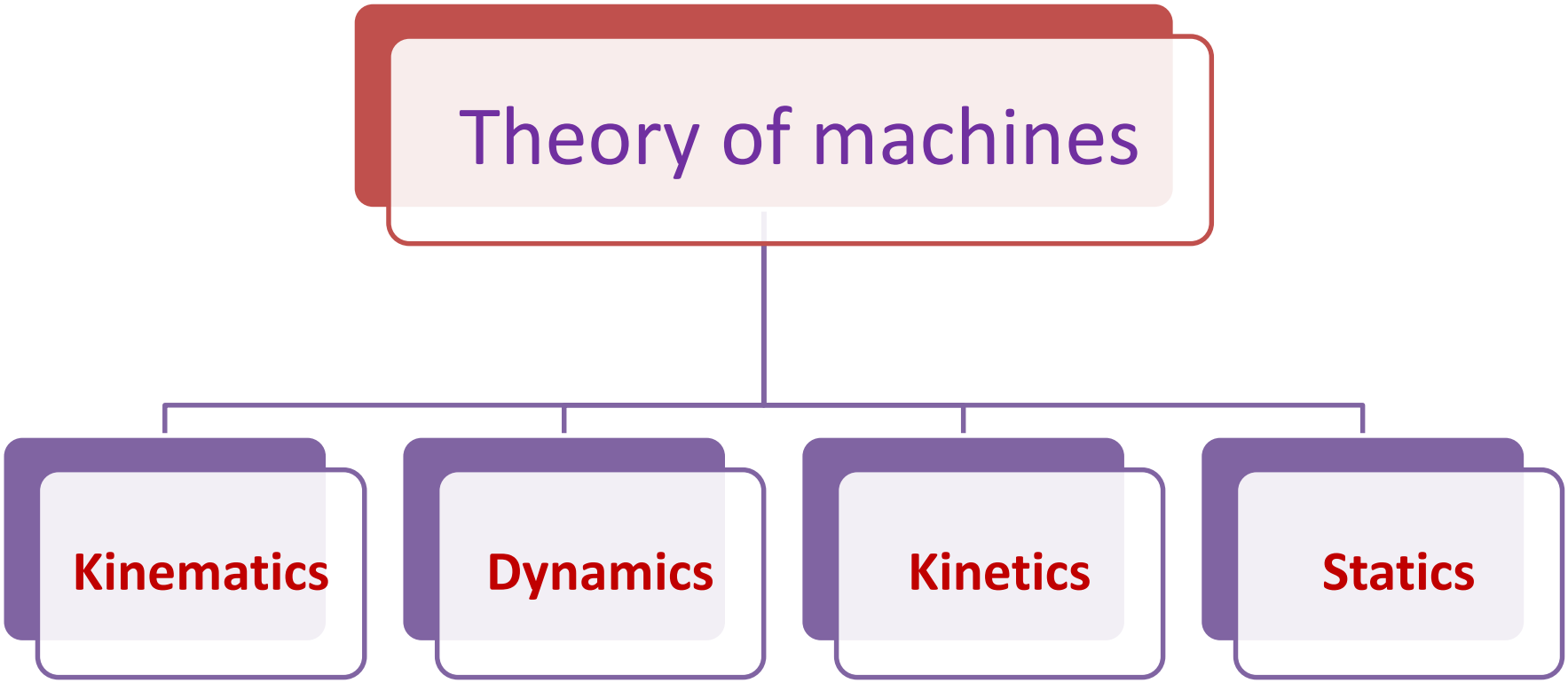
Subject-Theory Of Machine

Chapter-1-Basic Concept of Mechanism

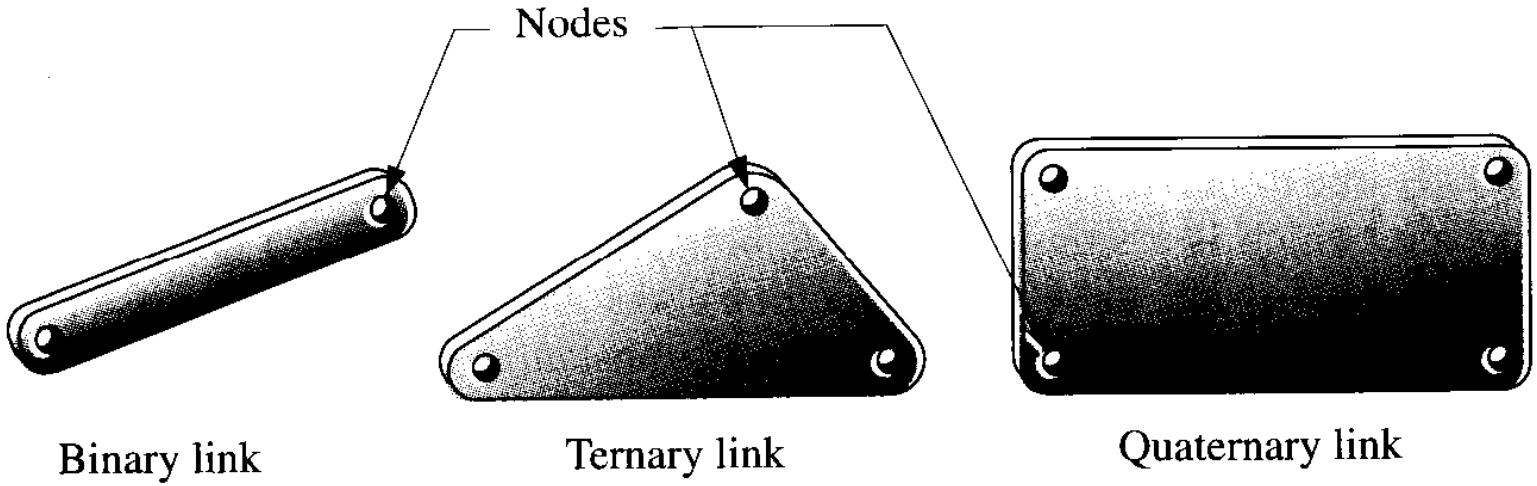
Prepared by :B. B. Sangame

Basic Concept of Mechanism

- Machine



- Link or Kinematic Link or Element



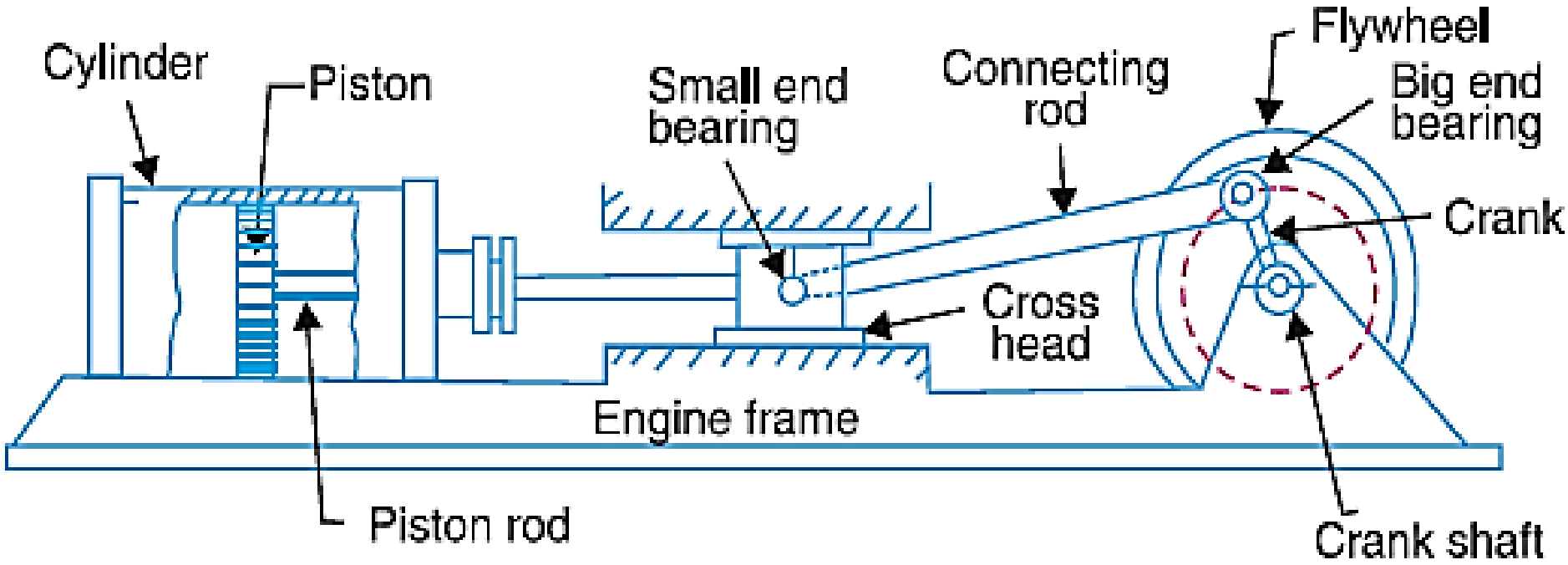
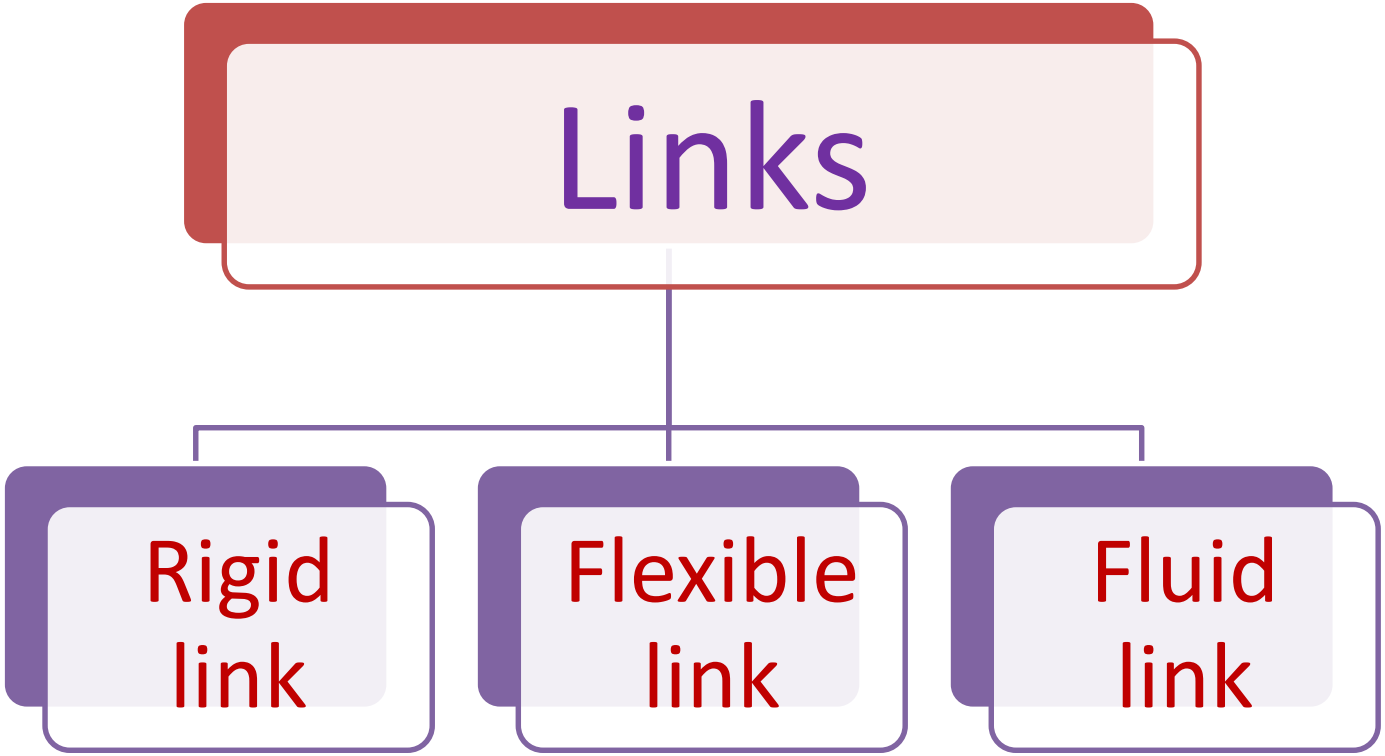


Fig. 5.1. Reciprocating steam engine.

