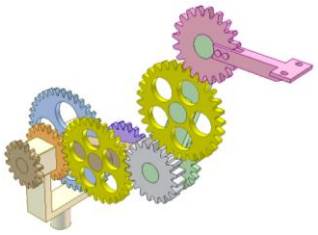
Linear manipulator 4
https://youtu.be/AKfC1RI9nsw
Blue, yellow, grey and brown bars create a parallelogram mechanism.
Brown, violet, yellow and green bars create a parallelogram mechanism.
Grey and yellow bars create an isosceles triangle.
Violet and green bars create an isosceles triangle.
Input: pink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



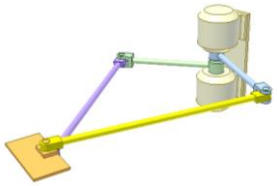
Linear manipulator 5
https://youtu.be/2ZY6liIIIHU
Blue bars and yellow plate create a parallelogram mechanism.
Green bars and yellow plate create a parallelogram mechanism.
Lengths of blue and green bars are equal.
Input: one of the blue bars.
Orange bar (gripper support) moves linearly.
This mechanism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



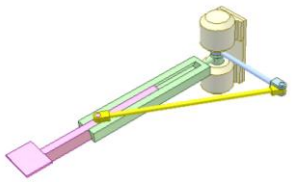
Planar manipulator 3
https://youtu.be/trtH7Id7HSA
Three inputs: brown, blue and orange gears.
Output: pink gripper support (fixed to pink gear) performing planar motion.
The video shows alternately:
1. Only brown assembly (gear and crank) turns, the pink support translates linearly along the line connecting 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.

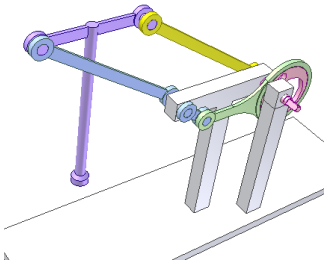


Planar manipulator 2



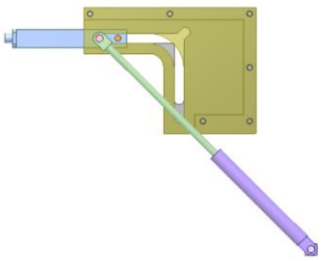
http://youtu.be/GuWlLurktAU
The mechanism has two degrees of freedom.
Pink slider performs planar motion.
Features:
- Actuators are base-mounted
- Pink slider and green bar have the same direction.
- Positon calculation of center of the revolute joint for the pink plate is less complicated in comparision with “Planar manipulator 1”.
This is a design from Goddard Space Flight Center, USA.

Pick and place mechanism 1



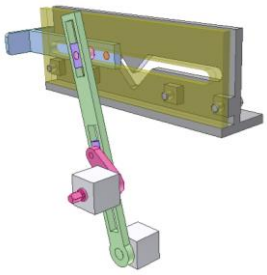
https://youtu.be/AEXYQhxnQEM
Input: pink eccentric shaft rotating regularly.
Violet conrod, blue and yellow rockers create a parallelogram mechanism.
The 4-bar mechanism (blue rocker, pink crank and green conrod) makes the parallelogram mechanism rockers oscillate near 180 deg.
The vacuum tool at the 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.

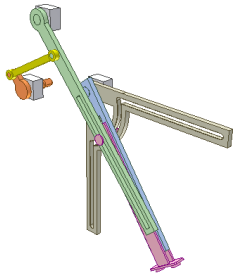
Pick and place mechanism 3



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

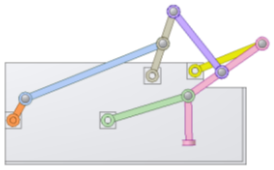
https://youtu.be/gZ6cNk7H-j8



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.

Pick and place mechanism 4

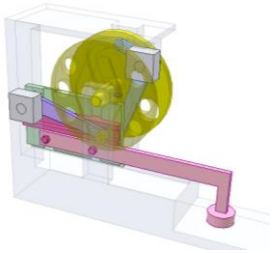
https://youtu.be/gwNRR4fjXfI



Input: orange crank rotating regularly.
This is a 7-bar linkage of all revolution joints.
The vacuum tool at the pink bar end picks and places workpieces.
This video was made based on
https://www.youtube.com/watch?v=28RU9jnHd0c

Pick and place cam mechanism 1

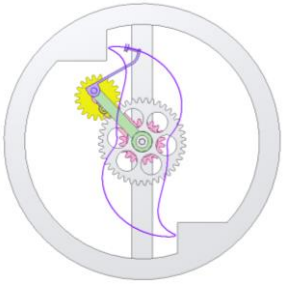
https://youtu.be/FniUD620D8M



Input: yellow shaft to which two cams are fixed.
Cam 1 of blue angular follower makes green slider move in horizontal direction, thus controls horizontal motion of pink gripper.
The blue follower has two rollers, one moves in cam 1 groove, the other in straight groove of the green slider.
Cam 2 of violet follower makes pink slider move in vertical direction, thus controls vertical motion of the gripper. The violet follower has two rollers, one moves in cam 2 groove, the other in straight groove of the pink slider.
The green slider moves in a runway of the base.
The pink slider moves in a vertical runway of the green slider.
The vacuum tool at the pink gripper end picks and places workpieces.

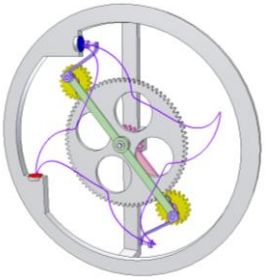
Pick and place gear mechanism 1

https://youtu.be/Q49Al9nhNBo

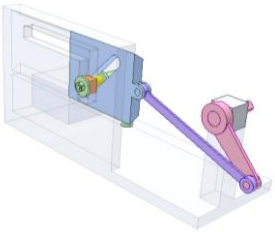


Input: pink carrier of a planetary gear drive (white stationary gear of tooth number Zw and yellow satellite gear of tooth number Zy; Zw = 2Zy).
The yellow gear pin, green crank and violet bar create a 4-bar linkage.
Violet gripper fixed to the violet bar picks and places the components (not shown) at two opposite places.
Violet line is the trajectory of the gripper.

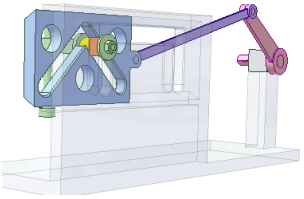
Pick and place gear mechanism 2
https://youtu.be/rsYcYkx3w8U
Input: pink carrier of a planetary gear drive (white stationary gear of tooth number Zw and yellow satellite gear of tooth number Zy; Zw = 4Zy).
The yellow gear pin, green crank and violet bar create a 4-bar linkage.
Violet grippers fixed to the violet bar pick the components (not shown) at blue place and place them at red place perpendicular to the blue one.
Violet line is the trajectory of the grippers.
Here two symmetric grippers are used.



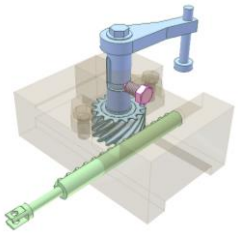
Pick and place mechanism 5c
https://youtu.be/eHTdbjU7SM4
Input: pink crank rotating continuously.
Yellow ball bearing on green pin moves along oblique slot of white base.
Orange square slider fixed to green pin moves along L-shaped slot of white base.
The vacuum tool at the green bar end picks and places workpieces.
This is a combination of a slider-crank mechanism and a wedge one.



Pick and place mechanism 6
https://youtu.be/RxvDlIgvaYs
Input: pink crank rotating continuously.
Yellow ball bearing on green pin moves along V-shaped slot of white base.
Orange square slider fixed to green pin moves along U-shaped slot of white base.
The vacuum tool at the green bar end picks and places workpieces.
This is a combination of a slider-crank mechanism and a wedge one.

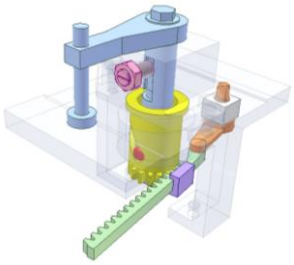


Pick and place mechanism of helical gear
https://youtu.be/JrYsB7X387A
Input: green rack receiving motion from a cylinder (not shown) or other motion source.
The vacuum tool at the blue bar end picks and places workpieces.
Helical gear-rack drive and the interaction between pink pin and L-shaped groove of blue shaft create the tool motion.



Pick and place mechanism of barrel cams 1

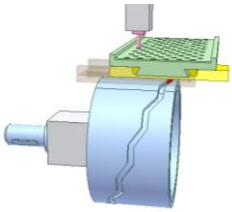
https://youtu.be/I6fdFnv2CQ4



Input: orange crank rotating continuously.
The vacuum tool at the blue bar end picks and places workpieces.
Yellow gear and green rack make yellow barrel cam turn forth and back.
Thus motion makes blue barrel cam, to which the blue bar is fixed, have pick and place motion thanks to the interaction between the square end of pink screw and U-shaped groove of the blue cam.

Barrel cam for placing machine

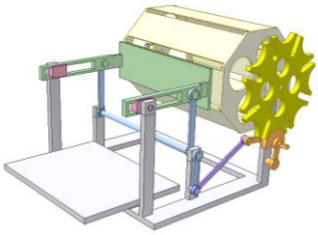
https://youtu.be/Vz3MurMYCxA



This is used for placing round products (not shown) on green tray.
Input: blue cam rotating continuously. Red pin fixed to yellow slider moves in zigzag shaped groove of the cam.
Motion transmission device from the cam to pink placing tool is not shown. One revolution of the cam corresponds 12 double strokes of the tool.
Motion transmission device from the cam to green slider is not shown. Green slider moves twice in one revolution of the cam.
One solution for moving the green slider is the mechanism shown at:
https://youtu.be/LL5YynZnmh4
then the violet and green sliders are connected together via a sliding joint.

Pick and place mechanism 7

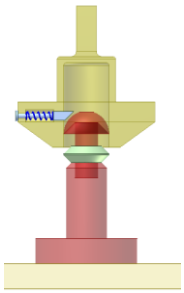
https://youtu.be/BLSqqE0Jlog



Input: orange shaft
Green coulisse carrying vacuum tool (not shown) picks workpieces from yellow cage rotating interruptedly and places them on horizontal plane.
Distance between revolution joint of pink slider and bearing of blue long shaft = L.sqrt(2)
L: length of blue double bar.
Geneva drive of 8-slot disk controls motion of the cage.
This video aims to explain working principle of egg tray making machine shown at
https://www.youtube.com/watch?v=r6svFCUW29g

Grapple frees loads automatically 1

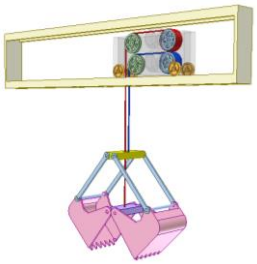
http://youtu.be/9lBBBTgeB-4



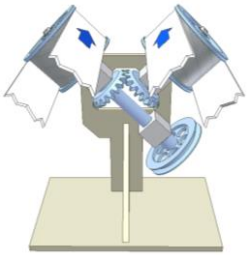
This self releasing mechanism is developed at Argone National Laboratory in Illnois, USA, to remove fuel rods from nuclear reactors. It is useful also where human intervention is hazardous or inefficient, such as lowering and releasing loads from helicopters.
There are 3 blue latches disposed around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

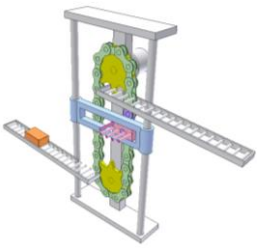
Crane bucket
http://youtu.be/ySAYljiSvKc
The blue cable is used for bucket moving up and down.
The red cable is used for bucket opening or closing.
Pay attention to the fact that the red cable must move when the bucket moves up and down to keep closing or opening state of the bucket.
Mechanism for moving 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.



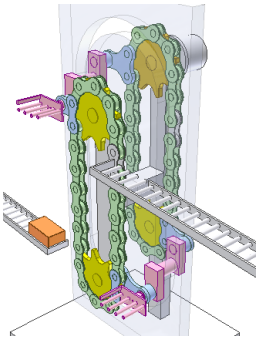
V-conveyor transmission
https://youtu.be/dVFL8Dnvr6Q
Input: V-belt pulley.
This conveyor is used for transporting empty cylindrical PET water bottles.



Vertical conveyor 1
https://youtu.be/ggQOtwqLMNs
Pink lifter is pivoted on a link of the chain and always kept horizontal thanks to two prismatic joints (vertical and horizontal).
Weakness: only one lifter can be arranged.

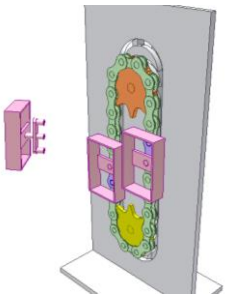


Vertical conveyor 2
https://youtu.be/rycnlA9wxL0
Two chain drives are installed with a large vertical offset A.
The pink lifter has revolution joint with a link of each chain.
Center distance between the two revolution joints is equal to A.
Such arrangement keeps the pink lifter always horizontal.
More lifters can be mounted along the chain length.



Vertical conveyor 3

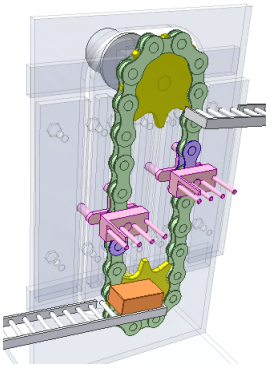
https://youtu.be/2z6hH21MoTo



Pink frame is pivoted on a link of the chain and always kept horizontal thanks to the interaction between its 3 pins (or rollers) at back side and slots of stationary guide.
Several frames can be arranged along the chain length.
For simplicity the measure to keep the frames steadily during motion is not shown.

Vertical conveyor 4

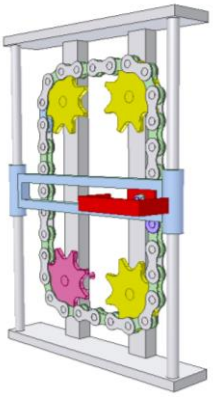
https://youtu.be/zigWcnKh894



Pink lifter is pivoted on a link of the chain and always kept horizontal thanks to the interaction between its 4 pins (or rollers) at back side and 6 slots of the white guide.
Several lifters can be arranged along the chain length.
This animation aims to explain the working principle of vertical conveyor shown at:
https://www.youtube.com/watch?v=kD4i1iLXXo4&t=8s
For simplicity the measure to keep the lifters steadily during motion is not shown.

Rectangular conveyor 1

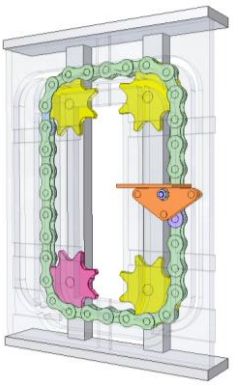
https://youtu.be/yj2-zWqgZvw



Red plate is pivoted on a link of the chain and always kept horizontal thanks to two prismatic joints (vertical and horizontal).
Weaknesses:
- only one plate can be arranged.
- distance between two guide posts must not too large.
This concept can be applied for other shapes of the chain drive such as:
http://youtu.be/Or0k0VpDtBw
http://youtu.be/7-0wXqRga4M
http://youtu.be/V0_wqv0y7rg

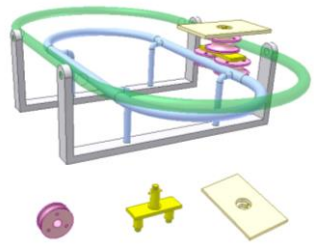
Rectangular conveyor 2

https://youtu.be/7r8pWr7Yuy8



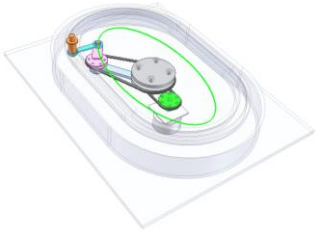
Orange plate is pivoted on a link of the chain and always kept horizontal thanks to the interaction between its 3 pins (or rollers) at back side and slots of stationary guide.
Several plates can be arranged along the chain length.
For simplicity the measure to keep the frames steadily during motion is not shown.
This concept can be applied for other shapes of the chain drive such as:
http://youtu.be/Or0k0VpDtBw
http://youtu.be/7-0wXqRga4M
http://youtu.be/V0_wqv0y7rg

Curved linear rail with 3-wheeled carriage 2



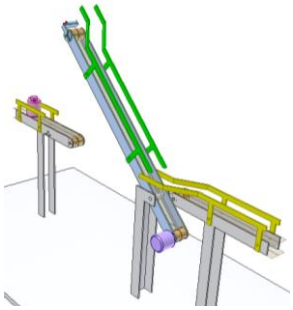
https://youtu.be/8WWJHFQKTjg
A 3-wheeled carriage is pushed by hand along a rail consisting of two oval-shaped bars.
At curved portions of the rail the contact between the bars and the rollers is not good. However, it does not cause problems for the carriage motion. System of 3 rollers helps keeping the carriage direction stable during motion.
This video was made based on:
https://youtu.be/kqsPsoa55UQ

Transmission for sliders of oval-shaped runway



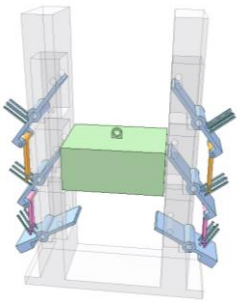
https://youtu.be/vPc5F-zCc1w
Input: blue crank receiving rotation from a motor via a belt drive of green and blue pulleys.
Satellite pulley of pink crank rotates on the blue crank thanks to a belt drive of stationary pulley (in grey). Diameter of the grey pulley is double the one of the pink pulley. The pink crank traces an ellipse (in green) that approximates the oval-shaped runway.
Cyan conrod connects the pink crank with the orange slider (roller) and makes the latter move in the oval-shaped runway.
Velocity of the slider along the runway is not constant.
Two last scenes of the video show the way to transmit motion to 6 sliders.
This concept can be used for The Oval Lazy Susan:
https://youtu.be/xCCnMUBz1iU

Lift Gate Conveyor



https://youtu.be/-XfTmiekGz0
The gate is used when a passage way is required in a production line. By manual lifting the conveyor section (a gate), access is gained to the rear of the line. The gate acts as a drawbridge: when raised, product stops at the end of the previous conveyor, and only continues when the gate is closed.
Pay attention to the arrangement of the gate at closed position to enable the product to go through the gate. Red pin is for positioning the gate.
This video was made based on
https://youtu.be/JsXA-BLXsIg

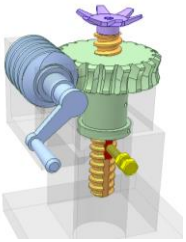
Storage rack 1



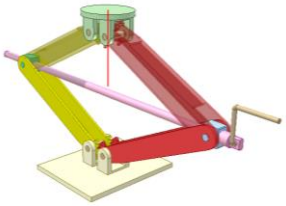
https://youtu.be/1F5V2wHBY5U
This rack allows loading and unloading goods in vertical direction. Blue levers prevent the contact of packages.
Blue levers of each level do not stop the package if there is no other package on the lower next level and vice versa.
Blue levers of each level do not prevent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

27.4. Lifting mechanisms

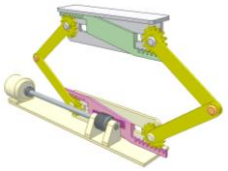
Nut-screw and worm jack
http://youtu.be/kp-dNLE8pMI
Combination of nut-screw and worm mechanisms gives the jack a high mechanical advantage.



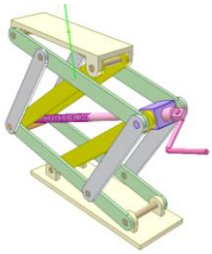
Gear and linkage mechanism 3c
http://youtu.be/78T8ufcyGjY
This jack is a combination of linkage, gear drive and nut screw one. The green disk moves along an absolutely straight line, its top plane is always horizontal.



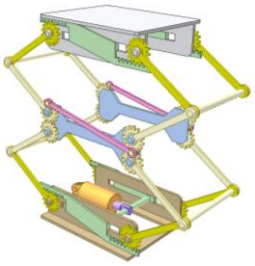
Lifting mechanism 1a
http://youtu.be/vCm01leXh30
A nut portion is created on the lower rack and receives motion from a motor via the grey screw.



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.

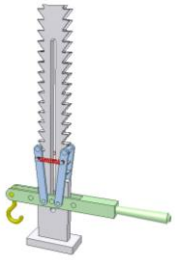
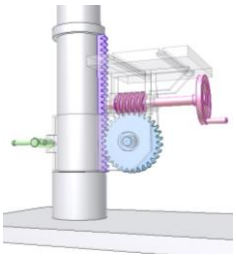
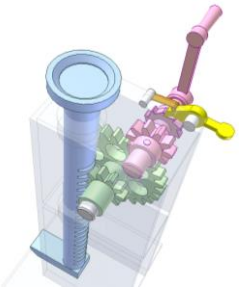


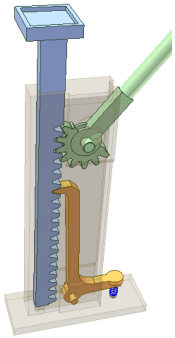
Table lifting mechanism for upright drilling machines 1
https://youtu.be/5QMYR2QcaD8
Turn pink shaft for raising or lowering the table.
The gravity can not move the table down because of the pink worm self-locking.
The table is turnable around the machine post.
Use green screw to fix the table after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



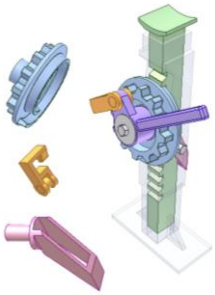
Rack-pinion jack 1
https://youtu.be/-RK_iuu6-Dg
Turn pink crank clockwise to move blue rack up.
Pink ratchet wheel and yellow pawl prevent the rack from falling down.
Push the pawl to bring it out of contact with the ratchet wheel and let the rack move down slowly by holding the crank.



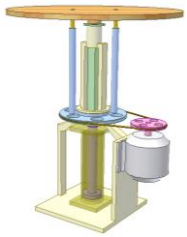
Rack-pinion jack 2
https://youtu.be/kkIAJJwb2GU
When turning green lever clockwise, its gear sector pushes the blue rack up.
When turning green lever counterclockwise, gear force pushes the gear sector out of contact with the rack so the latter is kept immobile thanks to orange pawl. Blue spring forces 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.

Lift of double parallelogram mechanism 1
https://youtu.be/Q6SBHliZrH0
Raise or lower the platform by turning the orange screw that engages with yellow nut fixed to yellow racks.
Gear-rack drives make green middle and right rockers turn in opposite directions with the same angle, thus the platform can move vertically.

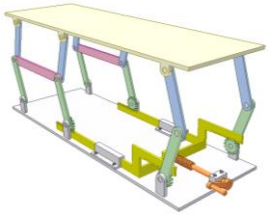


Table of adjustable height 1a
https://youtu.be/y_4Spm2d_14
This table uses the 8-bar mechanism shown at:
https://youtu.be/joJUV5Cbr4w
Turn the pink crank to change the table height thanks to the screw-nut drive (pink screw, red nut).
The upper frame translates along an approximately straight line and is kept parallel to the base.
Distances between revolution joints of grey base or upper frame: a
Length of blue bar: a
Length of green bars: 0.4a + 0.6a but 0.4142a + 0 .5858a is better
Length of orange bars: 0.4a but 0.4142a is better
Advantage over tables of scissor mechanism: no prismatic joints
See a real table:
https://youtu.be/rsAOW3T4i_4

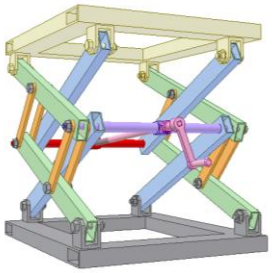


Table of adjustable height 2
https://youtu.be/rj-g2qHkjvE
This table uses the scissor mechanism.
Thanks to the vertical arrangement of green cylinder, the table speed Vt is constant if the piston speed Vp is constant.
Here Vt = 8Vp
The cylinder is fixed on the small car (in brown) that can roll on the base.

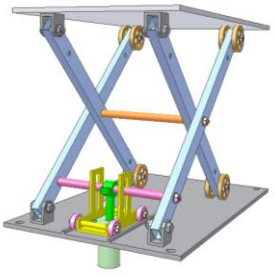
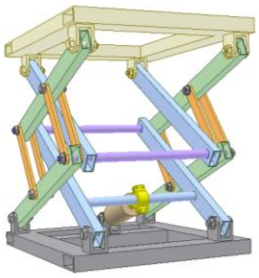
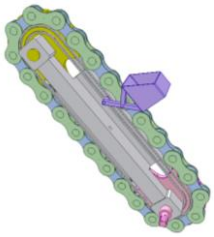


Table of adjustable height 1b



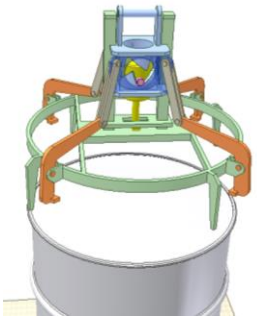
https://youtu.be/ui9ysjCUMdw
This table uses the 8-bar mechanism shown at:
https://youtu.be/joJUV5Cbr4w
Brown cylinder controls up-down motion of the upper frame.
The upper frame translates along an approximately straight line and is kept parallel to the base.
Distances between revolution joints of grey base or upper frame: a
Length of blue bar: a
Length of green bars: 0.4142a + 0 .5858a
Length of orange bars: 0.4142a
Distance from lowest position to highest one of the table is around 1.15a
Advantage over tables of scissor mechanism: no prismatic joints

Bucket elevator



https://youtu.be/rDNHDcdSgZg
Violet bucket is pivoted on a chain link. Its pin slides in a closed groove G that is equidistant to the locus of the chain link axes A.
Distance between G and A is shorter than distance between two pins of the violet bucket.
The bucket turns 180 deg. at both ends of the chain drive.
The same action is can be got if the bucket without pins is fixed to the chain link, however the bucket is easier to be shaken during motion.

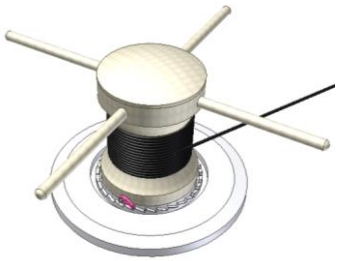
Drum lifter 1



https://youtu.be/Qd_s3UXxSUE
Mechanism shown at
https://youtu.be/IRFDwZR3VzU
is applied to this lifter.
Input: blue cam block moving up-down.
Green frame has prismatic joint with the cam block.
Orange angular levers, brown conrods, the cam block and the frame create slider-crank mechanisms.
For lifting the drum yellow T-hook is set to be below green traverse of rectangular hole. This position make distances between hooks of the orange levers larger than the drum diameter.
Then the cam block moves down. When the frame contacts the drum, further down and up motion of the cam block makes the yellow hook turn 90 deg. Now the latter can move up through the hole of the green traverse and reduce distances between hooks of the orange levers. Thus, the lifter can lift the drum.
The process of placing the drum on the ground is carried out in the same way.
See the drum lifter in action:
https://www.youtube.com/watch?v=QfwsfT-cldI
https://www.youtube.com/watch?v=g9NZy4s5cSc

Manual capstan

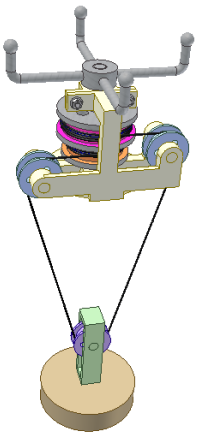
https://youtu.be/vV7UxZe7ETE



Stationary ratchet wheel has teeth at its face.
One end of black rope is fixed to the rotor.
Pink pawls prevent the rotor from counterclockwise rotation.
Flip the pawls for counterclockwise rotation.

Coaxial Chinese windlass

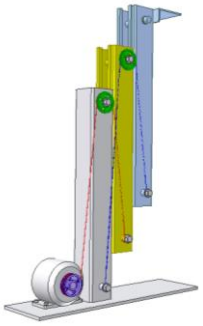
https://youtu.be/47BMeSY9soA



The mechanism is inspired by the Chinese windlass and the mechanism numbered as 490 of the book “507 Mechanical Movements”.
The gray pulley block consists of pink and orange pulleys fixed together.
One end of the black cable is fixed to the orange pulley.
The other end is fixed to the pink pulley.
The cable is wrapped several revolutions around the orange pulley, then goes around the blue, violet, other blue pulleys and is wrapped several revolutions around the pink pulley.
Dp, Do are the diameters of the pink and orange pulleys respectively.
h is the displacement of the weight in one revolution of the grey handle.
A is the angle between two branches of the violet pulley.
Approximately h = (Pi/2)*cos(A/2)*(Dp-Do)
If the difference between Dp and Do is small, the mechanical advantage of the windlass can be very large.
In this video: Dp = 124 mm; Do = 104 mm; h is smaller than 31.42 mm.
The mechanism works as if it is a screw-nut drive.

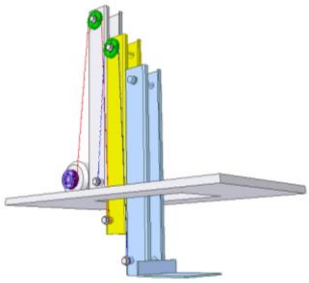
Cable telescopic sliders 1a

https://youtu.be/ydkJCE956ko



Input: motor pulley (in violet).
There are two cables, red and blue.
The red cable is wrapped around the green idle pulley of the base runway.
One end of the red cable is fixed to the violet pulley.
The other end of the red cable is fixed to lower pin of the yellow slider.
The blue cable is wrapped around the green idle pulley of the yellow slider.
One end of the blue cable is fixed to lower pin of the base runway.
The other end of the blue cable is fixed to lower pin of the blue slider.
The motor pulls the sliders up. The device to keep the sliders at up positions is not shown.
The sliders move down thanks to the gravity.

Cable telescopic sliders 1b

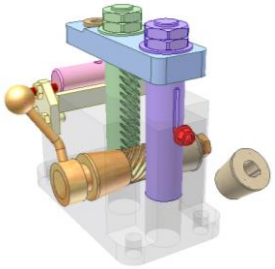


https://youtu.be/FJOTa7O4PkQ
Input: motor pulley (in violet).
There are two cables, red and blue.
The red cable is wrapped around the green idle pulley of the base runway.
One end of the red cable is fixed to the violet pulley.
The other end of the red cable is fixed to lower pin of the yellow slider.
The blue cable is wrapped around the green idle pulley of the yellow slider.
One end of the blue cable is fixed to lower pin of the base runway.
The other end of the blue cable is fixed to lower pin of the blue slider.
The sliders move down thanks to the gravity.
The motor pulls the sliders up. The device to keep the sliders at stop positions is not shown.

28. Clamping mechanisms

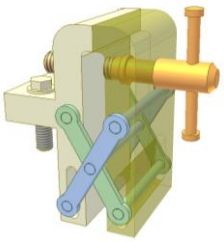
28.1. Mechanisms for clamping workpieces

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 cylinder.

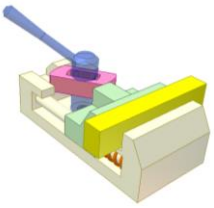


Turn the crank counterclockwise, the plate comes into contact with the work. Turn it further for clamping work. Axial gear force pulls orange gear shaft to the right to lock the shaft by action of the left cone.
Turn the crank clockwise, axial gear force pushes orange gear shaft to the left to unlock 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).

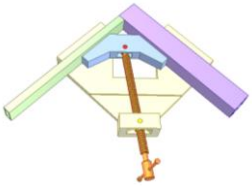
Nut-screw and bar mechanisms 4
http://youtu.be/IDvID90NT-A
Vice without runway.



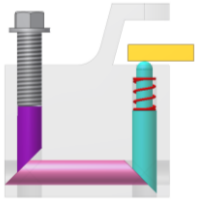
Disk cam mechanism DF10f F3
http://youtu.be/xGQjTeLqTq0
Cam vise. The pink cam has a rectangular slot at its center so it has linear motion during rotation. This helps move the green clamping head longer and faster.



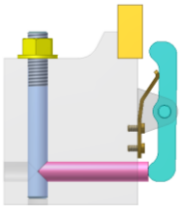
Angular Vice
http://youtu.be/Z2hujRfjv0U
Revolute joints for the red bush and the yellow nut of the screw enable clamping bars of different sizes.



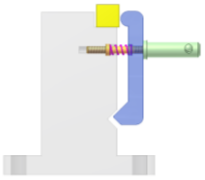
Wedge mechanism 11
http://youtu.be/Q9feu8j4OZ0
Double wedge mechanism.
Device for clamping workpiece (in orange).



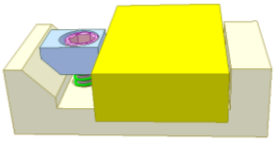
Wedge mechanism 12
http://youtu.be/QXXe8tCdO1g
Device for clamping workpiece (in orange).



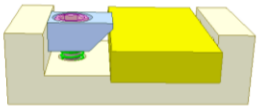
Wedge mechanism 25
http://youtu.be/LKYEhscIjHc
The wedge portion at lower end of the blue lever helps create vertical force component (friction) to press down the yellow workpiece (beside the horizontal one).



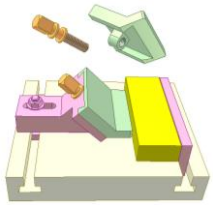
Wedge mechanism 26
http://youtu.be/fjdgmyK-WT8
The blue wedge helps create at the same time vertical (friction) and horizontal force components for clamping the workpiece.



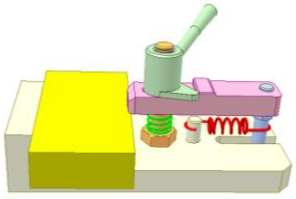
Wedge mechanism 27
http://youtu.be/pzj_AdvYZ7c
The blue wedge helps create at the same time vertical and horizontal force components for clamping the workpiece.



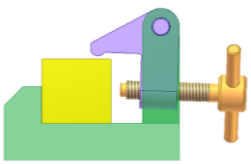
Machine tool fixture 5
http://youtu.be/H1utvZAUbUA
The green slider moves obliquely and creates at the same time vertical (friction) and horizontal force components for clamping the yellow workpiece.



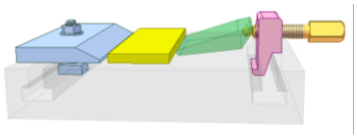
Machine tool fixture 1
http://youtu.be/F25gI0luThM
Turn the green cam-nut to tighten or release the workpiece and to clear space for its removing. Adjust positions of the green nut and the blue screw for adapting to the workpice's thickness.



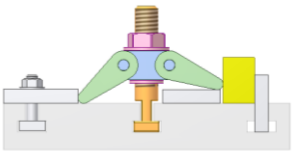
Machine tool fixture 2
http://youtu.be/geLVsyj88so
At the same time vertical and horizontal force components for clamping the yellow workpiece are created.



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

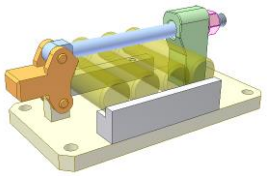


Machine tool fixture 4
http://youtu.be/BRkf-bi6_zM

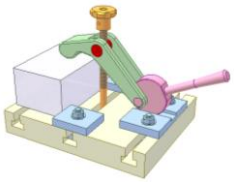


Machine tool fixture 9
http://youtu.be/B69K_33kapg
Turn the pink nut to clamp the yellow workpiece at two points.

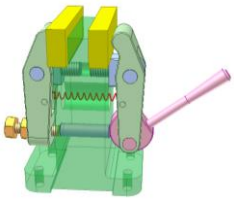
Machine tool fixture 17
http://youtu.be/C-EqQPTgXXQ
Multi-piece clamping.
Turn the pink nut to tighten or release the yellow cylindrical workpieces.



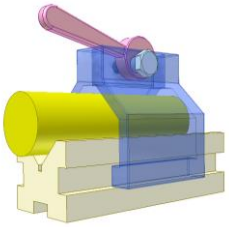
Machine tool fixture 6
http://youtu.be/RZIIRs0WWcw
The helix joint between the orange screw and the red pin-nut adapts the fixture to various thickness of workpieces.



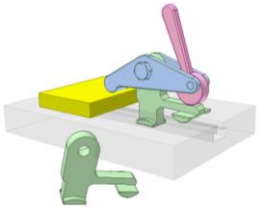
Machine tool fixture 10
http://youtu.be/Gq-Fe8A6ur0
The violet flowing pin enables firm clamping two yellow workpieces.



