

Introduction. Structural synthesis

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1. Kinematic synthesis of mechanisms

Ampère defined the *Kinematics* as “the study of the movement of the mechanisms and the methods for originate them”. The first part of this definition is related to the Kinematic Analysis and the second part with the Synthesis of Mechanisms

The *Synthesis of Mechanisms* is the part of the Kinematics that take care to find the mechanism that allows to generate a given movement.

The problems of the synthesis of mechanisms can be classified of the following way:.

a. *Structural synthesis.*

a1) *Synthesis of type or Reuleaux.*

It deals with the types of bars and mechanisms to use (cams, gears, springs, levers) in the design, based on criteria of equivalence, goodness and diverse qualities of the mechanisms.

a2) *Synthesis of number or Grübler.*

b. It deals with about the degrees of freedom, the chains kinematics, the topology, isomorphism, investments, cinematic configurations of a number of bars given, mobility, etc.

c. *Dimensional Synthesis.*

b1) *Synthesis of generation of functions* or coordination of bars.

It deals with the problem to coordinate the input and output bars of a mechanism in a specified number of positions.

b2) *Synthesis of generation of trajectories.*

It deals with the problem to locate the points of the bars of a mechanism throughout pre-established trajectories.

b3) *Synthesis of guidance of the rigid body.*

It deals with the problem to locate one bar of a mechanism in a specified number of positions.

2. Structural synthesis of mechanisms

The Structural Synthesis is the part of the Synthesis of Mechanisms that deals with the topological and structural study of the mechanisms. The problem that is solved is the one of the selection of the types of mechanisms and the ways to form them, starting off of minimum global exigencies such as:

- Number of input and output bars of the mechanism.
- Degrees of freedom of the movement that is desired to obtain.
- Level of exigency or precision of the movement that is desired to obtain: trajectory, position, speed, acceleration, etc.

As it was mentioned in the previous chapter, the structural Synthesis includes the following:

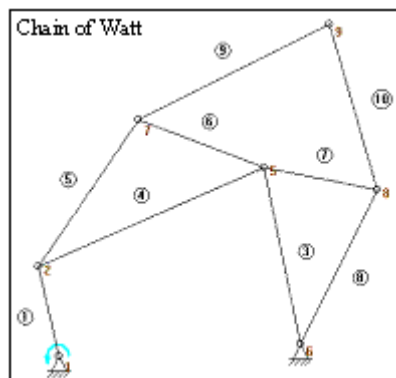
- Synthesis of type or Reuleaux.
- and the Synthesis of number or Grübler.

2.1. Synthesis of type or Reuleaux

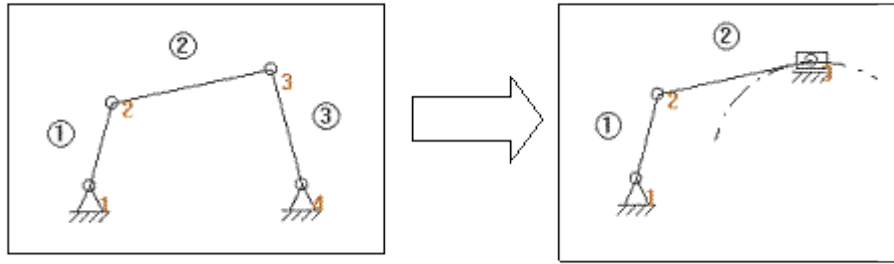
When the design or synthesis of a machine is approached, the first step consists in selecting the type of mechanism that allows to obtain the movements necessary to make the work for which it is tried to finally design and to construct to the mechanism and the machine. For the synthesis of the type of mechanism strict rules or laws do not exist, of there the enormous creativity that can be developed. Next simply some guidelines will be approached that can orient to the engineer at the moment for deciding on solutions or others.

Starting off with very elementary mechanisms like Slider Crank or Four Links mechanisms, some procedures to create other mechanisms are:

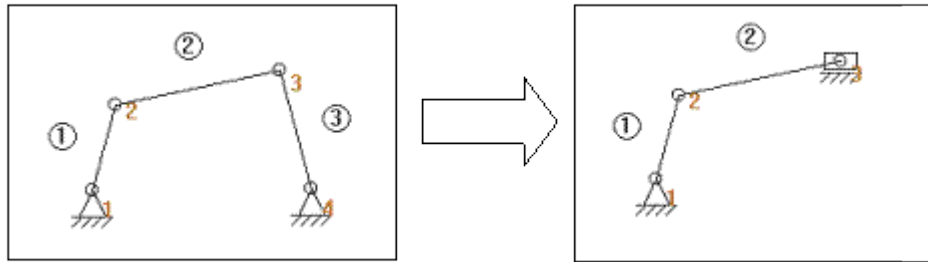
- Obtaining mechanisms by addition of pairing elements.



