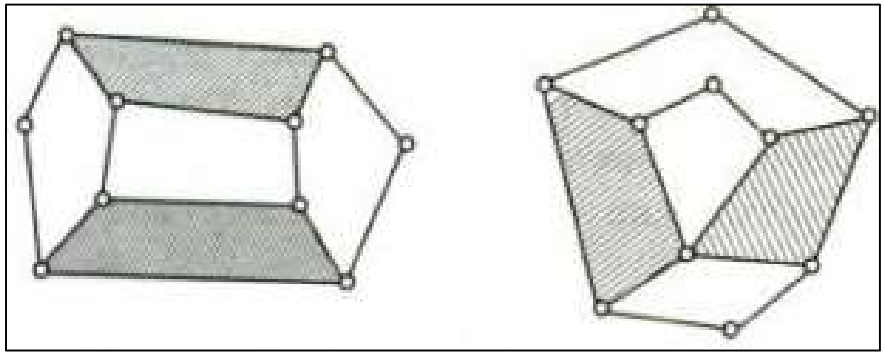
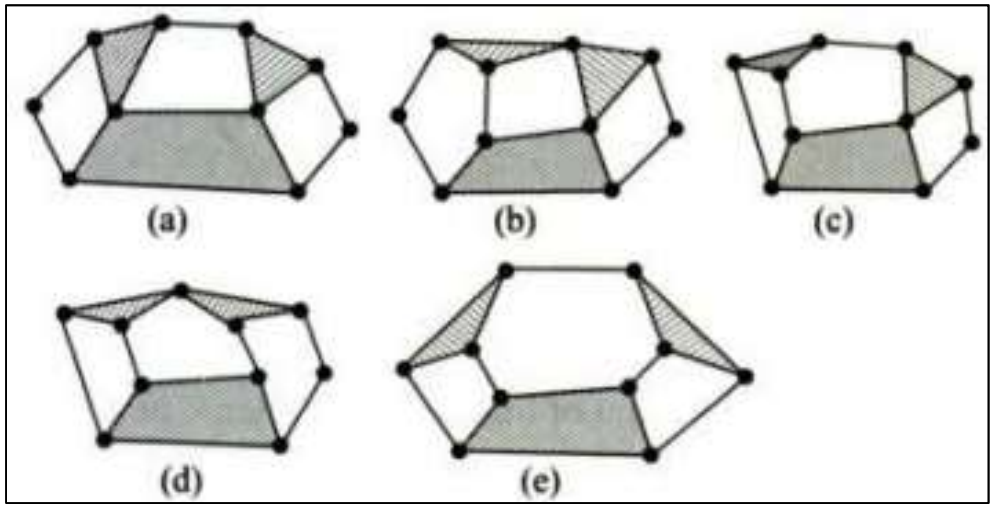
Possible link combinations for