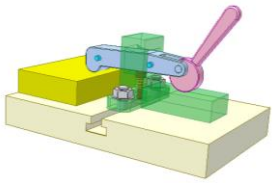
Machine tool fixture 12
http://youtu.be/rRajZ1XBzaY



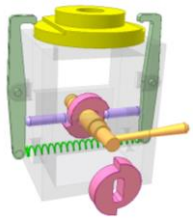
Machine tool fixture 13
http://youtu.be/H5W4arrmCPE
The green column is inserted into the table's T-slot. Its fixing to the table happens at the same time with the workpiece clamping.



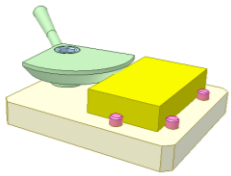
Machine tool fixture 14
http://youtu.be/ip7SyiZd7h4
The blue lever can move back to clear space for removing the yellow workpiece. The contact surfaces of the blue lever and the workpiece must be rough enough for the mechanism's good performance.



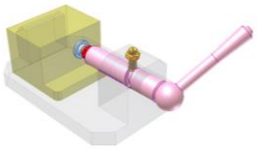
Machine tool fixture 8
http://youtu.be/wNckTzjwn4E
The pink double eccentric cam has a prismatic joint with the orange lever shaft. It enables firm clamping the yellow workpiece at two points.



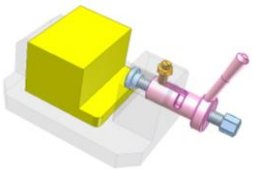
Machine tool fixture 11
http://youtu.be/_cPwqgrKJ-E
The green eccentric with a chamfer creates 3 force components including the down one to press the yellow workpiece toward locating elements.



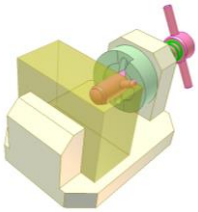
Machine tool fixture 15
http://youtu.be/5CWgcpLynnM
The pink lever can move back to clear space for removing the yellow workpiece. The clamping head's position can be adjusted by the red screw.



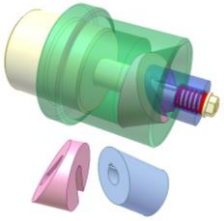
Machine tool fixture 16
http://youtu.be/_d2u8TEBMug
Use the blue screw to clamp or release the yellow worpiece.
Use the pink lever to move the pink nut for clearing space for removing the workpiece.



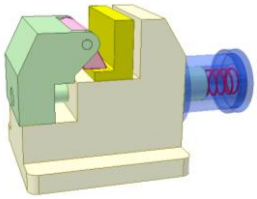
Machine tool fixture 7
http://youtu.be/L3Z5D3Ntor8
The green face cam is fixed. Push and turn the pink pin to tighten the workpiece. Turn the pink pin to release the workpiece. The cam slot and spring pushes back the pink pin quickly to clear space for removing the workpiece.



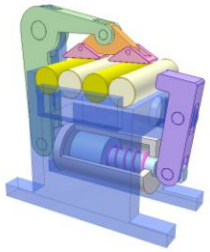
Wedge mechanism 16
http://youtu.be/oXlYX4AwXT0
Double wedge mechanism.
The green input slider and the blue output one move in opposite directions. The pink wedge moves perpendicularly to them
This mechanism can be applied for rotating clamping device.



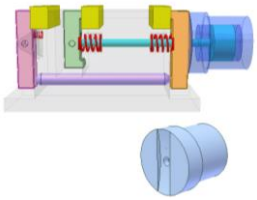
Machine tool fixture 19
http://youtu.be/0LukQCbXexY
Adding a pink bar that has a revolution joint with the green movable jaw enables clamping the workpiece from top side and left side simultaneously.
The movable jaw is fixed to the piston of a hydraulic cylinder.



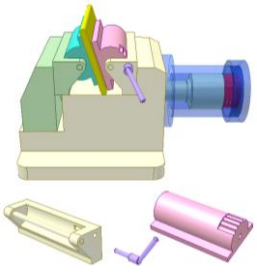
Machine tool fixture 20
http://youtu.be/U9fi2DJrIZY
Floating cylinder enables clamping 4 workpieces from top side and right side simultaneously.



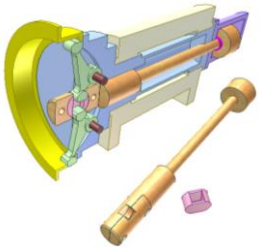
Machine tool fixture 21
http://youtu.be/fzz7-g6Qr1o
Floating cylinder enables clamping 3 workpieces simultaneously.
To clamp: Pressure fluid enters left space of the piston.
To unclamp: Pressure fluid enters right space of the piston.
Each workpiece has its vertical datum plane positioned directly to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



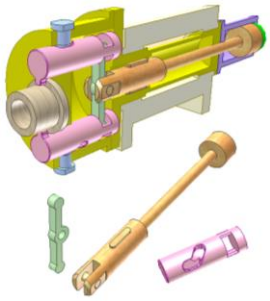
Machine tool fixture 22
http://youtu.be/9f1NolQBM94
A way for clamping a workpiece at an angle or clamping workpiece of non parallel planes.
Pink bar has revolution joint with the base. Its tilting angle is fixed by violet pin.



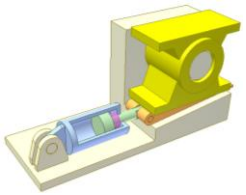
Machine tool fixture 23
http://youtu.be/YURD5Jf34EQ
Clamping a workpiece (in yellow) for lathes by a hydraulic cylinder (in violet).
In unclamping position green levers turn back and give space for mounting or removing the workpiece.
Revolution joint between pink cushion and orange piston is needed to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



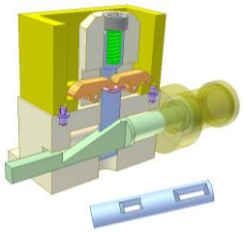
Machine tool fixture 24
http://youtu.be/UX5pEuTJGrY
Clamping a workpiece (in brown) for lathes by a hydraulic cylinder (in violet).
In unclamping position pink pins turn a little (thanks its helical groove) and give space for mounting or removing the workpiece.
Revolution joint between green arm and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



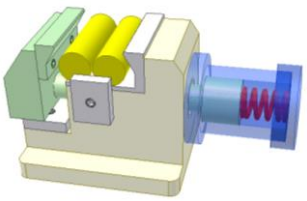
Machine tool fixture 25
http://youtu.be/ksDw--3vuhc
Clamping a workpiece (in yellow) by a hydraulic cylinder (in blue).
Orange wedge having revolution joint with green piston slides on the base. The cylinder has revolution joint with the base.



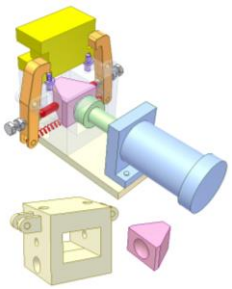
Machine tool fixture 26
http://youtu.be/OxDQFP5uAYo
Clamping a workpiece by a hydraulic cylinder through a wedge and two orange levers.
In unclamping position orange levers turn back and give space for mounting or removing the workpiece.
Revolution joint between pink cushion and blue vertical shaft is needed to compensate dimension error of the workpiece.
Most parts of the mechanism are cut off half for easy understanding.



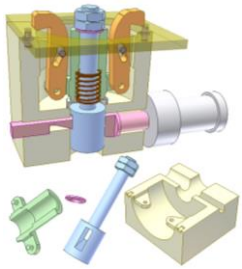
Machine tool fixture 27
http://youtu.be/p-dlg8IPLh4
Clamping two workpieces (in yellow) by a hydraulic cylinder (in blue).
Thanks to wedge-shaped plates (in green and grey) the workpieces are clamped firmly.



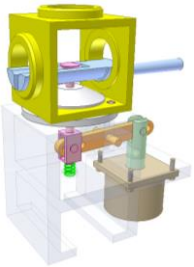
Machine tool fixture 28
http://youtu.be/nwEsGuGf6wQ
Clamping a workpiece (in yellow, cut off half for easy understanding) by a hydraulic cylinder through a wedge and two orange levers. Two violet pins are for positioning the workpiece.
In unclamping position orange levers turn back and give space for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



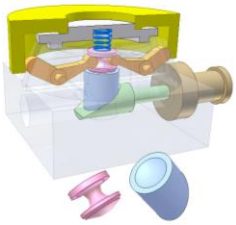
Machine tool fixture 29
http://youtu.be/VPxWWgFwRQo
Clamping a workpiece (in yellow) by hydraulic cylinder through a wedge and two orange levers. Two vertical violet pins are for positioning the workpiece.
In unclamping position orange levers turn back (thanks to their grooves and fixed horizontal violet 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.



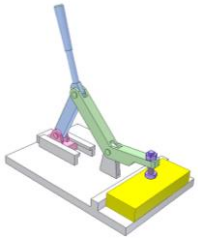
Machine tool fixture 30
http://youtu.be/xbQECJ3byeg
Clamping a workpiece (in yellow) by hydraulic cylinder through a orange lever, pink rod and blue detachable traverse. Violet pin is for angle positioning the workpiece.
Spherical portion on the pink rod is needed to compensate dimension error of the workpiece.



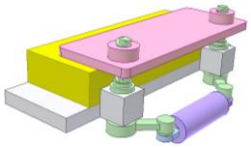
Machine tool fixture 31
http://youtu.be/QtFkUqAtxr0
Clamping a workpiece (in yellow) by hydraulic cylinder through a blue wedge and orange levers.
Spherical portions on the pink cushion and the blue wedge are needed to compensate dimension error of the workpiece.
The workpiece and the grey positioning disk are cut off half for easy understanding.



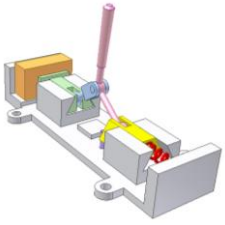
Machine tool fixture 32
https://youtu.be/yrA0PYOvISw
Turn blue lever to clamp or unclamp yellow workpiece.
At clamping position blue bar is nearly perpendicular to sliding line of pink slider so the mechanism gets into self-locking state. Force applied to the workpiece can not loosen it.



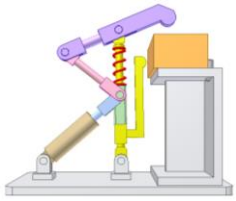
Machine tool fixture 33
https://youtu.be/X9CdVrwSSGo
Violet cylinder controls the clamping of yellow workpiece.
Threads of two green cranks are opposite-handed.
It is suitable for long workpieces.



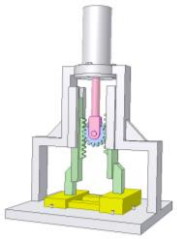
Machine tool fixture 34
https://youtu.be/W_H5g4ve6Aw
Pink lever controls the clamping of orange workpiece.
Red spring creates clamping force.



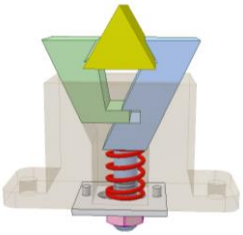
Machine tool fixture 35
https://youtu.be/2aVcRENbAjc
Brown cylinder controls the clamping of orange workpiece in both horizontal and vertical directions.



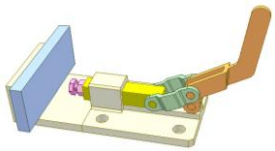
Machine tool fixture 36
https://youtu.be/ATsA3ra2mzg
Grey cylinder of pink piston controls the clamping of yellow workpiece at two points of different levels thanks to differential rack gear drive.



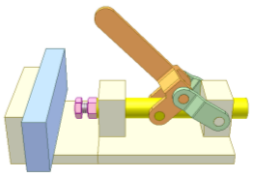
Wedge fixture 1
https://youtu.be/BrBVOdpJw5E
Turn pink nut for clamping or releasing yellow bar of equilateral triangle section.



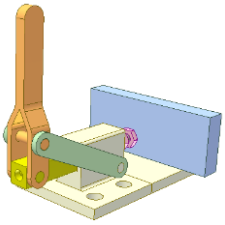
Toggle clamp 1b
http://youtu.be/lpjHsMKISB0
Toogle clamp using slider-crank mechanism.
Green conrod and orange crank come into toggle by an extension of each other.
The clamping force is applied to the crank.



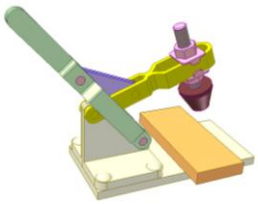
Toggle clamp 1c
http://youtu.be/Pjdb0CAj4Bc
Toogle clamp using slider-crank mechanism.
Green bar and orange conrod come into toggle by an extension of each other.
The clamping force is applied to the conrod.



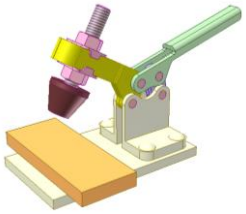
Toggle clamp 1d
http://youtu.be/cv8sqEfxCSs
Toogle clamp using slider-crank mechanism.
Green bar and orange conrod come into toggle by lining up on top of each other.
The clamping force is applied to the conrod.



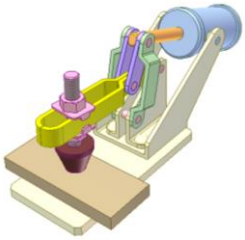
Toggle clamp 2a
http://youtu.be/Nmp_U-tkoH8
Toogle clamp using four bar linkage.
Green lever and violet conrod come into toggle by lining up on top of each other.
The clamping force is applied to the lever.



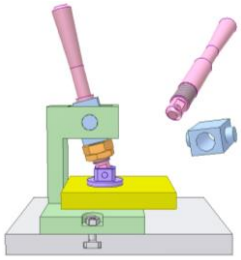
Toggle clamp 2b
http://youtu.be/lrL2_5tj1IE
Toogle clamp using four bar linkage.
Green conrod and violet lever come into toggle by an extension of each other.
The clamping force is applied to the conrod.



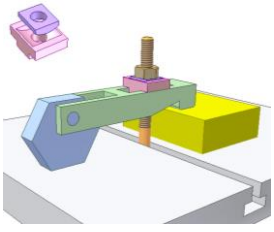
Toggle clamp 2d
http://youtu.be/ZtiW90wThO4
Toogle clamp using four bar linkage.
Violet conrod and green lever come into toggle by lining up on top of each other.
The clamping force of an air cylinder is applied to revolution joint between the violet conrod and the green lever.



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.

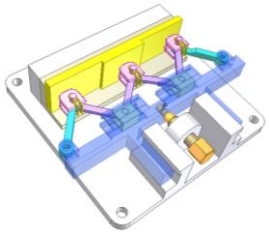


Machine tool fixture 38
https://youtu.be/ZzweJNcfR0c
The fixture can adapt to various heights of the clamped object (in yellow) thanks to various angular positions between the blue hexagon and the green clamp bar.
To change the position: release the brown nut, move up the clamp bar, turn the hexagon 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

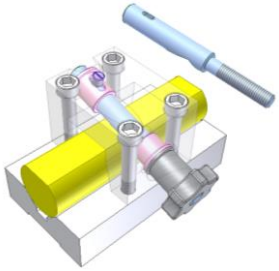
https://youtu.be/I5idxsmxhrk



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.

Machine tool fixture 43

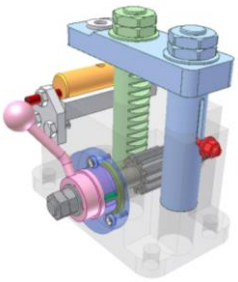
https://youtu.be/_fk_Vvhsl-E



Turn grey nut clockwise to clamp yellow workpiece.
Flat portion on blue bolt contacts flat portion on the workpiece for clamping.
Violet screw prevents the blue bolt from rotation.
Turn grey nut counter-clockwise and push up the blue bolt for removing the workpiece.

Drilling jig 2

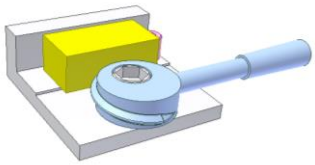
https://youtu.be/RsKdRhTLXIg



This jig is for drilling a hole on orange work.
The work is located thanks to a V-block and red stopper. It is clamped by blue plate having white drill bushing.
When turning pink lever counterclockwise, pink fork (fixed to the lever) forces green rollers into wedge-shaped space between blue stationary ring and yellow part (fixed to the grey gear shaft) and makes the shaft turn counterclockwise to lower the blue plate. When the blue plate contacts the work, the plate can't move more. Further motion of the fork presses the rollers tightly and causes self-locking phenomena: the work is clamped securely.
The same thing happens when turning pink lever clockwise. The fork forces green rollers into opposite wedge-shaped space between blue stationary ring and yellow part. The plate moves up to contact red stopper and is kept securely at top position thanks to self-locking.

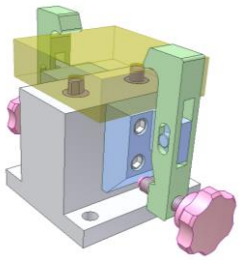
Machine tool fixture 11b

https://youtu.be/YE95K6wtb_8

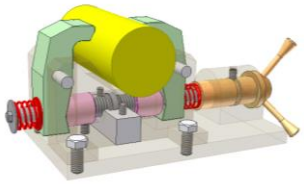


Helical rib on blue eccentric cam creates a friction force member to press down yellow work and other friction force member to press the work towards pink stopper.

Machine tool fixture 44
https://youtu.be/a8lrt0bQ5dY
Green clamping bars have 3 degrees of freedom that helps to remove yellow work easily.
When clamping first lift the green bars.

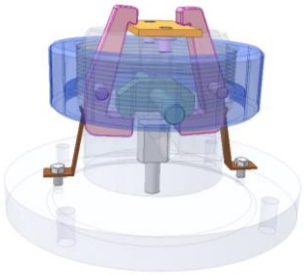


Machine tool fixture 45
https://youtu.be/KVrnwkRR0m8
Floating grey right and left screw has prismatic joint with orange crank. Pink right and left hand nuts control motions of green clamping bars.
Turn the orange crank clockwise to clamp yellow workpiece.
Red springs help to maintain contacts between the nuts and clamping bars.



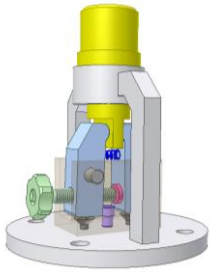
The clamping bars may not move synchonically but at the end they clamp tightly the workpiece that is centered on a V-block.
If the R&L screw is not installed free in axial direction, maybe only one green clamping bar contacts the workpiece.

Machine tool fixture 46
https://youtu.be/zKqEd2mwZXM
Turn blue nut clockwise to move down green arm via green pin.
The green arm turns two pink levers to clamp orange workpiece.
Turn blue nut counterclockwise, the green arm no more force the pink levers. Brown springs turn the pink levers to release the workpiece.

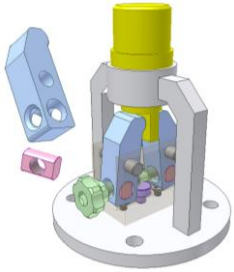


The clamping levers may not move synchonically but at the end they clamp tightly the workpiece that is positioned on the upper surface on the fixture.

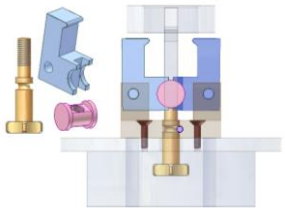
Machine tool fixture 47
https://youtu.be/yT7hCbkk8Iw
]Turn green screw to clamp or release yellow workpiece.
The blue clamping jaws may not move synchonically but at the end they clamp tightly the workpiece that is centered in the fixture base (equalizing clamping).



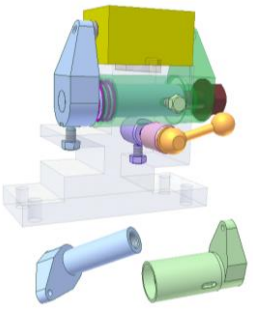
Machine tool fixture 48
https://youtu.be/uZfGSQaq4Js
Turn green screw to clamp or release yellow workpiece.
The blue clamping jaws may not move synchonically but at the end they clamp tightly the workpiece that is centered in the fixture base (equalizing clamping).



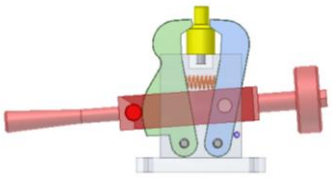
Machine tool fixture 49a
https://youtu.be/ASqPAUbWKYE
Turn orange screw to clamp or release yellow workpiece.
When the screw turns clockwise, it pulls pink nut down and the latter turns two blue jaws to clamp the workpiece.
The jaws may not move synchonically but at the end they clamp tightly the workpiece that is centered in the fixture base (equalizing clamping).



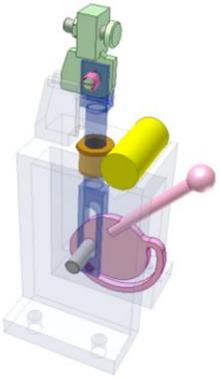
Machine tool fixture 49b
https://youtu.be/aHnh_yyOAMI
Turn brown screw to clamp or release yellow workpiece.
The blue and green clamping jaws may not move synchonically but at the end they clamp tightly the workpiece that is centered in the fixture base (equalizing clamping).
Green and blue screws are stoppers for the green and blue jaws respectively. The blue jaw and the violet slider have threaded holes.
Many equalizing clamps have limited rigidity. If the portion of the part being clamped were subjected to heavy cutting force, the part could move the clamp. In such instances a locking device may be added. Here such device consists of orange lever-screw, violet and pink sliders. It clamps the green jaw after the yellow work has been clamped (last scene of the video).



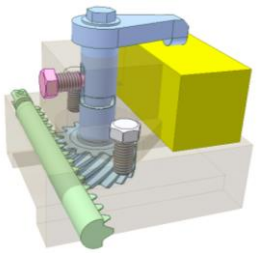
Machine tool fixture 50
https://youtu.be/Rph9MvvO_CQ
Turn pink lever to clamp or release yellow workpiece.
The blue and green clamping jaws may not move synchonically but at the end they clamp tightly the workpiece that is centered in the fixture base (equalizing clamping).
The green jaw also plays role of a cam.
Instead of the lever counterweight using a spring is possible.



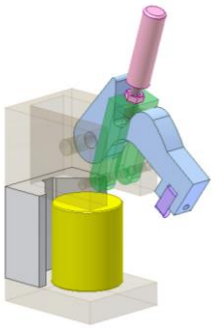
Machine tool fixture 51
https://youtu.be/4xSQ_q56m3E
Turn pink lever of a form-closed eccentric cam to clamp or release yellow workpiece.
For easy removing the workpiece green jaw is set vertical at unclamp position thanks to pink torsion spring and the interaction between the jaw and the base.



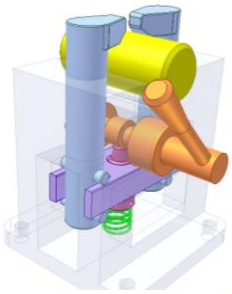
Machine tool fixture 52
https://youtu.be/uHn4cKdg4js
A cylinder (not shown) control green rack of oblique teeth to clamp or release yellow workpiece.
For easy removing the workpiece the blue jaw is set aside at unclamp position thanks to helical gear-rack drive and the interaction between the pink pin and L-shaped groove of the jaw.



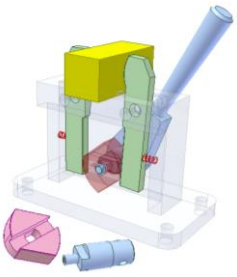
Machine tool fixture 53
https://youtu.be/iQAlQGzER6w
Turn pink lever to clamp or release yellow workpiece.
For easy removing the workpiece, the blue arm is set aside at unclamp position thanks to the interaction between the pink pin and the blue arm profile (cam profile). At clamp position the said profile ensures the self-locking for the blue arm.



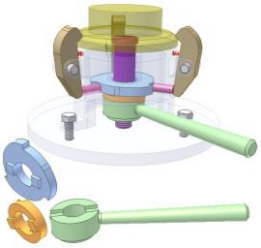
Machine tool fixture 54
https://youtu.be/_4U4cKYxl_0
Turn orange lever of an eccentric shaft to clamp or release yellow workpiece.
The blue clamping jaws may not move synchonically but at the end they clamp tightly the workpiece that is centered in the fixture base V-block (equalizing clamping).



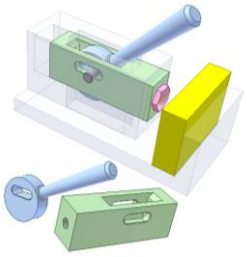
Machine tool fixture 55
https://youtu.be/T6zyUBax91A
Turn blue lever to clamp or release yellow workpiece.
Pink floating cam ensures the equalizing clamp of two green jaws for the workpiece.
Note: the cam can slide on blue shaft in the radial direction.



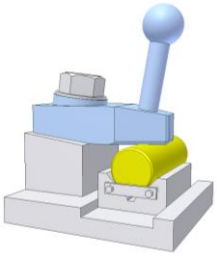
Machine tool fixture 56
https://youtu.be/EKjva9kHaI0
Turn green lever to clamp or release yellow workpiece.
Blue floating cam ensures the equalizing clamp of three brown jaws for the workpiece.
The green lever is pivoted on violet stationary center shaft.
The orange part has prismatic joint with the lever.
The cam has prismatic joint with the orange part.
The ridge and the groove on the orange part are perpendicular to each other.
So the cam and orange part can move in horizontal plane in relation with the center shaft.
The jaws may not move synchonically but at the end they clamp tightly the workpiece that is centered on upper surface of the fixture base (equalizing clamping).



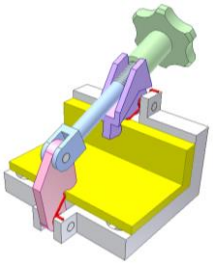
Machine tool fixture 57
https://youtu.be/lQ9HoVgZ_uM
Turn blue lever to clamp or release yellow workpiece.
At clamping position the mechanism get into toggle action.



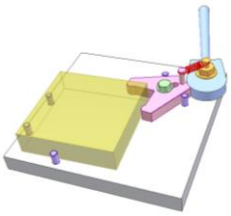
Machine tool fixture 58
https://youtu.be/CwDgk3uyEew
Turn blue lever to clamp or release yellow workpiece.
Rotary axis of blue law is not perpendicular to its contact plane with yellow workpiece.
In fact the blue part is a simplified face cam



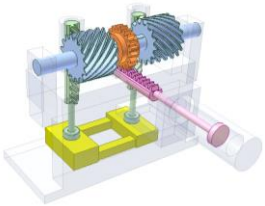
Two directional clamping 1
https://youtu.be/7ihg7ZcGNxA
Turn green nut to clamp or release yellow workpiece.
Red springs tends to release the workpiece.
Contact surface between the nut and violet jaw is spherical.
The screw-nut drive is set floating. The violet and pink jaws may not move synchonically but at the end they clamp tightly the workpiece.



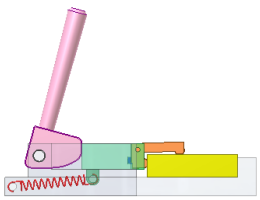
Two directional clamping 2
https://youtu.be/JYavvybju8I
Turn blue eccentric cam to clamp or release yellow workpiece.
Red spring tends to release the workpiece.
Pink part is set floating. Its two jaws at first may not move synchonically but at the end they clamp tightly the workpiece.



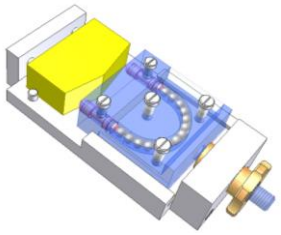
Machine tool fixture of floating helix gears
https://youtu.be/BfwvfUjpiOc
The cylinder of pink piston controls the clamping of yellow workpiece at two points of different levels.
Pink rack fixed to the piston turns orange gear.
A sliding key joint is created between blue shaft of two gears of opposite hand helical teeth and the orange gear. The shaft turns and moves axially to compensate the different heights of clamping points.



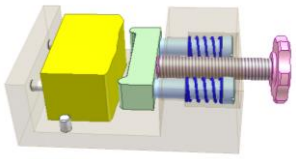
Two directional clamping 3
https://youtu.be/aq9kOco346I
Turn pink cam to clamp or release yellow workpiece.
Red spring tends to release the workpiece.
Blue spring tends to turn up orange jaws.



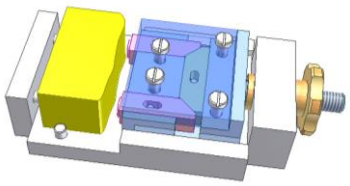
Equalizing clamping with balls
https://youtu.be/xi_kUb8gQNY
Turn orange nut to clamp or release yellow workpiece.
Balls help to equalize clamping forces from two pink pins.
It is used for clamping on uneven surface.



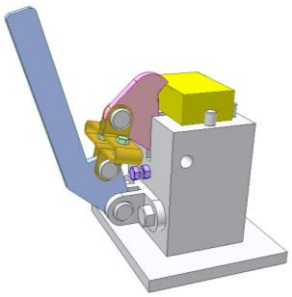
Equalizing clamp with srping screws
https://youtu.be/pYYlWYFSjU8
Turn pink screw to clamp or release yellow workpiece.
Spring blue screws help to equalize clamping forces at to points of green jaws. The gaps between blue screws and their holes in fixture body must be large enough to allow the jaw to rotate.
It is used for clamping on uneven surface.



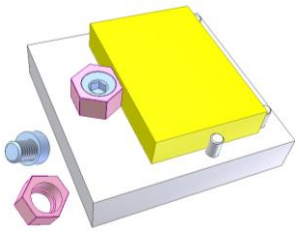
Equalizing clamp with wedges
https://youtu.be/9K4E5T-1v1Y
Turn orange nut to clamp or release yellow workpiece.
Three wedges help to equalize clamping forces from two pink jaws.
It is used for clamping on uneven surface.



Toggle clamp with spring
https://youtu.be/Qn628OO8vic
Turn blue lever to clamp or release yellow workpiece.
Green bolts are used to create precompressed state for the cross-shaped spring. So at clamping position the fixture gets into toggle position (centers of three grey pivots are inline) and the work is clamped by spring force.
Violet screw is for preventing the unclamping action (when the lever exceeds the toggle position).

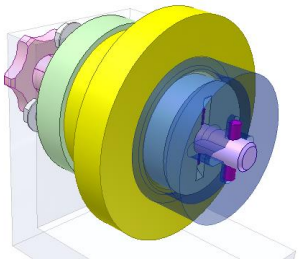


Eccentric clamp
https://youtu.be/aFQ9mdJSymU
Turn blue screw of eccentric head to clamp or release yellow workpiece.
The hexagon of the pink jaw is eccentric to its cylindrical hole. It has 6 different distances from side surfaces to the hole center.
Turn the jaw in relation with the screw before clamping to adapt to the workpiece size.
There is a considerable axial gap between the screw and the jaw so the screw doesn't clamp the jaw on the base.
It's used for low-profile edge clamping.
See the clamp in action:
https://youtu.be/aFQ9mdJSymU



Quick screw clamp 1

https://youtu.be/FkKDFehqYN8

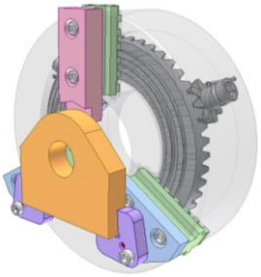


For removal of yellow workpiece:
- Turn pink nut counterclockwise to move outer pin of violet screw out of the groove on blue washer.
- Turn the latter 90 deg. to make the outer pin be in line with the slot on blue washer and remove the washer.
- Remove the workpiece.

Do the reverse to install the workpiece.
The groove on the face of green bush prevents the pink screw from rotation.
This fixture is numbered as 1320 in the book " Mechanical Fixtures Tooling"

Three-jaw chuck for irregular-shaped works

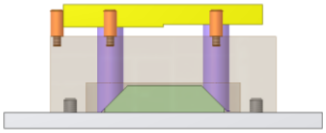
https://youtu.be/RDoYlt1lw9Y



Three jaws for a commercial three-jaw chuck are designed to hold an irregular-shaped work (in orange).
Pink part is fixed to one chuck jaw.
Violet parts are pivoted on the pins of blue bracket that are fixed to the other chuck jaws.
Red pins fixed to the blue parts and small holes on the violet parts act as an equalizer for the violet parts.
This fixture is numbered as 796 in the book " Mechanical Fixtures Tooling"

Leveling mechanism 1Da

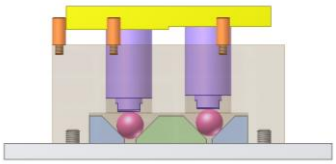
https://youtu.be/N0Xl_whUsQQ



Upper surface of yellow workpiece is kept always horizontal when placing it on two violet pins although its lower face consists of two planes.
Violet píns are identical.
Key factor: lower surfaces of the workpiece must be made parallel to its upper surface.
Last scene of the video shows a workpiece that is not suitable for this mechanism.
This design is used as an equalizer.

Leveling mechanism 1Db

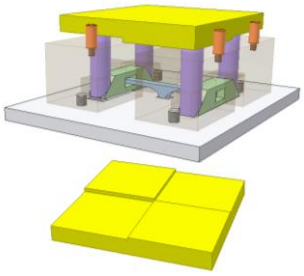
https://youtu.be/PioYzx1TNKk



Upper surface of yellow workpiece is kept always horizontal when placing it on two violet pins although its lower face consists of two planes.
Blue wedges are stationary, green wedge is movable.
Violet píns are identical.
Key factor: lower surfaces of the workpiece must be made parallel to its upper surface.
Last scene of the video shows a workpiece that is not suitable for this mechanism.
This design is numbered as 935 in the book "Mechanical Fixtures Tooling".

Leveling mechanism 2D

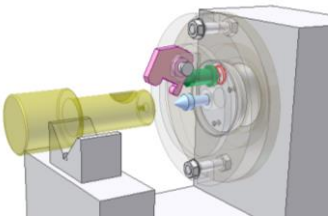
https://youtu.be/7Xfv7nivat8



Upper surface of yellow workpiece is kept always horizontal when placing it on four violet pins although its lower face consists of four planes.
Violet píns are identical.
Key factor: lower surfaces of the workpiece must be made parallel to its upper surface.
This design is used as an equalizer.
This video was made based on the design numbered as 937 in the book “Mechanical Fixtures Tooling” (with some changes because the simulation showed that the original is not workable).
It is used as an equalizer.

Positioning fixture 1

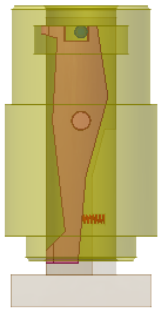
https://youtu.be/2mtjEn04B-w



Yellow part is positioned by a V-block, a center (in blue) and a key (in pink). The key is rotatable automatically to ease loading and removing the part.
This fixture is numbered as 1272 in the book “ Mechanical Fixtures Tooling”

Positioning fixture 2

https://youtu.be/QO09tBJldwQ

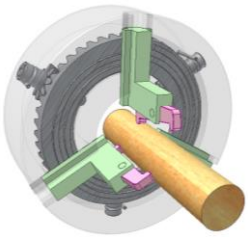


Yellow part is positioned along gray post based on inside recess of the part.
As the part is loaded, it strikes lower portion of pink rocker and pushes it to the right, moving the upper end of the rocker into the recess of the part.
When the part is raised in the removing operation, the lower end of the rocker is moved to the left by the spring and the upper end moves to the right.
This fixture is numbered as 1290 in the book “ Mechanical Fixtures Tooling”

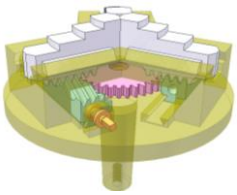
28.2. Mechanisms for clamping and centering workpieces

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.

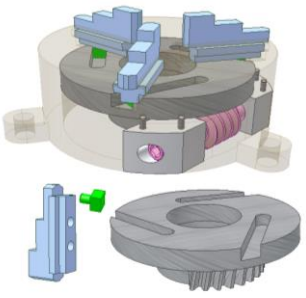
Self-centering chuck of six clamping points
https://youtu.be/nbaqSKBOkLQ
It is developed from the three-jaw self-centering chuck shown at
http://youtu.be/0ERIZeZhckw
A jaw lever (in pink) is pivoted on each green slider. Thus, the orange work (a stepped shaft) can be well centered and firmly clamped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



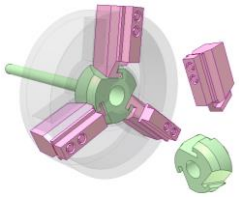
Three-jaw self-centering chuck 2
http://youtu.be/lPAfyZ5jCuA
Combination of screw-nut, gear-rack and rack-rack mechanisms.
Turn the sole orange screw for moving the jaws.



