Four Bar Mechanism

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(thanks to Wikipedia and many others)

http://www.library.cmu.edu/ctms/ctms/examples/motor/motor.htm

Steam Engine

- Who invented the steam engine?

Aelopile

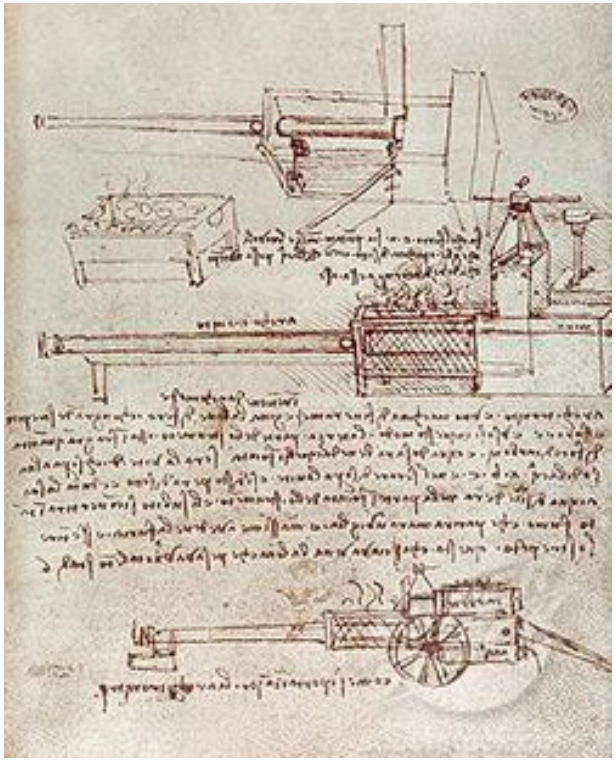
- Ball of Aeolus

- Hero Engine
- Described by Vitruvius, 1AD

- Probably Ctesibius, 200BC

Early Engines

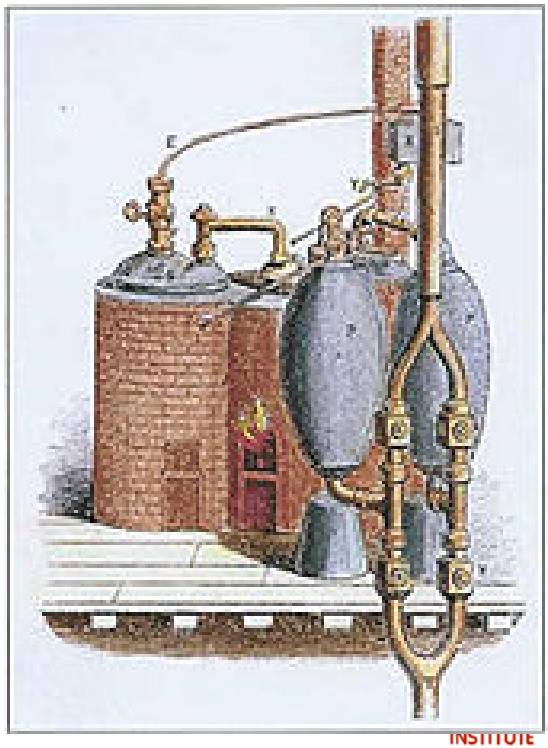
- DaVinci, Architonnerre, 15th Century
  - Gives credit to Archimedes
  - Steam powered cannon