- Types of Links



- Structure
- Difference Between a Machine and a Structure

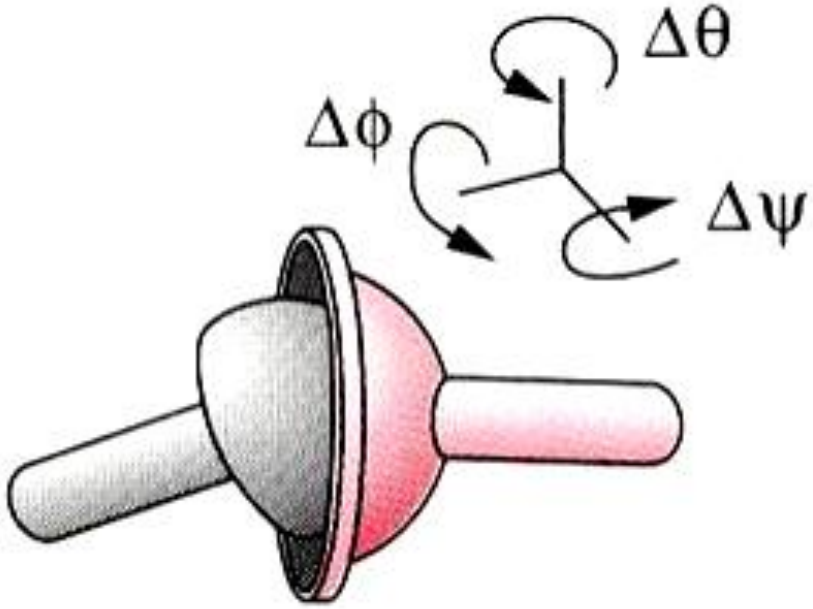
- **Kinematic pair**

Classification of Kinematic Pairs

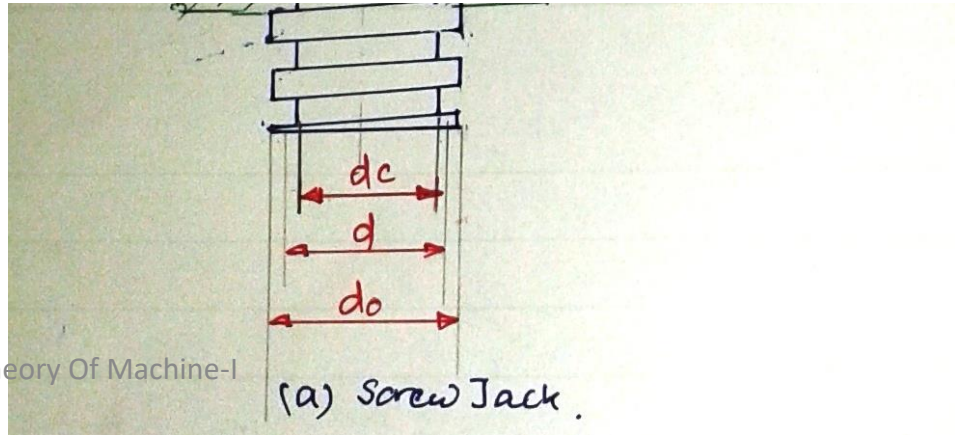
1. According to the type of relative motion between the elements
2. According to the type of contact between the elements.
3. According to the type of closure.

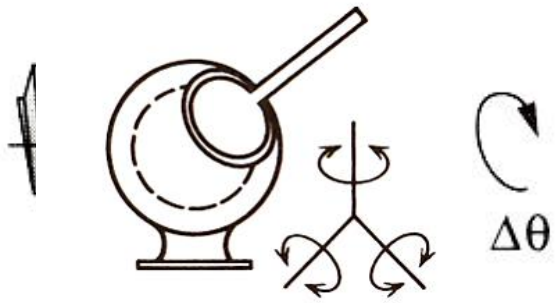
1. According to the type of relative motion between the elements

- (a) Sliding pair
- (b) Turning pair.
- (c) Rolling pair.
- (d) Screw pair.
- (e) Spherical pair.



Spherical (S) joint—3 *DOF*





2. According to the type of contact between the elements.

- (a) Lower pair
- (b) Higher pair.

3. According to the type of closure.

- (a) Self closed pair
- (b) Forced closed pair.

Types of Constrained Motions

1. Completely Constrained Motion
2. Incompletely Constrained Motion
3. Successfully Constrained Motion

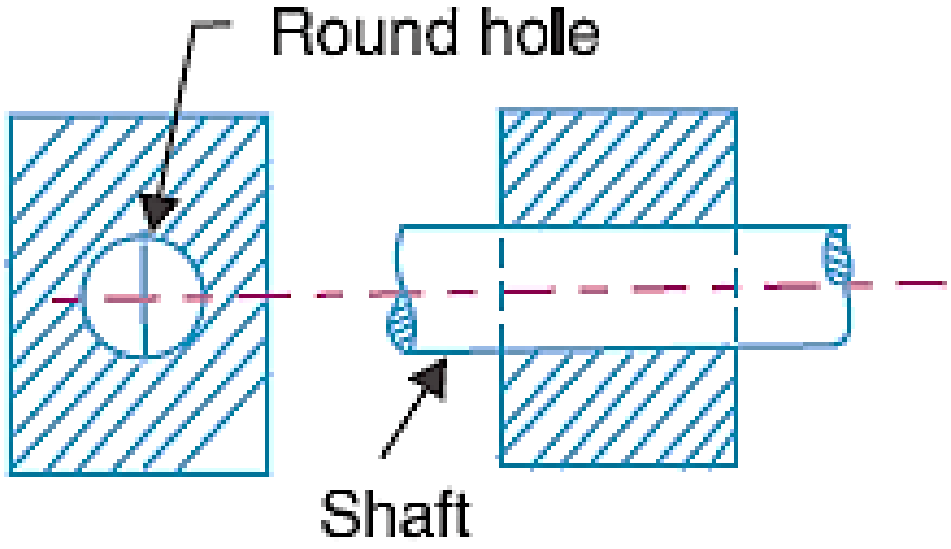


Fig. 5.4. Shaft in a circular hole.

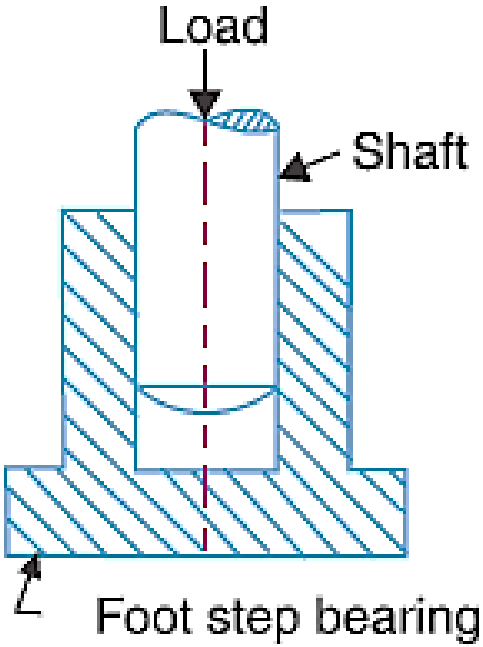


Fig. 5.5. Shaft in a foot step bearing.

- Kinematic chain

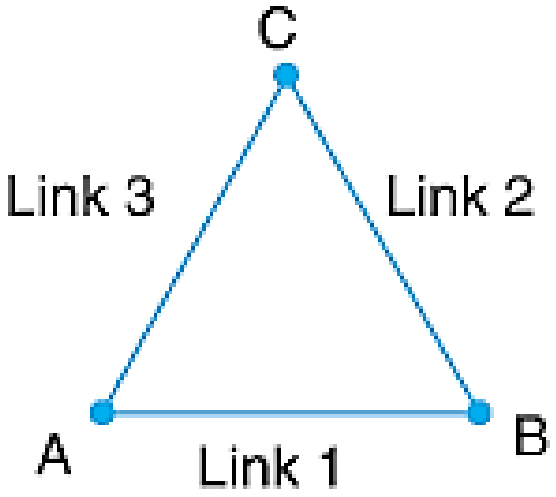


Fig. 5.6. Arrangement of three links.

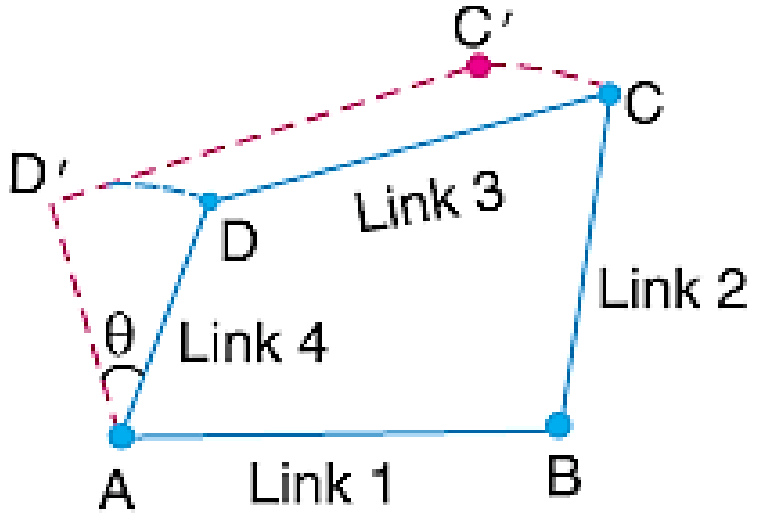


Fig. 5.7. Arrangement of four links.

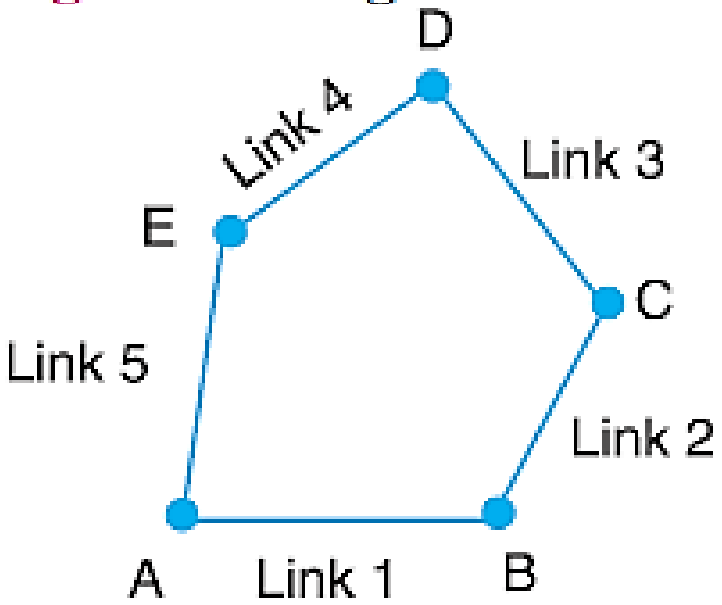


Fig. 5.8. Arrangement of five links.

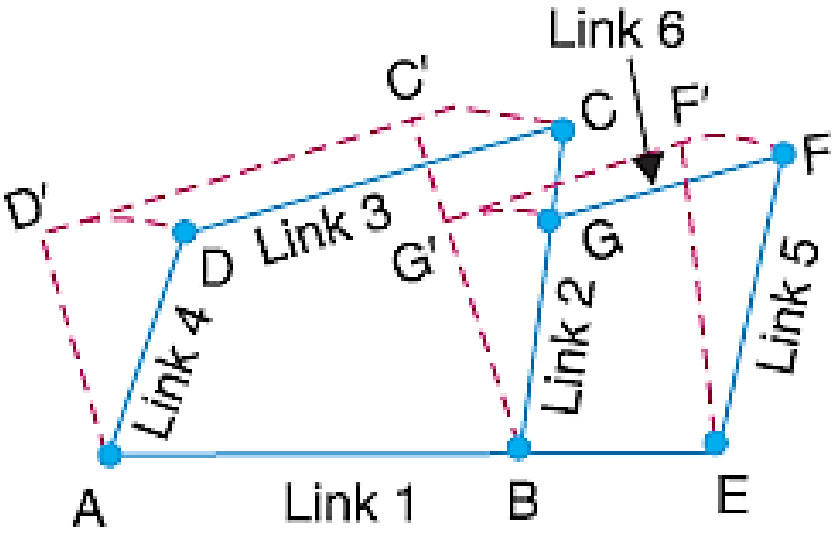


Fig. 5.9. Arrangement of six links.

Types of Joints in a Chain

1. *Binary joint*.