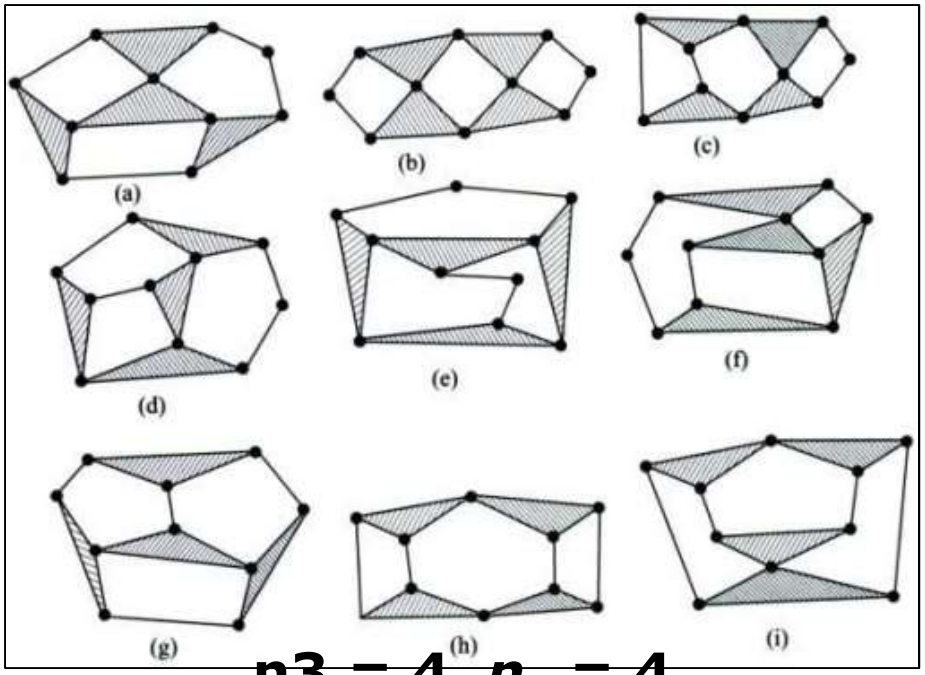
n = 8 & DOF = 1, j = 10



$n_4 = 2, n_2 = 6$



$n_4 = 1$, n3 = 2, $n_2 = 5$



n3 = 4, $n_2 = 4$

Grashof Crieterion

- **Comments on the feasibility and relative motion of lengths of 4-bar mechanism**
- ***s*** = shortest link length; ***l*** = longest link length; ***p, q*** = intermediate link lengths
- Link fixed to the ground is referred to as ***frame*** or ***fixed link***
- Link opposite to the fixed link is referred to as ***coupler*** or **connecting link**
- Link hinged to the frame are referred to as ***side links***
- A link which rotates through 360^{o} w.r.t a 2nd link is said to **revolve** w.r.t the 2nd link
- Side link which revolves w.r.t the frame is called ***crank***
- A link which doesn't revolve is called ***rocker***
- **Grashof chain**: $l + s < p + q$ ➔ At least one of the link will revolve
- **Non-Grashof chain**: $l + s > p + q$ ➔ All the links will rock (*Triple rocker*)

Consequence of Grashof criterion

Case	Shortest link (***s***)	Type of mechanism
1	Frame	Double crank mechanism
2	Coupler	Double rocker mechanism
3	Side link	Crank-rocker mechanism

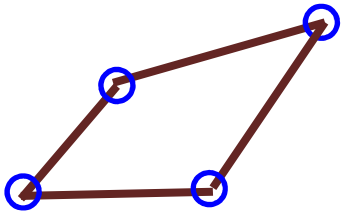
- The order of connection is immaterial for validity of Grashof linkage

Special Case: $s + l = p + q$

- Similar to Grashof chain except for the scenario of links becoming collinear
- Uncertainity configuration: All the links lie on a line. Need extra intervention
- If the linkage has two pairs of equal links:

Parallelogram linkage
(*Double crank mechanism*)

- Deltoid linkage: If the equal links are adjacent

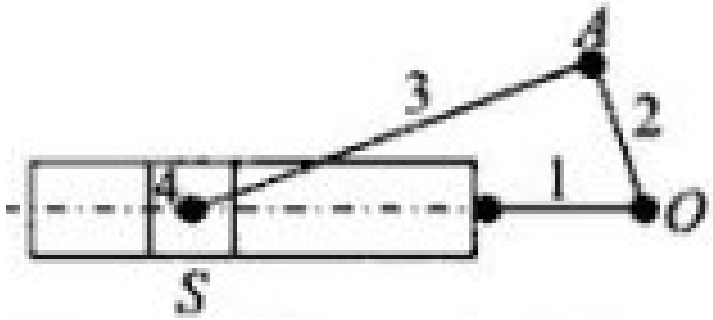


  - If the longer link is fixed, it leads to a crank-rocker mechanism
  - If the shorter link is fixed, it leads to a double crank mechanism

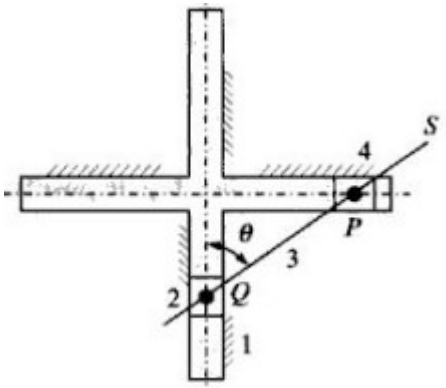
Inversion

- Mechanisms formed by choosing different link of a chain as frame are collectively termed as inversion of the given chain
- Number of inversion of chain = Number of links
- For a given chain, the relative motion between any two links remain unchanged, no matter which link is chosen as the frame
- The absolute motion will obviously be quite different since it is w.r.t the frame
- *Crank-rocker, double rocker, double crank* are the inversions of Grashof 4 bar linkage
- Two immediate extension of 4-bar mechanism (4R) are:

