

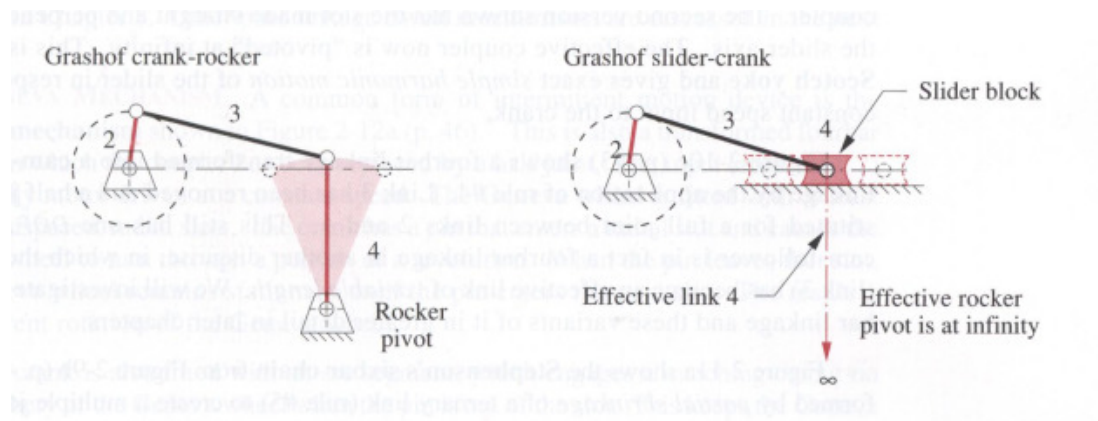
ME220 Theory of Machines and Machine Design

Lec 5 – 21 Jan 2020

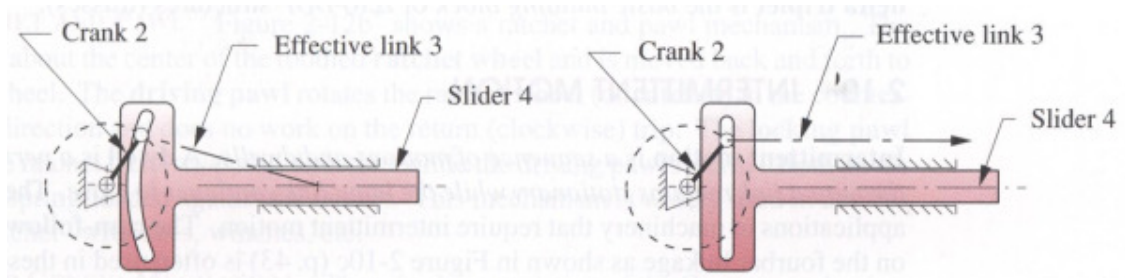
Linkage Transformations

- 1 Revolute joints in any loop can be replaced by prismatic joints with no change in *DOF* of the mechanism, provided that at least two revolute joints remain in the loop.
- 2 Any full joint can be replaced by a half joint, but this will increase the *DOF* by one.
- 3 Removal of a link will reduce the *DOF* by one.
- 4 The combination of rules 2 and 3 above will keep the original *DOF* unchanged.
- 5 Any ternary or higher-order link can be partially “shrunk” to a lower-order link by coalescing nodes. This will create a multiple joint but will not change the *DOF* of the mechanism.
- 6 Complete shrinkage of a higher-order link is equivalent to its removal. A multiple joint will be created, and the *DOF* will be reduced.

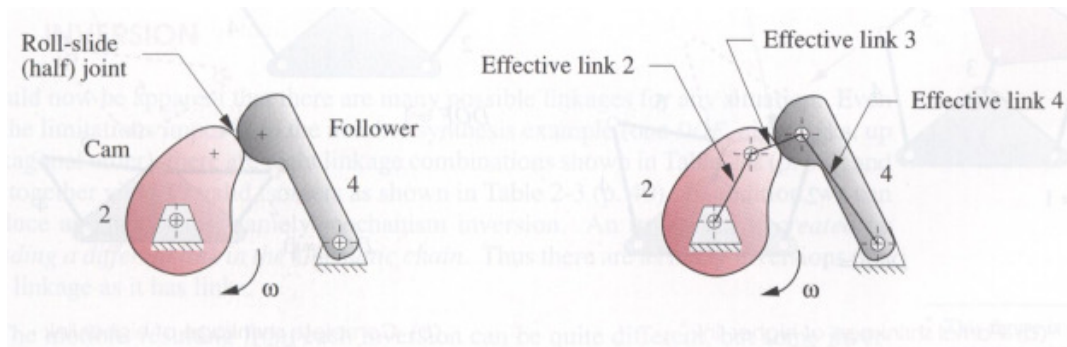
Transforming a Fourbar Crank-Rocker to a Slider-Crank