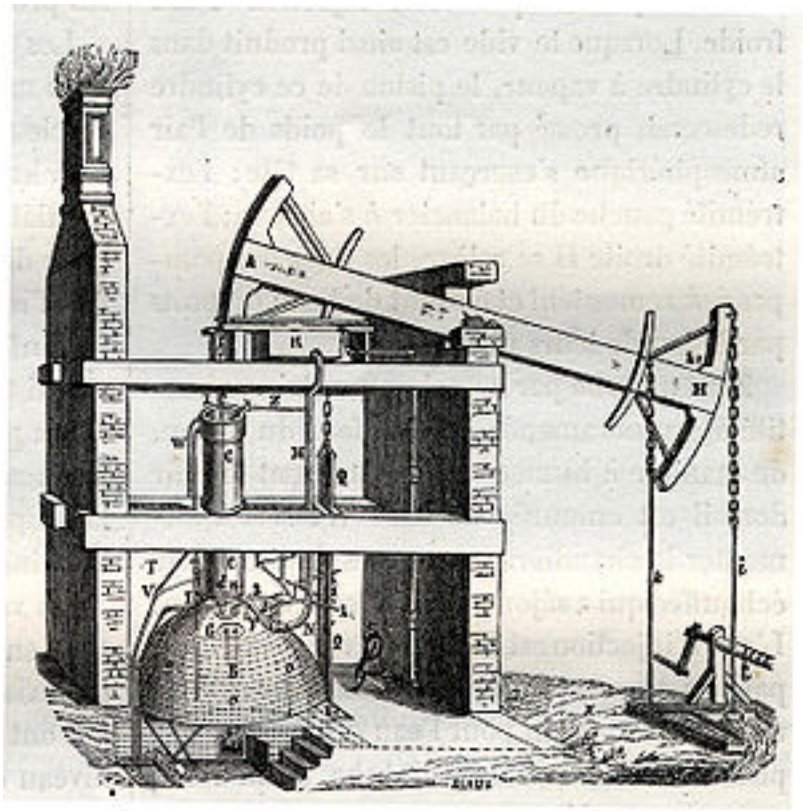
- Jerónimo de Ayanz y Beaumont
  - Patented first steam engine / pump 1606

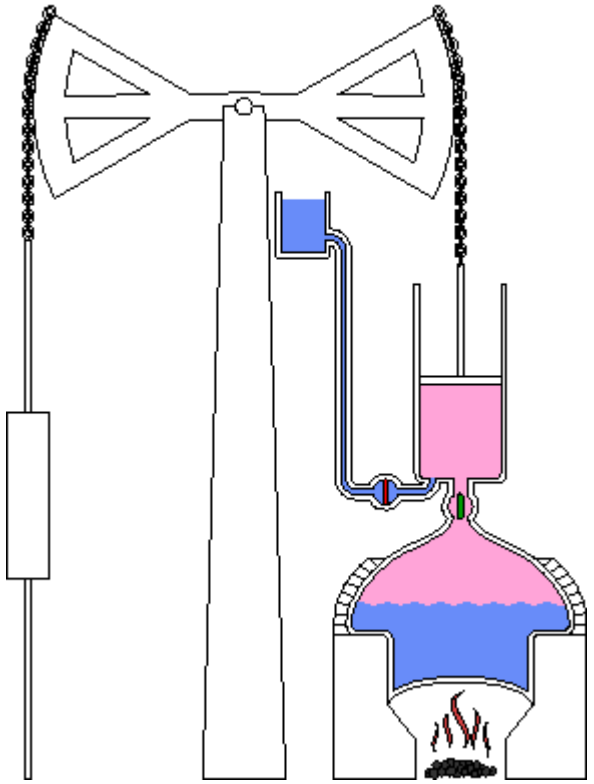
Thomas Savery

- First engine applied to industry, 1698, 14-21 year vague patent, drain mines
- Operation
  - Condensed steam produced a partial vacuum in the pumping reservoir and using that to pull the water upward.
  - Rapidly cool the steam to produce the vacuum by running cold water over the reservoir.
- Problems
  - A lot of wasted heat
  - High pressure stressed engine
  - Needed lots of pumps for longer distances
  - Atmospheric pressure only worked so well (30 ft)