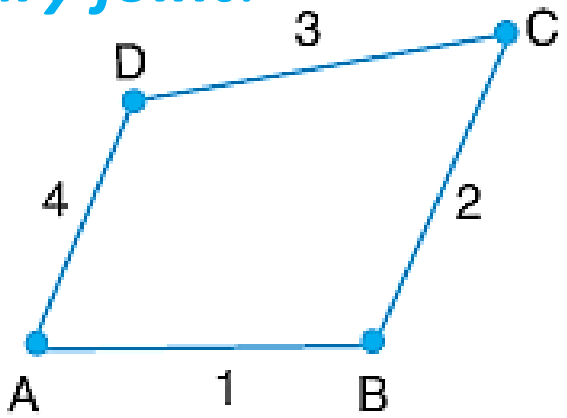


Fig. 5.10. Kinematic chain with all binary joints.

2. *Ternary joint.*

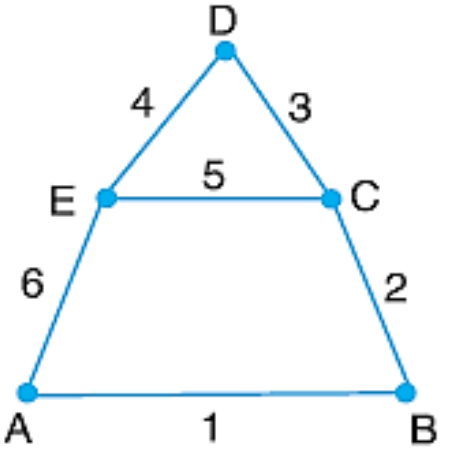
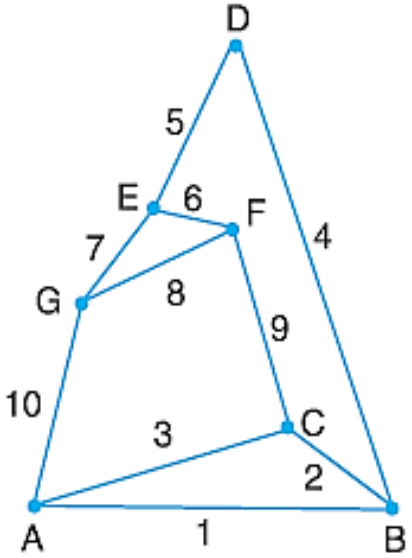
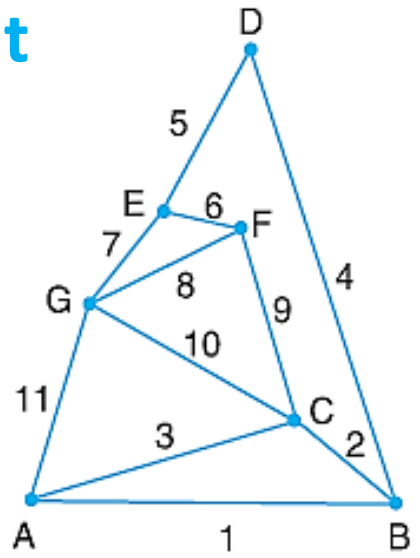


Fig. 5.11. Kinematic chain having binary and ternary joints.

3. Quaternary joint

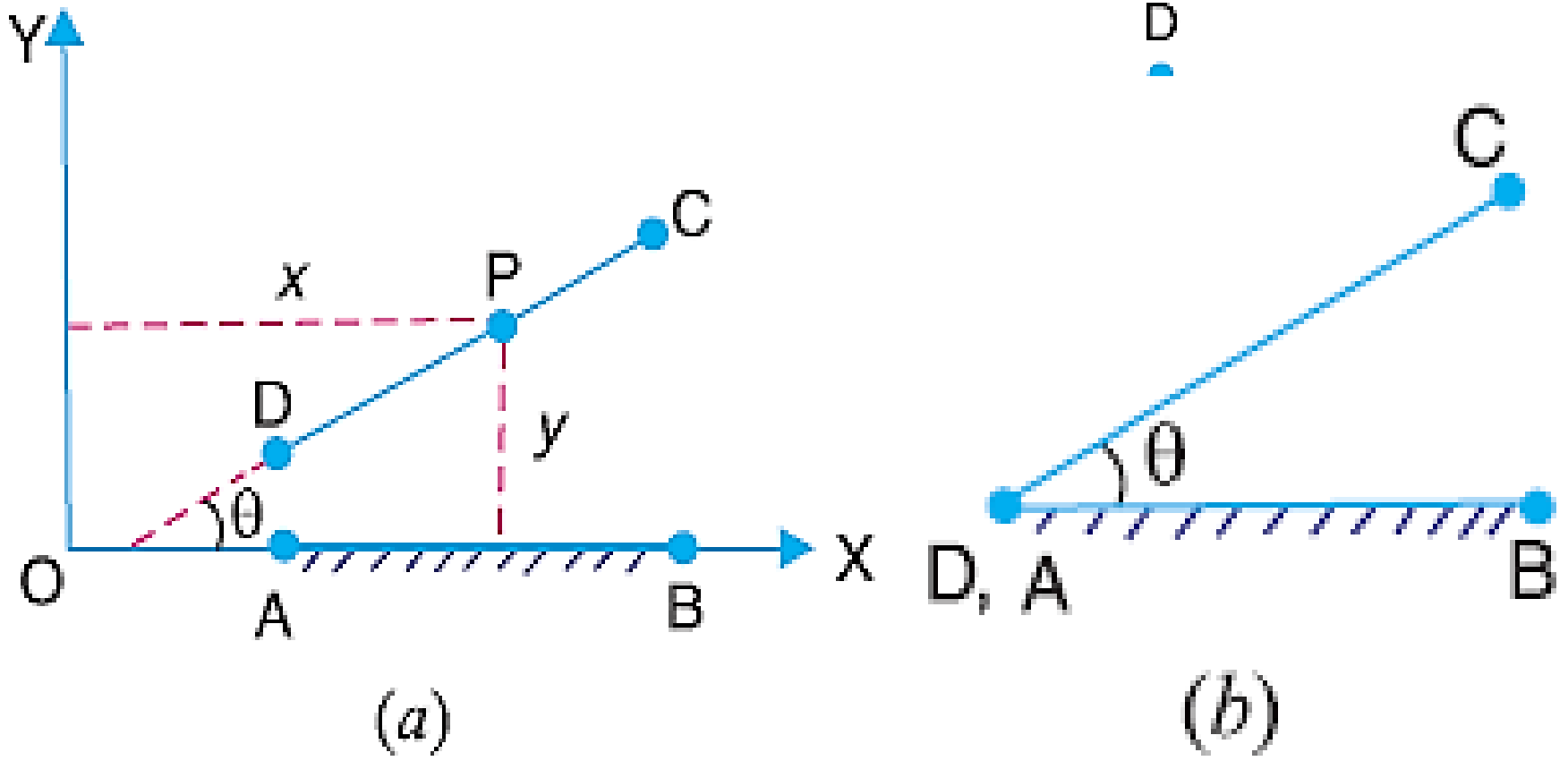


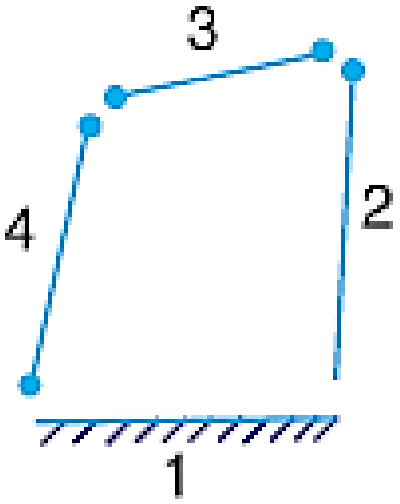
(*b*) Kinematic chain having binary and ternary joints.



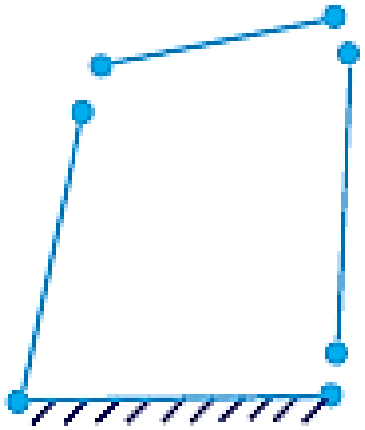
(*a*) Looked chain having binary, ternary and quaternary joints.

- Mechanism
- Number of Degrees of Freedom for Plane Mechanisms

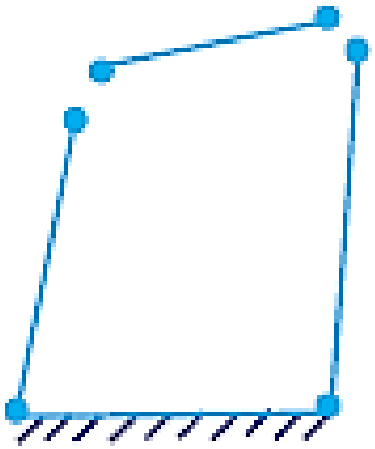




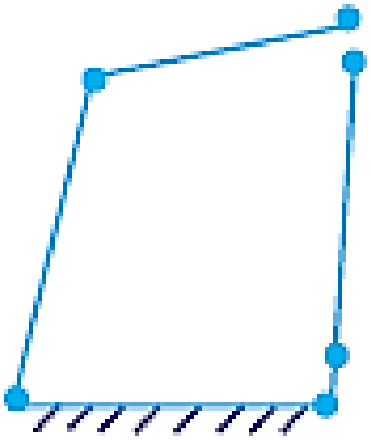
(a) $n = 9$



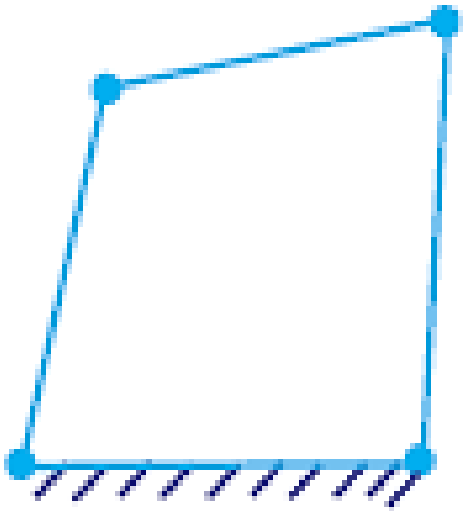
(b) $n = 7$



(c) $n = 5$



(d) $n = 3$

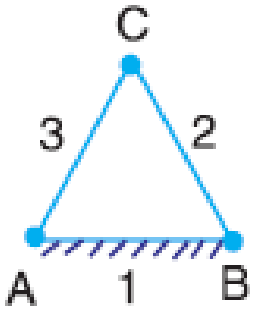


(e) $n = 1$

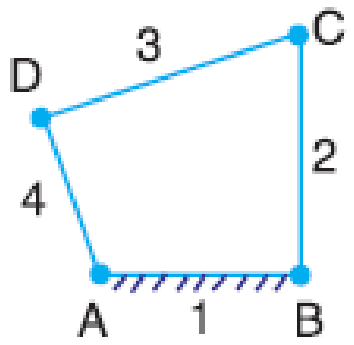
$$n = 3\,(l - 1) - 2\,j - h$$

- Application of Kutzbach Criterion to Plane Mechanisms

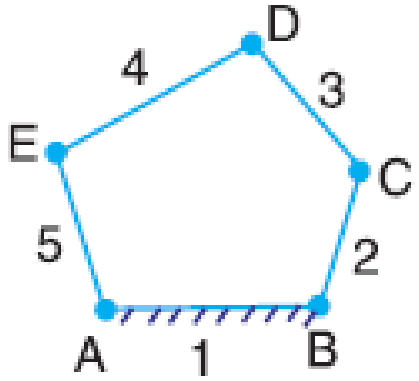
$$n = 3\,(l - 1) - 2j - h$$



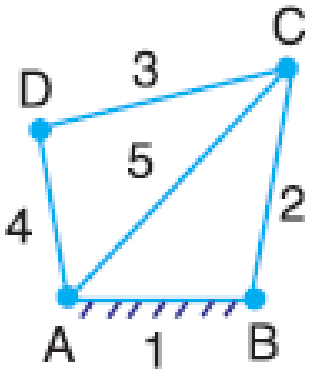
(*a*) Three-bar mechanism.



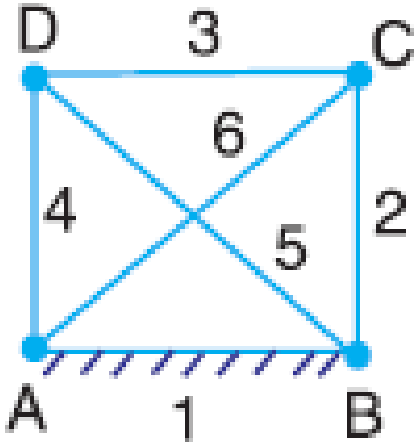
(*b*) Four bar mechanism.