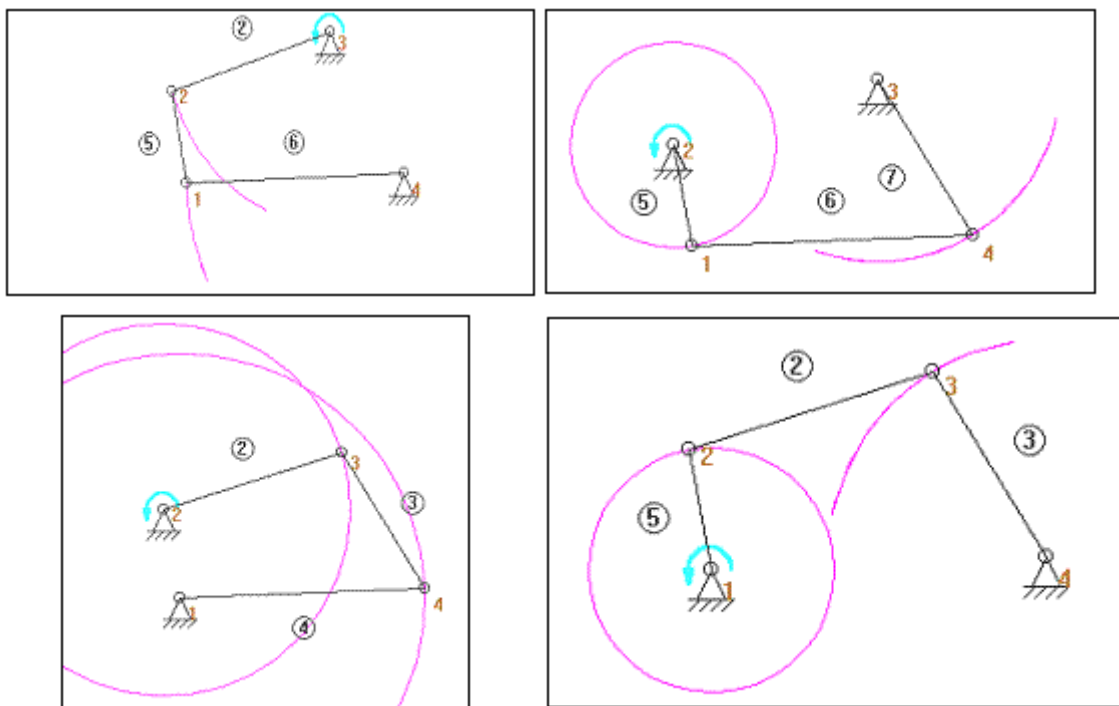
- Obtaining mechanisms from equivalence kinematics



- Obtaining mechanisms by degeneration kinematics.



-Obtaining mechanisms by inversion kinematics.



2.2. Synthesis of number or Grübler

Simultaneously that is selected the type of mechanism is necessary to analyse the mobility of the same one, like first verification of which the chosen mechanism will be able to make the movements that are going away to him to demand. This is the function that carries out the *synthesis of number*. Some important aspects that are considered in the synthesis of number are:

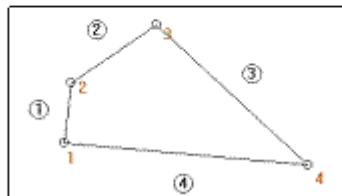
- Degrees of freedom of the cinematic chain or mechanism.

Laws of Grübler

Element	Degrees of Freedom
1 bench	0
(B-1) mobile bars	3(B-1)
p1 kinematic pairs R, P o H	-2p1
p2 kinematic pairs L.	-p2
Full Mechanism	$G = 3(B-1) - 2p1 - p2$

- Mobility of some special mechanisms.

Laws of Grashof

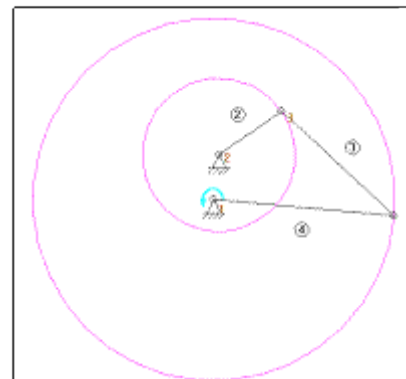


$l_1 < l_2 < l_3 < l_4$
In order l_1 turns 360° :
$l_1 + l_4 < l_2 + l_3$

If l_1 bench

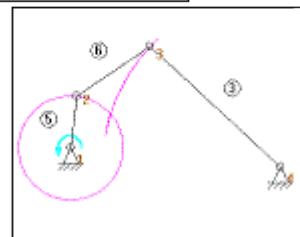
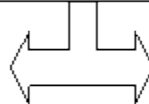


Double crank



If l_2 o l_4 bench (adjacent to l_1)

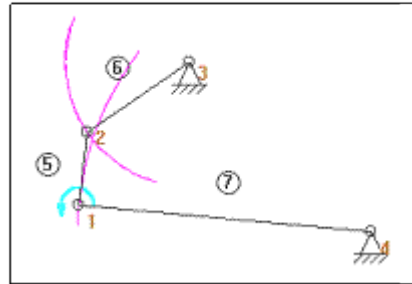
Crank-rocker



If l_3 bench (opposite to l_1)



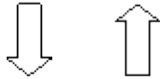
Double rocker



- Mechanical Advantage and Transmission Angle of the mechanism.

Mechanical advantage

$$\frac{M_4}{M_2} = \frac{w_2}{w_4} = \frac{R_{P_{24}-O_4}}{R_{P_{24}-O_2}} = \frac{R_{O_4-B'}}{R_{O_2-A'}} = \frac{l_4 \sin \gamma}{l_2 \sin \beta}$$



$$\cancel{V_{P_{24}}} = \cancel{V_{O_2}} + w_2 \times R_{P_{24}-O_2} = \cancel{V_{O_4}} + w_4 \times R_{P_{24}-O_4}$$