Newcomen: Atmospheric Engine, 1712





Newcomen: Atmospheric Engine, 1712

Drain mines, 150 ft

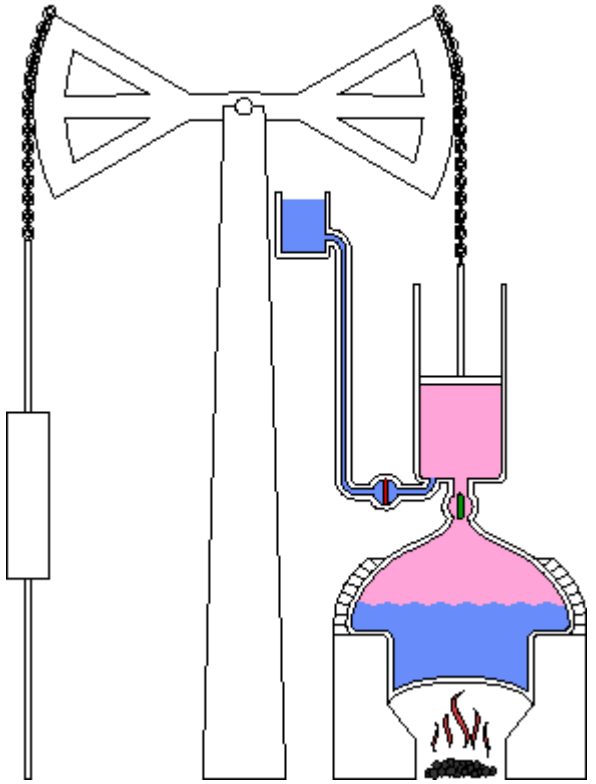
Used steam and cold water to create a vacuum

Vacuum pulled piston (not the water)

Pivoted beam connected to pump and piston with chains

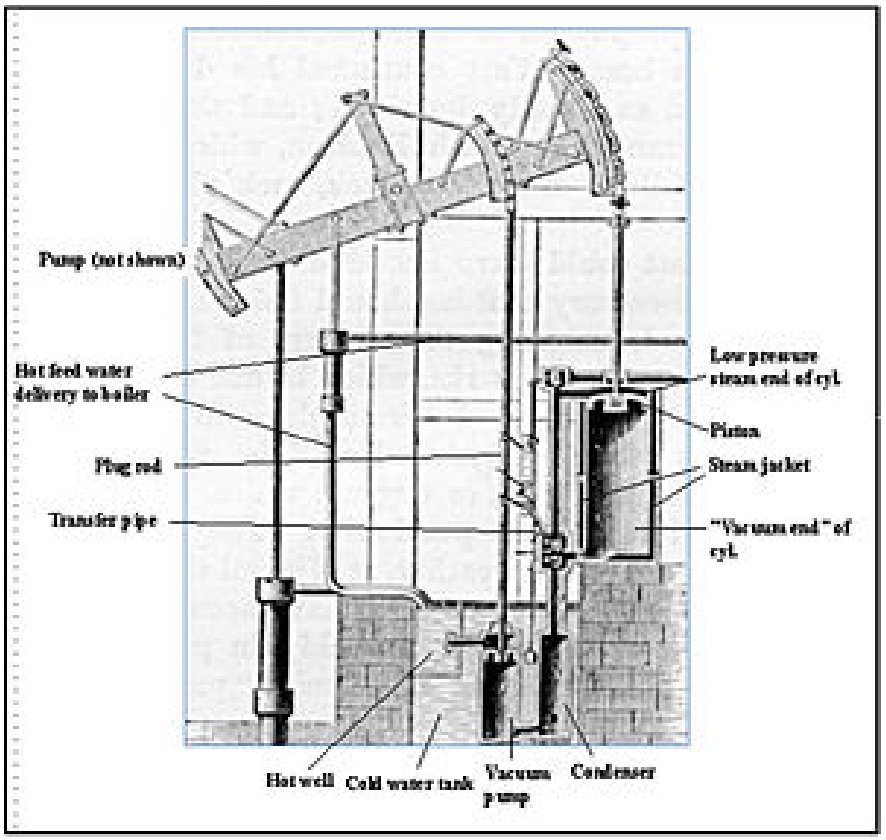
John Smeaton made improvements

Watt thought 80% Inefficient (heat loss)