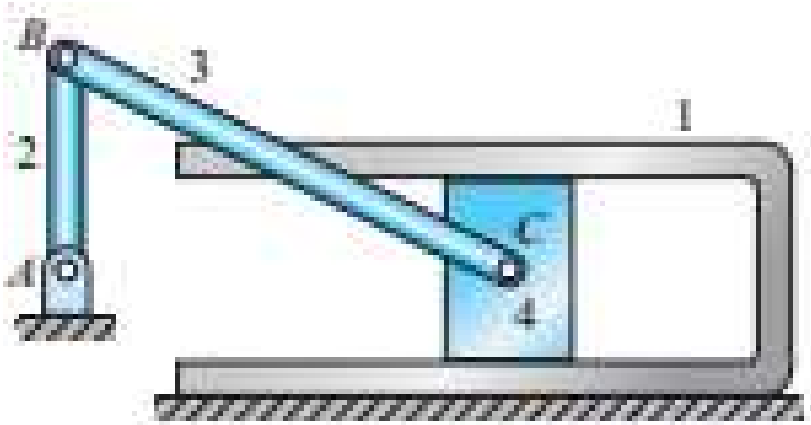
(i) 3R1P



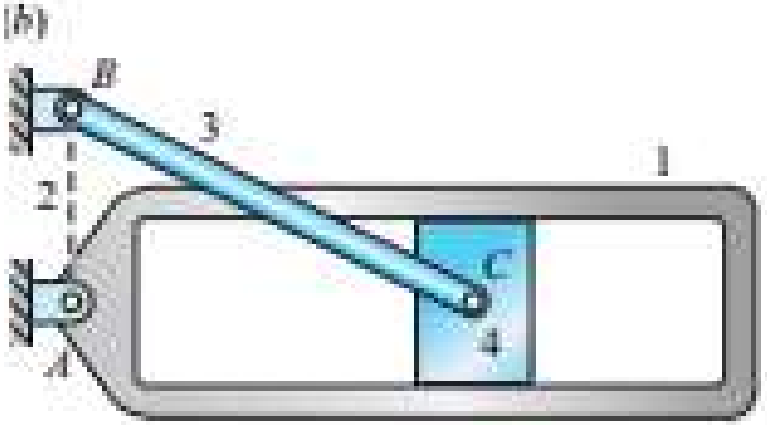
(ii) 2R2P



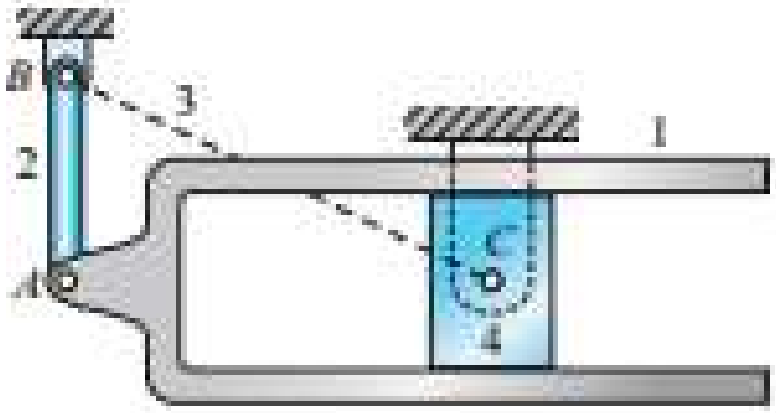
Inversion of 3R1P



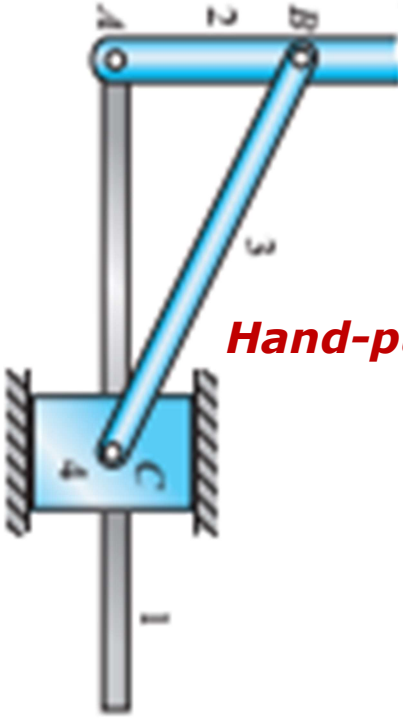
Slider-crank mechanism



Whitworth quick return mechanism