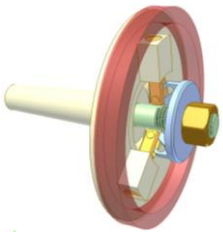
Three-jaw self-centering chuck 6
https://youtu.be/qmGE5jh_9sc
Turn pink worm to move three blue jaws radially via green sliders and grey block (gear and grooved disk) for clamping or releasing workpieces (not shown).
The self-locking feature of the worm drive helps clamp the worpieces steadily.
In comparison with the traditional chuck of spiral disk:
Advantages:
- easy manufacture.
- quick action
Disadvantages:
- for a defined input torque the clamping forces are not the same for workpiece different diameters.
- limited turning positions because only one pink worm can be arranged.



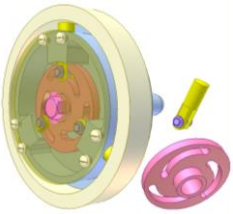
Three-jaw self-centering chuck 3
http://youtu.be/xUUeWQoY4CI
An application of the wedge mechanism.
The green rod is connected to a pneumatic cylinder (not shown) to get reciprocating motion.



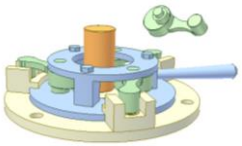
Self-centering chuck for lathes
http://www.youtube.com/watch?v=QerPu2BaUNA
A combination of translation cam and nut-screw clamping.
The red ring is a workpiece.
The input nut is rotated and translated.
The screw is fixed.



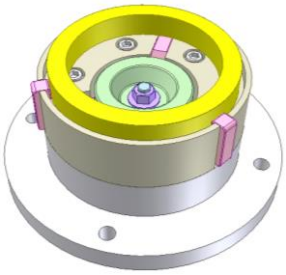
Three-jaw self-centering chuck 4
http://youtu.be/zzcj0-C6Njo
Turn the pink cam of three eccentric slots for clamping or releasing the popcorn workpiece. This chuck should be used only for operation of light cutting force.



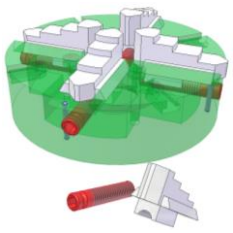
Machine tool fixture 37
https://youtu.be/sxOnMjMZFdM
An application of a slider crank mechanism: blue crank, green conrods, sliders: green pins sliding in slots of the base.
There is eccentric on each conrod. When turning the crank, these eccentrics center and clamp orange workpiece.



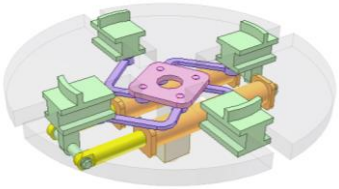
Three-jaw self-centering chuck 5
https://youtu.be/dsVPsF2V5a4
Turn violet nut to move the green slider down. The latter makes three pink jaws center and clamp yellow part.
This fixture is numbered as 772 in the book " Mechanical Fixtures Tooling"



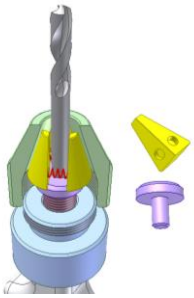
Four-jaw independent chuck 1
http://youtu.be/U_U0Cxrd_KE
Turn each red screw for moving the corresponsive jaw.



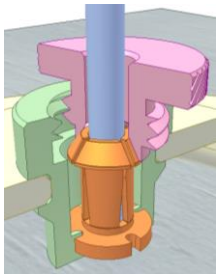
Four-jaw self-centering chuck 1
http://youtu.be/SEgw6hcujwk
An application of crank slider mechanism.
The pistons are connected to a green slider and the cylinders to opposite one. The cylinders can be connected to the rotary table in order to reduce pistons' displacement.
This chuck is used in tire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



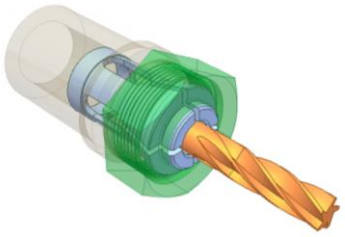
Chuck for hand powered drill
https://youtu.be/Iz-M6XvqYho
Turn green hood for clamping or releasing the bit.



Screw collet clamping 1
https://youtu.be/hFXD__9k2fk
Turn pink screw to clamp blue post via orange elastic plastic collet.

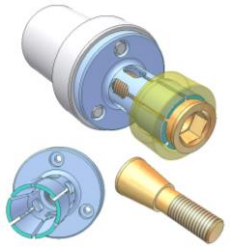


Screw collet clamping 2
https://youtu.be/NulvCvEf0rw
Turn green nut to clamp orange tool via blue spring steel collet (single taper compression collet).
The gap between the tool and the collet hole is intentionally increased for easy understanding.

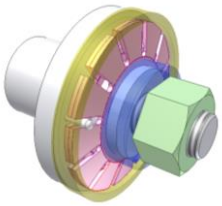


Screw collet clamping 3
https://youtu.be/1C_5YVCtOQA
Turn green nut to clamp brown tube (workpiece) via blue spring steel collet (double taper expansion collet).
The gap between the collet and the tube hole is intentionally increased for easy understanding.

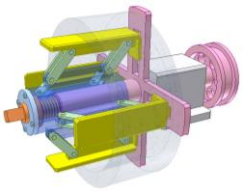
Screw collet clamping 4
https://youtu.be/9WqOlInlNTA
Turn orange screw to clamp yellow tube (workpiece) via blue spring steel collet (flange type expansion collet).
The gap between the collet and the tube hole is intentionally increased for easy understanding.



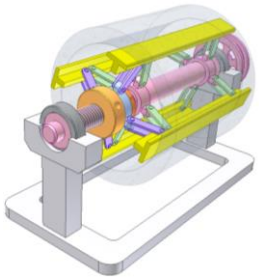
Screw expansion disk clamping
https://youtu.be/MVA2HgzGMbQ
Turn green nut to clamp yellow ring (workpiece) via a couple of pink spring steel expansion disks. Axial pressing the disks increases their outer diameter.
Use two couples for long workpieces.



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.

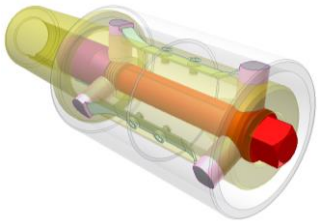


Self-centering uncoiler 2
https://youtu.be/XDHO9JHlPzI
Turn orange nut to move yellow bars radially for centering a coil (in glass). Then the coil is turned for uncoiling. A brake drum on the pink shaft end is for creating uncoil tension.
Here is applied slider crank mechanism (green cranks, violet conrods 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.



Self-centering fixture on stepped hole

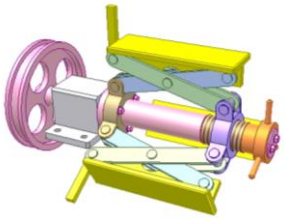
https://youtu.be/envG2fpfu-k



Violet and red cones are jointed together by a helical (violet nut and red screw) joint. They are set floating in hole of yellow body of tapered shank.
Six pink jaws always contact the cones thanks to 3 green flat springs. Turn red screw clockwise to push outside all the jaws for clamping white workpiece.
This video was made based on the design numbered as 1006 in the book “Mechanical Fixtures Tooling”.

Self-centering uncoiler 3

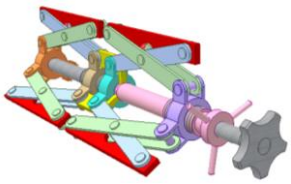
https://youtu.be/MQ8zG8KBMWs



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 scissor mechanisms are applied to convert axial linear motion of the violet hub into radial linear motion of yellow bars.
The scissor mechanisms give large adjusting range to meet coil internal diameters.
This uncoiler is for coils of small width.

Internal alignment clamp for welding 1

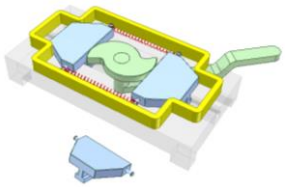
https://youtu.be/-iPF77cy93c



It is for alignment and clamping a flange to a pipe.
Turn grey screw to centering and clamping the pipe.
Turn pink hollow screw to centering and clamping the flange.
The brown and violet parts have internal threads.
The brown, cyan and yellow parts are fixed together creating a block.
The pink screw has revolution joint with the block.

Self-centering fixture 1a

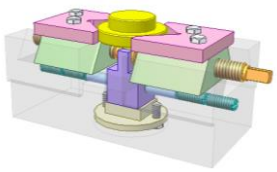
http://youtu.be/VQLBovXF9Uw



The green double eccentrics and two blue wedge-sliders center the yellow workpiece along transversal and longitudinal direction.

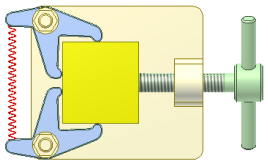
Self-centering fixture 1b

http://youtu.be/0kFUfX1m5aI

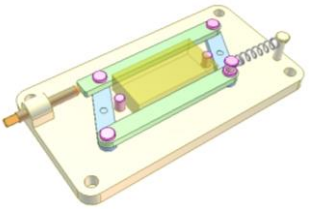


Orange screw having threads of right and left hand moves V-blocks to center yellow workpiece along transverse and longitudinal direction.
Blue pins and screws (in lower part of the base) are used for adjusting the fixture center position along longitudinal direction.

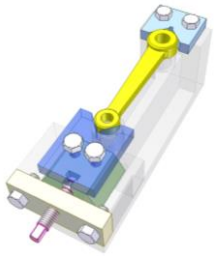
Self-centering fixture 2b
http://youtu.be/8UrBjWE96vc
Two symmetric V-shaped levers center the yellow workpiece along longitudinal direction.



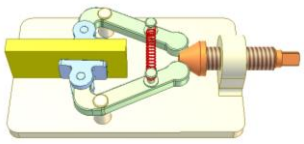
Self-centering fixture 2c
http://youtu.be/GzweOeQAiqM
The green connecting rods of a parrallelogram mechanism center the yellow workpiece along longitudinal direction.



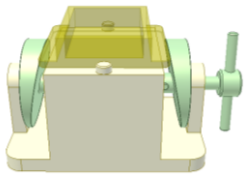
Self-centering fixture 2d
http://youtu.be/FpdSiDXOOCA
The V blocks (one is fixed, the other is movable) center the yellow workpiece along longitudinal direction.



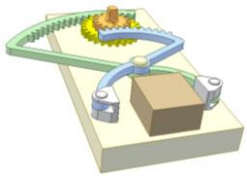
Translating cam mechanism 5
http://youtu.be/w8Hk3E5gfj0
Device for clamping workpiece (in yellow).
Wedge is the orange screw of cone head that has helical motion.



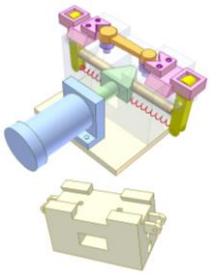
Self-centering fixture 2a
http://youtu.be/4tM1zNKiQPI
Two symmetric face cams center the yellow workpiece along longitudinal direction.



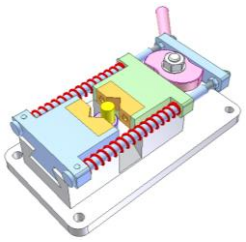
Self-centering fixture 4
http://youtu.be/lT49olsv-EU
Turn the block of orange and yellow gears to clamp brown work.
Two grey pads center the work along its longitudinal direction.
Condition for centering:
R1/R3 = R2/R4
(angle speeds of blue and green gears are equal)
Relation of gear pitch radia:
R4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



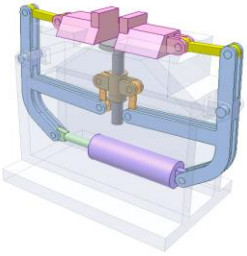
Self-centering fixture 5
http://youtu.be/L0BbQPfpMd0
Clamping a workpiece (in orange) by hydraulic cylinder through green wedge on the piston, two pins and two yellow levers.
Pink V blocks center the workpiece along its longitudinal direction.



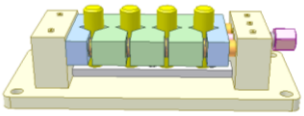
Self-centering fixture 1c
https://youtu.be/skZhoweAVgo
Pink cam lever controls the clamping process.
Red springs maintain the contact between the cam and fllowers.
It can be also used for a die of stamping undercut workpieces (soft metal).



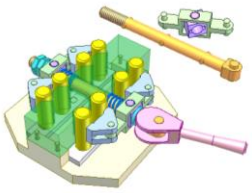
Self-centering fixture 6
https://youtu.be/42kmmozmp5U
Floating cylinder moves two pink jaws synchonically.
The slider-crank mechanisms of orange conrods bear inconsiderable load and ensure that displacements of the two jaws are equal.



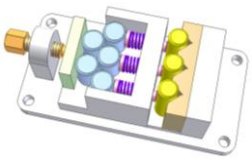
Self-centering fixture 4a
http://youtu.be/Oa5_0RAEbC0
Multi-piece clamping.
The V-blocks center the yellow worpieces along longitudinal direction. There are compression springs between the V-blocks.



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

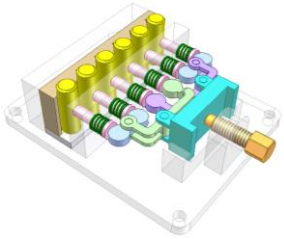


Machine tool fixture 39
https://youtu.be/H5d_S87Cx9k
Multi-piece clamping.
Turn orange screw to tighten or release yellow cylindrical workpieces.
This can be developed for clamping more than 3 workpieces.



Machine tool fixture 40

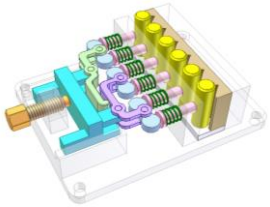
https://youtu.be/5_mDB-g_0iE



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

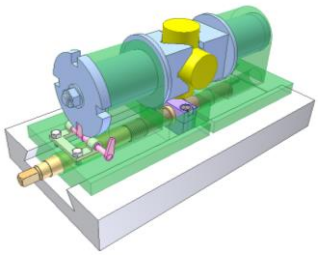
https://youtu.be/YUYdnTIrlaE



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 fixture 7

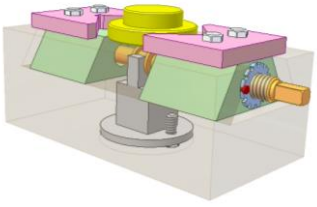
https://youtu.be/yT62zzFKHIo



This fixture is for clamping cross, tee, elbow-shaped works (in yellow). Several faces may be finished with one chucking.
Turn orange right and left screw for moving green sliders carrying blue jaws that can rotate on the latters.
Blue index plate of four notches and pink latch help to change machined surfaces.
The video shows in turn:
- Clamp yellow work to machine first surface.
- Release the work a little for 90 deg. indexing and clamp the work again to machine the next surface.
- Release the work completely for removing it from the fixture.

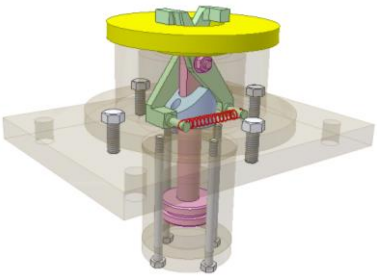
Self-centering fixture 1c

https://youtu.be/aryob53b6qI

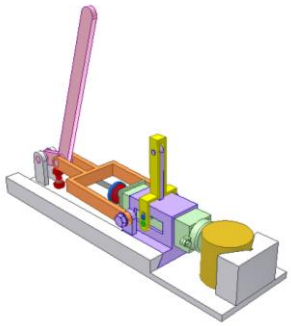


Orange screw having threads of right and left hand moves V blocks to center the yellow workpiece along traversal and longitudinal direction.
Blue nuts and red screws on green sliders are used for adjusting the center position along longitudinal direction. For such adjustment the video last scene shows how to move one V-block while keeping the other immobile.

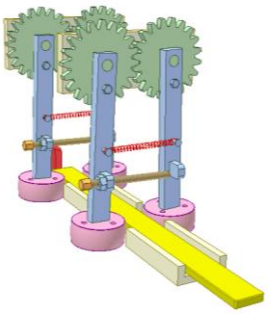
Machine tool fixture 59
https://youtu.be/MtpChfhXTiE
Pink piston moves two green jaw levers up/down to clamp yellow workpiece.
Blue cam controls angle A between the green levers.
When the piston moves down, A gets large for clamping the workpiece.
When the piston moves up, A gets small for removing the workpiece.



Fixture of constant clamping forces
https://youtu.be/Xo0BLZ2hVeI
Move pink lever forwards to bring slider-crank mechanism (orange conrod, violet slider) into toggle position for clamping yellow workpieces. Clamping forces come from red spring.
The clamping forces are kept nearly constant thanks to a mechanism consisting of yellow slotted lever and two sliders (green and blue, sliding inside the violet slider). Green pin is fixed to the green slider. Blue pin is fixed to the blue slider. Two said pins slide in the yellow lever slot. The mechanism ensures that a large displacement of green slider on violet slider corresponds with a small deformation of red spring.
So at toggle position the fixture can clamp workpieces of different sizes with nearly the same force.
Red screw stops the pink lever at the toggle position.



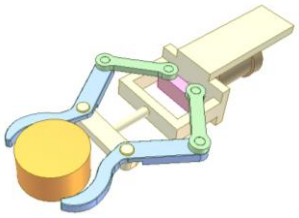
Self-centering fixture 3a
http://youtu.be/GF1Lw16lwco
The yellow running workpiece is centered along longitudinal direction when contacting with all the two pink roller couples. The fixture is used in a bamboo slitting machine. The red knife is stationary.



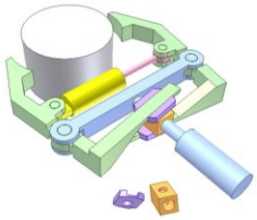
28.3. Gripper

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.

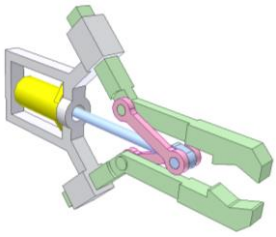
Robot gripper 2
http://youtu.be/YGlT0LtRzMw
A hydraulic or pneumatic cylinder opens and closes the jaws, permitting it to grasp and release objects.
Blue jaw, green conrod and pink slider create a slider crank mechanism.



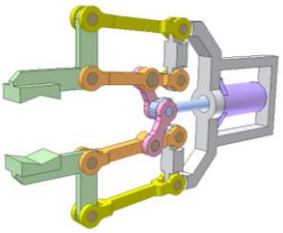
Robot gripper 3
http://youtu.be/oCVqapAj-7s
A hydraulic or pneumatic cylinder opens and closes the jaws, permitting it to grasp and release large objects.
Green jaw, violet swivel and orange slider create a tangent mechanism. There are revolution joints between violet swivels and orange slider.



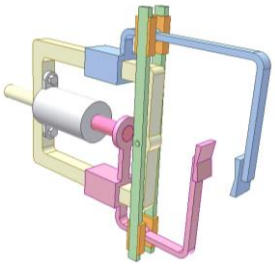
Robot gripper 4
http://youtu.be/CHyhQXoDI3I
A yellow cylinder opens and closes the jaws, permitting them to grasp and release objects.
Green slider, blue piston and pink conrod create an ellipse mechanism.



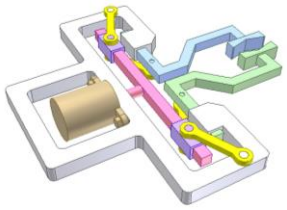
Robot gripper 5
http://youtu.be/95byfyaT3PQ
A violet cylinder opens and closes the jaws, permitting them to grasp and release objects.
Orange bar, blue piston and pink conrod create a slider crank mechanism.
Orange bar, yellow bar and green jaw create a parallelogram mechanism.



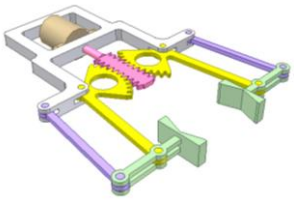
Robot gripper 6
https://youtu.be/Bpjr1slYxNQ
A grey cylinder opens and closes the jaws, permitting them to grasp and release objects.
Pink (or blue) slider, orange coulisse and green lever create a tangent mechanism.



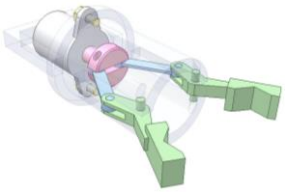
Robot gripper 7
https://youtu.be/pR_d4NTFNn4
A brown cylinder opens and closes the jaws, permitting them to grasp and release objects.
Pink slider, violet coulisse and yellow bar create a tangent mechanism.
Blue (or green) slider and two yellow bars create a slider crank mechanism.



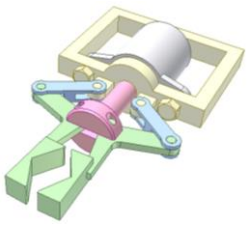
Robot gripper 8
https://youtu.be/ozP-yVZpv7s
A brown cylinder opens and closes the jaws, permitting them to grasp and release objects.
Yellow, violet and green links create a parallelogram mechanism.



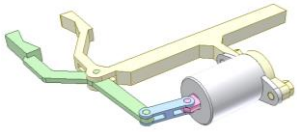
Robot gripper 9
https://youtu.be/shUN5VXV8mE
A grey cylinder opens and closes the jaws, permitting them to grasp and release objects.
Pink, blue and green links create a slider crank mechanism.



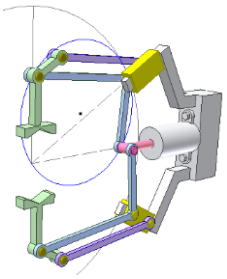
Robot gripper 10
https://youtu.be/pMAtl6MijSM
A grey cylinder opens and closes the jaws, permitting them to grasp and release objects.
Pink, blue and green links create a slider crank mechanism.



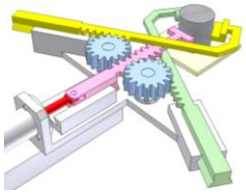
Robot gripper 11
https://youtu.be/Ggc24k6wErY
A grey cylinder opens and closes the green jaw to grasp and release objects.
Pink, blue and green links create a slider crank mechanism.



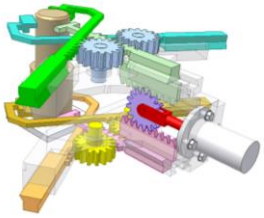
Robot gripper 12
https://youtu.be/YB4oSaCL0CY
A grey cylinder opens and closes the jaws, permitting them to grasp and release objects of large size range.
Yellow, violet, blue and green links create a parallelogram mechanism.
Green jaws linearly translate thanks to using mechanism of Cardano circles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



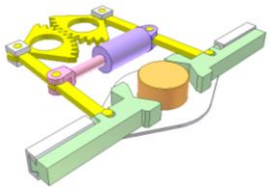
Rack self-centering fixture 1
https://youtu.be/03OCegpTRJY
Grey cylinder of red piston controls the fixture via gear rack drives.
Clamping planes of the three racks create a variable uniform triagular prism, center of its base is stationary.



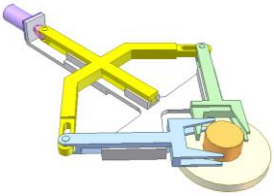
Rack self-centering fixture 2
https://youtu.be/5y70qOh7W1Y
Grey cylinder of red piston controls the fixture via gear rack drives.
Thanks to a differential rack gear drive (violet gear, pink and green racks) the clamping stepped shaft (in brown) can be realized at two different diameters.
It is a combination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



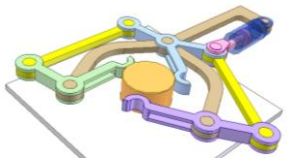
Gear self-centering gripper 1
https://youtu.be/yxnk1N3vARw
Violet cylinder of pink piston controls the gripper via yellow gear drive that moves two green jaws synchronically.



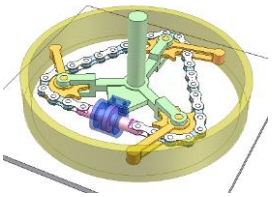
Wedge self-centering gripper 1
https://youtu.be/MCyK4QyVn5U
Violet cylinder of pink piston controls the gripper via yellow bar drive that moves two green and blue jaws synchronically. In fact the yellow bar and blue and green sliders create wedge mechanisms.



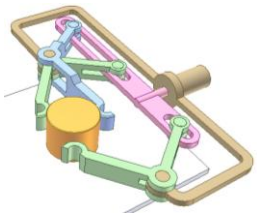
Bar self-centering gripper 1
https://youtu.be/wvwQ82y3vQs
Three jaws (blue, green and violet) pivoted on brown frame center and clamp orange work under action of blue cylinder. Centers of the jaw revolution joints with the frame are at vertices of an equilateral triangle. The center of the work is at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



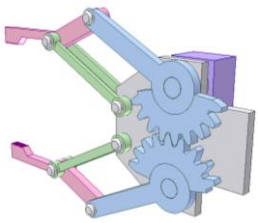
Chain self-centering gripper 1
https://youtu.be/uagWFJLj2EM
Blue fixed cylinder of pink piston controls the gripper via chain drive.
Yellow work is clamped at its inner surface by three orange levers fixed to the sprockets.



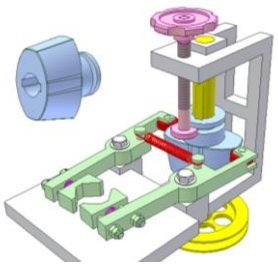
Bar gripper 1
https://youtu.be/JEI1X0y-II4
Brown cylinder of pink piston controls the gripper.
Three jaws move synchronically to grip or release orange work thanks sine mechanisms (common pink slider and three levers).
When the orange cylindrical work is gripped, its axis is in vertical plane that contains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



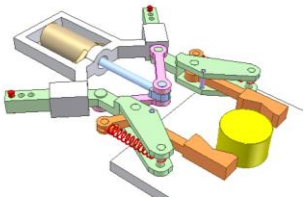
Robot gripper 13
https://youtu.be/0YEtfSkrGYQ
Blue gear-crank, green rockers and pink conrod (jaw) create a parallelogram mechanism.
Blue gear drive makes two parallelogram mechanisms move synchronically.
Violet motor transmits rotation to the upper gear-crank.
See a real gripper:
https://www.youtube.com/watch?v=NP655strtyE



Automatic clamp using cone cam
https://youtu.be/cbW_DKOkJYA
Input: yellow shaft.
It makes the blue cone cam rotate to close or open the grips.
Use the screw (in pink) to move the cam in the axial direction to adjust clamping angles of the two grippers (in green).
The clamping forces are generated by the pink compression springs.
The video shows the process for increasing the angle to clamp smaller objects.
The feeder for loading objects to be clamped is not shown.



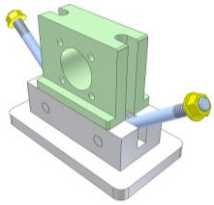
Gripper of constant clamping forces



https://youtu.be/UGdHwdvBA8g
Brown actuator controls clamping process but clamping forces come from red springs.
The clamping forces are kept nearly constant thanks to orange angular jaws. Torque from the spring around the jaw pivot is nearly constant because when the spring length is increased, the action radius of spring force around the pivot is reduced.
Constant clamping force is a requirement for clamping soft objects.
Red pins are stoppers for green sliders. Adjust their position on the green parts to adapt yellow work diameter.
Violet pins are limit stoppers for orange jaw non-working positions.
At clamping position the red pins prevent blue piston move more, violet pins don't touch the orange jaws.
Self-centering possibility for this gripper is not good because of the spring clamp.
This gripper is a combination of two mechanism shown at:
http://youtu.be/CHyhQXoDI3I
http://youtu.be/YzvwrYgNOH0

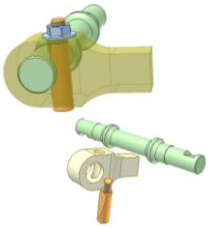
28.4. Mechanisms for clamping other objects

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



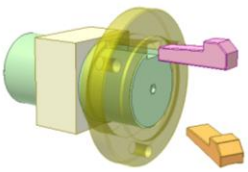
Wedge mechanism 19
http://youtu.be/pe3wTSXQa2c
Bicycle handlebar stem and fork coupling.
Wedge mechanism creates forces between the stem (yellow) and the fork (grey) and between the wedge (blue nut) and the fork to fix the stem to the fork.

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.

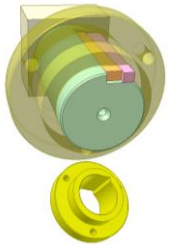


Wedge mechanism 21
http://youtu.be/Ybm4xZNfA9o
Cotter joint between two shafts. The slopes on the pink wedge and on the green shaft slot are equal. The prestress is created by collar of the green shaft.

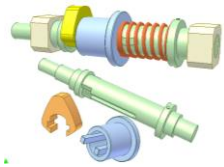
Wedge mechanism 22
http://youtu.be/6N0YcXU_0vc
Sunk taper key in strained joint.
The slopes on the pink key and on the yellow disk slot are equal.
Possible case for the taper key (in orange): no slot on the shaft and bottom surface of the taper key is cylindrical.



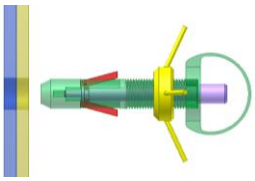
Wedge mechanism 23
http://youtu.be/qlPg8I8ZB1U
Tangential taper key in strained joint.
The slopes on two pink keys are equal.
If the green shaft is driving, the rotation direction must be clockwise.



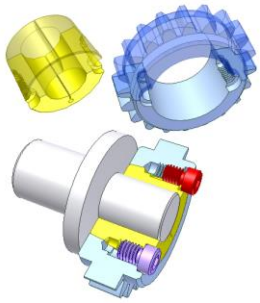
Quick changeable cam
http://youtu.be/TOi_2Xla5Xc
Move the blue sliding bush to free the cam for its change.



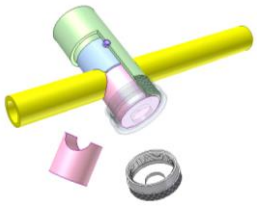
Fastener 1
http://youtu.be/wHIPzLIxdfI
Push the violet pin to retract the red wings.
Rotate the yellow nut to tighten the plates.
Pull the green ring to remove the fastener.
This NASA's invention is used for fasten things to a plate, back surface of which is inaccessible.



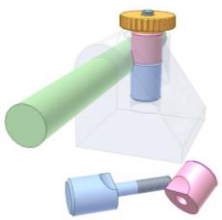
Fastener 5
http://youtu.be/8MnLVIU4Vuo
A way to fix a gear on a shaft thanks to a flexible split bush and two screws.
The bush has a tapered outer diameter.
The gear has a tapered inner diameter.
Only one hole among the two holes in the bush or in the gear is tapped.
Split tapped hole in the bush align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



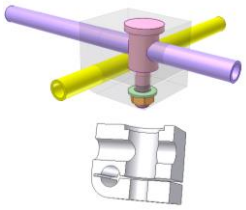
Fastener 2
http://youtu.be/6dSCQNG35Nc
Green tube and blue fixed jaw are fixed together.
Tight or release grey nut for clamping or repositioning yellow tube.
The green tube is cut off for easy understanding.



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.

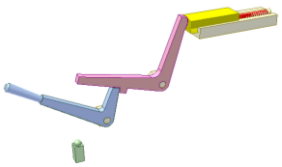
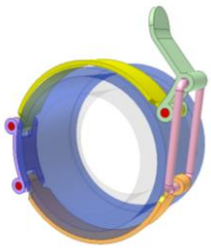


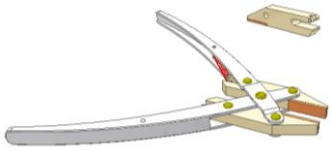
Table clamp
http://youtu.be/uzqd1rKp5qQ
Raise the pink latch to prevent its contact with the yellow table post for moving up down the table.
When releasing the latch, it turns down and comes into contact with the table post. Friction between them stops the table falling. There must be an adequate gap 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.

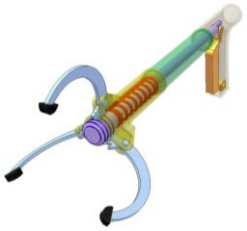
Toggle clamp 2c
http://youtu.be/k9tMxQfo2zo
Toogle clamp using four bar linkage.
Green conrod and pink lever come into toggle by lining up on top of each other.
The clamping force is applied to the conrod.



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.

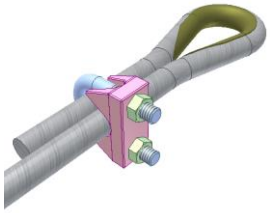


Grabber 1
https://youtu.be/ifNNnIT9jI4
Three blue claws of gear sector engage with violet rack of circular teeth.
Press orange trigger to grab an object.
Number of the claws can be 2, 3, 4 subject to shape of the object to be grabbed.

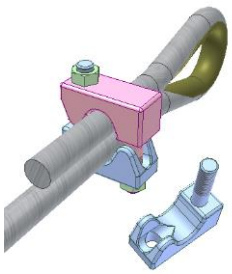


Grabber 2
https://youtu.be/An_B75JCyj8
Pull pink rod to grab an object.
This grabber can be considered as an application of slider crank mechanism of flexible links.
Slider: pink rod.
Cranks: blue bars.
Connection rods: green bars

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

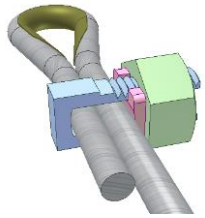


Wire rope clamp 2
https://youtu.be/Cd3XO3Ap5Lw



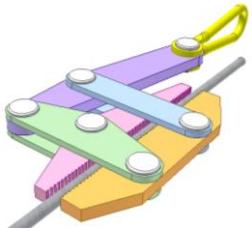
Wire rope clamp 3
https://youtu.be/e51o-ysFq8U

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

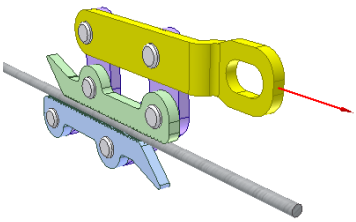


Wire rope clamp 5
https://youtu.be/kIDSC-qzsqE

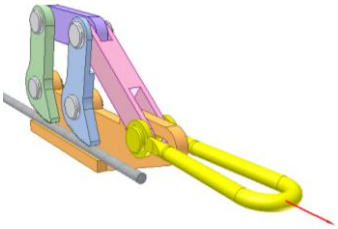
Quick clamp for cable 1
https://youtu.be/lgF8P-zZZA0
It is an application of parallelogram mechanism.
Red arrow represents working force.
The cable is clamped between orange and pink bars thanks to friction force.



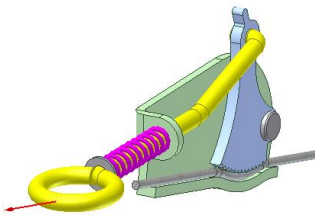
Quick clamp for cable 2
https://youtu.be/xnlh2i6J6XU
It is an application of parallelogram mechanism.
Red arrow represents working force.
The cable is clamped between blue and green bars thanks to friction force.



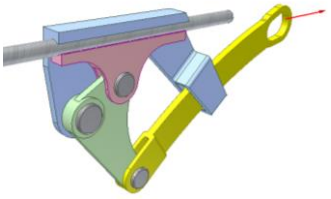
Quick clamp for cable 3
https://youtu.be/S-2NnUV5a_Y
It is an application of parallelogram mechanism.
Yellow pin slides in the slot of the orange bar.
Red arrow represents working force.
The cable is clamped between orange bar and two cams (in green and blue) thanks to friction force.



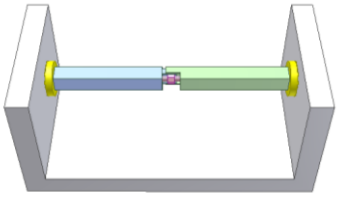
Quick clamp for cable 4
https://youtu.be/kfGUhGpaFok
Red arrow represents working force.
The cable is clamped between blue jaw and green base thanks to friction force. The cable is deformed when clamped.
The spring helps to hold the cable at the clamping start.