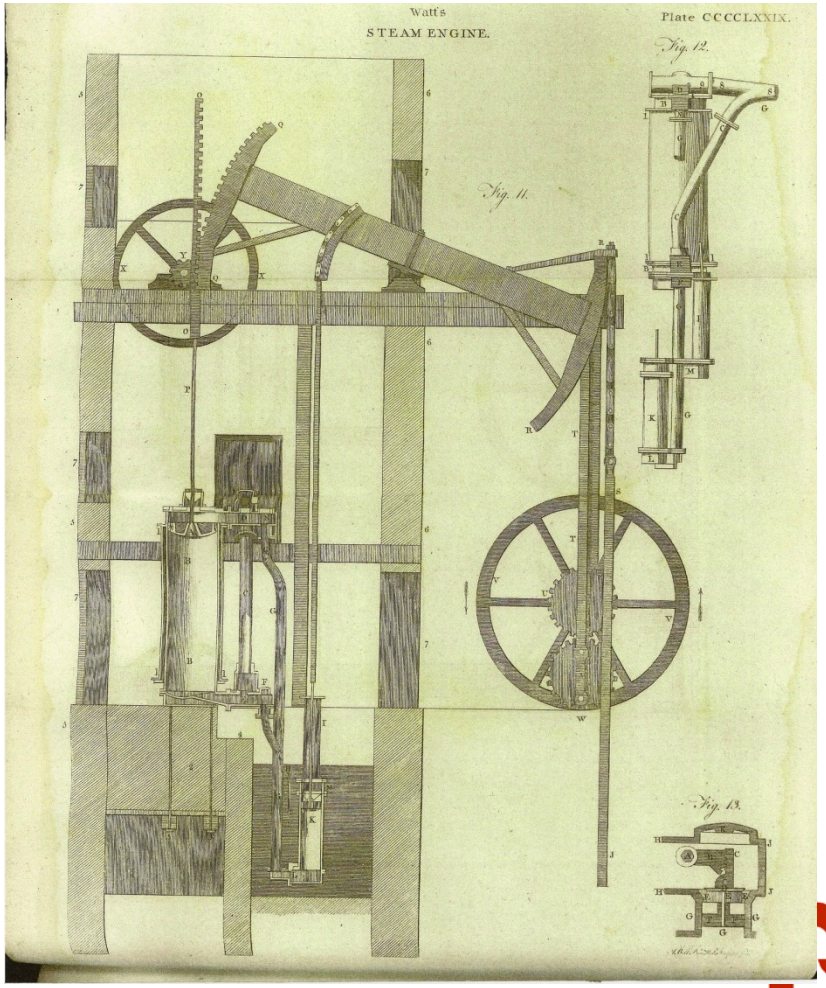
Watt Engine

- Used steam pressure just above atmospheric pressure (Separate condenser)
- Rotary motion (piston-beam connection)
  - Get value on both sides of stroke
  - Useful for machines
- Mathew Boulton – business partner

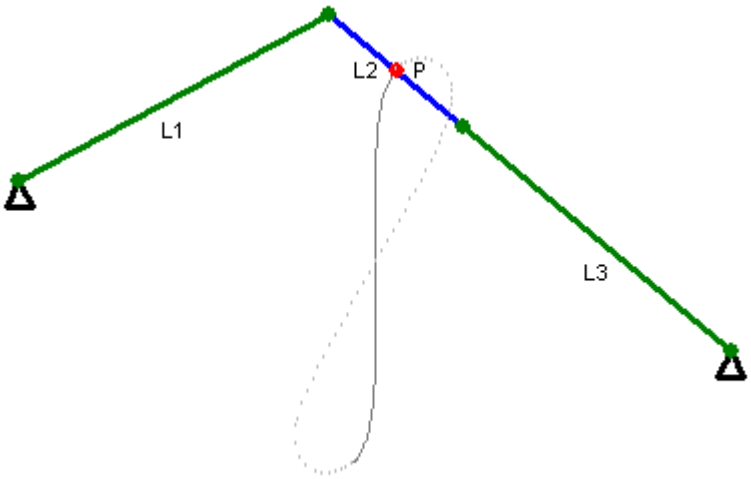


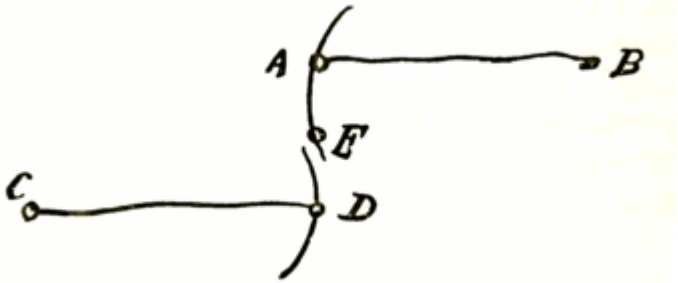
Watt Engine

- Used steam pressure just above atmospheric pressure (Separate condenser)
- Rotary motion
  - Useful for machines
- Double acting
  - Get value on both sides of stroke
- Mathew Boulton – business partner