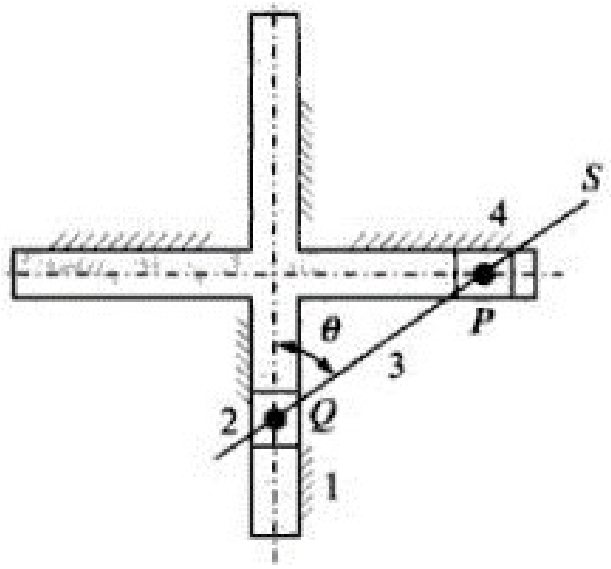


Slotted lever quick return mechanism

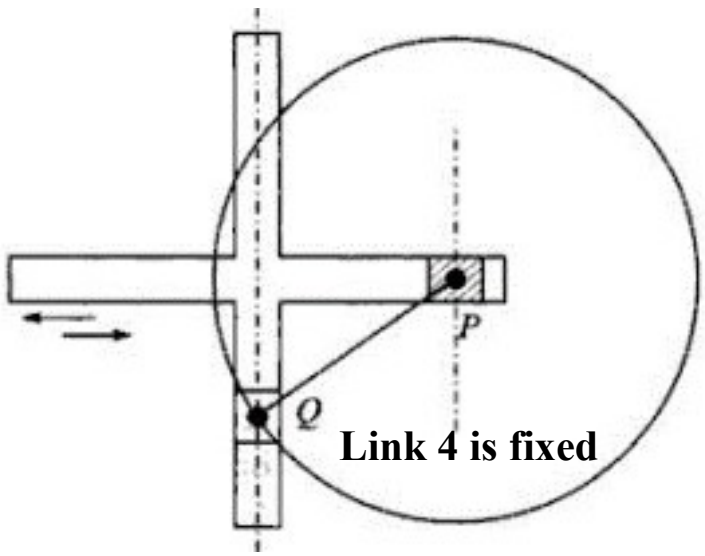


Hand-pump mechanism

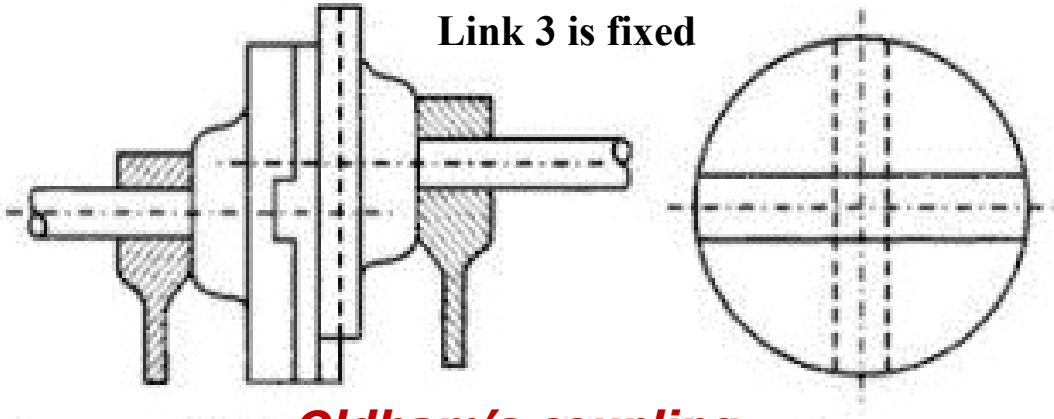
Inversion of 2R2P



Elliptical Trammel



Scotch-yoke mechanism



Oldham's coupling