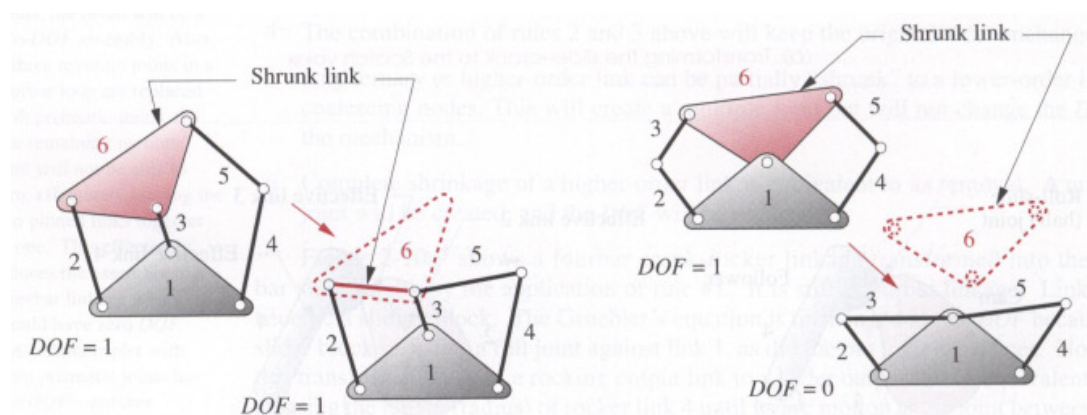
Transforming the Slider-Crank to the Scotch Yoke



Transforming Fourbar to Cam-Follower Mechanism



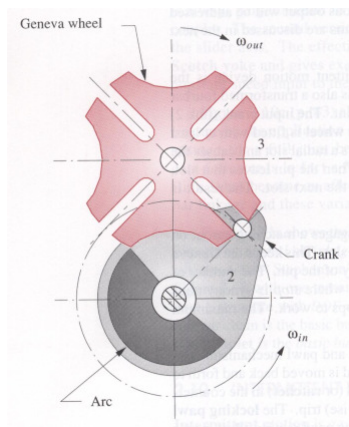
Shrinkage of Higher Links



Partial Shrinkage of higher links retains original DOF

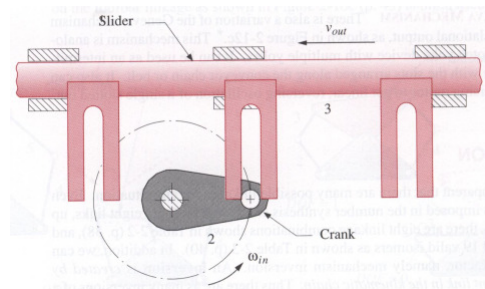
Complete shrinkage of higher link reduces DOF by one

Mechanisms for Intermittent Motions: Geneva Mechanism



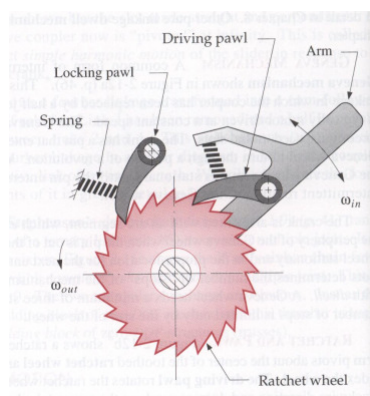
Four-Stop Geneva Mechanism

<https://youtu.be/85BsbnfRqA>



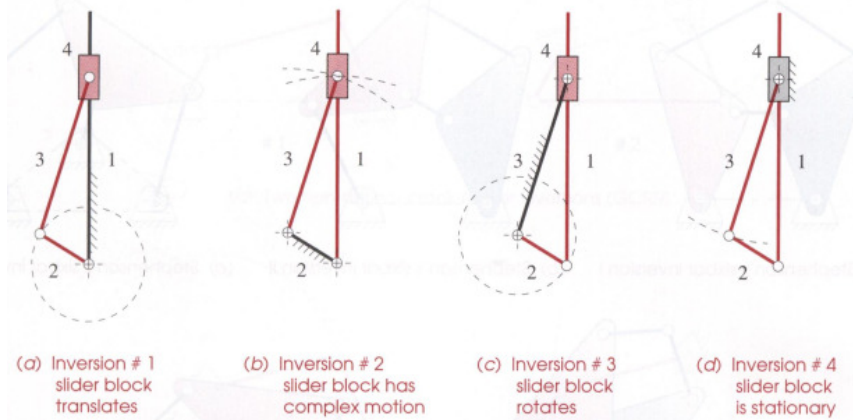
Linear Intermittent Motion 'Geneva' Mechanism