(*c*) Five bar mechanism.



(*d*) Five bar mechanism.



(*e*) Six bar mechanism.

- Grubler's Criterion for Plane Mechanisms

$$1 = 3\,(l - 1) - 2\,j \qquad \text{or} \qquad 3l - 2j - 4 = 0$$

- Inversion of Mechanism

- Types of Kinematic Chains

1. Four bar chain or quadric cyclic chain,
2. Single slider crank chain, and
3. Double slider crank chain.

1. Four bar chain or quadric cyclic chain

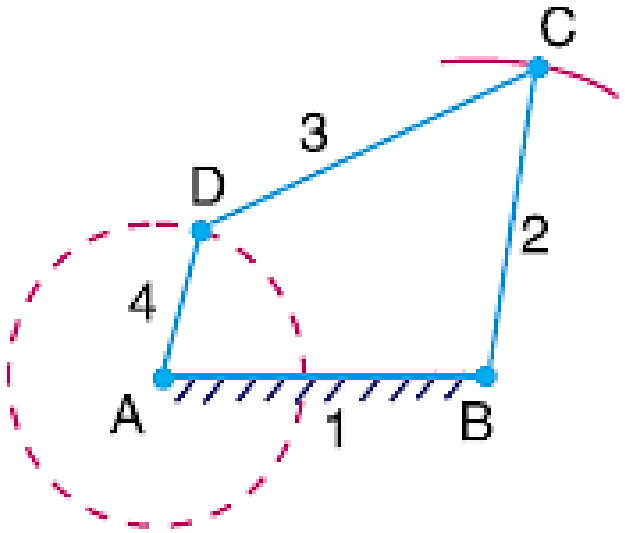


Fig. 5.18. Four bar chain.

Inversions of Four Bar Chain

1. Beam engine (crank and lever mechanism).

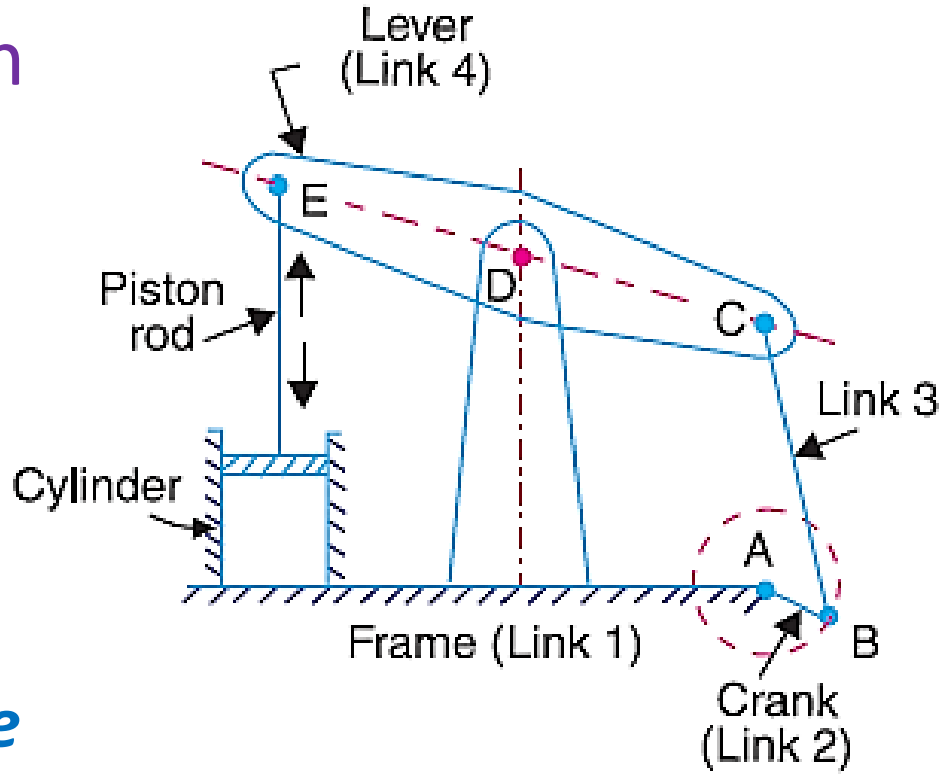
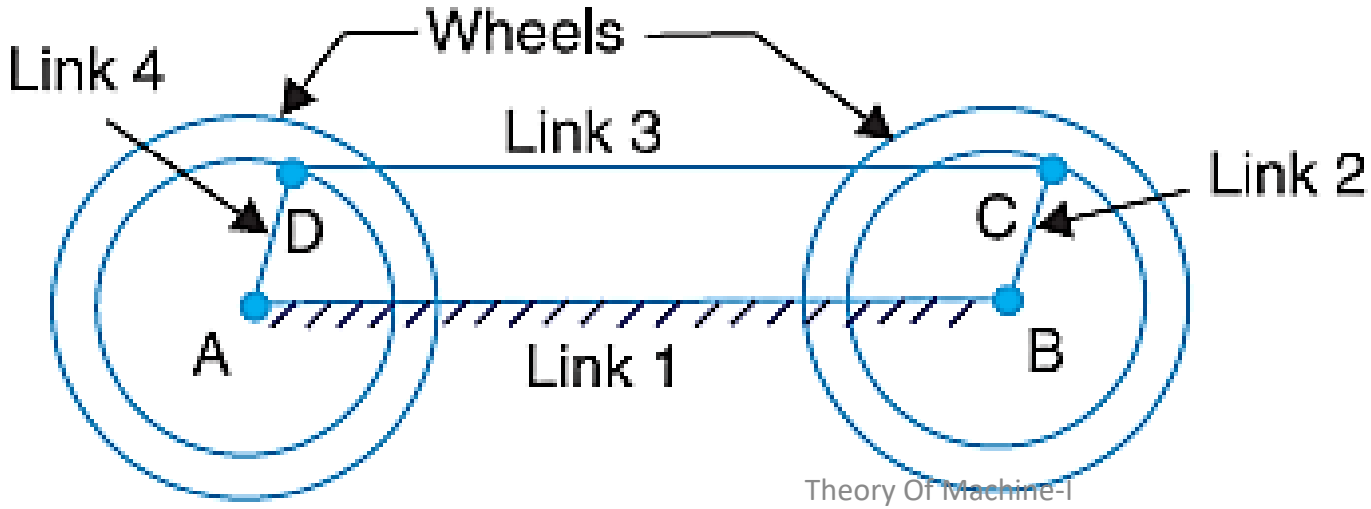
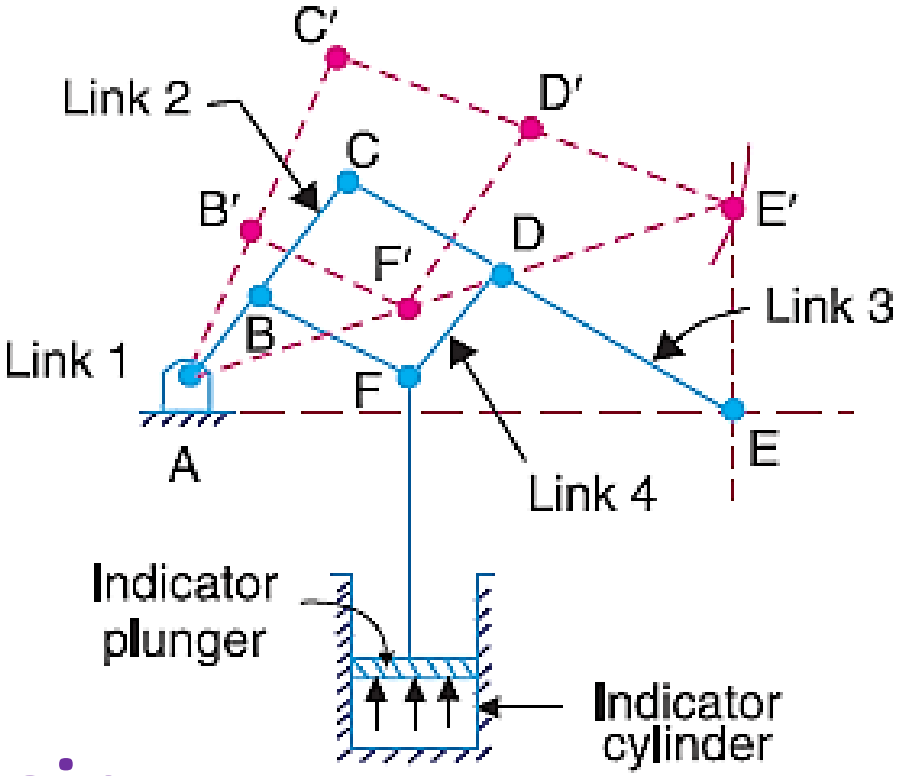


Fig. 5.19. Beam engine.

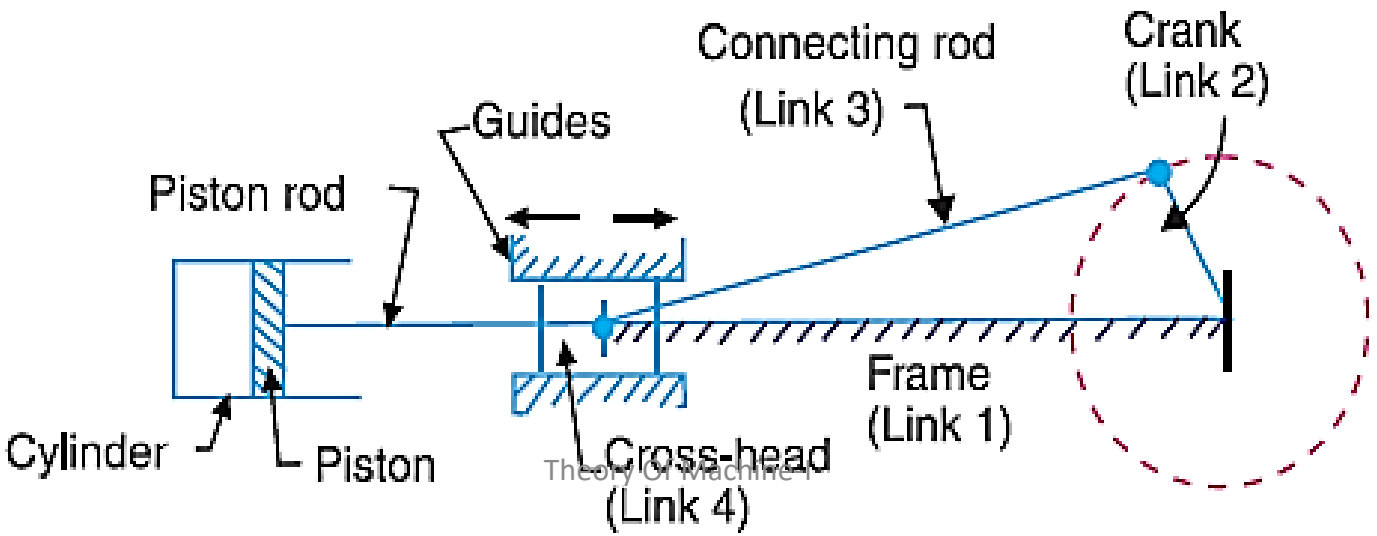
2. Coupling rod of a locomotive (Double crank mechanism).



3. Watt's indicator mechanism (Double lever mechanism).



- **Single Slider Crank Chain**



• Inversions of Single Slider Crank Chain

1. Pendulum pump or Bull engine.

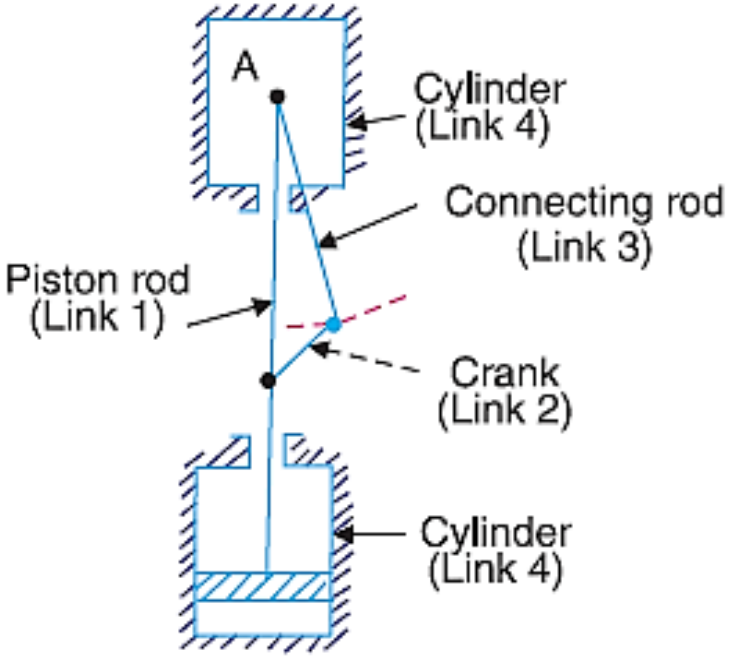


Fig. 5.23. Pendulum pump.