Watt's Four Bar





L1 = L3

L1 > L2

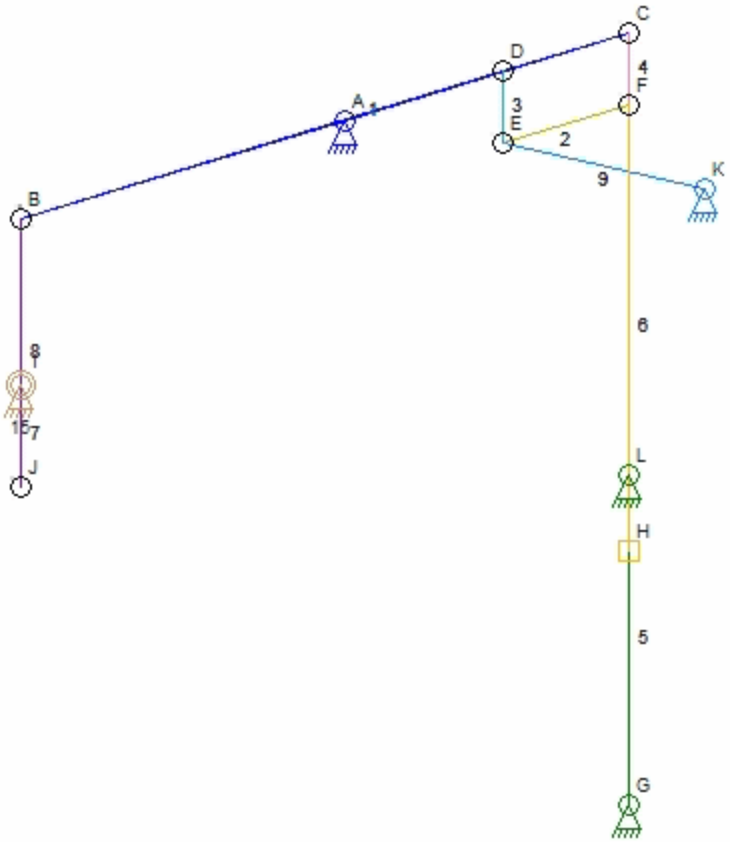
P mid point of L2

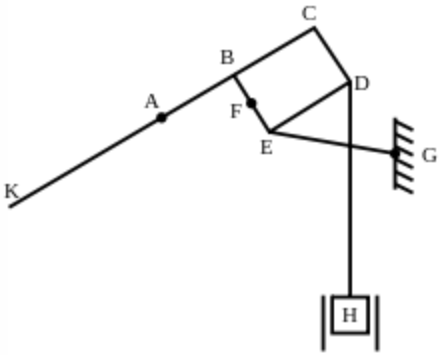
Ground link?

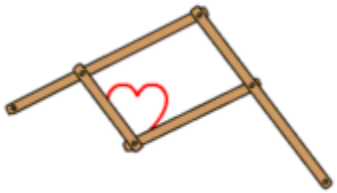
Hand-drawn diagram by James Watt (1808) in a letter to his son, describing how he arrived at the design

"I am more proud of the parallel motion than of any other invention I have ever made," letter to his son