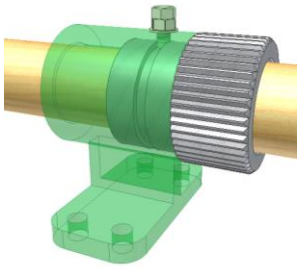
Quick clamp for cable 5
https://youtu.be/Hm_xZJy7nhI
Red arrow represents working force.
The cable is clamped between pink jaw and blue base thanks to friction force.



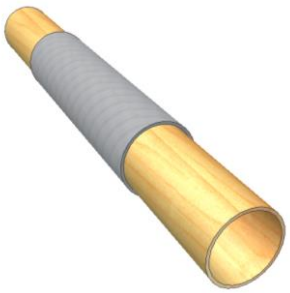
Hanging rod
https://youtu.be/nV07YvrsCUQ
Turn pink screw of right- and left-hand threads to make the bar (consisting of blue and green portions) prop against two opposite walls. Thus, the bar is clamped firmly thanks to friction at its yellow ends.
Pros: no need to drill holes in the walls for screwing.
Cons: the hanging rod can only bear light load.



Tube clamping 1
https://youtu.be/MIJG9y6P_DE
Turn gray bush to clamp orange tube on green base.
Large hole of the green base is eccentric to small hole of the base.
As for the gray bush, outer cylinder of circular groove is eccentric to the bush hole.
The outer cylinder turns in the base large hole.
While turning the bush forces the tube on the base hole thus generating friction forces to clamp the tube.
This design is numbered as 1190 in the book “Mechanical Fixtures Tooling”



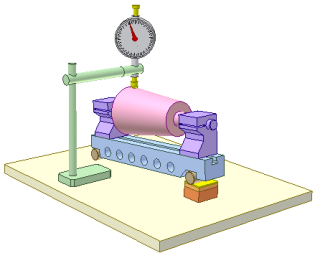
Tube clamp 2
https://youtu.be/vYTK6ge6gIo
Sections of outer and inner tubes are not round. They have a slight ovalness.
Keep the outer tube immobile, turn the inner tube to fix it with the outer tube. Friction at contact places of the tubes prevents the loosening.
Turn back the inner tube to release it.



29. Measurement and quality control

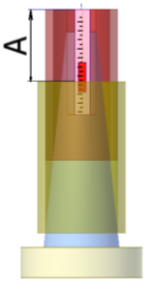
29.1. Geometry quality control

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



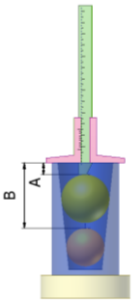
The taper to be measured is in pink color. It is mounted between two centres that are installed on a blue sine bar of two brown rollers. The rollers are always fixed to the bar.
Use slip gauge combination to make the highest generatrix of the taper parallel to the surface plate. The parallelism is checked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

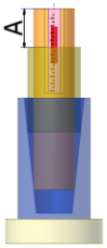
Female taper measurer 1
http://youtu.be/QiDu1k-6HUs



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

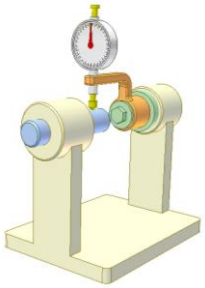
http://youtu.be/SvmRPrN7Zd4



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).
tanα = ((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

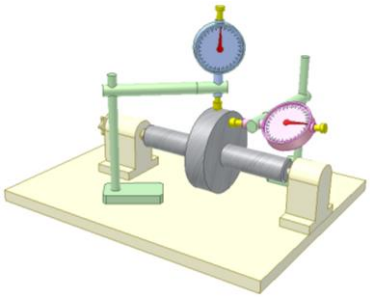
http://youtu.be/DkmLCIVo-1Y



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

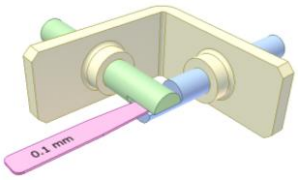
http://youtu.be/1JNCe9fwRUw



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

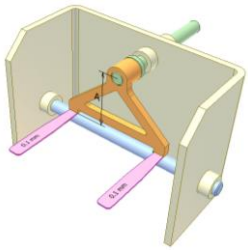


Ensure no gap between shafts and holes.
The flat portion of each shaft must contain shaft centerline. Insert a feeler gauge (as thick as possible) into the gap between the shaft flat portions to get the error in intersection (feeler gauge thickness). Turn the shafts 180 deg. if no gap appears.

Measuring distance between 90 deg. skew holes

http://youtu.be/bLfvIWlZZBc

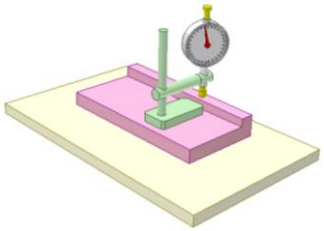
Ensure no gap between shafts and holes.
A is distance between the flat portions and the centerline of the orange part. It is determined according to allowed smallest value of the distance to be measured.
Insert two feeler gauges (of equal thickness and as thick as possible) into both gaps between the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

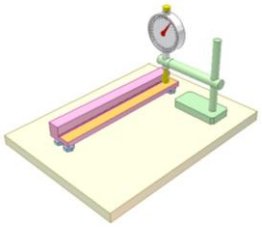
One plane is large enough for laying the indicator base.
Move the indicator set longitudinally to get values E1 and E2 at two points, distance between which is A.
Non-parallelism P = (E1-E2)/A
Using height gauge gives less accurate result.



Checking parallelism between two planes 2

http://youtu.be/YedyhVrmThk

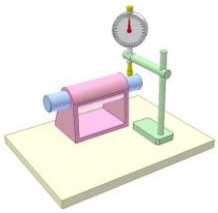
The planes are small so the indicator base can not be laid on one of them.
Make the orange plane paralell to the surface plate using the blue jack pins. Check the parallelism by the indicator, base of which moves on the surface plate.
Then check the parallelism of the pink plane to the orange one through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



Checking parallelism between hole and bottom

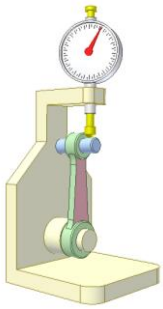
http://youtu.be/OfmDN3FuWRs

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

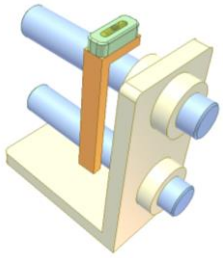
http://youtu.be/eEGu7azvNow



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

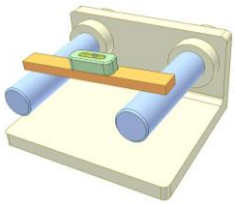
http://youtu.be/HONVeJB7Rsk



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

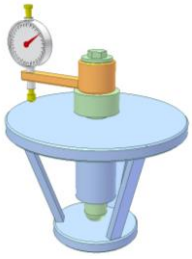
http://youtu.be/svSkqNaTHBE



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

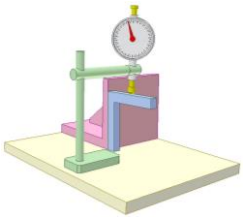
http://youtu.be/BEumouFrAj4



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

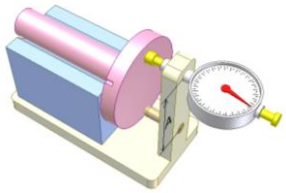
http://youtu.be/ZRvdzfM9lSo



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

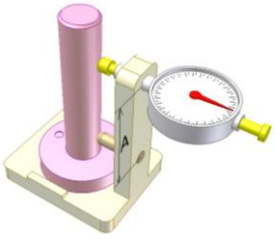
http://youtu.be/R7u0Af9dsIA



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

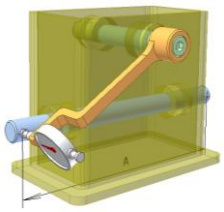
http://youtu.be/ZUurxNlb8r0



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

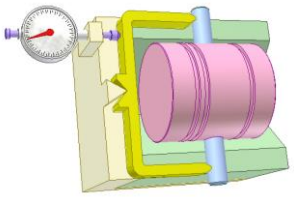
http://youtu.be/VKfFRS0H3Wc



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

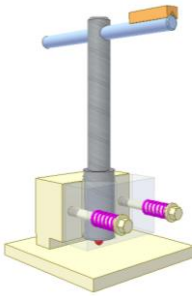
http://youtu.be/3TwxF7t4-_U



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

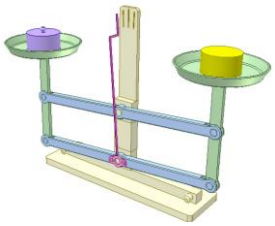
http://youtu.be/yr-MTaKDuis



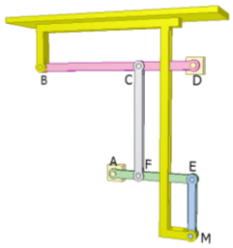
A blue round bar is inserted into the hole of of the grey shaft.
Ensure no gap there.
V-block and the shaft are arranged vertically.
Small error in verticality does not affect the checking result.
The shaft always contacts V-block thanks to two pink springs.
There is a red ball at the shaft bottom.
Checking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

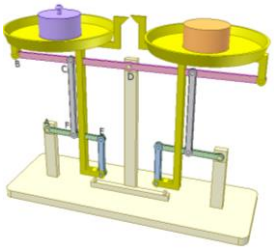
Two-pan balance 1
https://youtu.be/pSSpjnTNbIw
Parallelogram mechanisms are applied for this type of balances.
Disadvantage: there is error due to possible eccentricities between the masses and the pans.



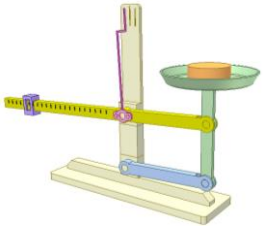
Vertical translating platform
https://youtu.be/cJIUVR_I7Z8
AE/AF= BD/CD
When pink and green bars are horizontal, grey and blue bars are vertical.
With small oscillating angle A of the pink bar, yellows platform is always approximately horizontal and move approximately vertically.
The video shows:
A =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



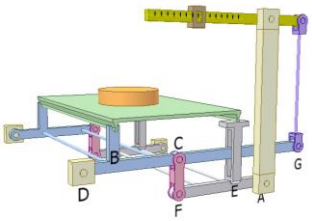
Two-pan balance 2
https://youtu.be/Ltw-dzul5DQ
AE/AF= BD/CD
Yellows pans are always approximately horizontal and move approximately vertically.
Possible eccentricities between the masses and the pans do not cause weighing error.
It is an application of mechanism shown in:
https://youtu.be/cJIUVR_I7Z8



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

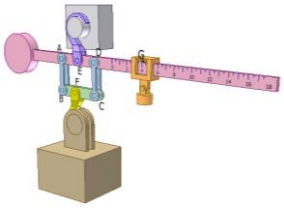
Green platform has revolution joint with blue bar and cylindrical slider joint with grey bar.

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).

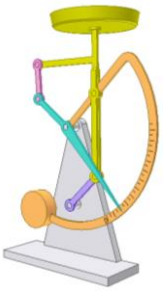
Q = G * EG / (2*(AE – BF))

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



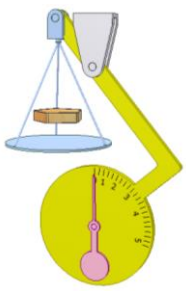
https://youtu.be/tgLh4S3slYE

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

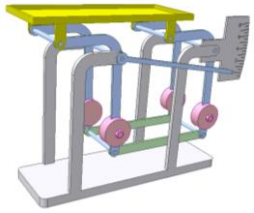
When no mass in the blue pan, the pink hand points to 0 mark.

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.

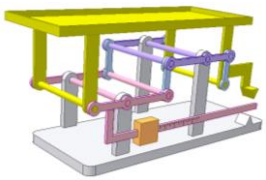
The graduation on the dial is nonlinear.

Disadvantage: moving graduatied dial causes reading difficulty.

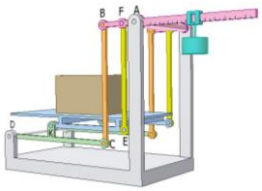
One-pan balance 2
https://youtu.be/cjv2eX2UCXg
Two blue angular bars, yellow pan and green bars create a double parallelogram mechanism. Blue hand is fixed to the blue bar.
When no mass in the pan the hand points to 0 mark.



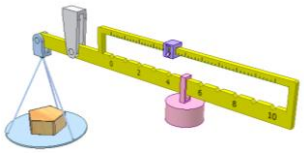
One-pan balance 3a
https://youtu.be/eQ8hhapy9U8
Pink graduated scale is fixed to pink bar. Move the orange sliding mass to get the scale horizontal. Position of the sliding mass shows the weight of the object placed on the yellow pan.
The video shows case when no object in the pan, the scale is horizontal because the sliding mass is set at 0 mark.



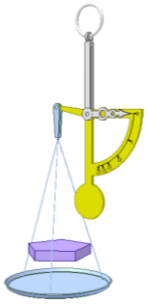
Platform weighing scale 2
https://youtu.be/knYY26VdNnY
Move cyan sliding mass to get pink scale horizontal. Position of the sliding mass shows the weight of the object (in brown) placed on the blue platform.
KE = EF
DK / DC = FA / AB
The platform is always kept horizontal.



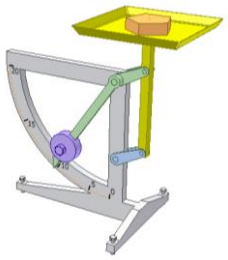
Steelyard of two graduated scales
https://youtu.be/QpIalioR33E
Pink large counterweight position shows the rough value on the lower scale.
Move violet small counterweight to set adding value on the upper scale for exact weight of the orange object.



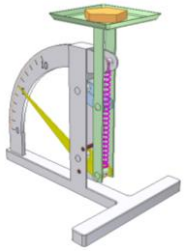
One-pan balance 5
https://youtu.be/juDyJ-8CssI
When no mass in the blue pan, the grey stationary hand points to 0 mark.
The video shows when the violet object is placed on the pan, the yellow bar rotates and the hand indicates the object weight.
The graduation on the dial is nonlinear.
This balance is used for light objects such as tea.



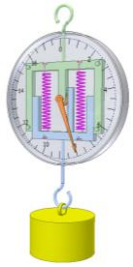
One-pan balance 6
https://youtu.be/4AuETQisTyE
When no mass in the yellow pan, the green hand points to 0 mark.
The video shows when the orange object is placed on the pan, the hand moves to indicate the object weight.
The graduation on the dial is nonlinear.
This balance is used for light objects.



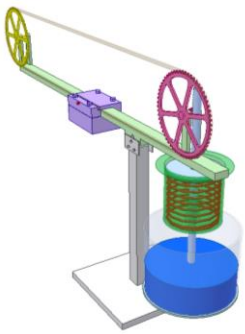
Spring scale 1
https://youtu.be/W-gxHZ5uahA
When no mass in green pan, yellow hand points to 0 mark.
The video shows when orange object is placed on the pan, the hand moves to indicate the object weight.
The graduation on the dial is linear.



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.

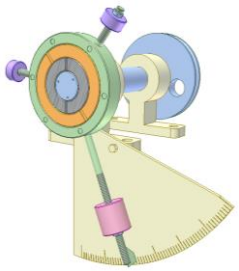


Self-balancing lever
https://youtu.be/bsF7eYGz8Gg
When the weight of the blue load increases, the blue rod overcomes the force of red spring and moves down. The rack portion of the rod is in mesh with the pinion on the chain wheel shaft and makes the shaft rotate. The violet counterweight is fixed to the chain of the chain drive by the red pin. So the counterweight moves apart from the lever fulcrum when the blue rod moves down.
Thus the green beam is automatically kept horizontal when the weight of the blue load changes.



i = (k*m)/W
i: transmission ratio of linear displacements between the blue rod and the violet counterweight.
k: spring rate N/mm
m: distance from the load to the lever fulcrum mm
W: weight of the violet counterweight N

Friction torque measuring



http://www.youtube.com/watch?v=QQfhv9AuYuM

A simple method to measure friction torque M generated in revolution joint of the grey inner ring and the orange outer one. The grey ring is fixed on the blue shaft, the orange ring is fixed on the green hand assembly.

M = PLsinα

P: weight of the pink weight

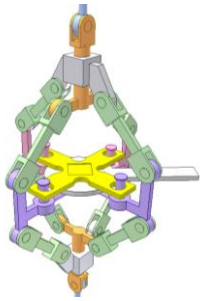
L: distance from the pink weight to the rotation axis

α: angle shown by the green hand

Force applied to the revolution joint is the weight of the hand assembly including the pink weight.

The hand assembly (without the pink weight) must be adjusted with the violet nuts to be in static balance.

Mechanism for 2D pulling test

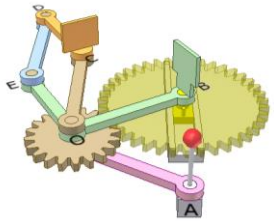


https://youtu.be/UyJZVaCffVY

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

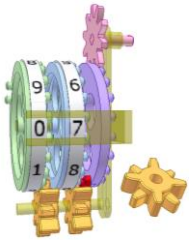
AB = BC

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

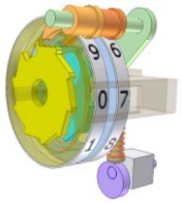
https://youtu.be/UOhFri6FPrs



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 07th to the 13th revolution.

Mechanical counter 1

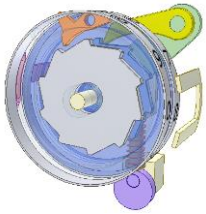
https://youtu.be/vyejpfe72rA



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.

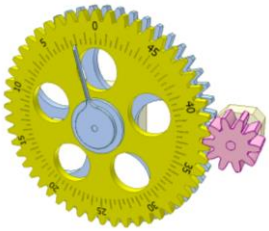
Zero return device for mechanical counter

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.

Revolution counter 1

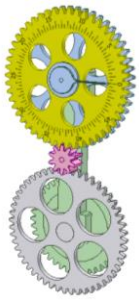
http://youtu.be/GNRgJLHD33A



Yellow gear (tooth number Zy = 50) idly rotates on blue gear (tooth number Zb = 51). Both are in mesh with pink gear (tooth number Zp = 10).
1 rev. of blue gear corresponds (Zb/Zy) rev. of yellow gear.
In 1 rev. of blue gear, yellow gear rotates faster than blue gear an amount:
((Zb/Zy) – 1) = (Zb – Zy)/Zy = (51-50)/50 = 1/50 rev.
The video shows two rev. of blue gear.
The hand and the dial on yellow gear show revolutions of blue gear.
Disavantage: reading difficulty due to the dial rotation.
This mechanism shows that for a given center distance, a gear can meshes with two coaxial gears of different tooth numbers.
Backlash in mesh of yellow gear and pink pinion doesn't much affect the counting result.
To eliminate the backlash, teeth of the yellow gear can be made thicker (corrected gears).

Revolution counter 2

http://youtu.be/gxvHH1pdISY

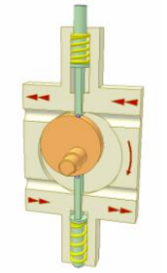


This is a satellite drive developed from mechanism shown in "Revolution counter 1". Input is green crank (carrier of this satellite drive).
Yellow gear (tooth number Zy = 50) idly rotates on blue gear (tooth number Zb = 51). Both are in mesh with pink gear (tooth number Zp = 10). Pink gear is also in mesh with a fixed grey gear (tooth number Zg = 51).
Because Zb = Zg, the direction of the blue gear and the hand fixed to it is kept unchanged during rotation.
Because Zy is not equal to Zb there is a relative rotation between the yellow and blue gears.
The video shows two rev. of the green crank.
The hand and the dial on yellow gear show revolutions of the green crank.
Backlash in mesh of yellow gear and pink pinion doesn't much affect the counting result.
In the past a similar mechanism was called "Ferguson's mechanical paradox" because of strange behaviour of the two satellite gears.

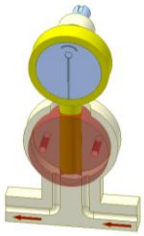
30. Pumps and engines

30.1. Pumps

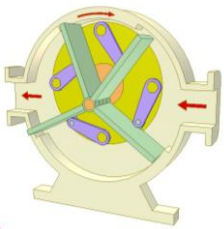
Pump with eccentric 1
http://www.youtube.com/watch?v=RVORJ91ELEE
The red arrows indicate the rotation direction of the eccentric shaft and the fluid moving direction.
The front half case is removed.



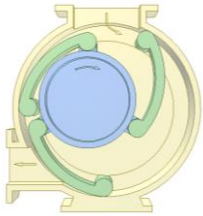
Pump with eccentric 2
http://www.youtube.com/watch?v=lvzHnE26P1o
The red arrows indicate the rotation direction of the eccentric shaft and the fluid moving direction.
The front half case is removed.



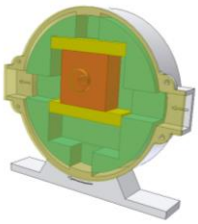
Pump with 4-bar mechanism 1
http://www.youtube.com/watch?v=RrDJzv699aA
The red arrows indicate the fluid moving direction.
The front half case is removed.
The space between adjacent sectors is expanded on the suction side and decreased on the discharge side.



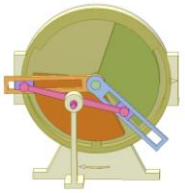
Pump with 4-bar mechanism 2
http://www.youtube.com/watch?v=YFb6tVo8rfg
The arrows indicate the fluid moving direction.
The front cover is removed.
An expanding cavity is created on the suction side and a decreasing cavity is created on the discharge side.



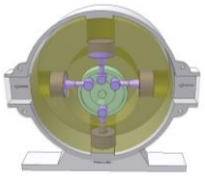
Pump with rotating square piston
http://www.youtube.com/watch?v=WiYK04vVPRY
Input: green disk.
Yellow slider slides in slot on the green disk.
Red piston slides in slot on the yellow slider.
The piston axle is fixed eccentrically on the yellow cover.
The arrows indicate the fluid moving direction.
The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



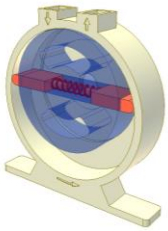
Pump with 4-bar mechanism 3
http://youtu.be/RSAyygL03po
The arrows indicate the rotation direction of the sectors and the fluid moving direction. Each sector is fixed with a coulisse.
The rotating sectors create an expanding cavity on the suction side and a decreasing cavity on the discharge side.



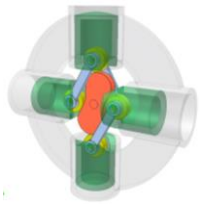
Pump with rotating cylinder
http://youtu.be/Bu7000931oQ
The arrows indicate the rotation direction of the yellow cylinder and the fluid moving direction. Green disk is fixed eccentrically on the case
The pistons create an expanding cavity on the suction side and a decreasing cavity on the discharge side.



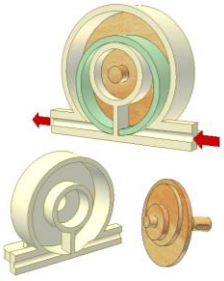
Pump with eccentric 3
http://www.youtube.com/watch?v=w8MDLutvcZo
The arrows indicate the rotation direction of the eccentric and the fluid moving direction.
The eccentric creates an expanding cavity on the suction side and a decreasing cavity on the discharge side. The front cover is removed.



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.



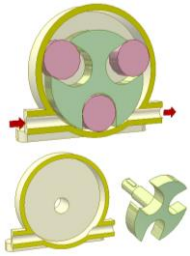
Scroll compressor

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

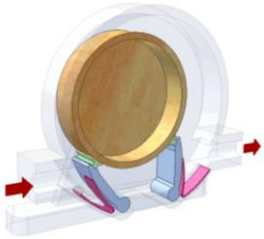
http://youtu.be/8AfzVEwOypQ



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

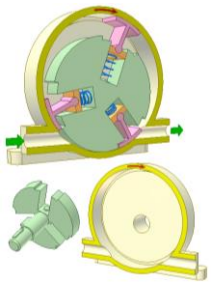
http://youtu.be/f-0yLq63tmI



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.

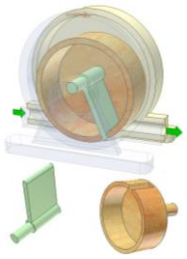
Pump with sliders 1a

http://youtu.be/S7qE55UJJXI

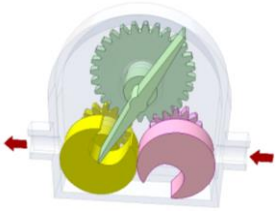


Input: green rotor that rotates eccentrically in the housing.
Orange sliders can slide in the rotor slots.
Pink sliders can slide in circular grooves of the housing.
There are revolution joints between orange sliders and pink ones.
It is an application of a coulisse mechanism where green rotor and pink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

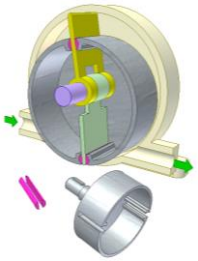
Pump with eccentric 4a
http://youtu.be/t5BQStcdqTo
Input: orange rotor that rotates eccentrically in the housing. Its bearing is located in the back half of the housing.
Green plate rotates concentrically in the housing. Its bearing is located in the front half of the housing.
There should be a soft contact (elastic seal) between the plate and the rotor.
The arrows show fluid flows.



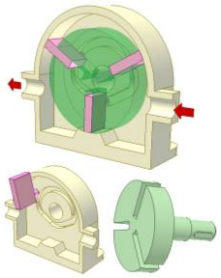
Pump of three shafts
http://youtu.be/jtWM5zclqfw
Input: green shaft
Curves on yellow and pink rotors are epitrochoids.
Tooth number of the green gear is twice the one of the other gears.
The arrows show fluid flows.
The pump is cut off half for easy understanding.



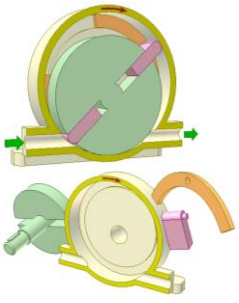
Pump with eccentric 4b
http://youtu.be/OiSO7FKtlTw
Input: grey rotor that rotates eccentrically in the housing.
Its bearing is located in the back half of the housing.
Green and yellow plates rotates concentrically in the housing. The pink parts have revolution joints with the rotor. The violet shaft is fixed to the front half of the housing (not shown).
The arrows show fluid flows.



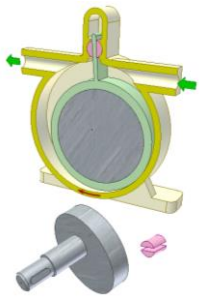
Pump of fixed disk cam
http://youtu.be/DHJiK1lfzNc
Input: green shaft
The pump housing has a groove (disk cam).
Each pink plate has pin sliding in the groove.
The arrows show fluid flows.
The pump is cut off half for easy understanding.



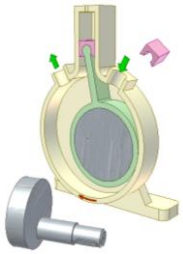
Pump with sliders 1b
http://youtu.be/4DtouBqxfSU
Input: green rotor that rotates eccentrically in the housing.
Pink sliders can slide in the rotor slots.
Orange sliders can slide in circular grooves of the housing.
There are revolution joints between orange sliders and pink ones.
It is an application 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.



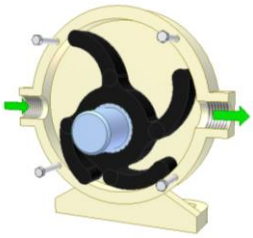
Pump with eccentric 5a
http://youtu.be/BoXO-7R51co
Input: grey rotor that rotates eccentrically in the housing.
Green conrod separates suction and discharge spaces of the pump.
The pink parts have revolution joints with the housing.
The arrows show fluid flows.
The pump is cut off half for easy understanding.



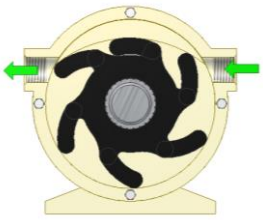
Pump with eccentric 5b
http://youtu.be/LJDs5Er6zJs
Input: grey rotor that rotates eccentrically in the housing.
Green conrod separates suction and discharge spaces of the pump.
The rotor, conrod and pink slider create a slider crank mechanism.
The arrows show fluid flows.
The pump is cut off half for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



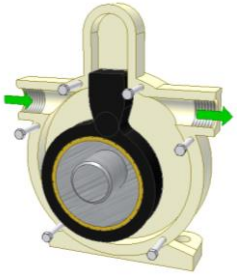
Flexible impeller pump 1a
http://youtu.be/JtQ-0ZYkH2c
Black rubber impeller, eccentrically rotating clockwise in the housing, transports fluid from inlet to outlet. The front half housing is removed for easy understanding.
Green arrows show fluid flow.



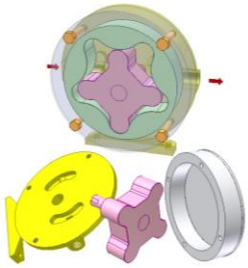
Flexible impeller pump 1b
http://youtu.be/x90OtAgbBp0
Black rubber impeller, concentrically rotating clockwise in the housing, thanks to inner noncircular profile of the housing, transports fluid from inlet to outlet. The front half housing is removed for easy understanding.
Green arrows show fluid flow.



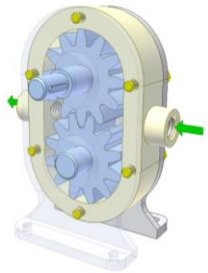
Flexible impeller pump 2
http://youtu.be/rV1cdVGnU5Y
Grey shaft rotates anticlockwise in the housing. Black rubber impeller having revolution joint with an eccentric of the grey shaft, transports fluid from inlet to outlet. The front half housing is removed for easy understanding.
Green arrows show fluid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



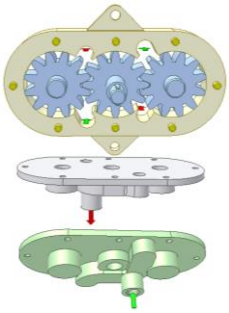
Trochoid gear pump
http://youtu.be/Xd3s5xEPSlA
A pin drive is applied for this pump. The pink driving rotor rotates 5 rev. while the green driven rotor rotates 4 rev.
Profile of the green rotor consists of trochoid curves.
If the pink driving rotor rotates clockwise the left space between teeth of the two rotors is of low pressure and the right one is of high pressure.
The two gears rotate clockwise. Red arrows show fluid flow.



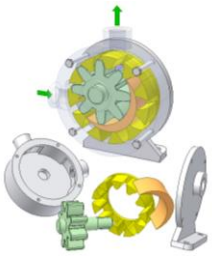
External gear pump
http://youtu.be/EPCI8poQAoI
Liquid between teeth and housing wall is transported from inlet to outlet.
The upper gear rotates anti-clockwise. Green arrows show fluid flow.



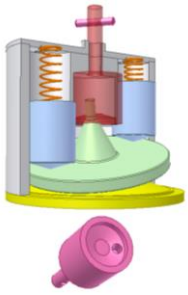
External gear pump 2
http://youtu.be/gp6SJiEsUu4
The driving middle gear rotates anti-clockwise.
Liquid between teeth and housing wall is transported from inlet (green arrows) to outlet (red arrows).
The inlet is on grey back cover.
The outlet is on green front cover.
In comparison with 2-gear pump, 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.



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.



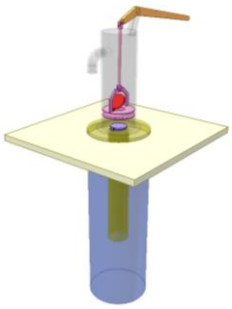
Cable drive 23

http://youtu.be/HoGTiXtCKmY

A liquid pumpjack. The 4-bar mechanism converts continuous rotation to reciprocating rotation that the cable drive converts to reciprocating translation of a pump piston.
The ball valves open and close automatically due to fluid pressure alteration in the space under the piston.
When the piston moves up, the lower valve opens, the upper valve closes. The outside liquid is sucked into the space under the piston. The liquid above the piston is pushed up.
When piston moves down, the lower valve closes, the upper valve opens. The liquid is pressed from the space under the piston into the space above the piston.
For more about valve action see:
http://www.youtube.com/watch?v=SFJFiyXTOa0

Hand water pump 1a

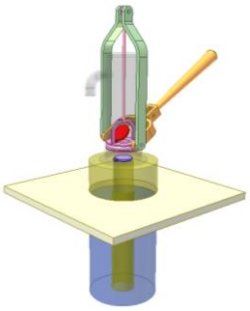
http://youtu.be/8xv21E7XKBU



Slider crank mechanism converts oscilation of orange crank to reciprocating translation of pink piston. Hand force is applied to the crank.
Disk valves open and close automatically due to fluid pressure alteration in the space under the piston.
When the piston moves up, the lower valve opens, the upper valve closes. The outside liquid is sucked into the space below the piston. The liquid above the piston is pushed up and flows outside. When piston moves down, the lower valve closes, the upper valve opens. The liquid is pressed from the space below the piston into the space above the piston.
For more about valve action see:
http://www.youtube.com/watch?v=SFJFiyXTOa0

Hand water pump 1b

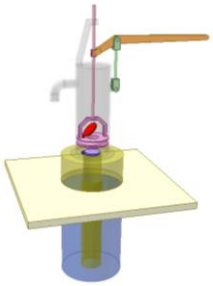
http://youtu.be/NtMIwYN7EeU



Slider crank mechanism converts oscilation of orange crank to reciprocating translation of pink piston. Hand force is applied to the crank.
Disk valves open and close automatically due to fluid pressure alteration in the space under the piston. When the piston moves up, the lower valve opens, the upper valve closes. The outside liquid is sucked into the space below the piston. The liquid above the piston is pushed up and flows outside. When piston moves down, the lower valve closes, the upper valve opens. The liquid is pressed from the space below the piston into the space above the piston.
For more about valve action see:
http://www.youtube.com/watch?v=SFJFiyXTOa0

Hand water pump 2a

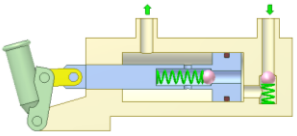
http://youtu.be/adMu9Yo0nCA



Slider crank mechanism converts oscilation of orange conrod to reciprocating translation of pink piston. Hand force is applied to the conrod.
Disk valves open and close automatically due to fluid pressure alteration in the space under the piston. When the piston moves up, the lower valve opens, the upper valve closes. The outside liquid is sucked into the space below the piston. The liquid above the piston is pushed up and flows outside. When piston moves down, the lower valve closes, the upper valve opens. The liquid is pressed from the space below the piston into the space above the piston.
For more about valve action see:
http://www.youtube.com/watch?v=SFJFiyXTOa0

Hand piston pump 1

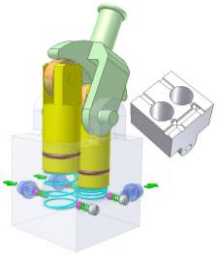
http://youtu.be/5a-UdttYEVs



Spring ball valves are operated automatically thanks to fluid pressure.
The arrows show fluid flows.
The cylinder and the piston are cut off half for easy understanding.

Hand piston pump 2

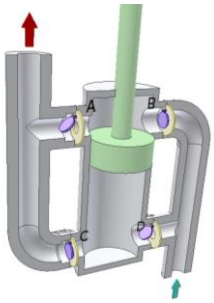
http://youtu.be/cVwOS5cd4Oo



Green double cam lever controls two pistons.
Spring ball valves are operated automatically thanks to fluid pressure.
The arrows show fluid flows.

Double acting pump

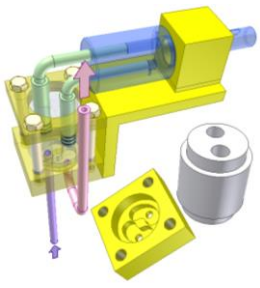
https://youtu.be/lGF8eVhrD5c



The suction and discharge happen in both motion directions of green piston.
When the piston goes down, valves A, D close, valves B, C open and vice versa.
The fluid pressure controls motions of the valves.

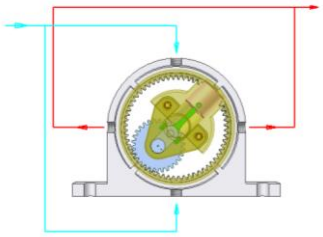
Pump of Hobson's joint

https://youtu.be/hhc2iTiWOHs



Input shaft: blue
Suction pipe: violet
Discharge pipe: pink
Two green pistons slide in the holes of white rotary cylinder.

Rotary cylinder pump



https://youtu.be/lLtReLOqRH8

Input: yellow cylinder-shaft.

The blue crank shaft plays role of a carrier in the planetary drive consisting of white stationary gear and blue satellite gear.