2. Oscillating cylinder engine

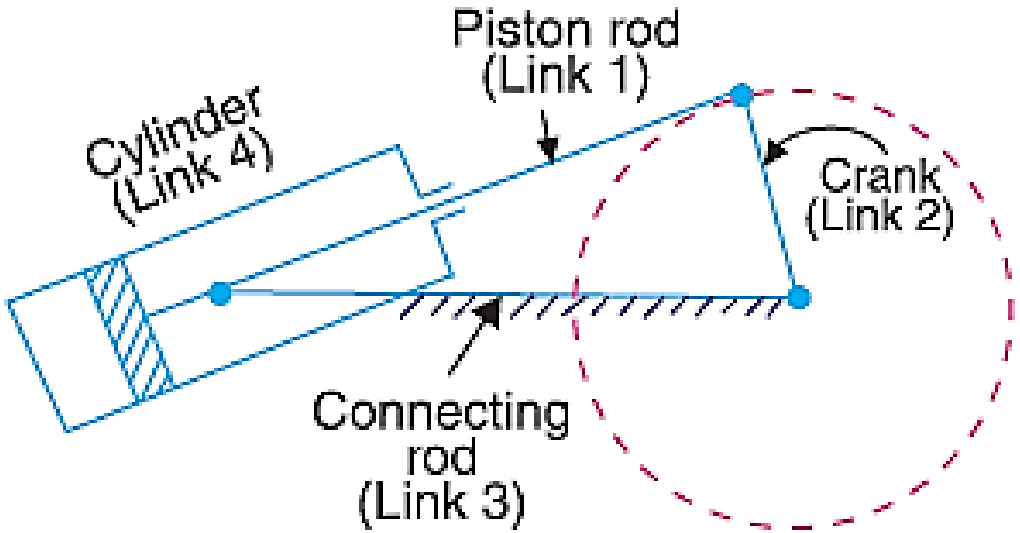


Fig. 5.24. Oscillating cylinder engine.

3. Rotary internal combustion engine or Gnome engine

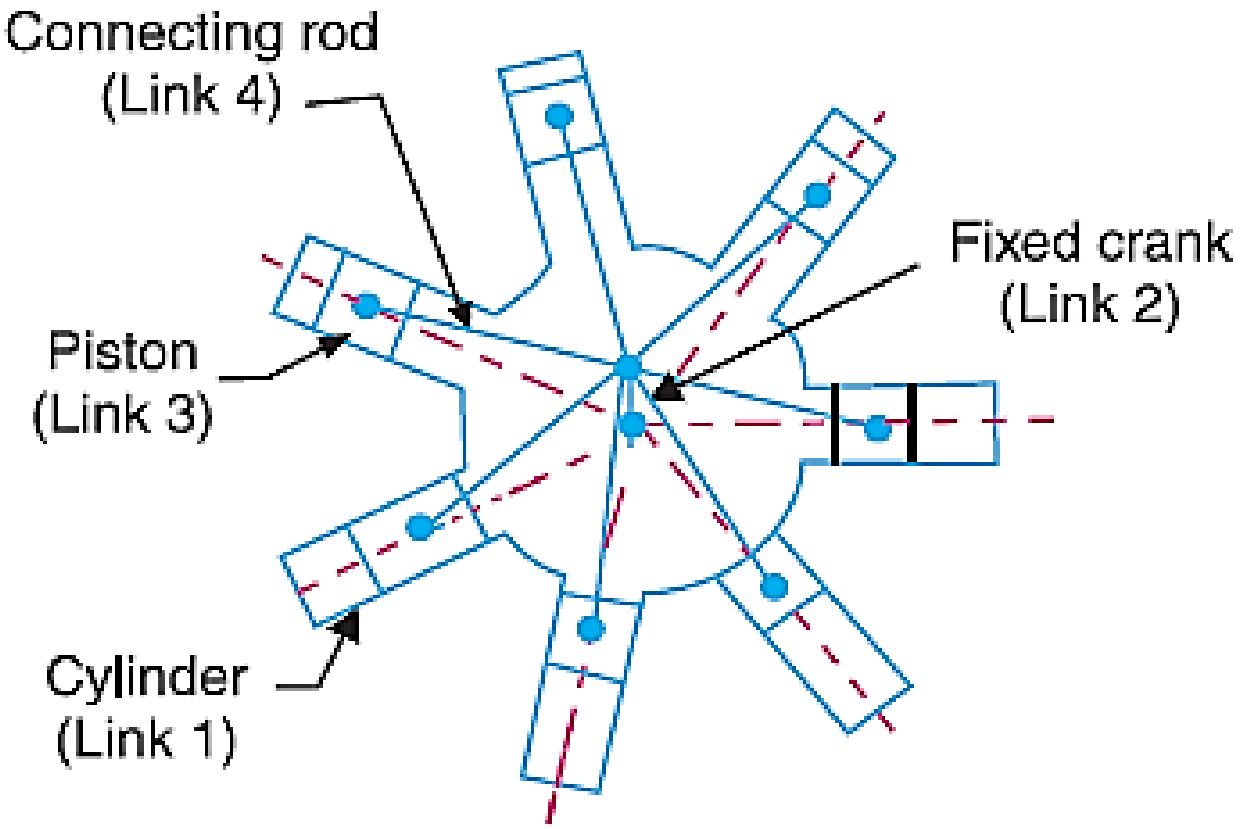
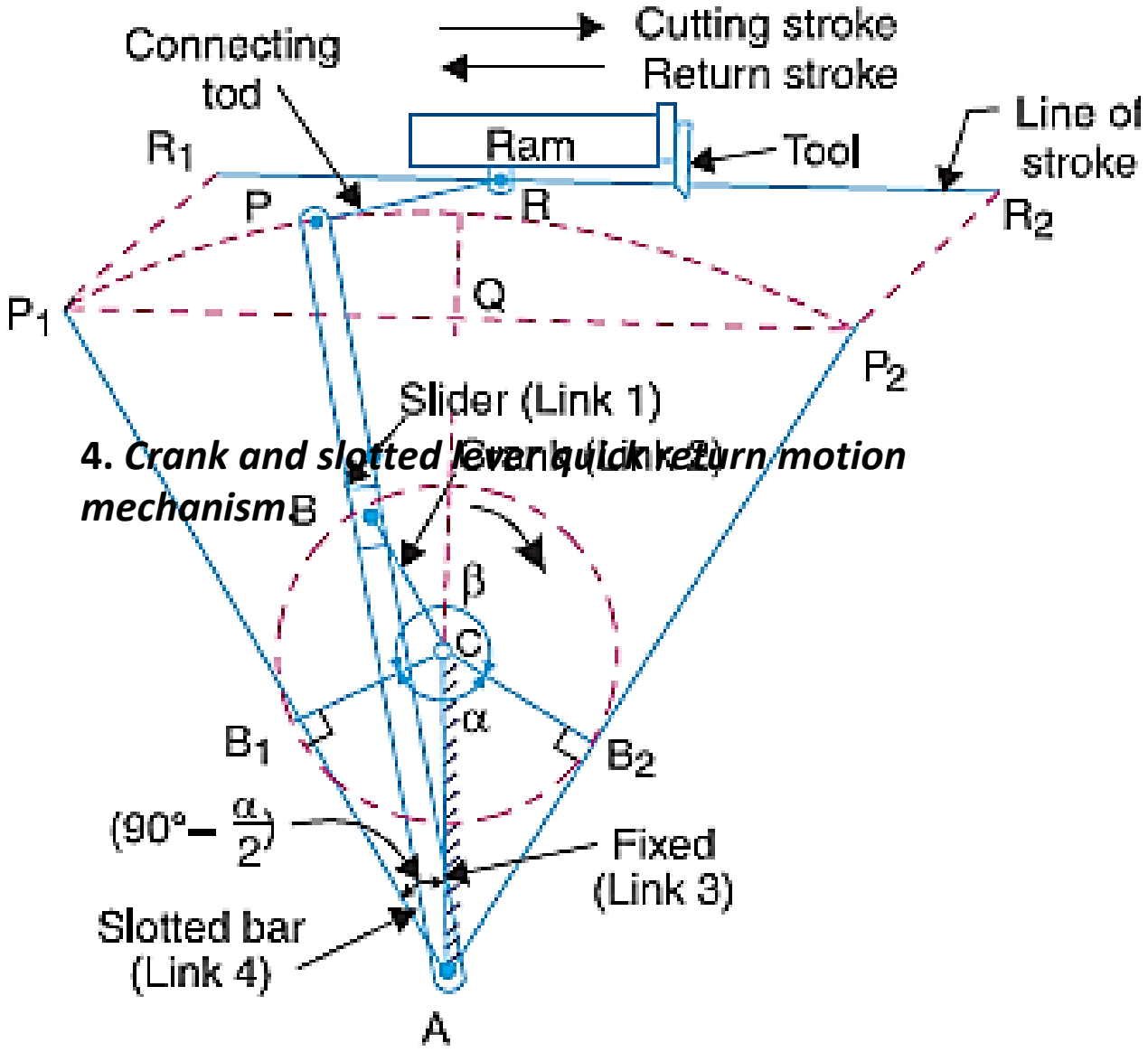


Fig. 5.25. Rotary internal combustion engine.

4. Crank and slotted lever quick return motion mechanism.



4. Crank and slotted lever quick return motion mechanism

ig. 5.26. Crank and slotted lever quick return motion mechanism.

5. Whitworth quick return motion mechanism.

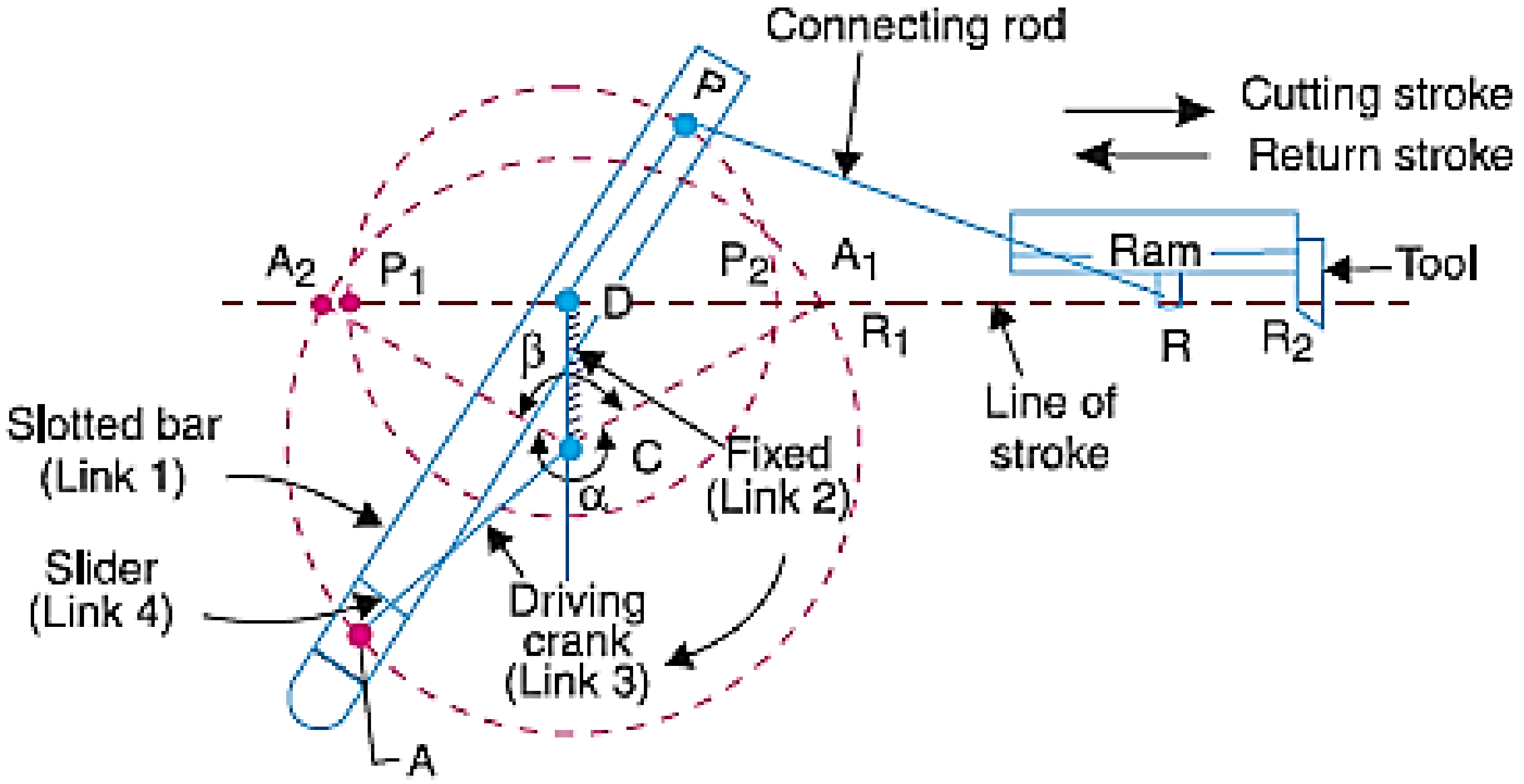


Fig. 5.27. Whitworth quick return motion mechanism.