Watt's Parallel Motion

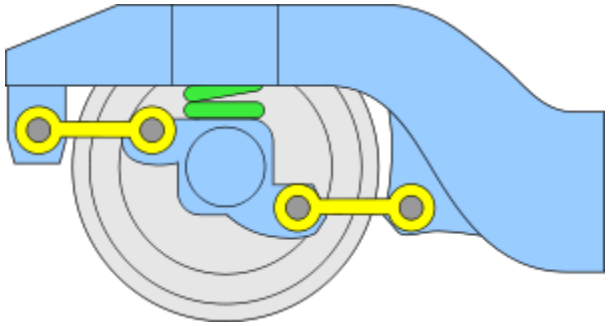


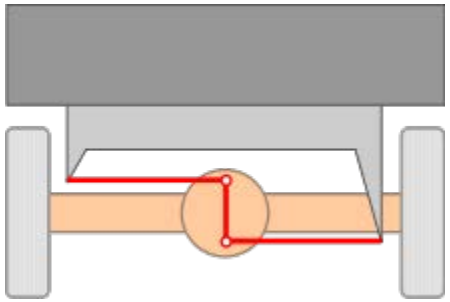


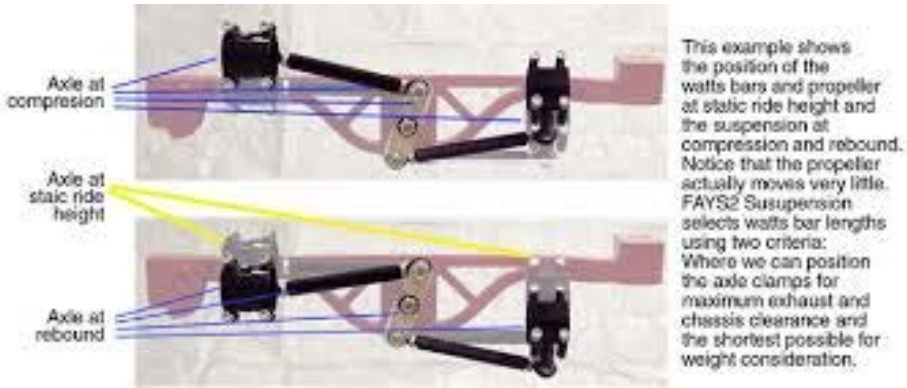


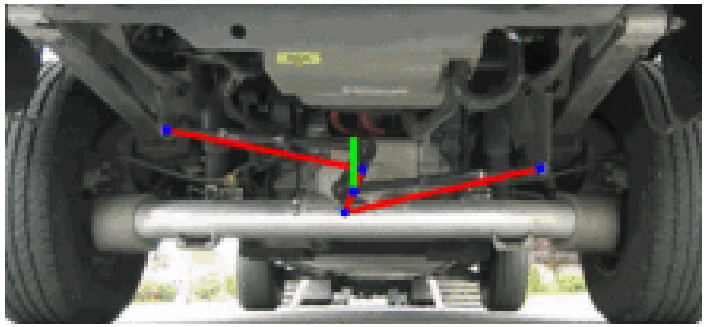
Pantograph, 1603
Christopher Scheiner

Automobile Suspension



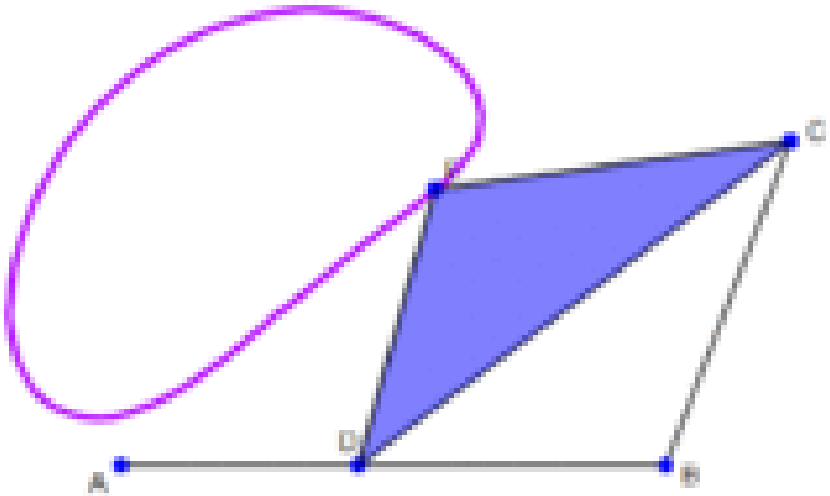


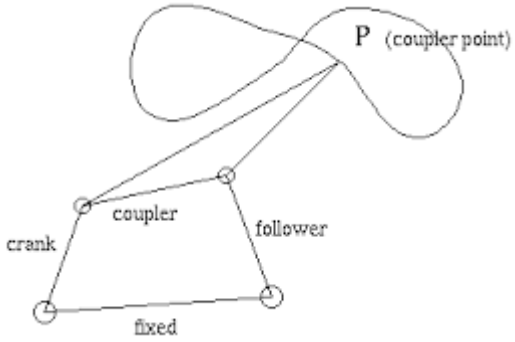


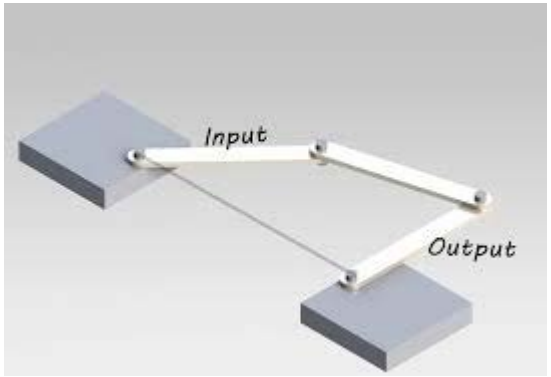


Range Rover EV 1998

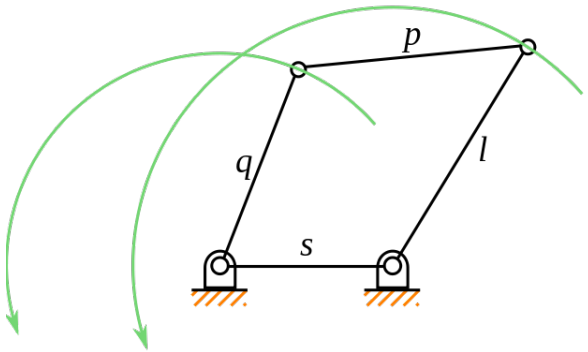
Four Bar Mechanism





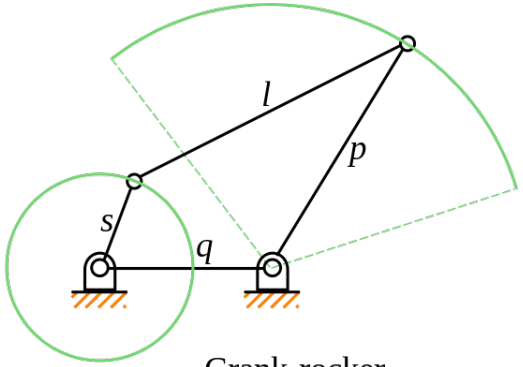


Grashof condition

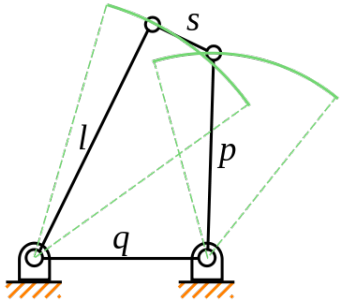


full revolution
both links

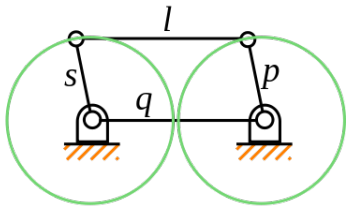
Drag-link
$s+l > p+q$
(continuous motion)



Crank-rocker
$s+l < p+q$
(continuous motion)