The tooth number ratio of the gears: 2. One revolution of the input corresponds to two working cycles of the piston.

Cyan lines represent suction pipes. Red lines represent discharge pipes.

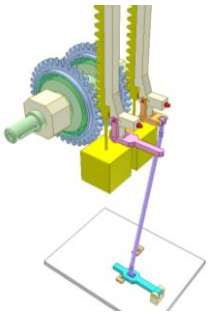
Problem to be solved: how to balance the rotary masses.

This video was inspired by

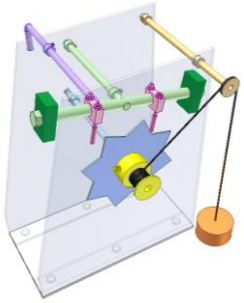
https://youtu.be/ZRUdQasuI78

30.2. Engines

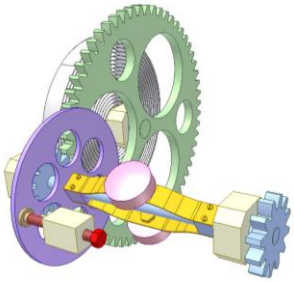
Gravity engine 1
https://www.youtube.com/watch?v=tsT-MVZudV4
A way to bring some weights into action consecutively in a gravity engine.
Press pink arm, red slider moves back, to start the engine.
When the first yellow weight contacts cyan lever, it brings the second weight into action.
Turn the green 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.



Gravity engine 2
https://youtu.be/Hr8FXNH4aWo
Orange weight tends to turn clockwise yellow part that is connected to blue output shaft of ratchet wheel via a one-way overrunning clutch of red pawl.
Green rocker of two pink pins makes the output shaft rotate intermittently thus reduce the output speed. Geometry and mass parameters of the green rocker parts decide the output speed.
Violet rod is used for start or stop of the engine.
Turn the yellow part counterclockwise (to raise the weight) to charge energy for the engine as shown in last scenes of the video.
Place orange pulley higher to get longer working duration of the engine.
This animation was made based on the oven shown at
https://www.youtube.com/watch?v=fnuV27v99fM&feature=youtu.be

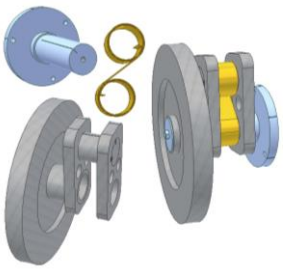


Speed control of spring motor
http://youtu.be/ehjgr3AYKvM
Orange leaf springs tend to get their neutral position and push violet flange to the left. Centrifugal forces of pink weights tend to move the violet flange to the right when the speed increases and cause the friction at the contact place between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



Oscillation engine of flat coil spring

https://youtu.be/IBBuBA1NhcY



Bring the gray flywheel out of its neutral position and let it oscillate freely.
The oscillation of the flywheel is caused by a flat coil spring of two spiral directions. One end of the spring is fixed to the stationary shaft (in blue). The other end is fixed to the axle of the crank (in gray). The latter and the flywheel are fixed together.
The mechanism works like a pendulum, but the oscillating angle can be very large (more than 1 revolution).

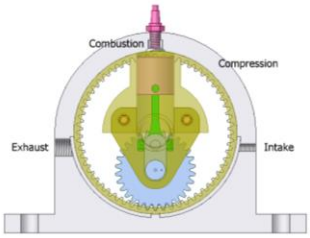
Spring motor of planetary gears drives

https://youtu.be/BfStnLIkmJY

Output: green shaft.
Two ends of a torsion helical spring (transparent white) are mounted on cyan and green disks, angular positions between which is changed during motion.
Turn the cyan disk to wind up the spring while keep blue and green shafts immobile. Use pink latch to fix the cyan disk to the blue disk after winding up. Positioning device (a torsion spring) for the latch is not shown.
Planetary drive of blue crank has stationary gear (in brown) of 18 teeth, satellite gear (in yellow) of 16 teeth.
Planetary drive of green crank has stationary gear (in grey) of 16 teeth, satellite gear (in yellow) of 16 teeth.
When the green disk turns 1 revolution in relation with the cyan disk, the output green shaft turns 17 revolutions.
Violet double Cardano coupling transmits rotation from one satellite gear to another one. The gear relative positions are changed during motion. For more about the coupling see:
https://youtu.be/aQrnXWo4DxE
https://youtu.be/95bZU6ylEzw
Device for motor speed control is not shown. See its example:
http://youtu.be/ehjgr3AYKvM

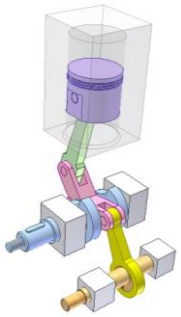
Rotary cylinder 4-stroke engine

https://youtu.be/2kZZP6P5HdI

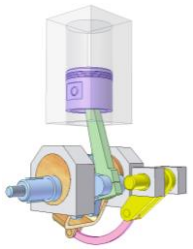


Output: yellow cylinder-shaft.
The blue crank shaft plays role of a carrier in the planetary drive consisting of white stationary gear and blue satellite gear.
The tooth number ratio of the gears: 2.
One revolution of the output corresponds to one 4-stroke cycle of the engine.
Problem to be solved: how to balance the rotary masses.
This video was made on request of the owner of the video
https://youtu.be/ZRUdQasuI78

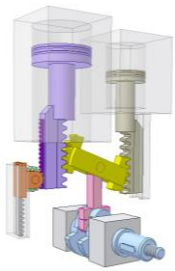
Variable compression ratio engine 1a
https://youtu.be/a9hYU2OnsfE
Angle position of orange control shaft is controlled by a motor (not shown). When red arrow points down, volume of the combustion chamber is min, the compression ratio is max and vice versa.
This working principle is taken from Nissan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



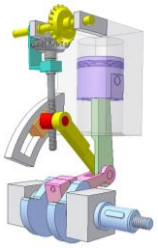
Variable compression ratio engine 2
https://youtu.be/-Zg4HKXlXT4
Position of orange cradle of the blue crank shaft determines compression ratio of violet piston cylinder. It gives different volumes of the combustion chamber. There is an offset between the blue crank shaft and the cradle axes.
The position 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.

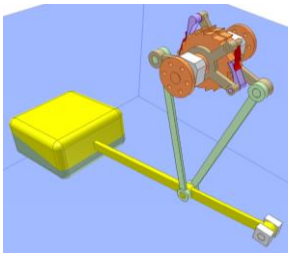


Variable compression ratio engine 4
https://youtu.be/XJR0kK9HNHw
Position of orange circular slider determines compression ratio of violet piston cylinder. Low position gives high compression ratio and vice versa.
The position is controlled by yellow shaft via bevel gears and nut-screw drive.
Attention: piston stroke length is varied considerably when adjusting.



Wave motor

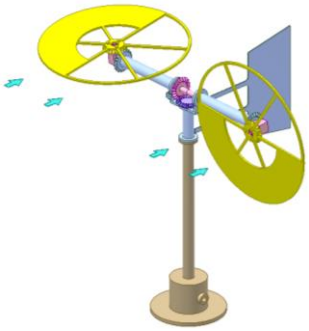
https://youtu.be/caZa4-CuM2w



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.

Wind turbine of semicircle-shaped airfoils

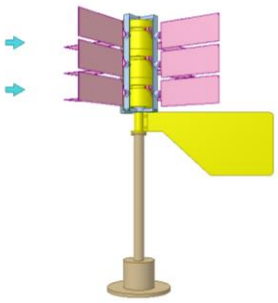
https://youtu.be/yDEjM7EA76U



Yellow airfoils show their faces toward the wind flow (blue arrows) when they are under the blue horizontal bar. The airfoils are arranged in different planes (here perpendicular) to ensure that the wind always creates torque for the turbine.
Blue tail rudder helps to rotate the blue bar (pivoted on brown post) toward the wind flow. Violet vertical gear shaft transmits torque to the electric generator (not shown).
This video was made based on TEN FOLD video:
https://www.youtube.com/watch?v=1-IA-a5_zJ0

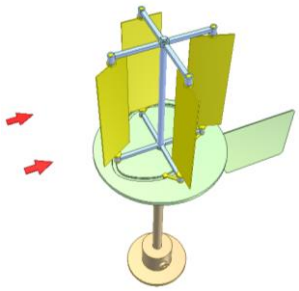
Wind turbine of flipping airfoils 1

https://youtu.be/xdIw3YOrc-E

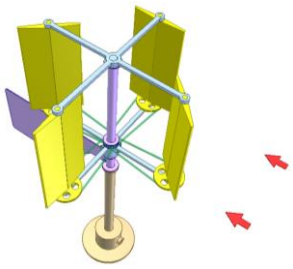


Pink airfoils show their faces toward the wind flow (blue arrows) only on one side of the turbine post thanks to yellow barrel cams. So the wind always applies torque on blue shaft of the turbine.
Yellow tail rudder helps to rotate the cam block (pivoted on brown post) toward the wind flow.
It's possible to use only one cam and connect the airfoils in each column by green bars (creating parallelogram mechanisms) as shown in the last scene of this video.
This video was made based on TEN FOLD video:
https://www.youtube.com/watch?v=HHbMDDeq_-0

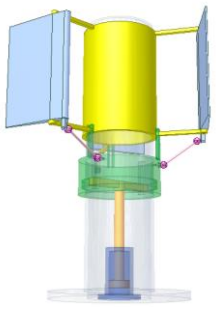
Wind turbine of flipping airfoils 2
https://youtu.be/zDW7jGOZGo0
Yellow airfoils show their faces toward the wind flow (red arrows) only on one side of the turbine post thanks to green disk cam. So the wind always applies torque on blue shaft of the turbine.
Green tail rudder helps to rotate the cam block (pivoted on brown post) toward the wind flow.



Wind turbine of flipping airfoils 3
https://youtu.be/qdUp6i8TNgM
Violet gear is immobile in relation with blue frame.
The timing belt drives to connect the violet gear and yellow gears are of transmission ratio i = 2. Such arrangement makes the airfoils rotate haft revolution when the blue frame makes one revolution.
So the wind flow (represented by red arrows) always applies torque on blue shaft of the turbine.
Violet tail rudder helps to rotate the violet hollow shaft of the violet gear (pivoted on brown post) toward the wind flow.
This video was made in reference to
https://www.youtube.com/watch?v=vdMGdF9g490

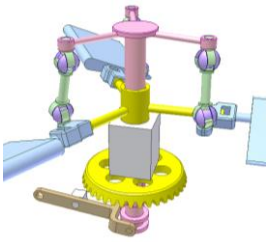


Blade angle adjustment for VWT
https://youtu.be/X9D6VrphBv4
Blue blades are mounted on yellow rotor of a vertical wind turbine (VWT) by revolute joints.
Green slider has prismatic joint with the rotor.
Pink conrods of two spherical joints connect the slider and the blades.
Orange piston, which can move up down only, has planar joint with the slider.
Blue cylinder moves piston and the slider up down to set angular positions of the blades in relation with the rotor.

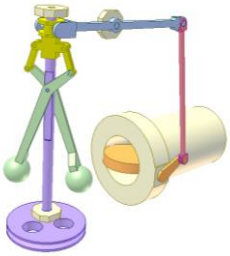


Savonius wind turbine
https://youtu.be/GxE8gCsdp94
The airfoils rotates as shown in the video regardless the wind direction.
The airfoils are fixed to the center shaft (its end plates) at their ends.
The upper plate of the airfoils is not shown in the video last scene, so the cross section of the airfoils can be seen. The section consists of two letters C arranged to create a letter S.
In comparison with horizontal axis wind turbines it is simpler but less efficient. For more about this turbine see:
https://en.wikipedia.org/wiki/Savonius_wind_turbine

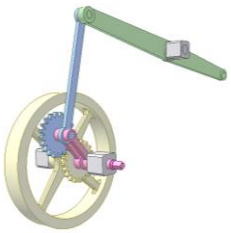
Pitch adjustment for air propeller 1
https://youtu.be/Dd628Oxq4RA
Blue blades are mounted on yellow propeller hub by revolute joints and connected to pink sliding shaft via double Hook joints.
Turn brown lever pivoted on stationary trunnion to adjust the propeller pitch.



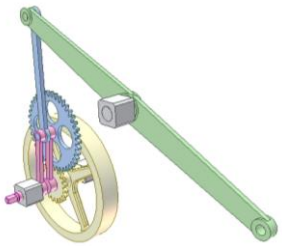
Flyball governor for flow control.
http://youtu.be/SiYEtnlZLSs
A water turbine spins the governor, which control the water flow, which feeds the turbine, creating a speed-regulated machine.
When the flow is too strong, the water turbine and the violet governor shaft rotates faster than the set velocity.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



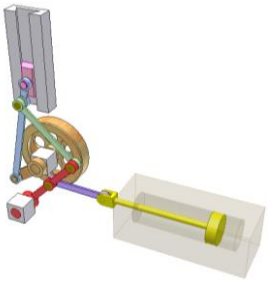
Flywheel speed amplifier 1a
https://youtu.be/i6jc48_4ugA
Input: rocker getting motion from a Watt steam engine.
Output: pink crank shaft.
Blue gear of tooth number Z1 is fixed to blue conrod.
Yellow gear of tooth number Z2 is fixed to yellow flywheel.
Z1 = Z2
The flywheel rotates two times faster than the crankshaft. It helps to reduce the flywheel size while keeping needed storage energy. However the flywheel and the crankshaft are not of constant velocity.
This idea is taken from
https://www.youtube.com/watch?v=7LpHf0ssIb8



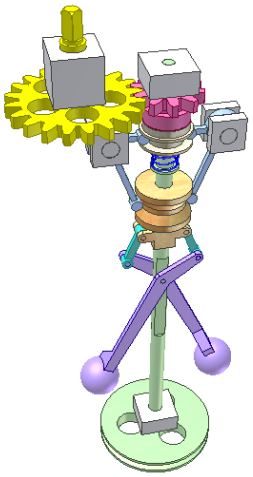
Flywheel speed amplifier 1b
https://youtu.be/ilBYI5bAMog
Input: rocker getting motion from a Watt steam engine.
Output: pink crank shaft.
Blue gear of tooth number Z1 is fixed to blue conrod.
Yellow gear of tooth number Z2 is fixed to yellow flywheel.
Z1 = 2*Z2
The flywheel rotates A = 3 times faster than the crankshaft. It helps to reduce the flywheel size while keeping needed storage energy.
In general A = (Z1/Z2)+1



Flywheel speed amplifier 2
https://youtu.be/Qy8IfHTckOM
Input: yellow engine piston.
The linkage causes the flywheel (in orange) to make two revolutions for each double-stroke of the engine piston. Thus, thanks to high speed the flywheel size can be decreased.
Key factor: there is a dead position when red, green, blue and orange links are in line. Inertia helps the mechanism overcome such position.
This video was made based on US patent 2295, October 11, 1841.



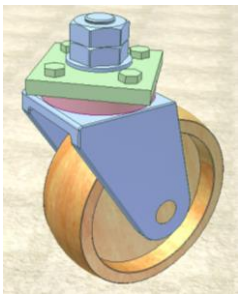
Rotation when get prescribed speed only
https://youtu.be/UdQMgxnb0hA
Input: green shaft.
Output: yellow shaft. It rotates only when the input rotates at prescribed speed V. Here the output speed = V/2
Brown semi-clutch of friction cone under pressure of blue spring makes pink gear rotate.
Centrifugal governor of two violet balls makes orange slider go up-down subject to the input speed. The governor is set in such a way that at prescribed input speed V the cam of orange slider does not contact blue angular arms and the brown semi-clutch can transmit motion to output shaft via pink gear. When the input speed is larger or smaller than V, the cam turns the blue angular arms to pull the brown semi-clutch from contact with the pink gear and the output shaft stops.
The video was made following a request from a YouTube viewer.



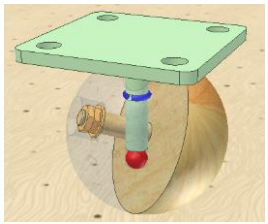
31. Transportation

31.1. Vehicles

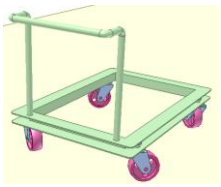
Swivel caster 1
https://youtu.be/9oE1LXboS-g
There are two revolution joints: vertical one between blue fork and green base, horizontal one between blue fork and orange wheel. Their offset distance is A.
When the caster is moved and the wheel is not facing the correct direction, the offset A will cause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



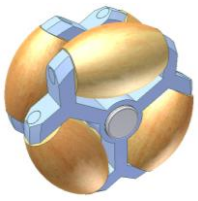
Swivel caster 2
https://youtu.be/5RWA_aAN5mQ
This is a structure embodiment of “Swivel caster 1”, spherical wheel.
There are two revolution joints: vertical one between green base and glass hemisphere and slanting one between glass hemisphere and orange hemispherical wheel. Their offset distance is A. 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.



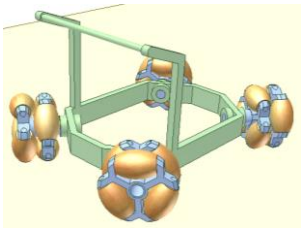
Swivel caster trolley
https://youtu.be/X_SdkZfDz1c
Four swivel casters ensure no drag because they are automatically adapted to the new moving direction of the trolley.



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).

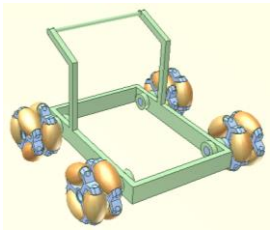


Omni wheel trolley 1
https://youtu.be/l4phSei5G8A



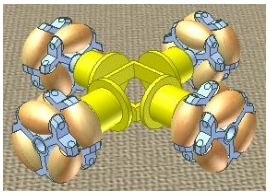
Four Omni wheels are mounted idly symmetrically on green frame. Pushing and rotating the trolley in different directions do not cause the drag of the wheels.
In the video the trolley alternately:
1. goes forward.
2. goes sideways
3. goes diagonally.
4. rotates

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.

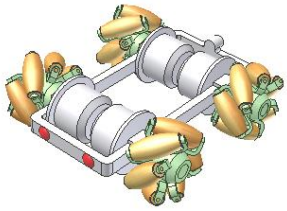
Motion of idly Mecanum wheel

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

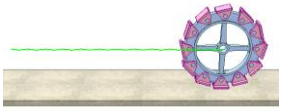


Four Mecanum wheels are mounted symmetrically on grey frame. Each wheel is driven by a separate motor, the rotation of which is programmable.
Various combination of the wheel rotations (velocities and directions) makes the car move in different directions.
In the video the car alternately:
1. goes forward
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

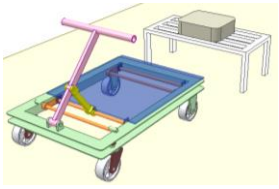
https://youtu.be/OvlOGd_Ut4k



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.

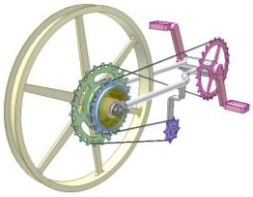
Lifting trolley

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.

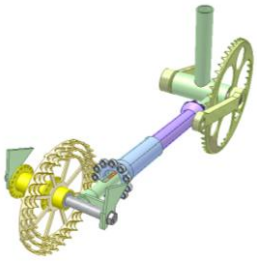
Retro-direct bike



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.

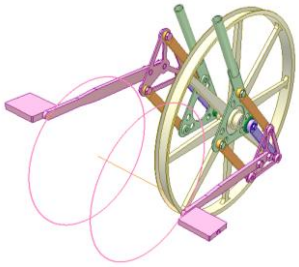
See a Retro-direct bike in action:
https://www.youtube.com/watch?v=P3Kvao07-eQ
See an Retro-direct embodiment of two chains, two chainrings:
https://www.youtube.com/watch?v=luQ3VRKZiN4
https://www.youtube.com/watch?v=MfxncSJTraU

Bicycle chainless drive of roller gears



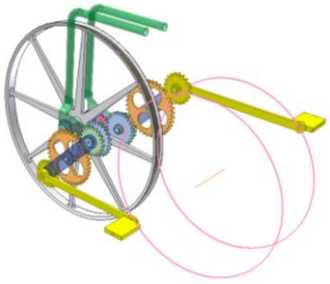
https://youtu.be/92hME9LGRbw
Being different from bevel gears:
https://www.youtube.com/watch?v=XKfXyPcddc0
roller gears of ceramic ball bearings in this design help to reduce friction and increase efficiency.
Blue roller gear has prismatic joint with violet roller gear (sliding key).
Set of face gears (in yellow) for bicycle rear wheel allows getting large speed numbers.
Gear shifting device (placed in the bicycle chain stay) consists of screw-nut mechanism, blue step motor powered by brown battery. The orange nut has a pin that slides in circular groove of the blue roller gear hole.
There is an oneway overrunning clutch (freewheel) placed between the rear shaft and the yellow rear hub (not shown).
The video shows shifting proccess from highest speed to lowest one.
This video was made based on design of CeramicSpeed:
https://www.youtube.com/watch?v=7gip7TSeKx4

BYGEN chainless bike 1



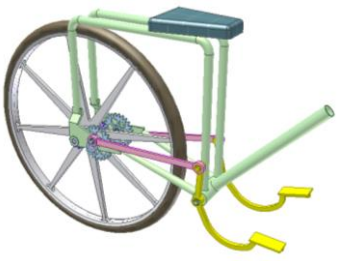
https://youtu.be/9Xg_xouLVgQ
Each pink pedal is attached to pink triangle-shaped conrod of a parallelogram mechanism of three cranks (in orange and violet). Violet shaft is fixed to the violet crank. The shaft rotates on two green bearings. Yellow wheel is connected to the violet shaft via a freewheel (not shown) placed inside the rim hub. Three crank concept helps the parallelogram mechanism overcome its dead positions.
The pedals rotate around a virtual axis. The pink circles are their trajectories.
Disadvantage of this drive in comparison with a chain one: its transmission ratio is 1. So it's necessary to use a gear box placed in the rim hub for increasing speed.
This video was made based on following video:
https://youtu.be/7prq2wV24tk

BYGEN chainless bike 2



https://youtu.be/kNSnABBpaHE
Blue gear is fixed to blue crank.
Yellow gear is fixed to yellow crank.
The yellow crank and orange gear rotate on the blue crank.
The orange gear is in mesh with green stationary gear (fixed to the bicycle frame).
The green gear and the yellow one are of the same tooth number so the yellow crank is kept always horizontal.
The yellow pedal rotates around a virtual axis. The pink circle is its trajectory.
The blue gear is connected to violet gear of the rear shaft via pink gear. So the rear shaft rotates in the same direction of the blue crank (and the yellow crank too) but faster because the tooth number of the blue gear is bigger than the one of the violet gear. White wheel is connected to the violet shaft via a freewheel (not shown) placed inside the rim hub.
This video was made based on video:
https://www.youtube.com/watch?v=kpnDI9eDilA
In an embodiment, the gear drive on the blue crank is replaced with a chain drive:
https://youtu.be/ZO4fJdNNVIA?t=2m30s

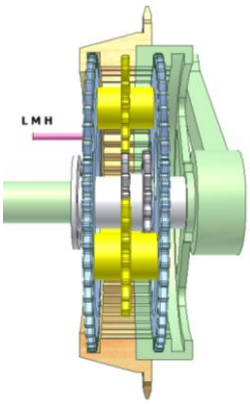
Chainless bike with 4-bar linkages



https://youtu.be/bzr9tup_J5g
The driver steps on yellow pedals to make blue cranks rotate thanks to 4-bar linkages of pink conrods.
Gear drives of blue gear (fixed to the blue crank) and violet gear (fixed to the rear shaft) are for increasing speed of rear wheel.
The rear wheel is fixed to the rear shaft.
Here the use of a freewheel is not suitable. It may causes complications in starting to get forward motion of the bike.
However it is not comfortable for driver when the bike moves thanks to its inertia.
This video was made based on video:
https://www.youtube.com/watch?v=1gFtIyjnFAA

EFNEO 3-speed crankset

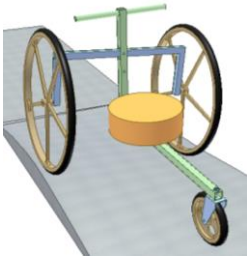
https://youtu.be/kRSGPkj4I2w



It's an effort to explain the bicycle crankset shown at:
http://www.efneo.com/wp-content/uploads/2014/05/efneo_MG_7588.jpg
in reference to patent WO2011065850A1
White gear block (2 gears of Zw teeth) is fixed to the bicycle frame.
Blue gear block of two identical large gear of Zb teeth plays role of a carrier in the planetary drive of 3 yellow satellite gears of Zy teeth.
Green internal gear of Zb teeth is fixed to the green input crank of V1 velocity.
Orange internal gear of Zb teeth is fixed to the orange output chainwheel of V2 velocity. In this video:
Zw = Zy = 18
Zb = 54
Pink shifting rod moves the blue gear block axially to get 3 speeds of the bicycle. The rod has a hook that slides in a circular L-shaped groove of the blue gear block. The device to control the rod is not shown.
The video shows how the crankset works for every gear.
1. High gear: Green and blue gears rotate together. Blue gears are not in mesh with orange gear. Yellow gears are in mesh with white gears and with orange gear.
V2 = 2.V1.(Zw+Zy)/Zb
In this video V2 = (4/3).V1
2. Medium gear: Yellow gears are in mesh with green and orange gears. Yellow gears are not in mesh with white gears. Blue gears are in mesh with green and orange gears. So green blue, yellow and orange gears rotate together.
V2 = V1
3. Low gear:
Orange and blue gears rotate together. Blue gears are not in mesh with green gear. Yellow gears are in mesh with white gears and with green gear.
V2 = V1.Zb.(Zw+Zy)/2
In this video V2 = (3/4).V1

Study of tricycle on uneven road 1

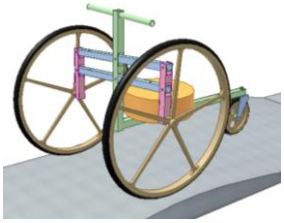
https://youtu.be/9JkoZ8RB-xg



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.

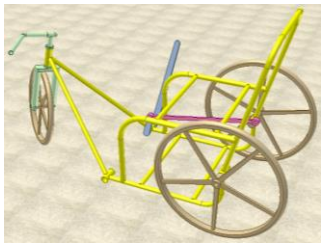
Study of tricycle on uneven road 2

https://youtu.be/tJ7YWWV3K2U



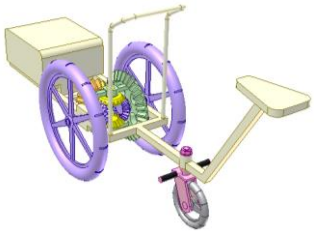
When rolling on an uneven road green frame, wheels of the vehicle are kept always vertical in traversal plane (perpendicular to the vehicle motion direction) thanks to:
1. Green, blue and pink bars create a parallelogram mechanism.
2. Center of mass of the green frame (with or without load (user weight)) 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.

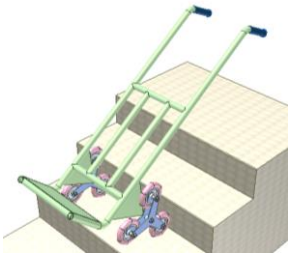


Hand-powered tricycle 2
https://youtu.be/cNcv4mKhHD4
It is driven via a four-bar linkage: blue lever, pink conrod and grey crank. Way to overcome dead point at start: turn the right rear wheel.
Violet steering wheel controls front wheel via spatial four-bar linkages. Orange conrods have spherical joints 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

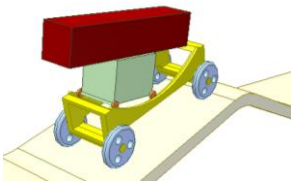


Six-wheeled stair climber 1
https://youtu.be/-PzRd6VhI_4
See a real stair climber:
https://www.youtube.com/watch?v=0PpNLD3TrdE
It needs less pulling force in comparison with a conventional two-wheeled hand truck:
https://www.youtube.com/watch?v=bCXaVspSXKM

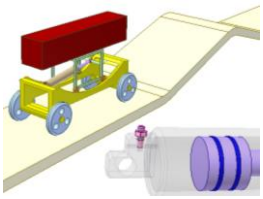


Twister car
https://youtu.be/BHxpgUgj3TQ
Other names of this toy: Rolling coaster car, Plasma car.
Only four orange wheels touch the ground.
Two violet wheels located at the front of the car do not touch the ground or spin: they are merely there for stability and safety in case the rider leans forward or drives into an elevated surface.
The car is propelled simply by rocking the pink steering wheel.

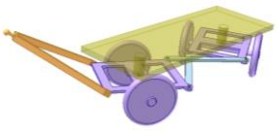
Coffin carrier 1
http://youtu.be/3Bp_Z3Kovxc
Circular runways of the yellow chassis enable to keep the coffin always horizontal regardless of sloping road provided that the carrier does not move too fast. The carrier is used in funeral homes.

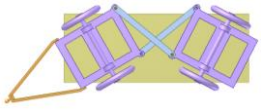


Coffin carrier 2
http://youtu.be/_vaAysAGf9g
Circular runways of the yellow chassis enable to keep the coffin always horizontal regardless of sloping road. The air cylinder is for damping, level of which is regulated by the pink screw.
The carrier is used in funeral homes.

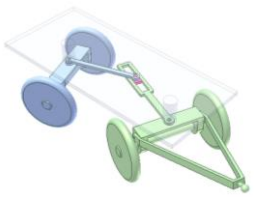


Mechanism for steering a 4-wheel trailer with small turning radius 1
http://www.youtube.com/watch?v=Dp-7uB0U-ow
An application of 4-bar mechanism.
It can work only when the gaps in the revolution joints of the connection rods are big enough.
In case of small gaps one of the two connection rods must be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

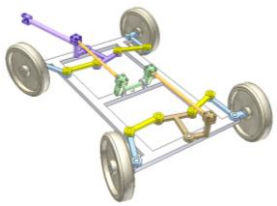




Mechanism for steering a 4-wheel trailer with small turning radius 2
https://youtu.be/FRy914PsV2s
An application of simple mechanism that reverses rotation between two shafts instead of a gear drive.
Disadvantage: Turning angles of the front wheel set and the rear one are not exactly equal.

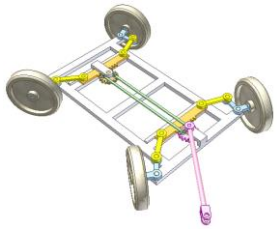


Mechanism for steering a 4-wheel trailer with small turning radius 3
https://youtu.be/sVEjb-YqjhQ



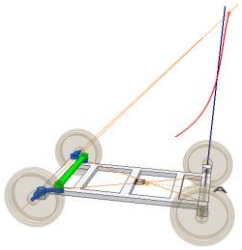
Combination of spatial and planar 4-bar linkages allows four wheels turn synchonically. Bar dimenssions are selected in such a way that the wheel turning centers are nearly concurrent.
Advantage: The quadrilateral created by contact points of four wheel with the ground (base area) almost is unchanged when turning.

Mechanism for steering a 4-wheel trailer with small turning radius 4
https://youtu.be/1etaPtE6ELg



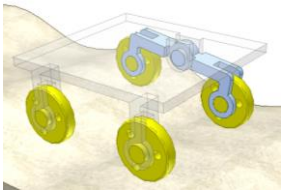
Combination of slider-crank mechanisms and gear-rack drives allows four wheels turn synchonically. Bar dimenssions are selected in such a way that the wheel turning centers are nearly concurrent.
Advantage: The quadrilateral created by contact points of four wheel with the ground (base area) almost is unchanged when turning.

Verification of Ackermann steering geometry
https://youtu.be/TBwa1HvpHMY



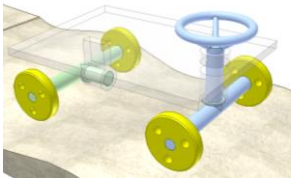
For 4-wheeled car, while on a bend, for avoiding wheel slipping, centers of wheel trajectories (circles) must be coincident. One solution is Ackermann steering geometry: using 4-bar linkage.
Center lines of the front wheel cranks intersect at point A that lies on the center line of rear wheel shaft. At any angle of steering, the centers of circles traced by front wheels must move along the blue straight line.
The simulation shows that when one front wheel turns from above 0 deg. to 30 deg., the common point of two front wheel axes traces the red line, which generally does not coincide with the blue line (two first scenes of the video).
The situation is better if the point A is in front of the center line of rear wheel shaft (point B) (two last scenes of the video).

Four-wheel vehicle 1
https://youtu.be/RWWFW-Q5fAA



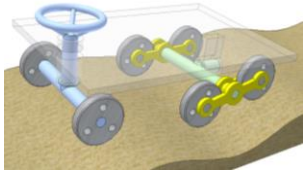
Unlike ordinary four wheel vehicles of no spring suspension, this ensures a permanent contact of all wheels with uneven roads.
Forces applied to the chassis are not symmetrically.

Four-wheel vehicle 2
https://youtu.be/y_RrPSHpbpM

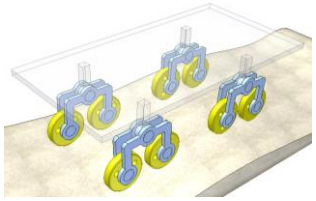


Unlike ordinary four wheel vehicles of no spring suspension, this ensures a permanent contact of all wheels with uneven roads and the possibility of moving direction change.
Green shaft has revolution joint with the chassis.

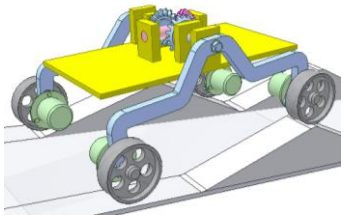
Six-wheel vehicle 1
https://youtu.be/Mix0fxVkL4Y
This ensures a permanent contact of all wheels with uneven roads and the possibility of moving direction change.
Green shaft has revolution joint with the chassis.



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

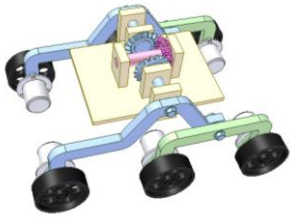


Four wheel car 3
https://youtu.be/L13FvHd1faM
A rocker (in blue) carrying two wheels is pivoted one each side of the car. The rockers are connected together via a bevel gear differential.
This arrangement ensures:
- The four wheels always contact the uneven ground.



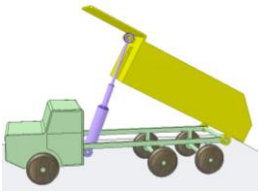
- The car chassis (in yellow) has a definite position, although it is suspended on two coaxial revolution joints.
- The oscillation of the chassis is reduced because:
Ab = (Ar1 + Ar2) / 2
Ab is the oscillating angle of the chassis.
Ar1 and Ar2 are the oscillating angles of the rockers
The last scenes of the video show when rocker 1 is immobile, the oscillating angle of the chassis is a half of the rocker 2 oscillating angle.

Rocker-bogie
https://youtu.be/hO8DbfE7hJw
The two rockers (in blue) are connected to each other and the vehicle chassis through a bevel gear differential. Relative to the chassis, when one rocker goes up, the other goes down. The chassis maintains the average pitch angle of both rockers.
One end of a rocker is fitted with a drive wheel, and the other end is pivoted to the bogie (in green).

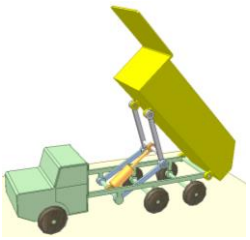


All six wheels are driven by individual motors.
The vehicle can climb over obstacles (such as rocks) that are up to twice the wheel's diameter in size while keeping all six wheels on the ground.
Steering: let the wheels of one side to rotate in the opposite direction to the other side (see the last scene of the video).
This video was made based on NASA's Mars rover.

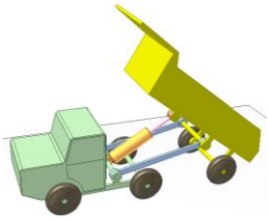
Dump truck 1
https://youtu.be/E52a1chWHkA
Yellow bed, violet cylinder and pistons create a coulisse mechanism.
The bed can turn large angle thanks to using violet telescopic cylinder.



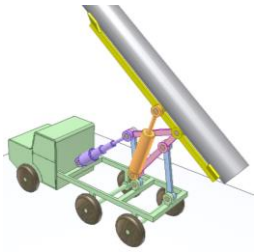
Dump truck 2
https://youtu.be/_Us-a_Wtffs
Yellow bed can turn large angle thanks to using six-bar linkage.