- **Double Slider Crank Chain**

Inversions of Double Slider Crank Chain

1. *Elliptical trammels*

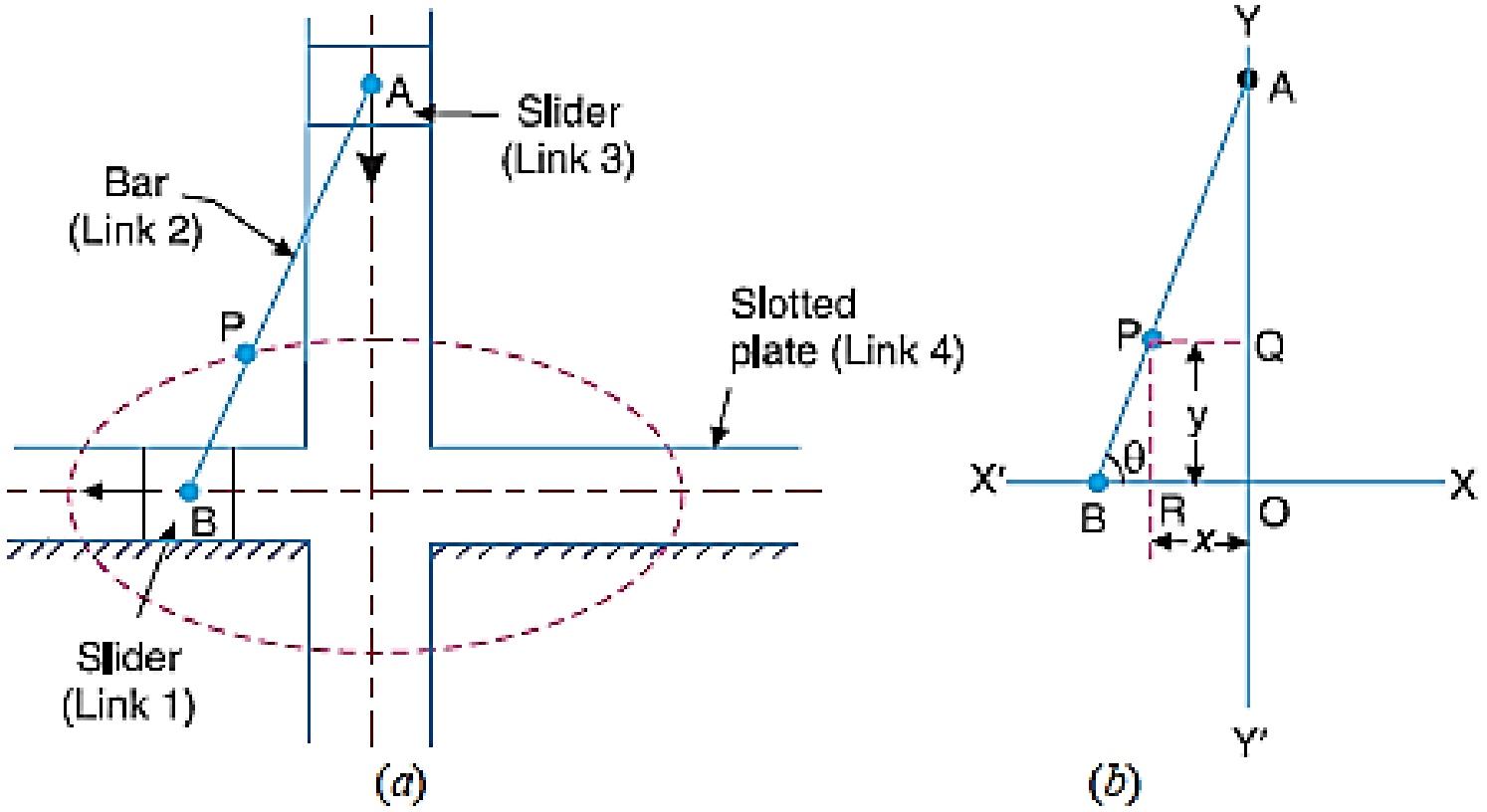


Fig. 5.34. Elliptical trammels.

2. Scotch yoke mechanism.

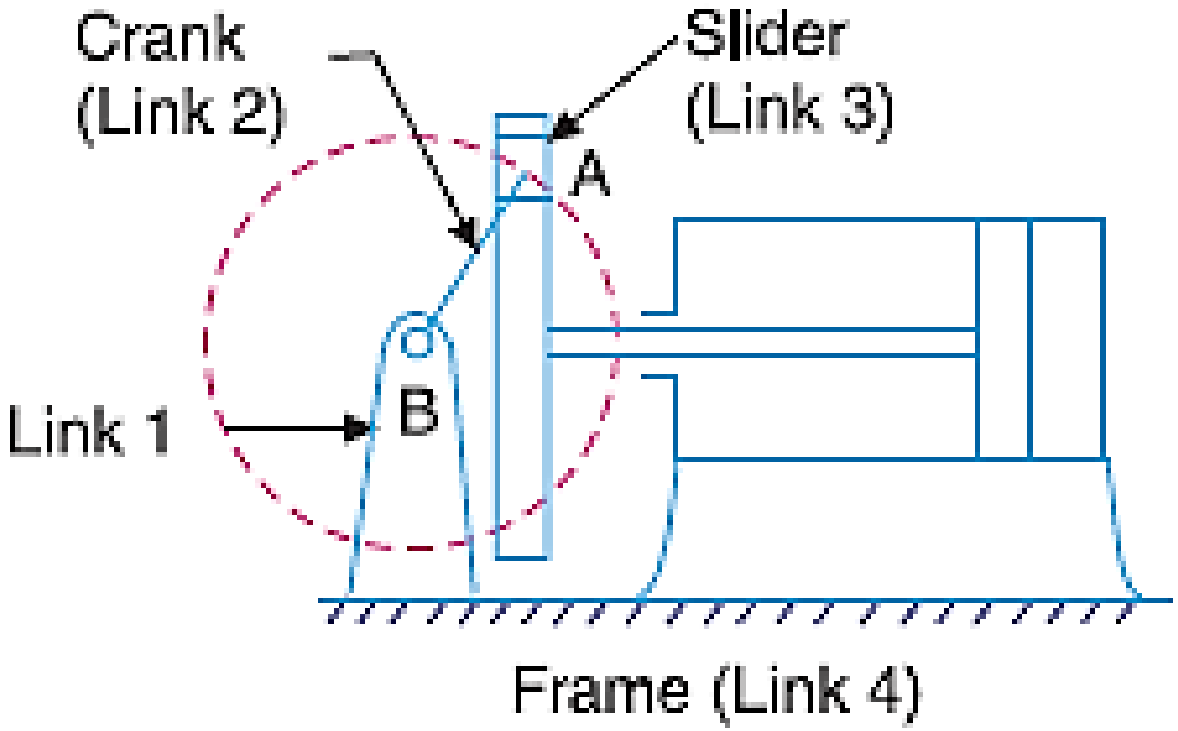
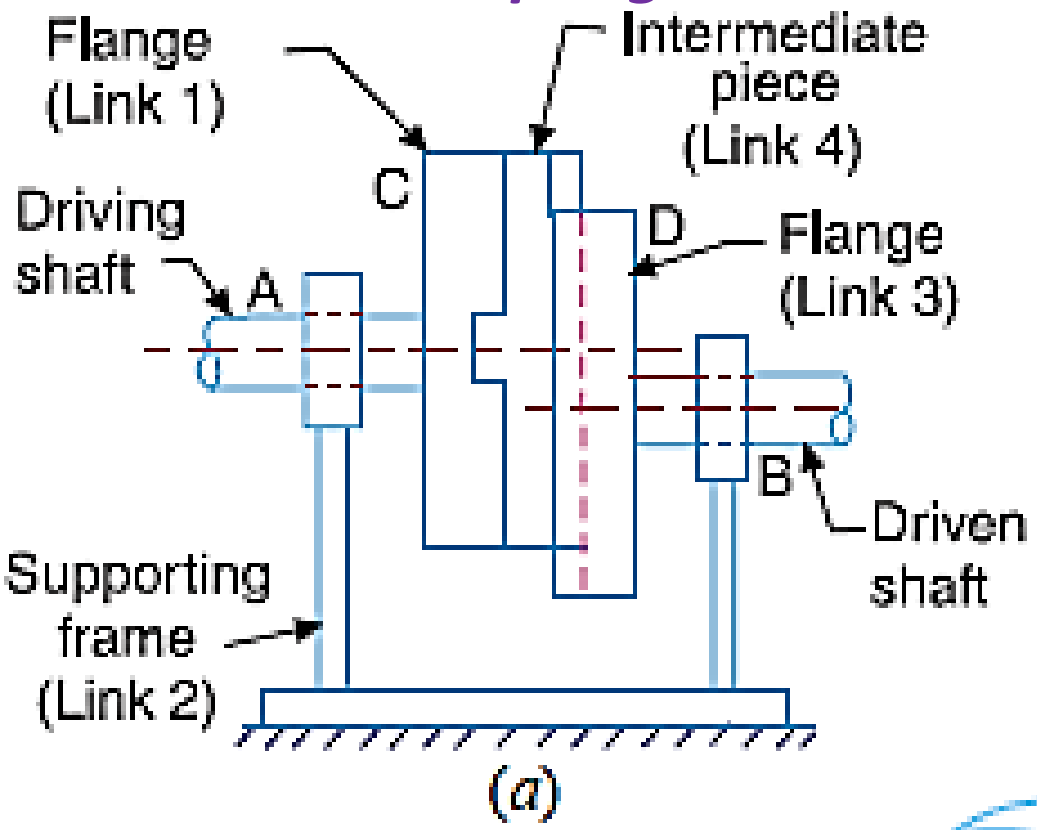
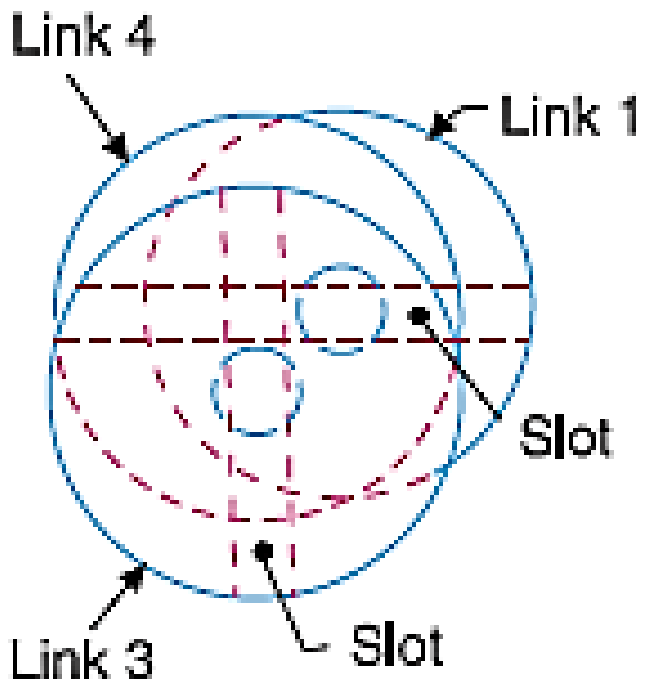


Fig. 5.35. Scotch yoke mechanism.