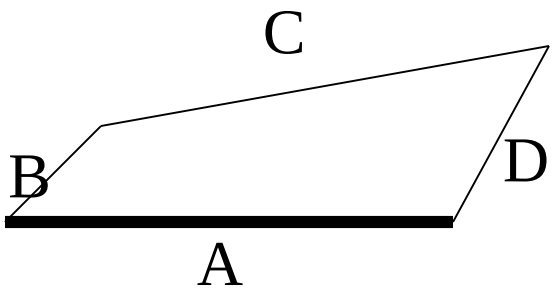
Double-rocker
$s+l > p+q$
(no continuous motion)



Parallelogram linkage
$s+l = p+q$
(continuous motion)

If the sum of the shortest and longest link of a planar quadrilateral linkage is less than or equal to the sum of the remaining two links, then the shortest link can rotate fully with respect to a neighboring link

Uses of Four-bars



- A – ground link
- B – input link
- C – coupler
- D – output link

- Function Generation (input/output relation)
- Line Path Generation (line on coupler)
- Point Path Generation (coupler point)
- Coupler configuration Generation

Cool Interactive Web Site

- https://courses.engr.illinois.edu/tam212/aml.xhtml
- Prof. Dullerud at UIUC
- Motion Gen http://www.stonybrook.edu/commcms/motiongen/