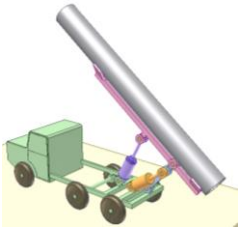
Semi dump trailer 1
https://youtu.be/Bai7WsAxdxo
Blue crank, yellow conrod (trailer bed) and rear wheels create crank slider mechanism (to some extent, because the wheel can be replaced with sliders).



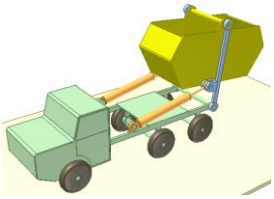
Pipe truck 1
https://youtu.be/gxJXT3bKygU
Blue and pink links create a parallelogram mechanism.
Orange cylinder turns the grey pipe 90 deg.
Violet cylinder translates the pipe.
Violet cylinder is of a double acting telescopic cylinder to increase motion range.
Pipe clamping device is not shown.



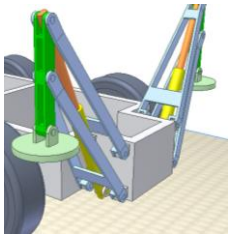
Pipe truck 2
https://youtu.be/iNT5vpnLtDw
Orange cylinder moves the grey pipe backward.
Violet cylinder turns the pipe 90 deg.
Pipe clamping device is not shown.



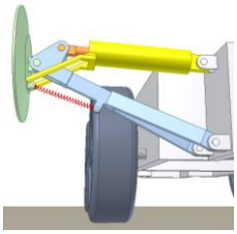
Container truck
https://youtu.be/r0ZUqWRzVYs
Application of coulisse mechanism which loads or unloads the yellow container for a truck.
The container can be removed from blue bars when it lays on the ground (removing device is not shown).



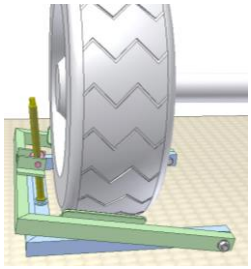
Outriggers (stabilizers) for crane trucks 1
https://youtu.be/P67J410u_ag
It is a combination of a rotary cylinder linkage (yellow cylinder, orange piston, upper blue rocker) and a parallelogram mechanism (blue rockers, green conrod).
Advantages:
- No prismatic joints.
- Fewer cylinders (one instead of two). See the common type:
https://youtu.be/ojccZj5mjxQ



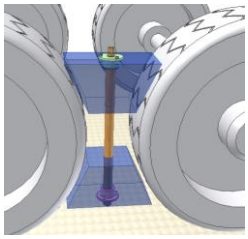
Outriggers (stabilizers) for crane trucks 2
https://youtu.be/NtJMBdVKMC0
It is an application of the rotary cylinder linkage (yellow cylinder, orange piston, blue rocker).
Device for turning the green disk using yellow fork and red spring is ingenious.
There are 4 outriggers acting simultaneously at 4 corners of the truck chassis (for simplicity only one is shown).
See real outriggers in action (missile S-400):
https://youtu.be/ebVXwUl0azI
Advantages:
- No prismatic joints.
- Fewer cylinders (one instead of two). See the common type:
https://youtu.be/ojccZj5mjxQ



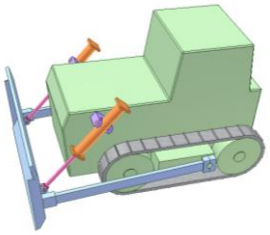
Trailer leveler
https://youtu.be/YKqZBaXbhJM
Leveling is necessary when a travel trailer is situated on terrain that is not completely level.
This mechanism helps to level from side-to-side.
Turn yellow screw to raise the wheel of the lower side.
Pink nut has revolution joint with green movable frame.
The screw has spherical joint with blue stationary frame.



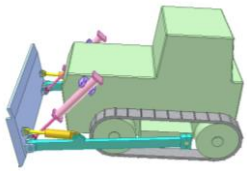
Chock for two adjacent wheels 1
https://youtu.be/P7AHEDWcv30
Turn orange screw clockwise to force blue pads (made of wood) on the wheels for chocking. The pink part is a nut.



Mechanism for controlling bulldozer blade 1
https://youtu.be/0WGEbmlph0c
It is an application of rotary cylinder mechanism.
Orange cylinders control the blade motion.
No relative motion between the cylinders and violet swivels.

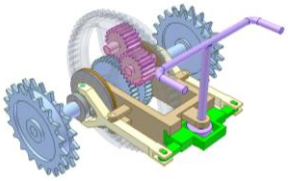


Mechanism for controlling bulldozer blade 2



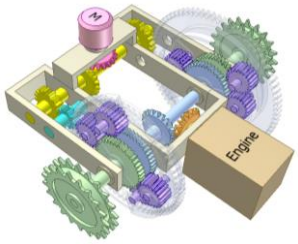
https://youtu.be/Tj4Xbj9nETY
Pink cylinders are for lifting the blue blade.
Yellow cylinders are for tilting the blue blade.
Axes of revolution joints between cyan bars and the blade and between yellow pistons with the blade are coaxial so lifting and tilting adjustments can be performed independently from each other.
No relative motion between the pink cylinders and violet swivels.

Braked differential steering



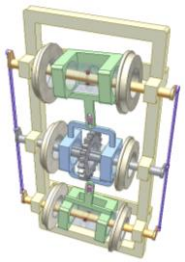
https://youtu.be/SqBQRS3J0yQ
It is for steering vehicles of continuous tracks.
Input: white ring gear of n1 velocity.
Output: blue shafts of large gears and wheels of n2 and n3 velocities. Pink satellite gears connect the two blue shafts. Each shaft has a grey brake controlled by an eccentric at the end of violet steering bar via green follower and yellow levers.
The video shows:
- When the steering bar is at neutral position, two brakes do not work, the vehicle moves straight (n1 = n2 = n3).
- When the steering bar turns counter-clockwise, the left brake works, the left shaft stops (n2 = 0), the right shaft speeds up (n2 = 2.n1), the vehicle turns left with minimum radius. By slipping the brake (n2 is greater than 0; n1 = (n2 + n3)/2), turns of greater radius can be achieved.
Here the differential with spur gears is used:
http://www.youtube.com/watch?v=tOSQK5ZZzhg
It can be replaced with any kind of car differentials.

Double differential steering



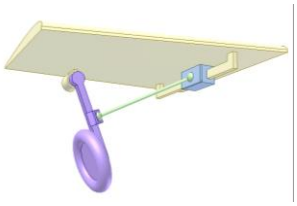
https://youtu.be/moOmzgpxfIw
It is for steering vehicles of continuous tracks.
Input:
1. Orange bevel gear of receiving rotation from the vehicle engine.
2. Pink bevel gear of nc velocity from a steering motor that makes two white gear boxes (carriers of two planetary mechanisms) rotate in opposite directions with the same velocity.
Output: green shafts of large gears and wheels of n2 and n3 velocities.
Violet satellite gears connect the two green shafts with blue shaft.
When the pink bevel gear is immobile (nc = 0), the vehicle moves straight (n2 = n3).
When the pink bevel gear rotates, the vehicle turns. The turning direction depends on the motor rotary direction. The turning radius depends on the motor velocity.
In first three scenes of the video: the vehicle first moves straight, turns right when the motor rotates clockwise and moves straight again when the motor stops.
This mechanism can perform neutral turn (when two green shafts rotate in opposite directions with the same velocity) as shown in last scene of the video.
Here the differential with spur gears is used:
http://www.youtube.com/watch?v=tOSQK5ZZzhg
It can be replaced with any kind of car differentials, for example:
https://www.youtube.com/watch?v=FWSYa7b3Vjo

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



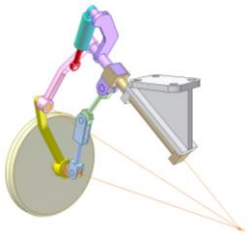
Three wheel sets of a locomotive are powered and can move in horizotal plane to adapt to the curves of the railway.
The green bearings of front and rear wheelsets pivot on the chassis.
The blue bearing of center wheelset can laterally displace thanks to key sliding joint on the grey center inner shaft. 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



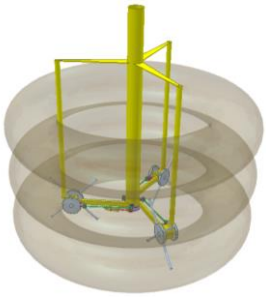
A spatial slider crank mechanism is used.

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.

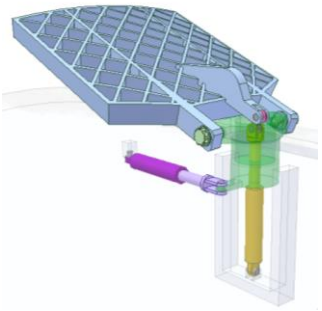
Mechanism for dropping lifebuoys
https://youtu.be/BoQMQ_2nXik



It's attached to drones.
Red piston (or rod of an actuator) controls pink pawls to let blue rotor turn 90 deg. under the weight of lifebuoys for dropping one at a time.

Grid fin

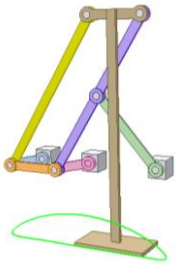
https://youtu.be/smfFSuAwBCo



Blue grid fin can perform two rotations around horizontal and vertical axes.
Yellow and violet actuators are grounded.
Green arms and yellow actuator are coaxial.
It is used on rockets or bombs for flight control.
At high Mach numbers, grid fins work better than planar fins.
I could't find any document on the transmission for grid fins so the mechanism in this video is my imagination only.
The video was made upon a YouTuber's request.

31.2. Walking machines

Linear translating motion 1
https://youtu.be/iQDq-5qMKzc

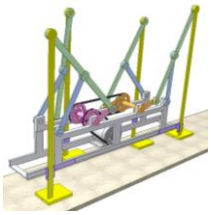


It is an embodiment of Chebyshev's Lambda Mechanism.
Input: pink crank rotating continuously.
Lengths of pink crank and blue bar: a
Length of green bar: 2.5a
Length of yellow bar: 5a
Length of violet bar: 2.5a + 2.5a
Length of orange and brown bars: b
Distances between stationary bearings: b + 2a
Green 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

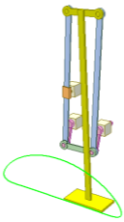
Input: grey motor making pink and orange crank-shafts rotate regularly at the same velocity thanks to 4 timing belt drives. Pink and orange cranks are parallel.
Here there are four mechanisms shown at:
https://youtu.be/iQDq-5qMKzc

Chebyshev's plantigrade machine 1b
https://youtu.be/ISfVS4mDTKs



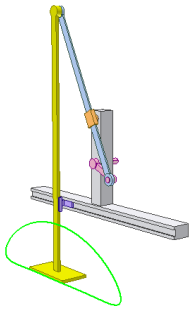
Input: grey motor making pink and orange cranks rotate regularly at the same velocity thanks to 2 timing belt drives. Pink and orange cranks are parallel.
Here there are four Chebyshev's Lambda Mechanisms, to which four yellow legs are connected by revolution joints. Violet sliders keep the legs always 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



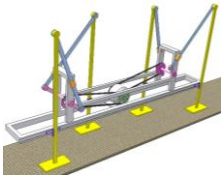
It is an embodiment of mechanism shown at
https://youtu.be/VZSZTB_OLPs
Input: one of pink cranks rotating continuously.
Lengths of pink cranks : a
Length of blue bars: 6a
Distances between vertical stationary bearings: 1.5a
Green line is locus of a point on yellow bar.
There are two parallelogram mechanisms 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



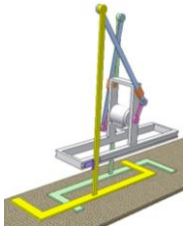
https://youtu.be/rZhC1aCkJW4
It is an embodiment of mechanism shown at
https://youtu.be/VZSZTB_OLPs
Input: pink crank rotating continuously.
Lengths of pink crank : a
Length of blue bar: 6a
Distances between vertical stationary bearings: 1.5a
Green line is locus of a point on yellow bar.
The mechanism 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/uGPKCg9RM6A

Bar plantigrade machine 1a



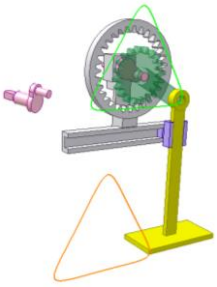
https://youtu.be/rZhC1aCkJW4
Input: grey motor making pink cranks rotate regularly at the same velocity thanks to 2 timing belt drives. Pink cranks are parallel.
It uses four mechanisms shown at
https://youtu.be/VZSZTB_OLPs

Bar plantigrade machine 1b



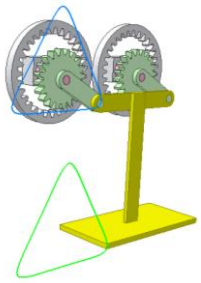
https://youtu.be/uGPKCg9RM6A
Input: pink shaft of two parallel cranks.
It uses four mechanisms shown at
https://youtu.be/VZSZTB_OLPs
U-shape of the legs maintains that the ground projection of center of mass of the machine is always in the leg area.

Gear linear translating motion 1a



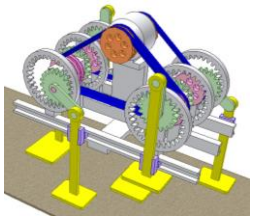
https://youtu.be/ym-pMkvr8aE
Input: pink crank.
Center of the pin on a green satellite pinion traces an equilateral triangle of rounded vertices.
Yellow vertical bar translates following the said triangle thanks to violet slider of two prismatic joints.
Internal gear: tooth number: 30; module: 3 mm
Pinion: 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



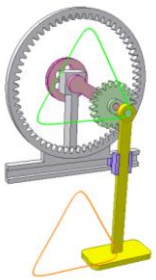
https://youtu.be/3kZnchaXiJQ
Input: pink cranks.
Center of the pin on a green satellite pinion traces an equilateral triangle of rounded vertices.
Yellow vertical bar translates following the said triangle thanks to a parallelogram mechanism (two green cranks and yellow conrod).
Internal gear: tooth 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



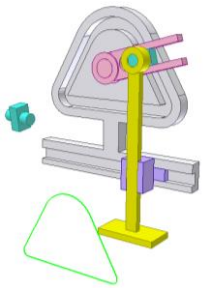
https://youtu.be/u21cYzWwFuQ
Input: grey motor making three pink crank-shafts rotate regularly at the same velocity thanks to 3 timing belt drives. Angles between cranks of the coaxial crank-shafts are 120 deg.
Here there are six mechanisms shown at:
https://youtu.be/ym-pMkvr8aE
The machine motion is not very even because time on the ground of each leg is less than 1/3 of working period.

Gear linear translating motion 2

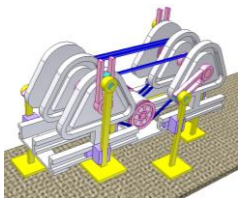


https://youtu.be/OPXL0uEw93U
Input: pink crank.
Center of the pin on green satellite pinion traces an equilateral triangle of rounded vertices.
Yellow vertical bar translates following the said triangle thanks to violet slider of two prismatic joints.
Internal gear: tooth number: 60; module: 3 mm
Pinion: 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

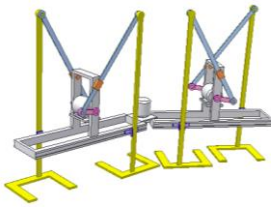
Cam linear translating motion
https://youtu.be/kUwZhcIzwAI
Input: pink crank rotating regularly.
A pin of cyan slider moving along grey cam slot.
Yellow bar has translating motion following the cam profile (green curve) that can be of any shape.
Here it is an equilateral triangle of rounded upper vertex.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



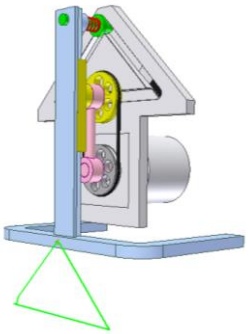
Cam plantigrade machine 2
https://youtu.be/P9H-hX26SmA
Input: grey motor making six pink crank-shafts rotate regularly at the same velocity thanks to 3 timing belt drives. Angles between cranks of the coaxial crank-shafts are 120 deg.
In this machine there are six mechanisms shown at:
https://youtu.be/kUwZhcIzwAI



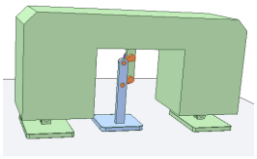
Bar plantigrade machine 1c
https://youtu.be/EyiWoa5fZws
It uses two mechanisms shown at
https://youtu.be/uGPKCq9RM6A
for studying how the plantigrade changes its moving direction.
Grey front and rear frames connected together by a revolution joint. Middle motor controls angle between them thus controls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



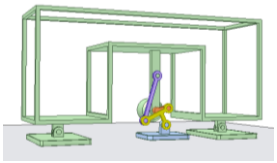
Belt linear translating motion
https://youtu.be/ eTrNJ4dU
Input: pink crank.
Grey pulley is stationary.
Belt drive of transmission ratio 1/1 keeps yellow rotary runway always vertical.
Triangular cam makes blue slider move up/down.
Spring follower moves one way direction thanks to deep portion (in black) of the cam groove.
So the blue slider translates along a triangular trajectory (green triangle).
Time for tracing horizontal portion of the trajectory corresponds 1/2 input revolution.
It can be used for plantigrade machines of 2 legs.



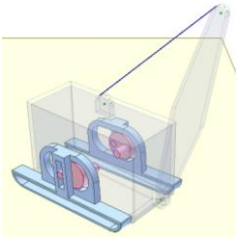
Walking mechanism 1
http://youtu.be/ZKNh4zbAY9M
Input: one among two orange cranks.
Blue foot and two orange cranks create a parallelogram mechanism.
The blue foot has circular translating motion.
This is applied for displacement of heavy equipments.



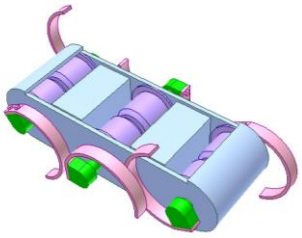
Walking mechanism 2
https://youtu.be/R5_1p5EPQWw
Input: orange crank.
Blue foot has revolution joint with yellow conrod of a 4-bar linkage.
This is applied for displacement of heavy equipments.



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.

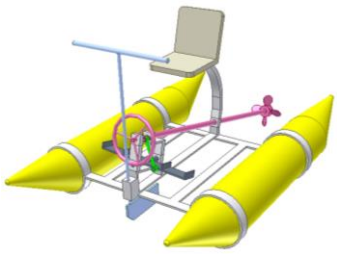


Walking car robot
https://youtu.be/a8OUHtCpjqE
Six curved legs (in pink) are driven independently by six motors (in violet). The robot can pass obstructive objects.
The moving direction is controlled by changing motor speeds or directions via a remote control.
The animation was made based on the Boston Dynamics prototype shown in
https://youtu.be/-e9QzIkP5qI
(minutes 9:43 – 11:23)

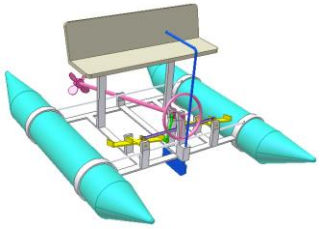


31.3. Boats

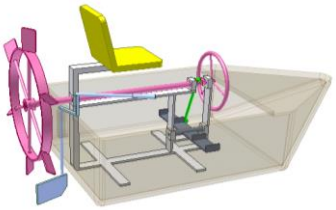
Water bike 1a
https://youtu.be/QB8ItKr5d94
It is a water bike for one person.
Four bar linkage (grey pedal, green conrod and pink crankshaft) is used to convert pedal oscillation into rotation of propeller like in foot powered sewing machines.
Turn the pink wheel clockwise a little at starting going forward if the linkage is in its dead position.
Blue handlebar is for controlling the blue rudder.



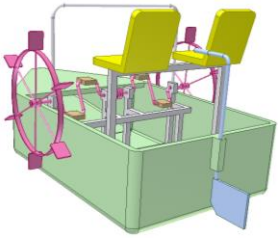
Water bike 1b
https://youtu.be/oMj7qbXiuZA
It is two person water bike.
Four bar linkage (yellow left pedal, green conrod and pink crankshaft) is used to convert pedal oscillation into rotation of propeller like in foot powered sewing machines.
Turn the pink wheel clockwise a little at starting going 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.



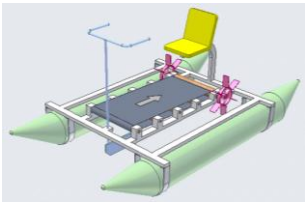
Foot powered boat 1
https://youtu.be/Hki0RPzBHjI
Four bar linkage (grey pedal, green conrod and pink crankshaft) is used to convert pedal oscillation into rotation of propeller like in foot powered sewing machines.
Turn the pink wheel clockwise a little at starting going forward if the linkage is in 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.

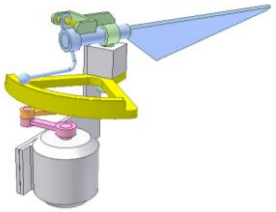


Walking on water device



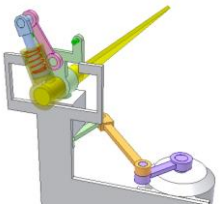
https://youtu.be/SS3ZzKVV128
It is inspired by bicycle treadmills:
https://www.youtube.com/watch?v=Sg-KpT9RNXE
The walker steps on a slant conveyor belt and thus moves it. The belt makes the propeller shaft rotate thanks to friction.
It is possible for the walker to sit and move the belt.
Measures for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

Oar of 2 DoF 1



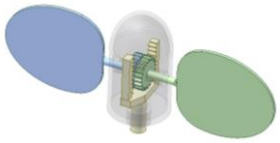
https://youtu.be/kMuxyhFrPYU
Blue oar moves with different oblique angles A.
A = 45 deg. when going forward.
A = 0 deg. when going backward.
A is changed at the ends of the oar stroke thanks to the interaction of blue ball and yellow face cam. Yellow springs tend to press the ball on upper surface of the cam.
Grey motor makes the oar turn around vertical axis via 4-bar mechanism.

Oar of 2 DoF 2



https://youtu.be/gSd6uFLe7zw
Yellow oar moves with different oblique angles A.
A = 45 deg. when going forward.
A = 0 deg. when going backward.
A is changed at the ends of the oar stroke thanks to spring toggle mechanism shown at:
http://youtu.be/u4oW1ZiiRGA
Grey motor makes the oar turn around vertical axis via 4-bar mechanism.

Application of rack pinion mechanism 5

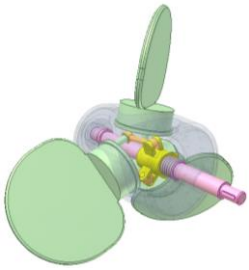


http://www.youtube.com/watch?v=3_3_XFwMpIo
Controlling angle of the ship propeller blades

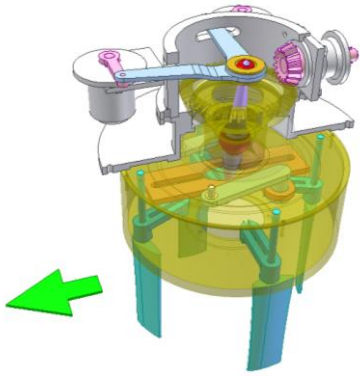
Pitch adjustment for boat propeller 1

https://youtu.be/XAxBGd46z0w
Yellow blades are mounted on glass propeller hub by revolute joints and connected to blue controlling shaft via bevel gears.
Turn the blue shaft in relation with the hub for pitch adjustment.
Device for fixing the shaft to the hub after adjustment is not shown.

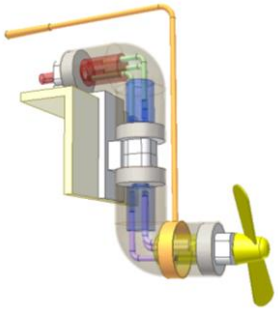
Pitch adjustment for boat propeller 2
https://youtu.be/TJip9Wde8ZI
Green blades are mounted on glass propeller hub by revolute joints.
The blades, orange conrods and yellow nut-slider create slider crank mechanisms.
Turn pink screw in relation with the hub for pitch adjustment.
Device for fixing the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



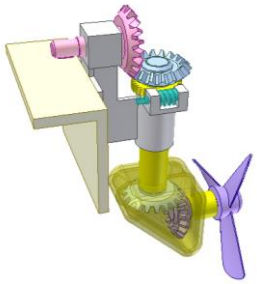
Ship vertical propeller
https://youtu.be/3qH6iRMnVc4
Yellow disk and lower brown disk rotate eccentrically from only a motion source (pink bevel pinion).
Their eccentric (value and direction) can be adjusted thanks two step motors via pink cranks, blue conrods and violet bar. The latter has spherical joint with the yellow disk, cylindrical joints with two red spheres at its ends. Two green cranks and orange cross create a parallelogram mechanism. The brown disk has two pins that slide in a slot of the orange cross.
Four cyan blades are pivoted on the yellow disk. Each blade has a slot in which a pin on the brown disk slides.
The mechanism ensures when the yellow disk rotates, the blades, direction of which is changed continuously, create the thrust in a determinate direction.
The video shows that changing the eccentric direction means changing motion direction of the ship (green arrow).
Increasing eccentric value means increasing the propeller thrust.
This video was made based on:
http://observethebanana.com/wp-content/uploads/2008/06/modelvsp.pdf
For more about the mechanism for adjusting the eccentricity see:
https://youtu.be/n8E0ulM8cNo
For more about ship vertical propeller read
https://en.wikipedia.org/wiki/Cyclorotor



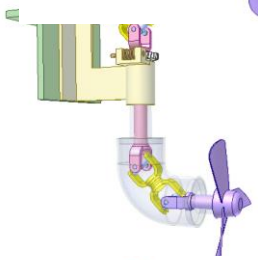
Azimuth thruster with Hobson's joints
https://youtu.be/OV1yZ75glCY
Two Hobson's joints replace two bevel gear drives of ordinary azimuth thruster.
Thrust direction is controlled by orange lever.



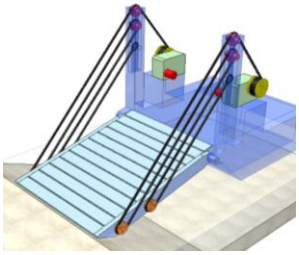
Azimuth thruster with bevel gear drives
https://youtu.be/F1K86mkk0J0
Engine torque is transmitted to propeller via two bevel gear drives.
Thrust direction is controlled via a worm drive.



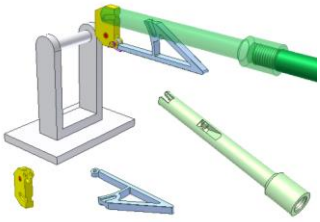
Azimuth thruster with universal joints
https://youtu.be/GsLZrlFd_80
Engine torque is transmitted to propeller via two double cardan joints.
Angle between yellow shaft axes and vertical direction is 45 deg.
That ensures a constant velocity transmission.
Thrust direction is controlled via a worm drive.



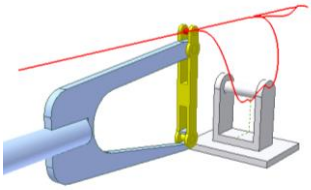
Cable mechanism for ferry slips
https://youtu.be/_UGAD6eFmwU
The blue bridge moves up down thanks to a cable mechanism.
The pulley system and reduction gear boxes (in green) help to reduce pulling force of two hydraulic motors (in red).
This animation was made according to a ferry slip seen at Cat Ba island, Vietnam, in September 2017.



Mooring line hook 1
https://youtu.be/ZIFz8O3KVls
Circular portions in the slots of the green rod and circular grooves of blue and yellow parts ensure that the parts have common revolution joints with the green rod. A torsion spring placed on the joints makes these joints stable.
The line fixed to the red hole of the yellow part is wrapped around the stationary bar when the rod moves forwards and backwards.
The last scene of the video shows reverse working position of the hook.
The red lines are the trajectory of the line.
This video was made based on US5740751A patent.
See how a commercialized product works:
http://www.easymoor.com/

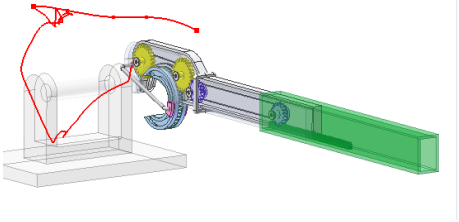


Mooring line hook 2
https://youtu.be/_hQxsgp7v7Y
At first stage of the working process, the red line is pulled to keep the yellow bar attached to the blue fork.
The line fixed to the red pin on the yellow bar wraps around the stationary bar when the fork moves forwards and backwards.
The red lines are the trajectory of the line.
This video was made based on following video:
https://youtu.be/Z8L6_cWLNBU



Mooring line hook 3

https://youtu.be/5c7Qx1CjYZM



One end of the red line is attached to the white U-shaped part that can slide in circular grooves of the blue hook (a C-shaped gear).
At first stage of the working process, set the stationary bar inside the blue hook.
Pull backwards the green pole. When the bar contact the blue hook, the white body is held and the green pole begins sliding on the white body, thus makes the blue hook rotate thanks to the system of rack, gears and timing belts. Then the hook allows the body move again, the line wraps around the stationary bar.
The red lines represent the line and the trajectory of the point where the line is attached to the hook.
This video is an attempt to explain what happens inside the hook shown in following video:
https://youtu.be/rMsyxnryt-s

Passing river by its flow 1

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

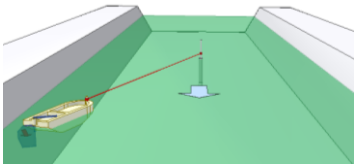
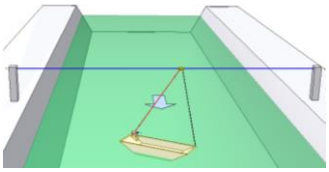


Illustration of movement 447 in the book "507 mechanical movements", 1908
"This method of passing a boat from one shore of a river to the other is common on the Rhine and elsewhere, and is affected by the action of the stream on the rudder, which is carries the boat across the stream an the arc of a 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

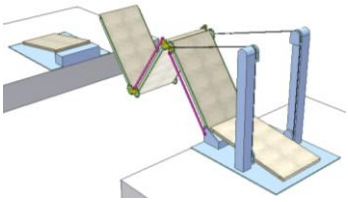
http://youtu.be/xna9hjis_d8



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.

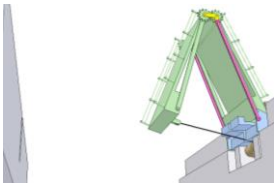
31.4. Bridges

Folding bridge 1



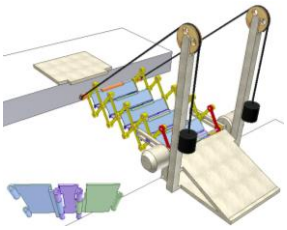
https://youtu.be/8b4xKZv-pl0
The bridge is contracted by two windlasses.
It is stretched under gravity.
Gear forces are very large.
It is an application of the mechanism shown at:
http://www.youtube.com/watch?v=4UpjmxQ3900
See a related real bridge:
https://www.youtube.com/watch?v=E5BF3Lvmi_8

Folding bridge 2



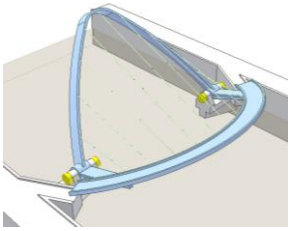
https://youtu.be/JqcCHlzsm9g
The bridge is contracted by brown windlass.
It is stretched thanks to the gravity.
Blue stoppers on the right shore prevents the brigde from falling down at its stretching position.
Gear forces are very large.
Weakness: gap between bridge and the right shore that can be surmounted 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.

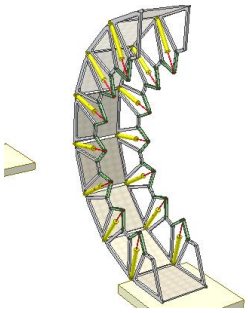
Tilting bridge



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

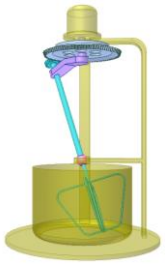
https://youtu.be/2yNamCnxdw4



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.

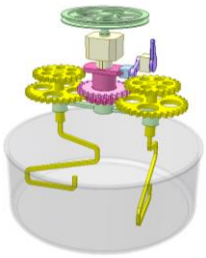
32. Mixing, stirring, crushing machines

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.

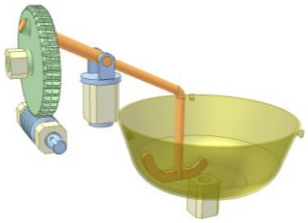


Mixing machine 4
http://youtu.be/6ktLcEOzY9o
Blue gear and violet worm are input links.

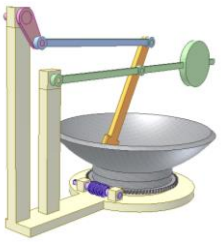
Mixing machine 5
http://youtu.be/iNl0R_26HSE
Blue gear and violet worm are input links.

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.

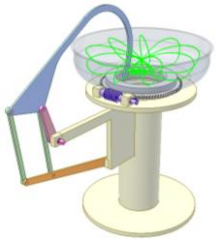
Dough-Kneading Mechanism
http://youtu.be/gYksowpfhFY
It is spherical 4R mechanism.
4R: 4 revolute joints.
Spherical: Joint center lines intersect at a common point.
The wobbling motion of the orange link is used to knead dough in the tank.



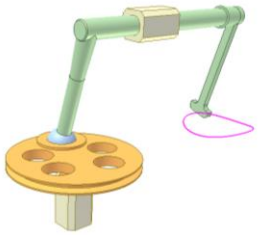
Stirring machine 1
https://youtu.be/a8gz7MvQ_qI
Input: pink crank and violet worm.
Revolution joint is located at center of spherical inner surface of grey container. Lower end of orange stirring bar is always in contact with the said surface under gravity. So practically the stirring mechanism is a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



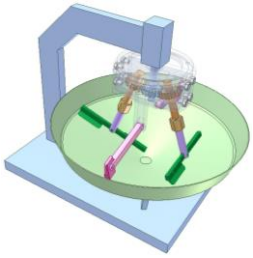
Stirring machine
https://youtu.be/sZAlO0BdYLI
Input: pink crank and violet worm.
Green line is trajectory of stirring bar in relation with glass container.



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.



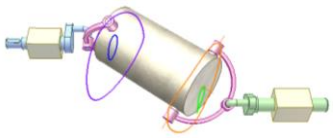
Stirring machine with satellite bevel gear 2
https://youtu.be/R28nSg0nFP8
Input: white pulley block getting rotation from a motor (not shown).
Violet stirring shafts are connected to orange bevel gears by spring prismatic joints so green stirring blades are always in contact with green container bottom.
Device for taking out the stirred materials is not shown.



Mixing machine 2

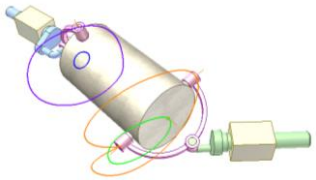
http://youtu.be/FyOH3jwSDFY
Input is the orange shaft.
The yellow propeller has reciprocating linear translation and continuous rotation at the same time owing to the rack of ring teeth.

Mixing machine 7



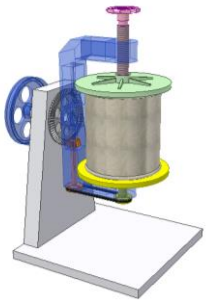
http://youtu.be/v_JZ3Q8pE1Y
Input: blue shaft.
Blue and green shafts are parallel offset.
Brown barrel has complicated motion.
Blue and green lines are loci of center points of the barrel end faces.
Orange and violet lines are loci of peripheral points of the barrel.
Strange things are:
1. In 1 rev. 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



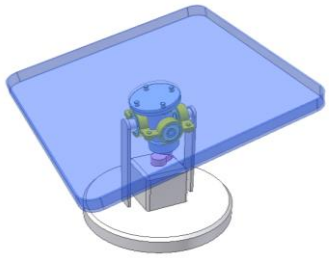
http://youtu.be/WdZ0JSi8mBc
Input: blue shaft.
Angle between blue and green shafts is 40 deg.
Brown barrel has complicated motion.
Blue and green lines are loci of center points of the barrel end faces.
Orange and violet lines are loci of peripheral points of the barrel.
Strange things are:
1. In 1 rev. 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.