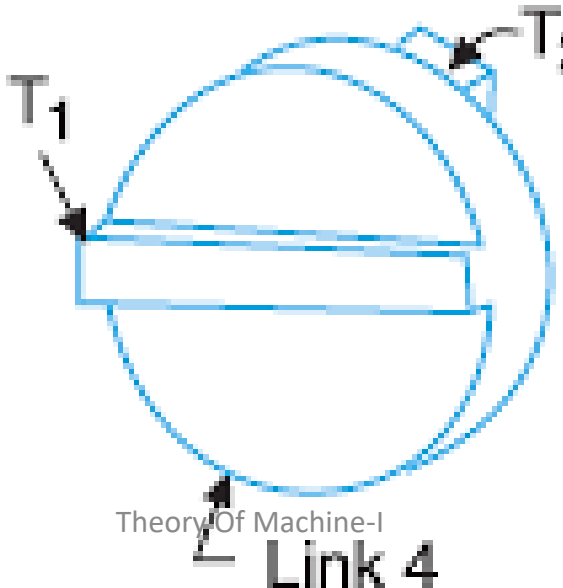
3. Oldham's coupling



(a)



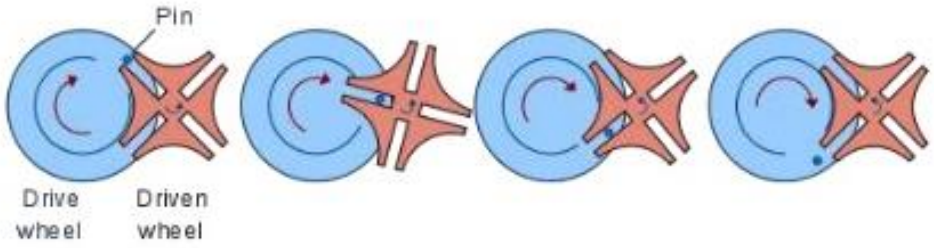
(b)

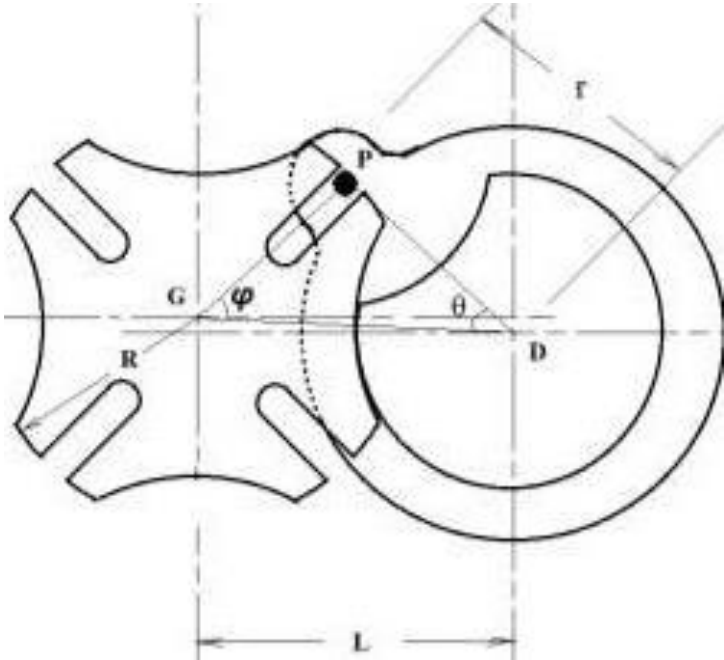


Geneva Mechanism

Working of Geneva Mechanism

- In the most common arrangement, the driven wheel has four slots and thus advances by one step of 90 degrees for each rotation of the drive wheel. If the driven wheel has n slots, it advances by 360°/n per full rotation of the drive wheel.
- Genevas are also combined with variety of other mechanism , such as four bar linkages , clutch-brake combinations , non –circular gears etc to modify the motion curves and dwell motion ratios obtained from pure Geneva.





Ackerman Steering Gear

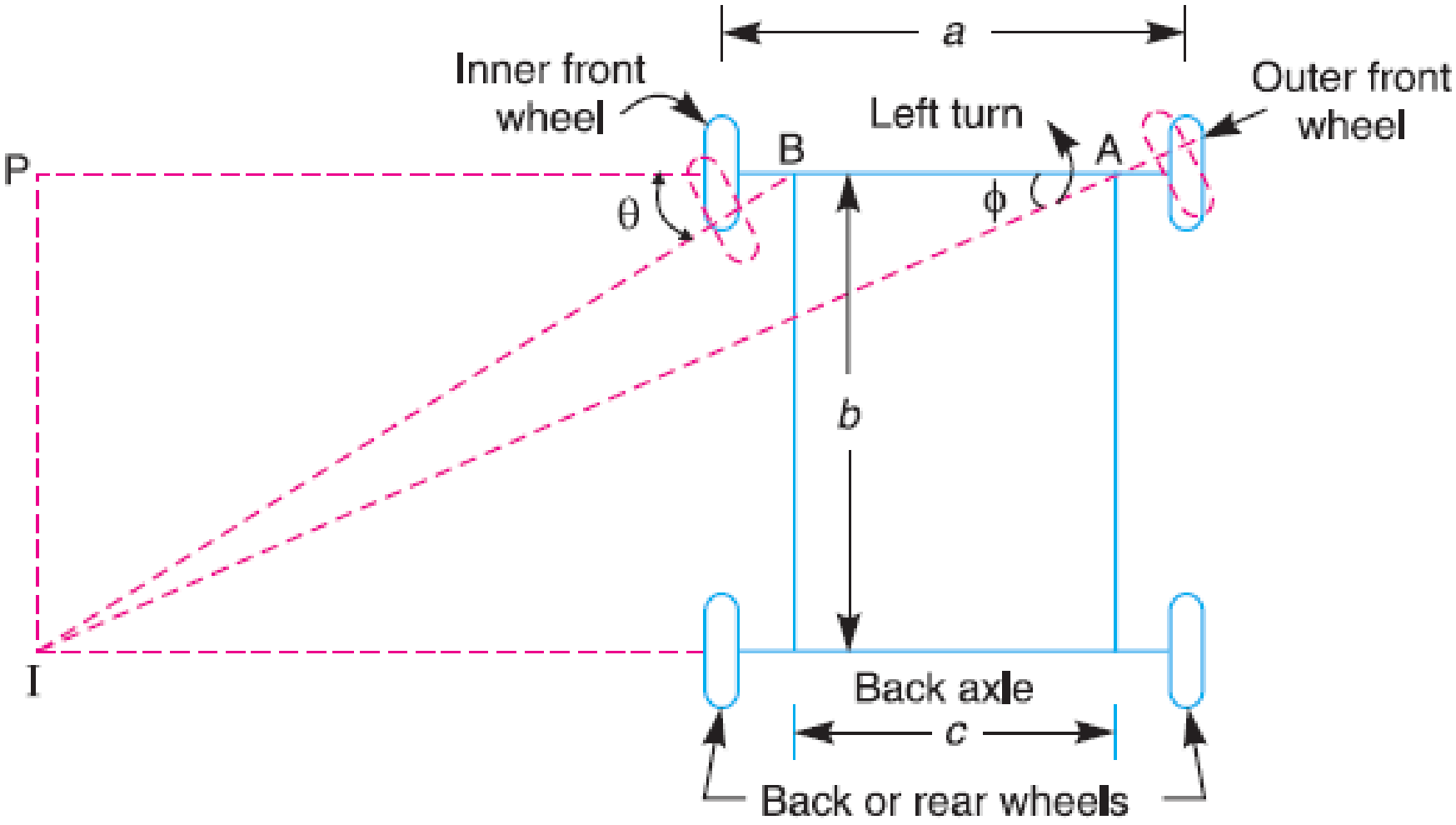


Fig. 9.15. Steering gear mechanism.

Davis Steering Gear

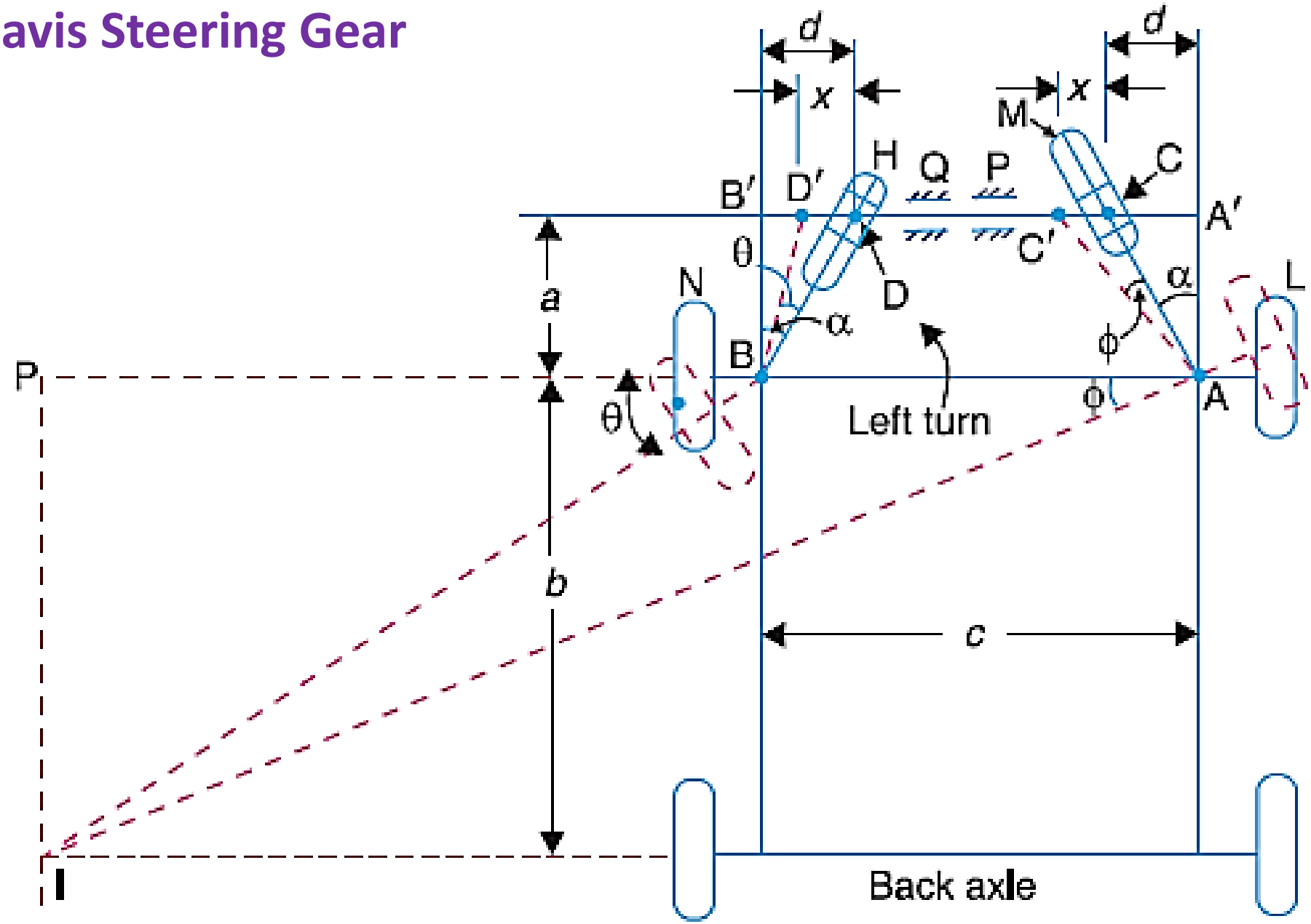


Fig. 9.16. Davis steering gear.