Mechanisms for Intermittent Motions: Ratchet and Pawl Mechanism



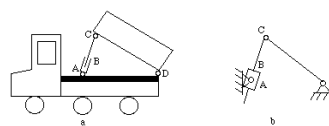
<https://youtu.be/eijyLC4ZzQk>

Inversions: Making a Different Link the Ground Link

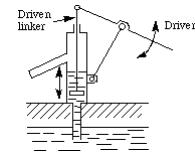


Example of Inversion # 1
An typical IC Engine
https://youtu.be/DKF5dKo_r_Y

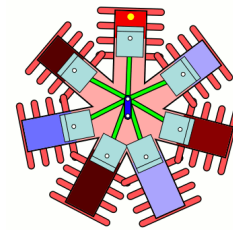
Example of Inversion # 2
A Quick Return Mechanism
<https://youtu.be/QOwwCKxywPo>



Example of Inversion # 3: A Dump Truck



Example of Inversion # 4: A Hand Water Pump



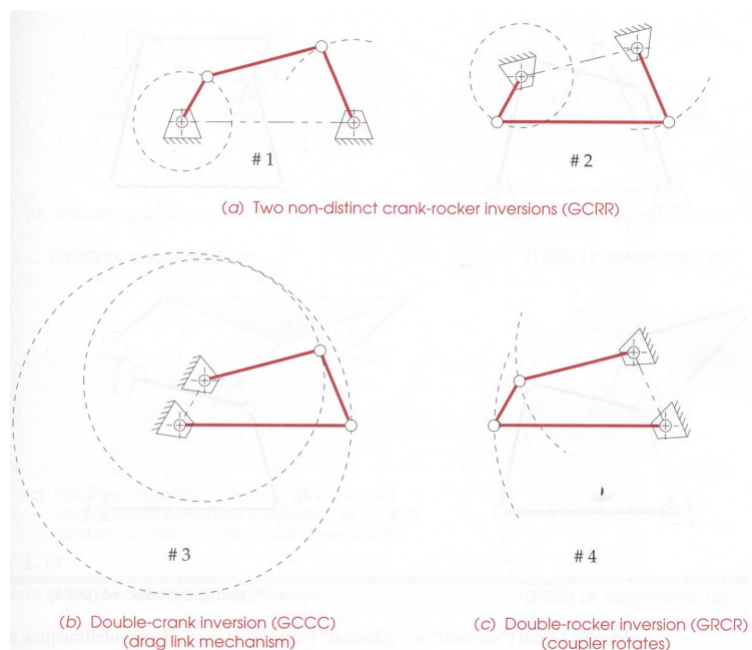
Another Example of Inversion # 2: A Rotary Engine with a Fixed Crank
https://en.wikipedia.org/wiki/Rotary_engine

Grashof Condition

S = length of shortest link
 L = length of longest link
 P = length of one remaining link
 Q = length of other remaining link

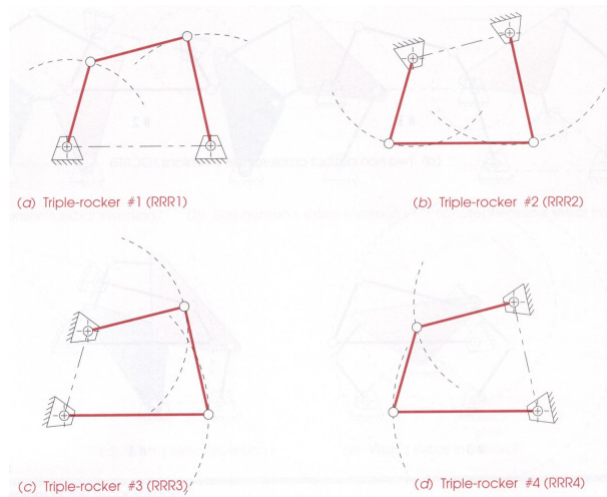
If $S + L \leq P + Q$ the linkage is called a Grashof linkage and atleast one link will be capable of making a full revolution.

- If the inequality is not satisfied then the linkage is non-Grashof and no link will be capable of a complete revolution relative to any other link.



Non-Grashof Case (Triple Rockers)

$$S + L > P + Q$$



All Inversions for the Non-Grashof Case lead to Triple Rockers