Gyro mixer 1

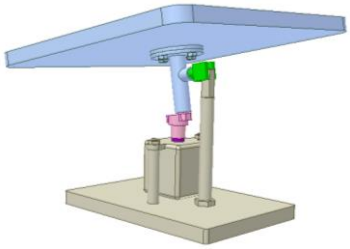


https://youtu.be/5nWyTZ4r7IA
It is an application of the planetary bevel gear drive. The large gear is stationary.
Input: blue shaft carrying C-shaped bracket.
The paint container is fixed between yellow and green disks by the pink screw.
The yellow disk is driven thanks to a belt drive.
The container rotates around its longitudinal axis and the horizontal one for mixing materials.
The video was made based on the patent EP1525914A2.
In some mixers the large gear is driven (no more stationary) by a second motor for getting various speeds of the container around its longitudinal axis.

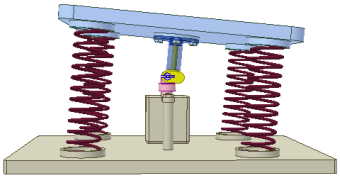
3D shaker 1
https://youtu.be/v5x4P6dMXOI
It's a laboratory equipment used to mix, blend, or agitate substances in a tube or flask by shaking them.
The blue board performs wobbling motion.
Rotary axes of all revolution joints must be concurrent.



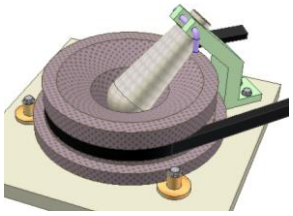
3D shaker 2
https://youtu.be/KkmWr7acI9w
It's a laboratory equipment used to mix, blend, or agitate substances in a tube or flask by shaking them.
The blue board performs wobbling motion.
Rotary axes of all revolution joints must be concurrent.



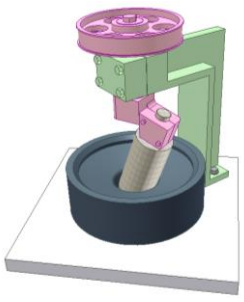
2D/3D shaker 1a
https://youtu.be/EjwT7V_olR0
It's a laboratory equipment used to mix, blend, or agitate substances in a tube or flask by shaking them.
The blue board can perform 2D (in horizontal plane) or 3D shaking.
The video also shows how to shift from 2D mode (the yellow pin and the pink shaft are parallel to each other) to 3D one (not parallel).
A nut on the top of the yellow pin maintains the revolution joint between the yellow pin and the blue board and compresses the springs.



Motorization of traditional stone wet grinder 1
https://youtu.be/IsWwhnO9oG8
It is a concept for motorization of the grinder shown at:
https://youtu.be/XOWyP4wFJiE

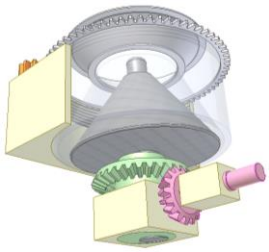


Motorization of traditional stone wet grinder 2
https://youtu.be/jZJouvvUMAA
It is a concept for motorization of the grinder shown at:
https://youtu.be/yLk-FBpYfVM
The roller (in brown) performs a wobbling motion:
- rotation together with the crank-shaft (in pink) around the bearing on the stationary post.
- rotation around the bearing on the crankshaft due to the friction with the mortar or the ground material.



Cone crusher

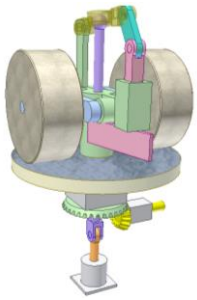
https://youtu.be/p7uIE_TYz4Y



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

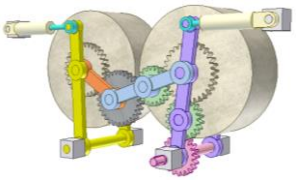
https://youtu.be/goOBCts7i7o



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

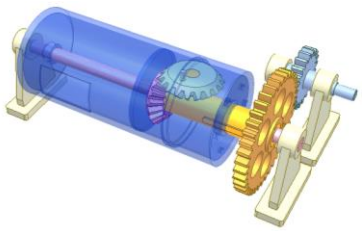
https://youtu.be/ORIEY5M2kU0



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.

Converting Rotation to Rotary and Linear reciprocating motion 1

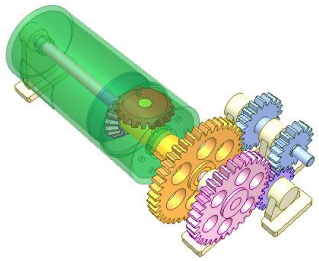
http://youtu.be/YwpGA-5lD4k



The pink shaft with a bevel gear is fixed.
The orange bush with a spur gear receives rotation from the input blue gear. The green satellite bevel gear has a pin sliding in a circular slot of the blue output cylinder.
The latter rotates and linearly reciprocates simultaneously.
If two bevel gears have the same tooth number, 1 revolution of the cylinder corresponds its 1 double stroke. This relation can be varied by using bevel gears with different tooth numbers.

Converting Rotation to Rotary and Linear reciprocating motion 2

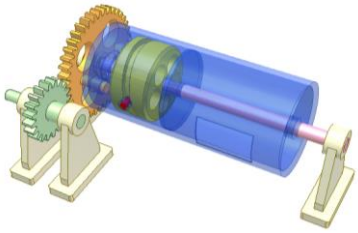
http://youtu.be/Tl5N3dX42mE



The pink shaft, the pink bevel gear and the pink spur gear are fixed together and receive rotation from the input blue shaft.
The orange bush and the orange spur gear are fixed together and receive rotation from the input blue shaft.
The red satellite bevel gear has a pin sliding in a circular slot of the green output cylinder. The latter rotates and linearly reciprocates simultaneously.
For this case, 1 revolution of the cylinder corresponds its 2 double strokes. This relation can be varied by altering speeds and rotary directions of the orange and pink spur gears.

Converting rotation to rotary and linear reciprocating motion 3a

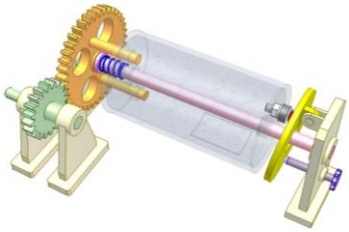
http://youtu.be/io1JL1U7kUs



Input: the green gear. The pink shaft with yellow cam is fixed. The orange gear rotates without axial motion. The blue cylinder has a red pin that slides in the cam groove. The cylinder rotates and linearly reciprocates simultaneously.

Converting rotation to rotary and linear reciprocating motion 3b

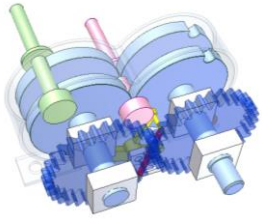
https://youtu.be/kiNlWu3VusA



Input: green gear.
Orange gear rotates without axial motion around pink stationary shaft. Grey cylinder has a red ball that contacts yellow swashdisk, inclined angle of which is controled by violet screw. So the cylinder rotates together with the orange gear thanks to two orange pins and linearly reciprocates due to the yellow swashdisk.
Blue spring maintains contact of the yellow swashdisk with the red ball and the violet screw.
The mechanism is used for printing machines.

Taffy puller 1

https://youtu.be/6r3CywqwuPc



The machine has 3 pulling rods (green, pink and orange). Each moves along eight-shaped trajectory.
Yellow T-arm of snap motion controls the rod motion.
Caution: wrong initial position of the T-arm does not give desired eight-shaped trajectory.
This video was made based on a patent registered in 1918.
See a real machine (from minute 1:09)
https://youtu.be/9Bx-Gs1Zh38?t=69
By the way the taffy pulling is an interesting matter both in maths and in mechanics. See:
http://www.math.wisc.edu/~jeanluc/talks/clarkson2015.pdf

33. Agriculture machines

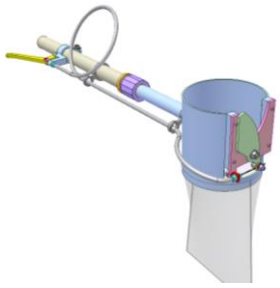
Fruit picker 1

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

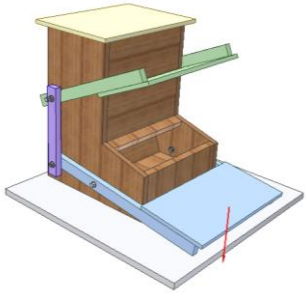
https://youtu.be/kSTHor87_i8



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.

Automatic chicken feeder

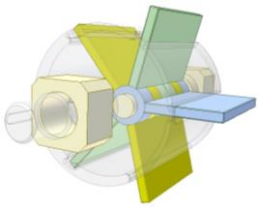
https://youtu.be/7XLj7Rn-m3w



When chickens stand on blue step, green lid of the food container open automatically.
Open top cover to load food.
The feeder prevents other animals from eating chicken feed, also prevents chicken from soiling the food.
https://youtu.be/-Q4W9_n8Ig4
https://youtu.be/AVGHIqwIWv4
In case the chickens are scared of noise generated when closing the lid, add anti shock devices as shown in two last scenes of the video.
For cylinder variant there is a small hole on lower portion of the cylinder wall (or bottom) to connect under-piston space with outside space. The hole diameter determines closing speed of the lid.

Mechanism of grain harvesting machines

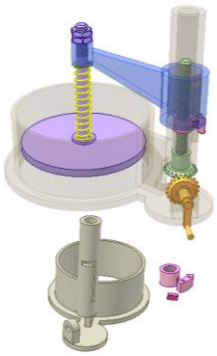
https://youtu.be/ERoYPBIoZQs



Input: glass drum of axial slots.
Blue, green and yellow blades rotate on a fixed pivot.
There is an eccentricity between rotary axis of the drum and the pivot.
The blades are protruded on the right and contracted on the left of the drum.

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

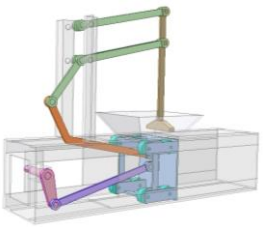
Tea rolling machine

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

Mini hay baler

https://youtu.be/8UHmVVkDzzs

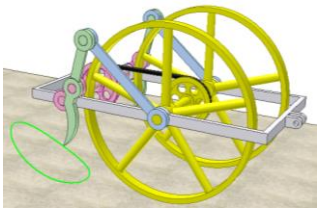


It consists of:
1. Slider crank mechanism. Pink crank receives motion from a engine and moves blue slider to compress the hay.
2. Parallelogram mechanism making brown bar move up-down to fill the hay into the space in front of the slider.
Orange bar connects two said mechanisms together.
This video was made on request of a YouTube viewer.
Related source:
https://www.youtube.com/watch?v=ETJDgAEoBtw&feature=youtu.be

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.



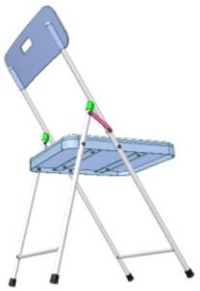
34. Furniture

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 chair 4
https://youtu.be/B1k6ThgHMl4
It is an application of the 4-bar linkage with only revolution joints. The seat plays role of a connection rod. Green parts are used as buffers when unfolding.
Lift the front side of the seat to fold.

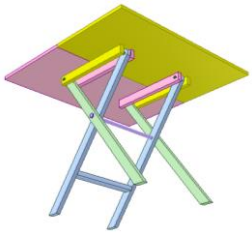


Folding chair 5
https://youtu.be/t_tyy4Oz45I
It is an application of the slider-crank mechanism. The seat plays role of a connection rod. When folding, the contact between the seat rear bar with the back tubes creates a sliding joint. Upper crossbar of the front legs is used as a stopper when unfolding.
Lift the back side of the seat to fold.

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

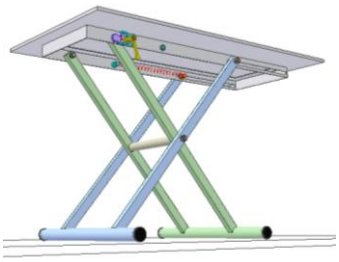
Folding table 2
https://youtu.be/6i3c7QYNIuA
During folding/unfolding process it is not closed kinematic chain.

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



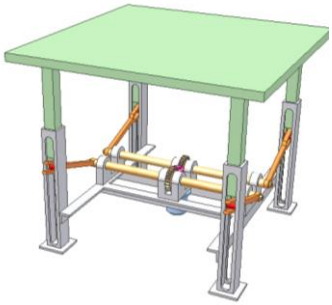
Folding table 4
https://youtu.be/JFYFs4cz_TU
During folding/unfolding process it is not closed kinematic chain.
This video was made based on:
https://www.youtube.com/watch?v=FtdaEFsvyQg

Table of quick adjustable height
https://youtu.be/iBGu_XkZYkU
Red springs tend to raise the table.
The pink wedge prevents the table from rising.
Turn the yellow lever clockwise and push down the table (pink arrow represents the force) to reduce the table height. Release the lever to hold the table in the new position.
In fact, a very large pushing down force can also lower the table without turning the yellow lever.

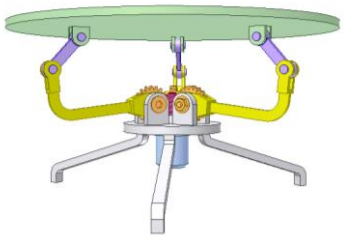


The last three scenes show how the clamping positioning device works.
Using positioning slotted disk here is not suitable because of limited space and the small rotary angle between the green leg and the white frame.
This design may be used in the video:
https://youtu.be/gCyPlGS58Ns

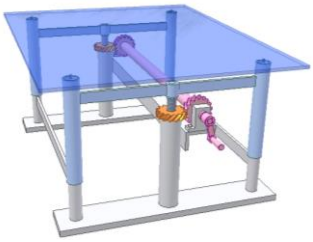
Lifting table 1
https://youtu.be/_NHka_qaPp4
Blue motor via worm drive makes two orange shafts rotate in opposite directions.
Orange cranks fixed to the shafts move up-down green table thanks to tangent mechanisms.
Forces applied to all four legs of the table at the same time make the table move easily.
This mechanism is used for large tables.



Lifting table 2
https://youtu.be/6gVdqL2XhaQ
Blue motor via worm drive makes three yellow levers rotate up- down synchronically. The levers move up-down green table via violet conrods.
The latter are arranged symmetrically and help the table move vertically while keeping it horizontal although there is not any vertical runway for the table.



Lifting table 3
https://youtu.be/lDL0zZD1EDE
Turn pink shaft to raise or decrease the table
All 45 deg. right hand helical gears are of the same tooth number.
Orange gears have threaded holes to play the role of nuts for blue screws.



Precise height adjustable table
http://www.youtube.com/watch?v=PRYNpNA8elw
A measuring table goes up and down very slowly for many turns of the input bevel gear. All the threads has the same hand. Their pitches are t1 mm and t2 mm. In 1 revolution of the green bevel gear the table moves (t2 – t1) mm.

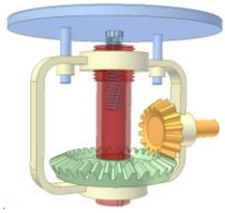


Table lift mechanism 1
https://youtu.be/XmKNluLHomM
Blue rockers and green bars form parallelogram mechanisms.
Blue springs create forces for keeping the table firmly at highest position. Use stronger force for lowering the table.
This video was made based on:
https://www.youtube.com/watch?v=wCpm5zBwYAc

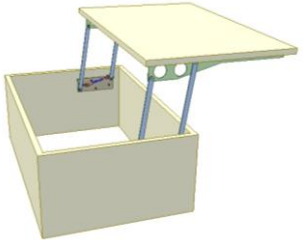
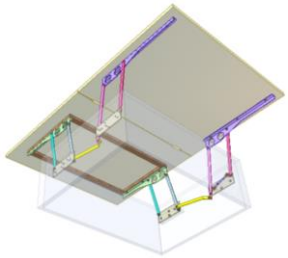
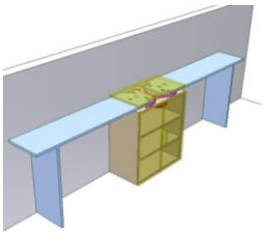


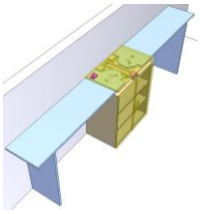
Table lift mechanism 2
https://youtu.be/hRSLttMb3nU
This is a combination of two mechanisms shown at:
https://youtu.be/g5EgLzZzQoI
Yellow bars co-ordinate their motions.
Table is lifted and its surface area is doubled.
This video was made based on:
https://www.youtube.com/watch?v=CTw7I5WSCPY



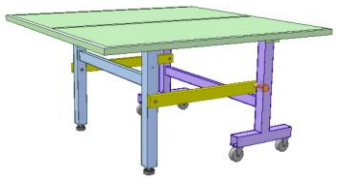
Shape transformable table 1a
https://youtu.be/EE_0Hr_jHR4
Pink gears are fixed to blue tables.
Red motor hidden in the cabinet turns the tables 90 deg. to get one of their two arrangements.



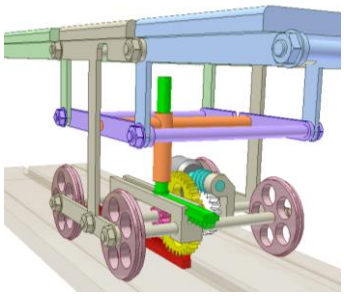
Shape transformable table 1b
https://youtu.be/UnL7yWInTNs
Green angular bars are fixed to blue tables.
Pink slider has a pin that slides in slots of the two green angular bars.
Red motor hidden in the cabinet turns the tables 90 deg. to get one of their two arrangements.



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.



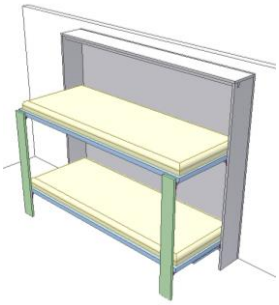
Chair-bed
https://youtu.be/JBEZxQ1a5AQ
When moving forwards, the chair-bed is transformed into a bed.
When moving backwards, the chair-bed is transformed into a chair.
Grey motor makes gear block of white worm wheel, yellow large and pink small spur gears rotate thanks to cyan worm.
When rotating the large spur gear (in mesh with red stationary rack) moves the carriage of four wheels. At the same time the small spur gear moves green rack. The latter via orange swivel bush moves violet coupler of a four-bar linkage of blue and green rockers thus changing angular positions of blue and green mattress.
The self-locking worm drive keeps the chair-bed stable at every adjusted position.
This design was made on request of a YouTube viewer.



Folding bunk bed

https://youtu.be/nVOUe_zubEs

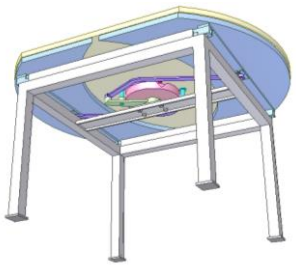
Blue beds and green legs create a parallelogram mechanism.
The gravity keeps the bed stable at stretching and folding positions.
The white frame must be fixed firmly to the wall.
This video was made based on:
https://www.youtube.com/watch?v=BKoRGkzJ2dw



Expanding table 1

https://youtu.be/WV9Vz-KrZOE

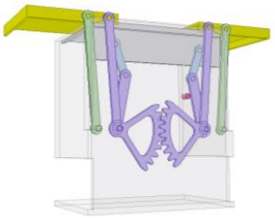
Turn yellow center plate counter-clockwise to expand the table.
When the center plate is turned, two blue side plates move out or in thanks to slider-crank mechanisms of violet conrods and green double crank. The latter has vertical prismatic joint with the center plate via two cyan pins that are fixed to the center plate.
At the end of the expanding process the center plate is lowered thanks to gravity, pink face cams and red pins (fixed to the center plate), thus the center plate is in a plane with the side plates.
This mechanism may be used in
https://www.youtube.com/watch?v=9uTQVHWS5no
https://www.youtube.com/watch?v=TnuumMhl6fg



Extendable table

https://youtu.be/IBwslMs6DkY

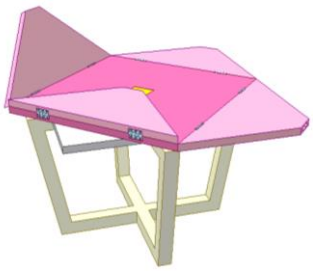
Pull aside one of two yellow side panels to double table surface area. The middle panel has prismatic joint with the base. Pink stopper prevents the middle panel from falling down at its upper position.
Weakness: there are two longitudinal slots between the three panels.
It can be used for hiding an object under the table after displaying.



Expanding table 2

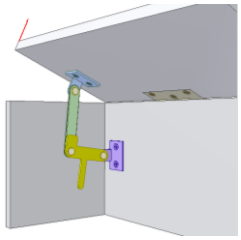
https://youtu.be/We7hTnVz4Ng

Turn white lowest square 45 deg. counter-clockwise to create a supporting plane.
At the same time two red pins fixed to the white square move yellow center square down thanks to yellow barrel cam (fixed to the center square) to create gripping space for flipping 4 triangular plates to expand the table.
The yellow center square has prismatic joint with the table legs.
The middle pink plate is fixed to the table legs by 4 orange pins.
This mechanism may be used in
https://www.youtube.com/watch?v=VHqgyVFKUKw



Bench seat strut 1

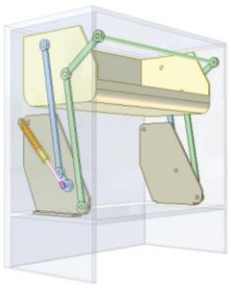
https://youtu.be/ozczEpcOtvo



It is an application of 4 bar linkage.
Raise the seat (red arrow) and turn the yellow lever clockwise (black arrow) to lock the seat at open position. The seat weight pushes the yellow lever toward the back board.
Turn the yellow lever counterclockwise (black arrow) to close the seat.

Pull down shelf 1

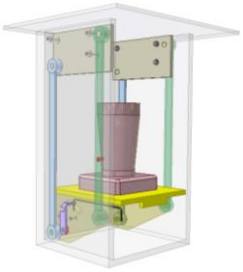
https://youtu.be/FdFmeAY8nmo



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

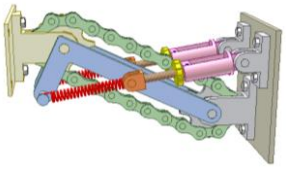
https://youtu.be/mJGUocWFd4M



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

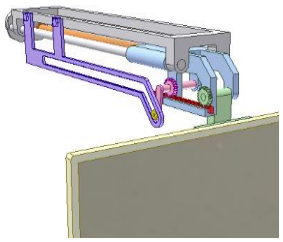
TV wall bracket 1

https://youtu.be/COZLfUvlu0Q

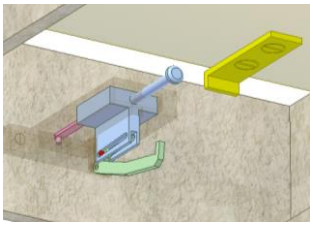


Instead of a parallelogram mechanism here a chain drive ensures that the TV direction is kept unchanged when it moves up down. The grey sprocket is stationary. The TV back is fixed to the other sprocket (in yellow).
Red springs equilibrate the mechanism. Positions of the spring pivots are the key factor. 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.

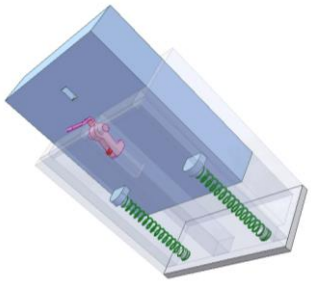
Mechanism for spreading a monitor
http://youtu.be/QAF4EligtPM
The monitor is hidden in a box (not shown). Orange screw powered by a motor moves blue slider. The green display support has revolution joint with the slider. Violet cam via pink crank, two pinions and a red rack turns the support 90 deg. 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.



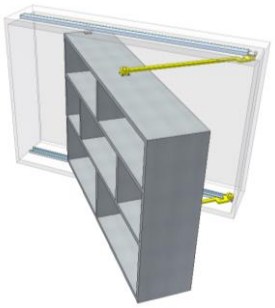
Push-push drawer
https://youtu.be/KaP5Yff94Cc
It is an application of “Push-push button 2” shown at:
https://youtu.be/5JzjSsxSsb8
Push the drawer more to lock after closing it.
Push the drawer to unlock before opening it.
Green pivoted lever has red pin that moves along the slot of blue slider.
It can be also used for locking a plug.



Spring powered drawer
https://youtu.be/a2JZns4HkIU
Turn pink latch to open.
Push blue drawer to close.
Red spring forces the latch towards the drawer.
Green springs force the drawer outwards.
It works better if adding a damper.



Flipping cabinet
https://youtu.be/VUvF9jb-hq0
This cabinet can be flipped to show its two faces to the user.
It is an application of the slider-crank mechanism where the crank (in yellow) are longer than the connecting rod (distance between two revolution joints of the cabinet). Red sliders move along blue runways.
Apply force to the cabinet for flipping it.
For a motorized embodiment of this cabinet place a motor inside the cabinet and transmit rotation to the yellow crank at the revolution joint of the crank and the cabinet.
Related videos:
https://www.youtube.com/watch?v=futDKV8TLIM&feature=youtu.be
https://www.youtube.com/watch?v=8qbmaW0ia-E&feature=youtu.be

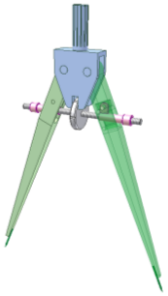


35. Office appliances

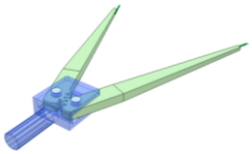
Pair of compasses 1
https://youtu.be/KJqJb3I4IWg
It is a combination of two crank-slider mechanisms. Green and yellow bars play the role of conrods.
Blue and orange legs are coaxial and turn in opposite directions with the same velocity to ensure that the handle is always on the bisector of angle created 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.

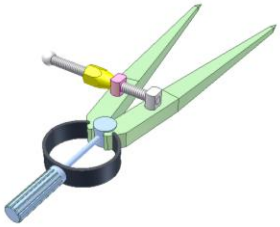
Pair of compasses 2b
https://youtu.be/cOlsc64Xaao
Two green legs are not coaxial.
Pink nuts have revolution joints with green legs.
The screw has planar joint with the handle.
Turn screw of two opposite handed threads to alter distance between needle points. The mechanism ensures that the legs turn in opposite directions with the same velocity and the handle is always on the bisector of the angle created by the legs.



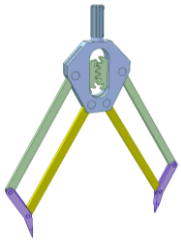
Pair of compasses 3
https://youtu.be/_AayprgIcgc
Two green legs are not coaxial. They are in gear engagement with each other thus turn in opposite directions with the same velocity to maintain that the handle is always on the bisector of the angle created by the legs.



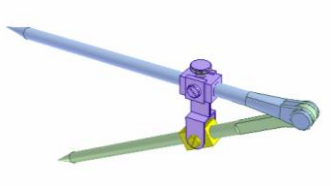
Pair of compasses 4a
https://youtu.be/EpQl8o0sfV8
Blue handle has revolution joints with green legs. Circular spring (fixed to the handle and to the legs) always forces the legs move apart from each other. Pin part (bearing for grey screw) and grey part (fixed to grey screw) have revolution joints with 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.



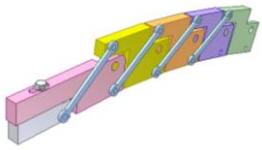
Pair of compasses 5
https://youtu.be/s-jp3tBTGjg
Gear engagement between green rockers ensures that blue handle is always on the bisector of the angle created by the green rockers.
Green and yellow rockers, violets conrod create parallelogram mechanisms that ensure violet points are always perpendicular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



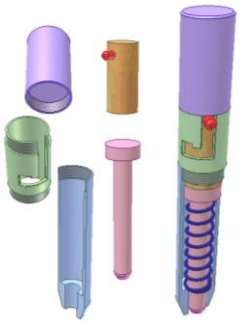
Pair of compasses 6
https://youtu.be/azkkR_d5nPA
This video was made based on the design numbered as 939 in volume 2, Mechanisms in modern technic, I. Artobolevski.
It's an application of the tangent mechanism.
Move violet slider to vary distance between two spearheads of blue and green legs.
Use violet screw to fix the violet slider after adjustment.



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.



In/out motion by slide and twist
https://youtu.be/do3GPCD6uVM
Use your thumb to slide and twist for in/out motion of the pink rod.
The mechanism may be applied to pens:
https://i.ytimg.com/vi/tVKsQYojiw4/maxresdefault.jpg



Two button mechanism 1b
https://youtu.be/AKIk_TnkD68
Push the white cap to get out motion.
Press the blue clip to get in motion.
The blue and pink parts are made of plastic elastic materials.
The yellow straight ink tube is bent during the assembling process by the contact parts.
The mechanism is applied to ballpoint pens.

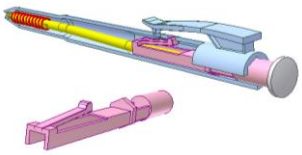
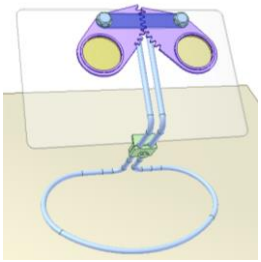


Table-Top Stereoscopic Viewer

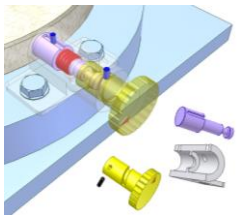
https://youtu.be/WVL-DdOKq00



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

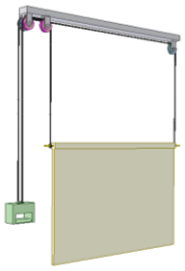
https://youtu.be/EWqC8mdkrUI



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

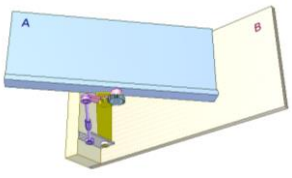
https://youtu.be/xTALILtw-GI



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

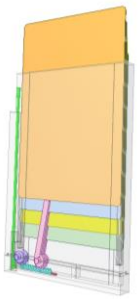
http://youtu.be/AAOihkueJLw



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

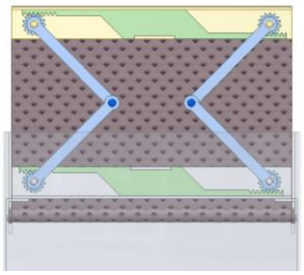
https://youtu.be/wMMzQT6m9DQ



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

Rolling screen

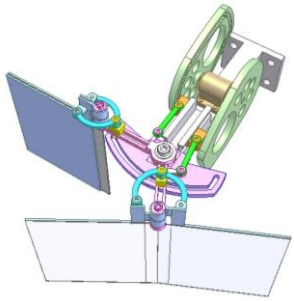
https://youtu.be/GjNHipIhDF4



Input: violet actuator. It moves lower green rack for lifting yellow horizontal bar to deploy the screen. The screen scroll is rotary mounted on a fixed horizontal shaft. The scroll tends to roll back the screen thanks to a spiral torsion spring mechanism (not shown).
The green racks ensure that the blue gear bars that are connected together by a revolution joint rotate at the same velocity in opposite directions. So the yellow horizontal bar always moves vertically.

Automatic display of pop-up pictures 1

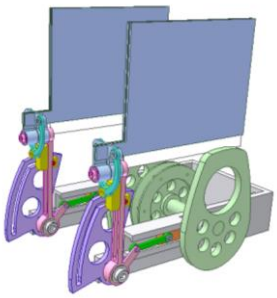
https://youtu.be/hzgxmnYHtqA



Input: green cams of brown motor.
The green cams control rotation of pink cranks.
Stationary violet cam controls open and closing of the white pop-up pictures.
The video was made upon an YouTube viewer request.

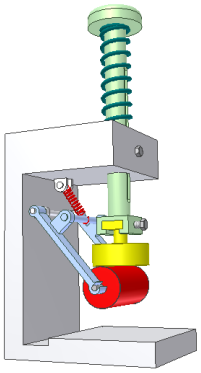
Automatic display of pop-up pictures 2

https://youtu.be/r_mccNT-IIw

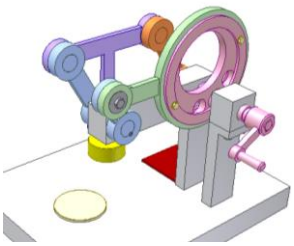


Input: green shaft of two green cams.
The green cams control rotation of pink cranks.
Stationary violet cams control open and closing of two white pop-up pictures one after another.
So the mechanism consists of two modules. Each module contains green and violet cams, pink crank, …
It is possible to increase the number of the pop-up pictures to 3 or 4 by adding more modules and use mechanisms for successive 360 deg. rotation shown at:
https://youtu.be/MMbCGqT3o4I
https://youtu.be/_XdOD28zyu0

Office seal stamp 1
https://youtu.be/ES5_nGlPPT0
Before the invention of self-inking stamps this mechanism was used for stamping objects of big quantity such as mail envelopes. It can be manual, cam or electric magnet operating.
The yellow stamp is inked by red ink roller before stamping.



Office seal stamp 2
https://youtu.be/sOEZTRqtItg
It is a combination of a four-bar linkage (pink eccentric shaft, green conrod and blue rocker) and a parallelogram mechanism (blue and orange rockers, violet conrod).
It can be manual or electric motor operating.
The yellow stamp is inked by red ink pad before stamping.
See a prototype of this design:
https://youtu.be/JOBOtXO3lf4



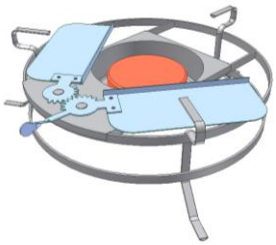
Camera tripod
https://youtu.be/FWsmwj85Jqw
Move up-down orange slider to fold or unfold the tripod.
The orange slider, yellow conrods and green rockers create slider-crank mechanisms.
When the slider is at its lowest position, any force applied to the green bars can't move the slider up because angle between the yellow conrods and the white post is less than 90 deg..
The camera is fixed on the top surface of the tripod.
Yellow tube can be adjusted along vertical direction.
Violet part can be adjusted around vertical axis.
Cyan part can be adjusted around horizontal axis.
For adjusting the green leg length see:

36. Food processing

Alcohol glue stove

https://youtu.be/04yOe86OoOc

Turn blue gears to adjust the flame or switch off the stove.



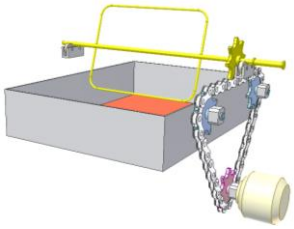
Roasting oven 1

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.



Device for closing dumplings

https://youtu.be/ydgb7WUhR2Y

The dough is placed on moving plates of a stepper conveyor (its transmission is not shown).

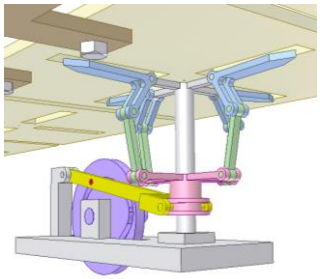
The black square on each plate represents the dough before closing. At one position of the conveyor the dough is closed.

The dough after closing is shown in the left down corner of the video first scene.

The closing device consists of a cam drive and slider-crank mechanisms.

This mechanism may be used in following machine (see from 1.00 minute):

https://www.youtube.com/watch?v=uHhJsCv2lxI



Murukku making machine

https://youtu.be/iQyMyTyTEwA

This video aims creating a mechanism that can be used for murukku making machine:

https://youtu.be/zu4YF4jdrIo

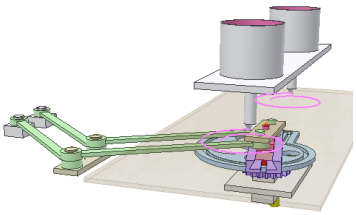
Input: yellow shaft.

Thanks to double parallelogram mechanism of green bars the table translates along an Archimedean spiral of several turns.

Mechanism shown at:

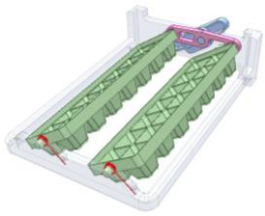
https://youtu.be/euvvukuz1TQ

creates such spiral (last scene of the video).



Refrigerator ice tray

https://youtu.be/uuqPbSfNEhM

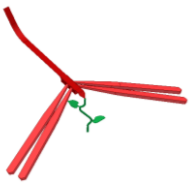


Green trays (rockers), blue knob (input crank) and pink conrod create a double parallelogram mechanism.
Turn the knob to flip the trays for removing pieces of ice.
Torques of red coil springs and the contact between the pink conrod and trays determine horizontal and flipping positions of the trays.
At flip position increased torque of the springs twists the trays and separates pieces of ice from the trays.
The video was made based on the ice tray of Samsung refrigerator RT25M403358

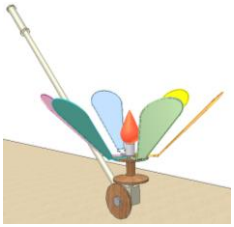
37. Entertainment stuff

37.1. Toys

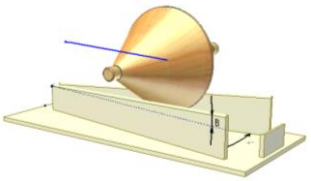
Inventor dragonfly
http://www.youtube.com/watch?v=iQEK0CuneTY
Stable balance. The center of gravity is lower than the fulcrum.



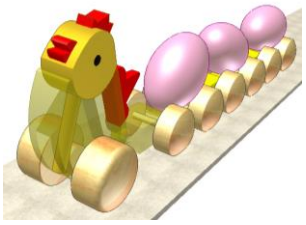
Toy rotation flower
https://youtu.be/G6bYNudeZV8
This toy is popular in Vietnam during Mid-Autumn Festival.
Push the toy on the road. Rotation of the horizontal roller is transmitted to the vertical one to which the flower is fixed. The friction force between the rollers is generated by gravity.
A candle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



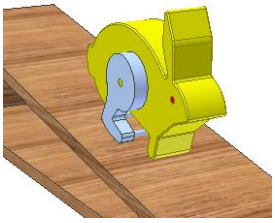
Uphill roller
https://youtu.be/O7jj_lFWbCg
It was presented by William Leybourn in his book “Pleasure with Profit”, 1694.
Under the gravity the roller moves to the right. It looks that it moves up along the inclined rails. In fact the roller center of mass moves down. Blue line is its trajectory.
Motion 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



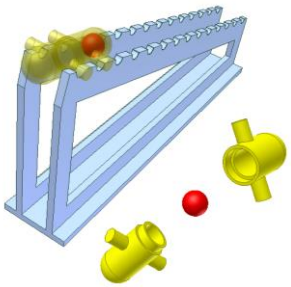
Pulling eggs hen
https://youtu.be/DulJZ8IPBd0
The eggs rotate thanks to friction between them and wheels.
The hen head swings thanks to a cam on the front wheel shaft.



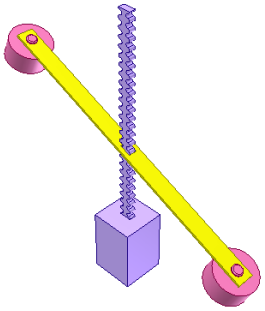
Rabbit going downhill
https://youtu.be/S7RfaYUD4gY
It’s a gravity toy.
Reasonable dimensions of the parts make the downhill motion possible.
Calculation of this mechanism is not easy because the inertia and friction play important roles for the motion.
Here “adjust and try” method is used instead of the calculation.
This video was made based on
https://youtu.be/aBq6VArNyQY



Somersaulting capsule
https://youtu.be/bnQH8kaHALo
It is a gravity toy.
Reasonable dimensions of the capsule, suitable weights of the capsule and the red ball make the somersaulting motion possible.
Calculation of this mechanism is not easy because the inertia plays important role for the motion.
Here “adjust and try” method is used instead of the calculation.
This video was made based on
https://youtu.be/nBocov6amSw

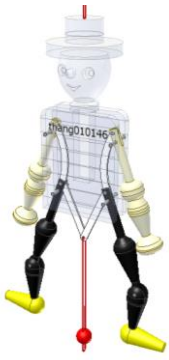


Seesaw
https://youtu.be/hb9Mj0s0Rgc
It is a gravity toy.
Reasonable dimensions of violet rack teeth and yellow bar rectangular hole make the seesaw motion possible.
Center of mass of the bar including two pink weights must be lower than contact points between the bar and the rack
Calculation of this mechanism is not easy because the inertia and collision play important roles for the motion.
Here “adjust and try” method is used instead of the calculation.
This video was made based on
https://youtu.be/OR-q3_VFFHM
(minute 4:17 - 5:10)

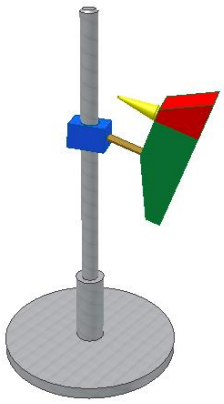


Tumbling head on ladder
https://youtu.be/Ons1_PcdMaY
It is a gravity toy.
Reasonable dimensions of the ladder and the pink head make the tumbling motion possible.
Calculation of this mechanism is not easy because the inertia and collision play important roles for the motion.
Here “adjust and try” method is used instead of the calculation.
This video was made based on
https://youtu.be/Gmh5jeAWSGU

Happy jumps
https://youtu.be/E7vMxaT3Amg
Pull red string to let the puppet jump.
Upper limb, thigh of the puppet and curved conrod create a parallelogram mechanism.
For simplicity the four white conrods can be replaced with strings.

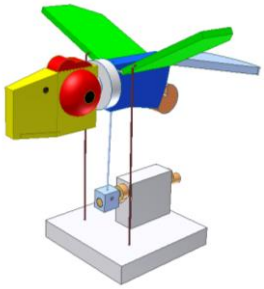


Woodpecker



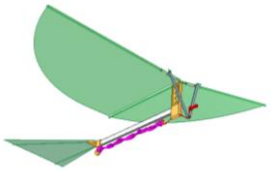
https://youtu.be/zqnzgwYDKLY
It is a gravity toy.
Blue slider and body of the woodpecker are connected by a leaf spring that makes the body oscillate and the slider jerkily move down.
Gravity, elastic and friction forces cause the motion.
There is a small gap between the slider and the post.
Pay attention not to let the yellow beak touch the post. If not, no more oscillation and the woodpecker stops moving down.
The video was made based on:
https://youtu.be/vvEBDfof6WU
It is possible to use helical spring instead of leaf spring:
https://youtu.be/C-9jBm6B3GY

Kinetic art of flying bird



https://youtu.be/ea1JKeslKeI
Turn orange crank shaft to make the bird fly.
Two brown elastic rods fixed to the base (acting as flat springs) have revolution joints with green wings.
The green wings also have revolution joints with the bird body block consisting of head, body, legs and tail.
The blue conrod is fixed to the bird body block.
So it is a planar mechanism that has 4 movable links and 4 revolution joints. The elastic rods ensure the mechanism motion stable. Gruebler's equation can not be applied here for DOF calculation of the mechanism because of these elastic links.
The bird motion looks lively because beside the wing flapping, the bird body also moves up/down.
The video was made based on:
https://youtu.be/MIBOQ9_GtE4

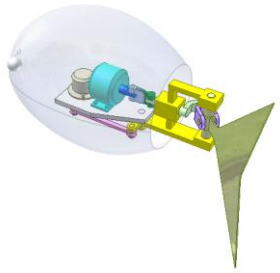
Rubber band powered flying bird



https://youtu.be/LqTLt3Jrjhs
Use red crank to wind pink rubber band and launch the bird.
Two 4-bar linkages of a common crank are used to give the wings angular reciprocating motions. Green tranparent wings and tail are made of nylon film.
Pay attention to two facts caused by the simplification in this toy:
- Motions of two wings are not hundred percent symmetrical.
- The shape of red crank-shaft is not planar.
For more about this toy please see:
https://www.youtube.com/watch?v=FfNZv1_ojjU
https://www.youtube.com/watch?v=0rAMh0hxgrs

Tail fin for robot fish 1a

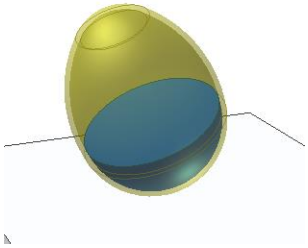
https://youtu.be/ofDUQT-2_KE



A spherical 4-bar linkage is installed on yellow bracket for converting rotation of green crank into angular oscillation of the tail fin. The green crank receives rotation from cyan motor via a coupling of blue fork and green tongue.
Beige motor is for changing motion direction of the fish. It changes angular position of the yellow bracket in relation to the white base via a parallelogram mechanism of pink conrod.
Both motors are placed on the base.
Related videos:
http://www.youtube.com/watch?v=M7r-6CFFuK8
http://www.youtube.com/watch?v=rAM7YRCQWEc

Wobbling egg

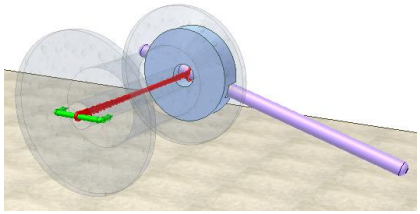
https://youtu.be/g6JJwCK1mLU



The egg consists of shell and insight weight that are fixed together.
Condition for wobbling motion:
Center of mass of the whole egg (including the insight weight) must be lower than center of the lower spherical surface of the egg.

Wheel of rubber motor

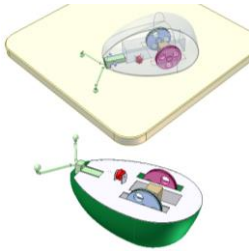
https://youtu.be/9oUzNAoKIjM



This a simple toy.
Turn violet lever clockwise to store energy in red rubber ban. Once the wheel is placed on the ground, the latter prevents violet lever from reverse rotation and the wheel rotates while going forwards.
Green pin is fixed to the wheel.
Lubricate the contact surface between blue washer and the wheel to ease the motion.
This video was made based on:
https://youtu.be/vCnSRNXxtIA

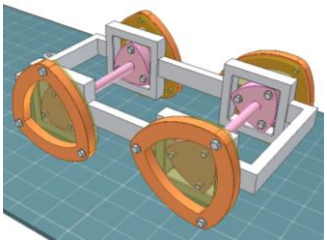
Unfallen beetle

https://youtu.be/G04TPKo1YQ0



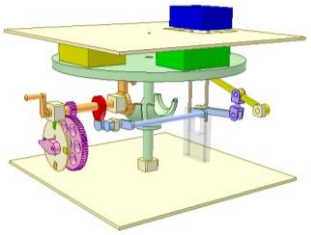
Large pink wheel receives motion from brown motor.
Large blue wheel and small red wheel are idly mounted.
Green antenna has longitudinal revolution joint with the chassis. Violet pin is for restricting the antenna rotation.
When the antenna is on the plane surface, the beetle contacts the desk via 2 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.

Car of triangular wheels



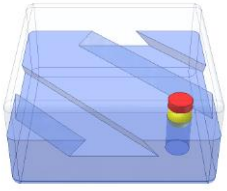
https://youtu.be/s2nsUyyF1_Y
If the shafts of triangular wheels rotate in round bearings, the car chassis go up and down when moving on horizontal ground like the video last scene shows.
If the bearings consist of Reuleaux triangles and square frames, the car moves rather smoothly.
Pink triangles are of Reuleaux ones. Orange triangular wheels are similar to the pink ones.
According to Jin Akiyama, Tokai University, Japan, this car was invented by Mexican high school students, Sebastian von Wuthenau Mayer and Claudia Masferrer Leon.
Perhaps it is only a toy, no practical use.

Magic chest 1



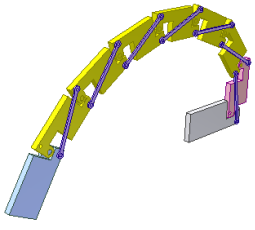
http://youtu.be/aJnnoExw77s
It is a toy. Once opening the chest (its cover and surrounding plates are not shown) a box among blue, green, yellow and orange ones appears. Turn orange crank to select the target box based on its color shown on the dial.
Spatial Geneva mechanism is applied here.
This toy was made on request of Mr. Mladen Radolovic from Croatia.

The impossible dovetail box



https://youtu.be/YIRqqj6WYv8
Outside look causes the impression of impossible box (first scene of the video).
In fact the box can be assembled and dissembled by diagonal motion (second scene of the video).
The box is equipped with a lock that consists of red magnet and yellow ball. The magnet keeps the ball at lock position. Strong strike separates the ball from the magnet thus the box can be opened (last scene of the video).
For assembling back, insert the upper part (in white) to right position and flip the box 180 deg. The ball comes into lock position by gravity.
This toy is commercialized:
https://youtu.be/xp-PENvptu0

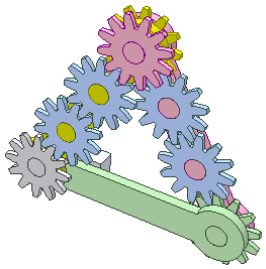
Rolling rod of bar mechanisms



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.

Rolling rod of spur gears

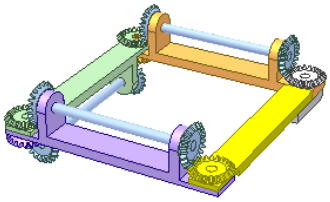
https://youtu.be/Dj--7y1GONA



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

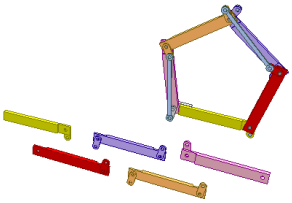
https://youtu.be/jKLM5_QOwOI



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

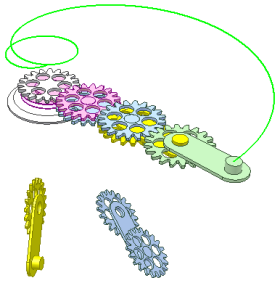
Rolling rod of anti-parallelogram mechanisms

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.

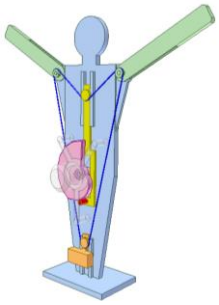
Gear whiplash



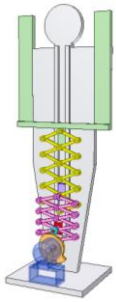
https://youtu.be/-E2pNGHip6U
Input: pink gear crank.
System of gears and bars stretches and folds continuously when the input rotates.
White gear is stationary.
Blue gears are in mesh with white and green gears.
Pink gear is in mesh with yellow gear.
The stretching length can be increased by adding the 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

37.2. Sports, games

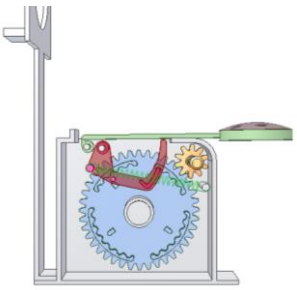
Hands up dummy 1
https://youtu.be/fe8pu1bo8mA
Input: pink cam driven by a motor (in glass).
Orange weight maintains contact between the cam and red pin of yellow follower.
Blue cable should be wound more than one revolution on green pulleys to increase friction torques.
The dummy is used in basketball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



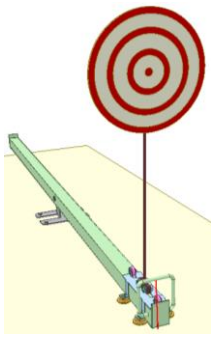
Pie throwing game.
https://youtu.be/KcQzXsqfRKg
Game apparatus comprising a base supporting a vertical wall and a chin rest for a player (on the left). The wall has an opening facing the chin rest and an arm (in red) is pivotally supported on the base on the side of the wall opposite the chin rest. The 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

Dart cart

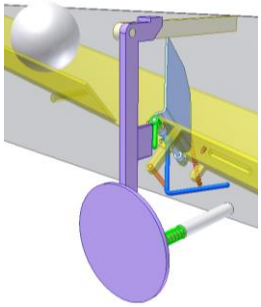
https://youtu.be/arXgx75icIU



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

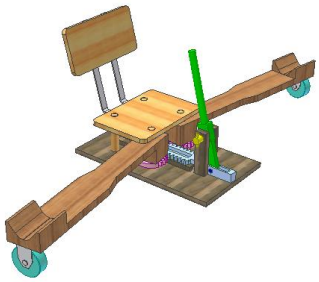
https://youtu.be/ufPPbVnoYgg



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.

Leg stretcher for exercisers

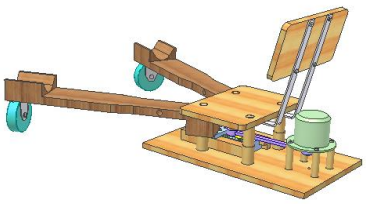
https://youtu.be/T0RcJ4OJZfQ



Pull the green lever to stretch the legs via gear-rack drive.
This mechanism may be applied to the following:
https://youtu.be/mJglg9KvwK8

Leg stretcher for rehabilitants

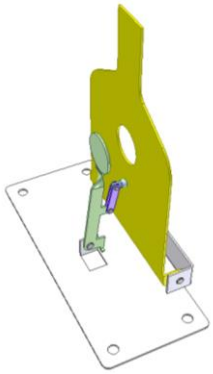
https://youtu.be/mobKOOVxGqk



Electric motor, slider-crank linkage and Scotch Yoke mechanism enable the rehabilitant to stretch his or her legs. The stroke length of the blue slider (thus the stretch angle) can vary by adjusting the position of red screw. Turn in the screw to increase the stroke length (last scene of the video). The blue slider moves forwards only when the yellow slider contacts the red screw. Because of inertia the stretch angle may vary a little (not important for this kind of machines). For better understanding this adjusting way please see: http://youtu.be/YJhMMj3u73M

Target for field target game

https://youtu.be/Kl1OQNRfBaU

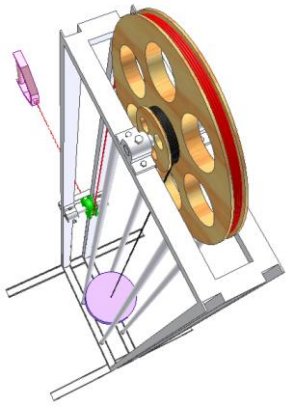


When air gun pellet hits red circle, green bar and yellow bottle-shaped face plate flip down to show that the target has been hit.
The target is reset by tugging on a length of cord (not shown) attached to the face plate above the hinge (at the end of blue bolt). The tugging force is represented by the black arrow.
Green bar, violet conrods and yellow face plate create a 4-bar linkage. It is designed to get following features:
- The linkage flips down only when the pellet hit the red circle. It does not happen if the pellet hit the face plate.
- The gravity keeps the linkage firmly at standing position.

These targets are available on the market. For example: https://www.mcavoyguns.co.uk/contents/en-uk/p11412_BSA_Rabbit_field_target.html

Pulling exercise equipment 1

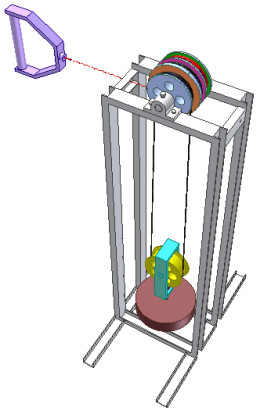
https://youtu.be/8W6rNdjzh2k



The pulley block (in orange) consists of small and large pulleys fixed together. The black cable is wrapped several revolutions around the small pulley. One end of the cable is fixed to the pulley, the other end to the violet weight W.
The red cable is wrapped several revolutions around the large pulley. One end of the cable is fixed to the pulley, the other end goes around the green pulley and then is fixed to the pink grip.
D2 = 4*D1
D1, D2 are diameters of the small and large pulleys respectively.
s = 4*h
F = W/4
F is the force applied to the grip.
s is the displacement of the grip (pulling distance).
h is the displacement of the weight
The mechanism allows to get s = 6 m, when h = 1.5 m

Pulling exercise equipment 2

https://youtu.be/si6unzQEzxY



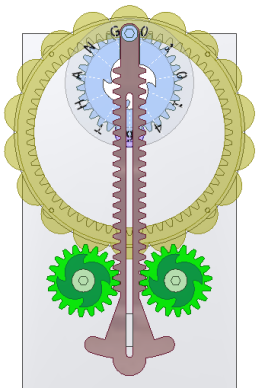
The mechanism is inspired by the Chinese windlass.
The pulley block consists of green, pink and orange pulleys fixed together.
One end of the black cable is fixed to the orange pulley.
The other end is fixed to the middle pink pulley.
The black cable is wrapped several revolutions around the orange pulley, then goes around the yellow pulley and is wrapped several revolutions around the middle pink pulley.
The red cable is wrapped several revolutions around the green pulley. One end of the red cable is fixed to the green pulley, the other end is fixed to the violet grip.
Dg, Dp, Do are the diameters of the green, pink and orange pulleys respectively.
s is the displacement of the grip (pulling distance).
h is the displacement of the weight
The mechanical advantage MA = s/h = 2*Dg/(Dp-Do)
If the difference between Dp and Do is small, MA can be very large.
In this video: Dg = Dp = 124 mm; Do = 104 mm; MA =12.4

37.3. Kinetic arts

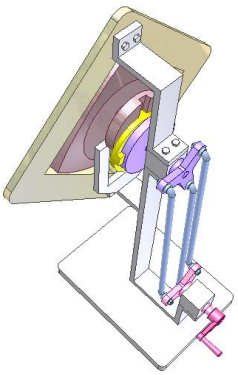
Multigear kinetic scupture
https://youtu.be/q8THK8q6cAw
Gears of two colors create squares during motion.
Input: the central gear.
The video was made based on:
https://www.youtube.com/watch?v=0_22x26qYPA

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.

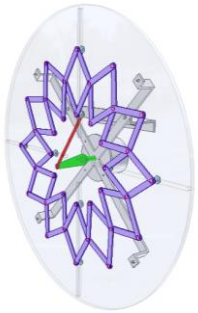
Gear kinetic sculpture 1
https://youtu.be/rYpz4dKFPZ0
Input: violet crank.
Tooth number of the internal gear is double the one of the blue gear.
It's an application of Cardano circles:
https://www.youtube.com/watch?v=Ti1hyjLXItg
Requirement for assembly: ensure that there is the position where violet crank, blue crank and the rack are in line.
This animation was made based on:
https://youtu.be/Vfz-GkXLwHk



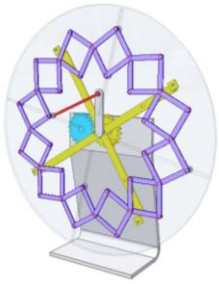
Reuleaux triangle kinetic sculpture
https://youtu.be/a60Cvh9qh-g
The Reuleaux triangle receives rotation from input pink crank via parallelogram mechanism and Oldham coupling.
This video was made based on:
https://www.youtube.com/watch?v=hEKVL-8E3aI&feature=related



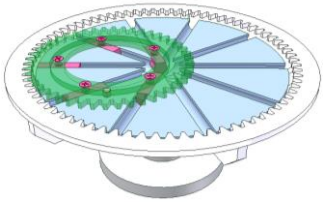
Variable shape 12 point star 1
https://youtu.be/SgEdofpDiyw
Input green hand.
Two pins slide along each radial slot of the yellow base.
This video was made based on the kinematic art shown at:
https://youtu.be/CguulSHbmUo
(minute 1:25)



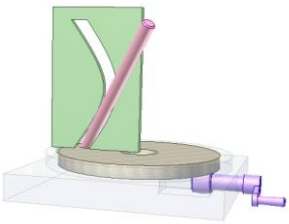
Variable shape 12 point star 2
https://youtu.be/TeD172Vl9VU
Input cyan gear of a motor.
Two pins slide along each radial slot of the white disk.
Red crank rotates around a fixed pivot.
Violet 12 point star changes its shape while the disk rotates.
This video was made based on the kinematic art shown at:
https://youtu.be/CguulSHbmUo
(minute 1:25)



Five shuttle trammel of Archimedes
https://youtu.be/rX7fLcCrRX4
It is a kinematic art.
In put: white gear of internal teeth.
Five shuttles move in 10 radial straight grooves.
Unusual thing: there is not a bearing for geometric axis of green gear.
This was made based on video (minute 1:57):
https://youtu.be/wVslP9mvqjM
Last scene of the video shows other way to transmit motion for the green ring.
An embodiment of this mechanism when the blue disk is input link:
https://youtu.be/9qAneldaEWo

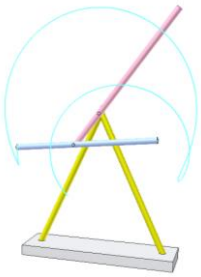


Hyperbola hole
https://youtu.be/01g77cxMaKg
This toy shows that a straight rod (in pink) can glide through a curved hole.
Axis of the rod traces a hyperboloid surface (in pink).
Violet roller and brown disk create a friction drive.
This video was made based on:
https://youtu.be/wVslP9mvqjM



Swinging Sticks

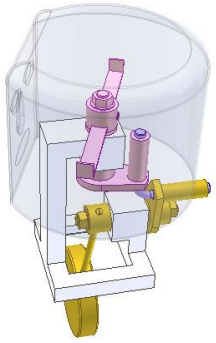
https://youtu.be/TcCAvqwV1JQ



This is the kinetic sculpture shown in “Iron man 2” film. It consists of A letter-shaped frame and two sticks that are connected together by two revolution joints. In fact, it is a double pendulum. The motions of the parts are chaotic. Blue trajectory is drawn by the end point of the blue stick. Like a single pendulum finally the mechanism will stop because of friction in the joints and air resistance (last scene of the video, a simulation with large friction in the joints). To keep it in continuous motion an electric magnet is installed in the base as shown in:
http://www.waynesthisandthat.com/How%20Swinging%20Stick%20Kinetic%20Sculptures%20Work.html

Disagreeable man

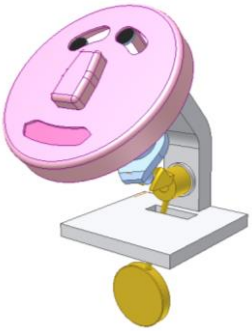
https://youtu.be/zrAkRQfhUS4



This is an example to get oscillation around vertical axis from a gravity pendulum.
A Hobson’s joint helps to transfer motion from yellow pendulum to pink vertical shaft.

Watchful man

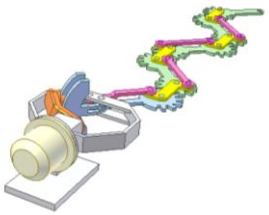
https://youtu.be/g5EgLzZzQoI



This toy is an example to get oscillation around 45 deg. oblique axis from a gravity pendulum.
Thanks to a spherical mechanism (blue shaft and yellow horizontal shaft) the oscillation from yellow pendulum is transferred to blue oblique shaft.
Rotary axis of the blue shaft, axis of blue pin on the blue shaft and rotary axis of the yellow shaft are convergent.
Joint between blue and yellow shafts is of cylinder on plane like in video
http://www.youtube.com/watch?v=aYYJ-x_1nLg

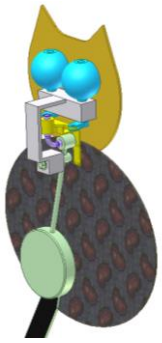
Snake motion

https://youtu.be/5DyBhty_f-g



An attempt to mimic snake motion.
It may be used for snake or eel robots.
Input: orange crank.
This is a combination of two mechanisms shown at:
https://youtu.be/7hrzllpQHJA
http://www.youtube.com/watch?v=4UpjmxQ3900
The video shows the motions for cases when different links are kept stationary.

Restless cat



https://youtu.be/ow5KCtULpYU

This toy is an example to show how the gravity pendulum oscillation is transmitted to two vertical shafts.

Here there is a combination of Hobson's mechanism of violet angular bar and parallelogram one of yellow conrod.

The cat face is stationary.

The cat body is fixed to the yellow conrod.

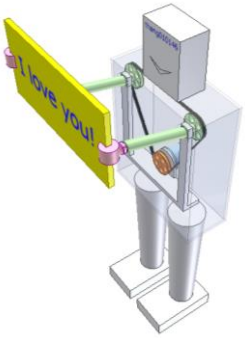
The cat tail is fixed to green pendulum.

The cat eyes are fixed to blue vertical shafts.

The video was inspired from:

https://youtu.be/TUDhM4ELOz8

Robot thang010146



https://youtu.be/bGkaQK3hxS8

Input: orange pulley receiving rotation from blue motor.

Two green oblique cranks and block of two pink forearms and yellow board create a parallelogram mechanism.

Output: the yellow board (circular translation).

Both green cranks receive rotary motion from the motor via a belt drive thus dead positions are not a problem for this parallelogram mechanism.

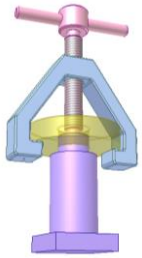
Weakness: unlike in a real man, in this robot green upper arms rotate.

To hide that, use flexible tube-shaped coverings for the upper arms. One end of the covering is fixed to the robot body, the other end to the forearm.

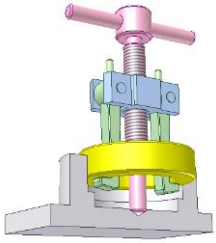
I made this video after seeing a robot of the same function in front of a shop in Vietnam.

38. Unclassified mechanisms

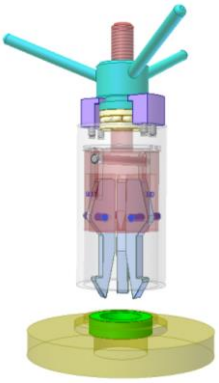
External puller 1
https://youtu.be/jn0RTUaaG90
It is an application of screw-nut drive for removing a disk (in yellow) out of a shaft (in violet). Hold the blue nut to prevent it from rotation at first stage of removing process.



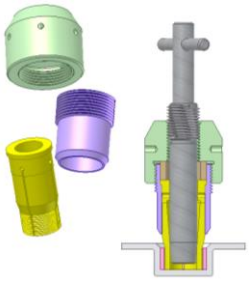
Internal puller 1
https://youtu.be/KpgLyvXUVFw
It is an application of screw-nut drive for removing a bush (in yellow) out of a hole (in grey). Hold the blue nut to prevent it from rotation at first stage of removing process.



Internal puller 2
https://youtu.be/Z9S9yzSkbqE
It is an application of screw-nut drive for removing a bush (in green) out of a hole (in yellow).
Three blue springs tend to turn out three blue hooks
Red slider can't rotate due to grey cross pin sliding in slots made on transparent cylinder.
For removing the bush:
- Hold the puller by one hand and place it on the bush.
- Turn cyan nut counterclockwise by other hand to move the slider down until the hooks hook onto the bush.
- Turn cyan nut clockwise to move the slider up (to pull the bush out of the hole).
- Once the bush is out of his hole, press radially the hooks with fingers, the bush will fall down.

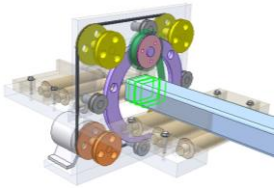


Internal puller 3
https://youtu.be/KQ-IqC_UxQE
It is for removing a bushing (in pink) out of a blind hole.
Green nut is screwed tightly to violet body. Yellow collet is clamped to the body by the nut.
While the nut is held by hand, grey core is screwed down spreading the collet and causing its jaws to grip the bushing.
Continued turning the core presses the core against bottom of the hole, forcing the collet to pull up the bushing.



Wrapping machine for bar products

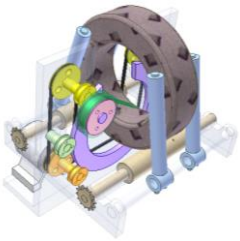
https://youtu.be/5B_NEMaa86E



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

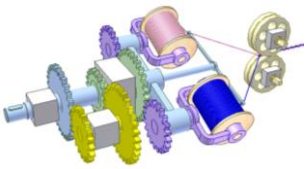
https://youtu.be/UknoNWF7xd0



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

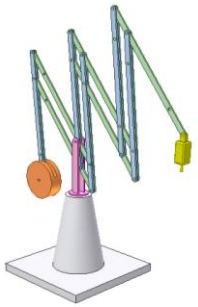
https://youtu.be/UT0FR6VhdcM



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.

Counterbalance bar system

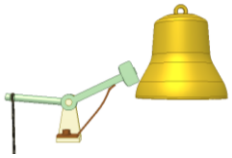
https://youtu.be/QlNrAMDR_qM



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

Hammer for striking bell 1

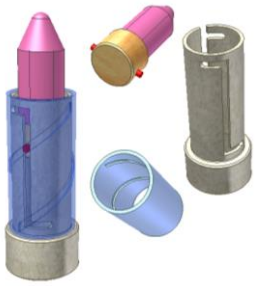
http://youtu.be/gT-QpjkZ6dA



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.

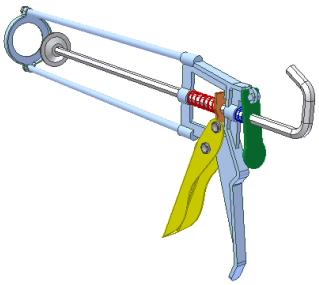
Hammer for striking bell 2
http://youtu.be/xikwuK-axb8
Input: green gear rotating continuously.
Output: pink oscillating shaft having a flat spring and a hammer.

Lipstick case 1
https://youtu.be/hs20LTttgrE
It is an application of the barrel cam.
Orange base of the pink lipstick has a pin (in red).
The pin slides in two Z-shaped slots of the beige rotary tube,
It also slides in two helical grooves of the blue stationary tube.
Turn the beige tube for moving the lipstick in-out. The lipstick is locked in the vertical direction at its end positions thanks to circular portions of the grooves in the beige tube. The lipstick rotates when moving up-down.

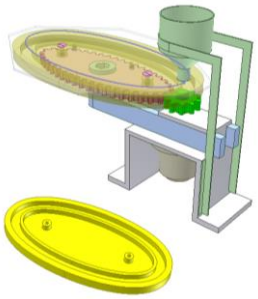


Equiment for pouring concrete
https://youtu.be/sPqfUsWcHrE
It is used for pouring concrete on a plane.
The mechanism has two degrees of freedom. Its motion is controlled by two motors (not shown) via two bevel gear drives.
Yellow and violet vertical pipes are coaxial with the rotation joints of blue bar.
The pipe connections at A and B are revolution joints.
Red arrow represents input concrete flow from the pump.
Blue arrow represents output concrete flow.

Silicone sealant gun
https://youtu.be/gzwalLFBNHg
Pull and release yellow trigger continuously to move white piston rod forwards.
For moving the piston rod backwards first make the green latch perpendicular to the piston rod, then pull the piston rod backwards (last scene of the video).
The latches (in green and orange) can influence the rod motion only when they are not perpendicular to the rod.
At slanting positions the latches prevent their relative motion with the rod in direction that tends to make them more slanting. Friction forces play crucial role here.
Hexagon holes of the latches must be a little larger than hexagon section of the rod to allow the latches to be slanting.
This slanting latch mechanism is a good replacement for ratchet mechanisms in case of small load.
See a relevant mechanism:
http://youtu.be/uzqd1rKp5qQ



Automatic spraying glue machine



https://youtu.be/Yk12c8PKPk8

Input: green gear of beige motor.

Blue slider carrying oval gear that engages with the green gear moves along stationary runway. Yellow groove cam maintains contact between two gears.

Nozzle of green glue container sprays glue on white plate tracing an oval (in blue). It is an equidistant curve to the rolling oval of the oval gear.

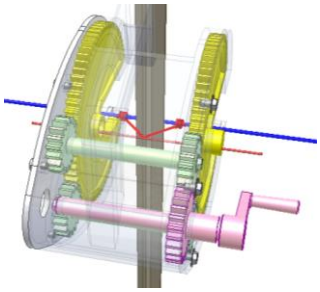
The nozzle and the green gear are coaxial.

Advantages:

- Constant speed of the nozzle along the blue oval.
- Motor and glue container are grounded.

It's possible to replace gear drive with friction one if making non-circular gear is not wanted.

Fence tool



https://youtu.be/XRhAhc-c7J4

Insert the red wire into holes of yellow gears and turn the pink handle to twist the red wire for binding horizontal wires (in blue) to brown posts of the fence.

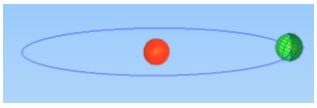
Yellow gears of large slots rotate around the blue horizontal wire thanks to green gears that ensure continuous transmission to the yellow teeth-uncompleted gears.

This video was made based on Fabriman fence tool (motorized and with the wire feeder) shown at:

https://youtu.be/ljUNktwbyqY

Sorry that the video can not show the deformation of the red wire during binding (Autodesk Inventor does not support that).

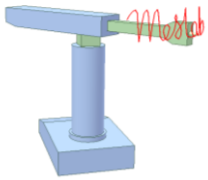
Inventor Earth motion



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