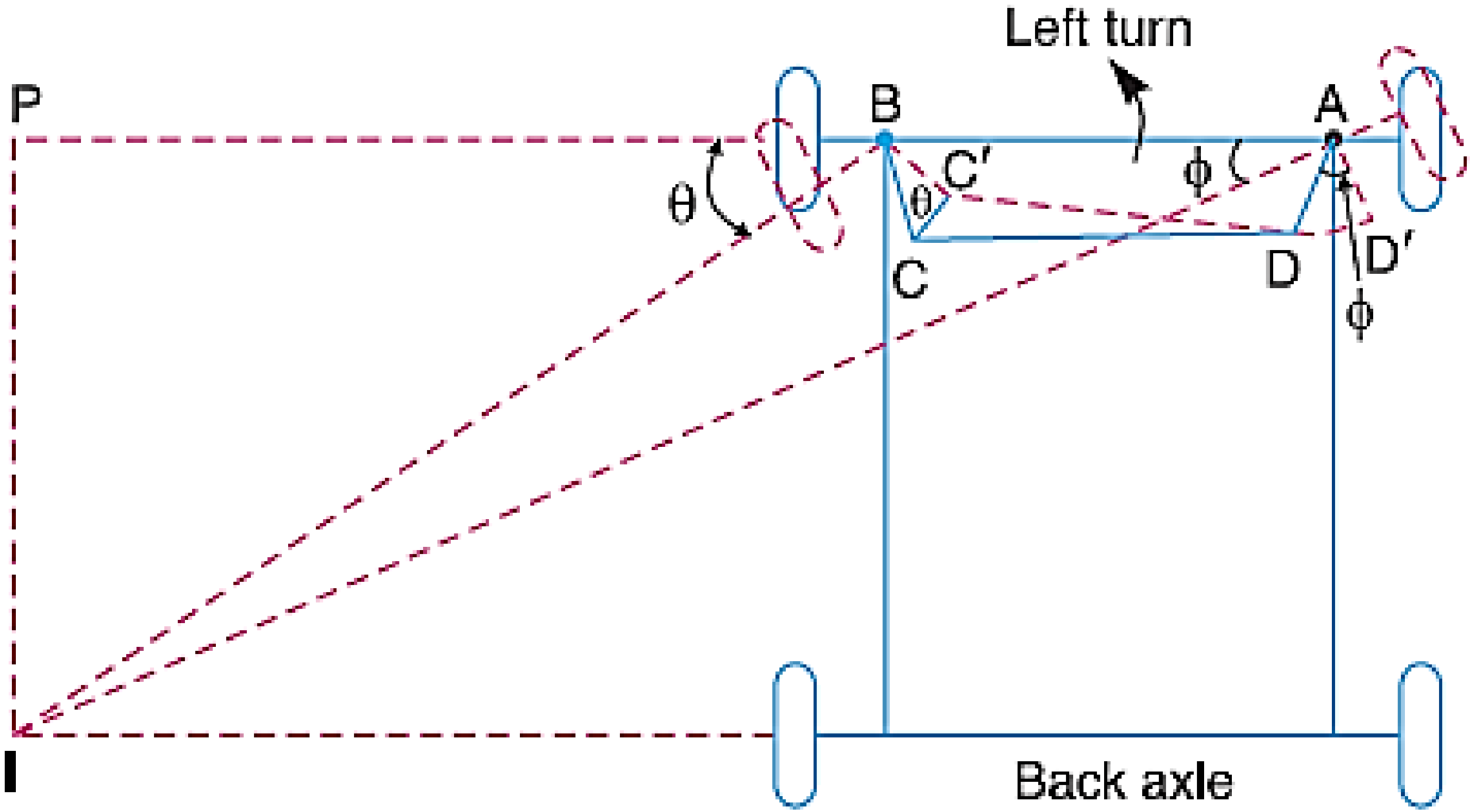


Fig. 9.17. Ackerman steering gear.

Universal or Hooke's Joint

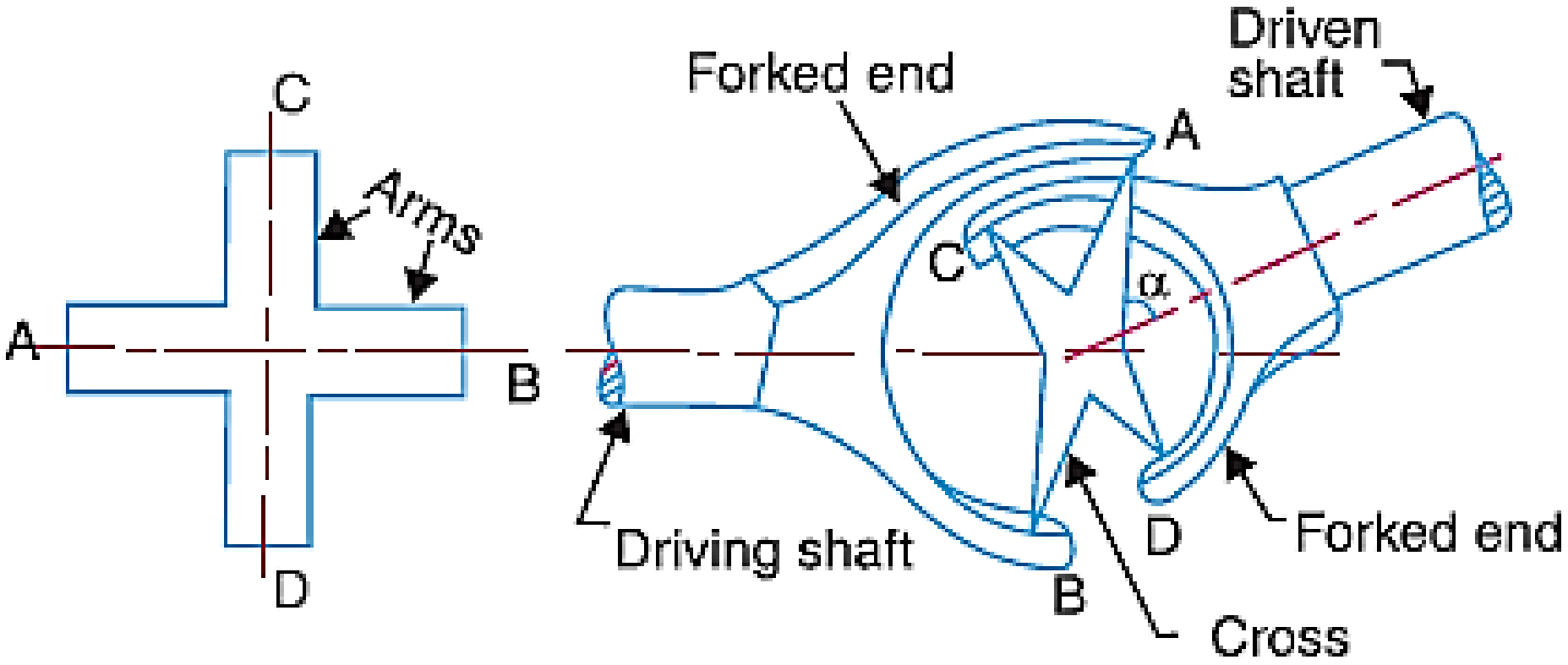
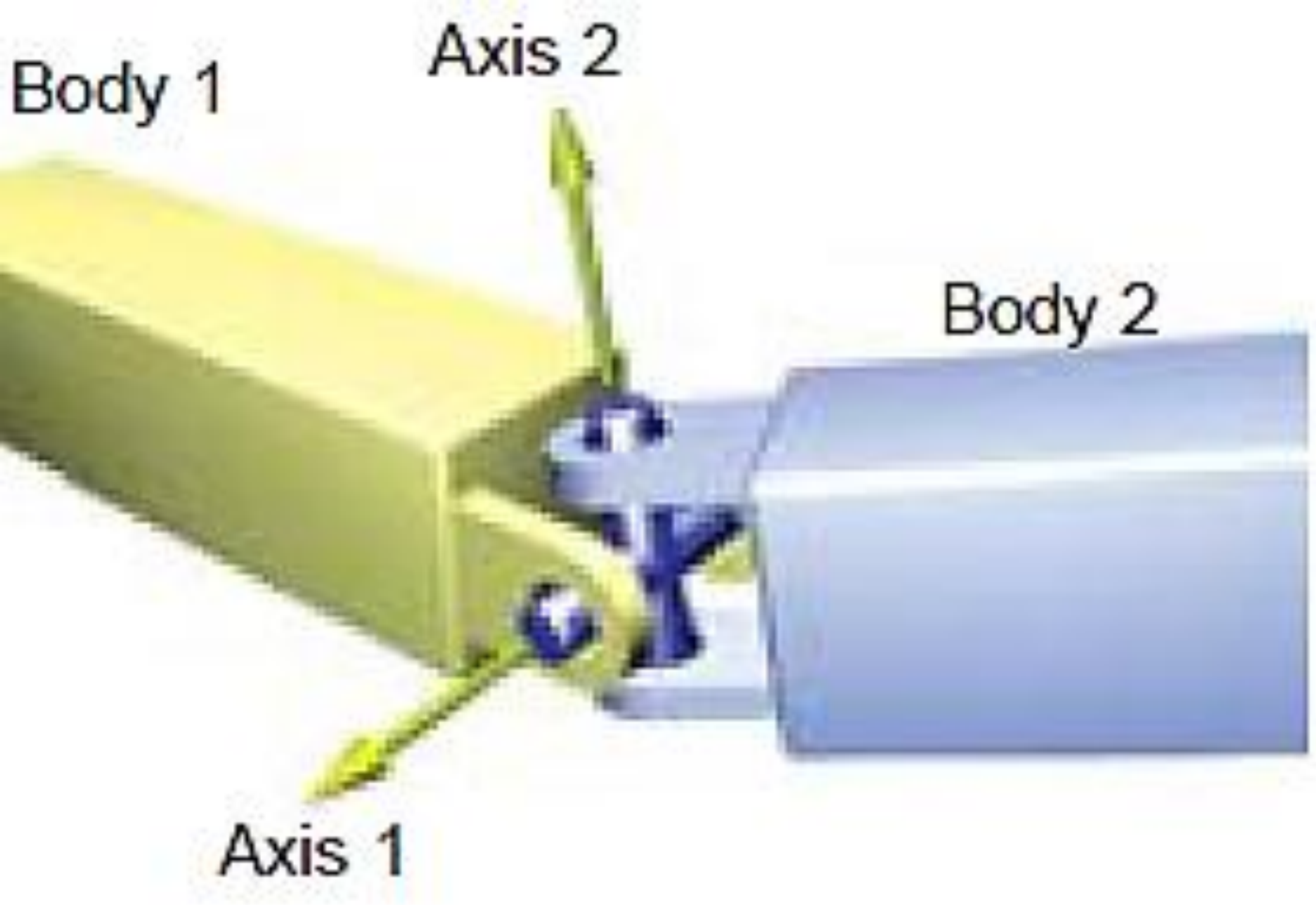


Fig. 9.18. Universal or Hooke's joint.


Body 1
Axis 2
Body 2
Axis 1

Ratio of the Shafts Velocities

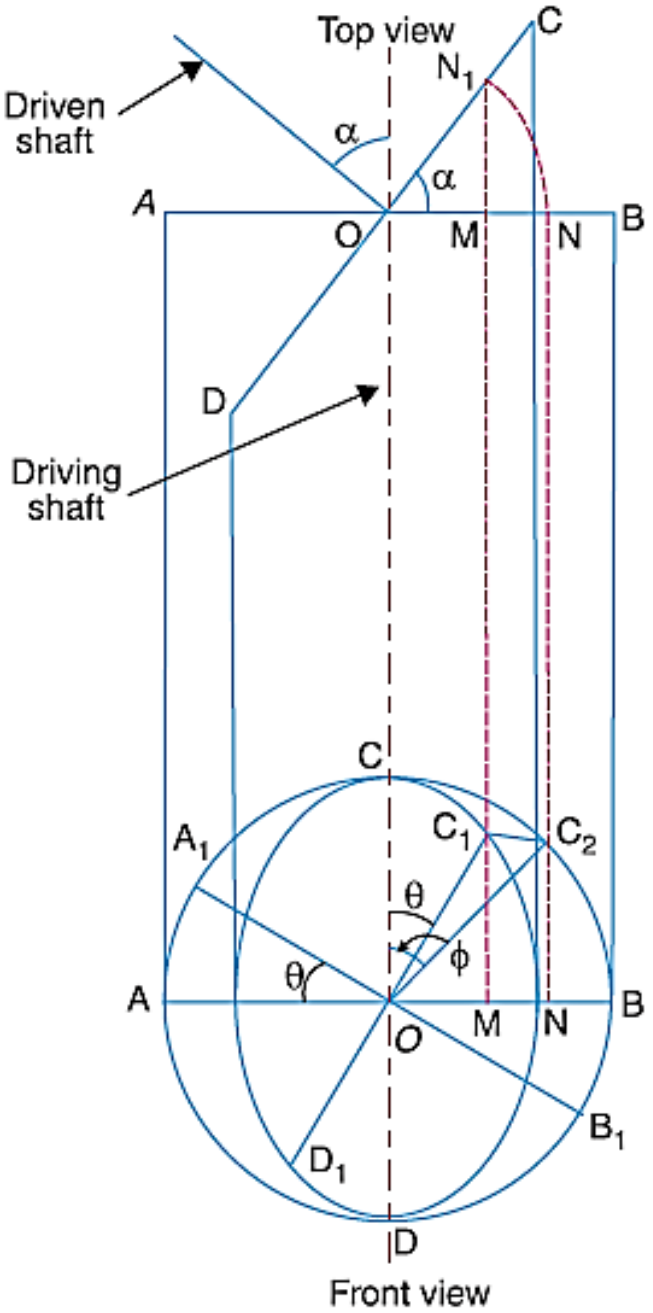


Fig. 9.19. Ratio of shafts velocities.

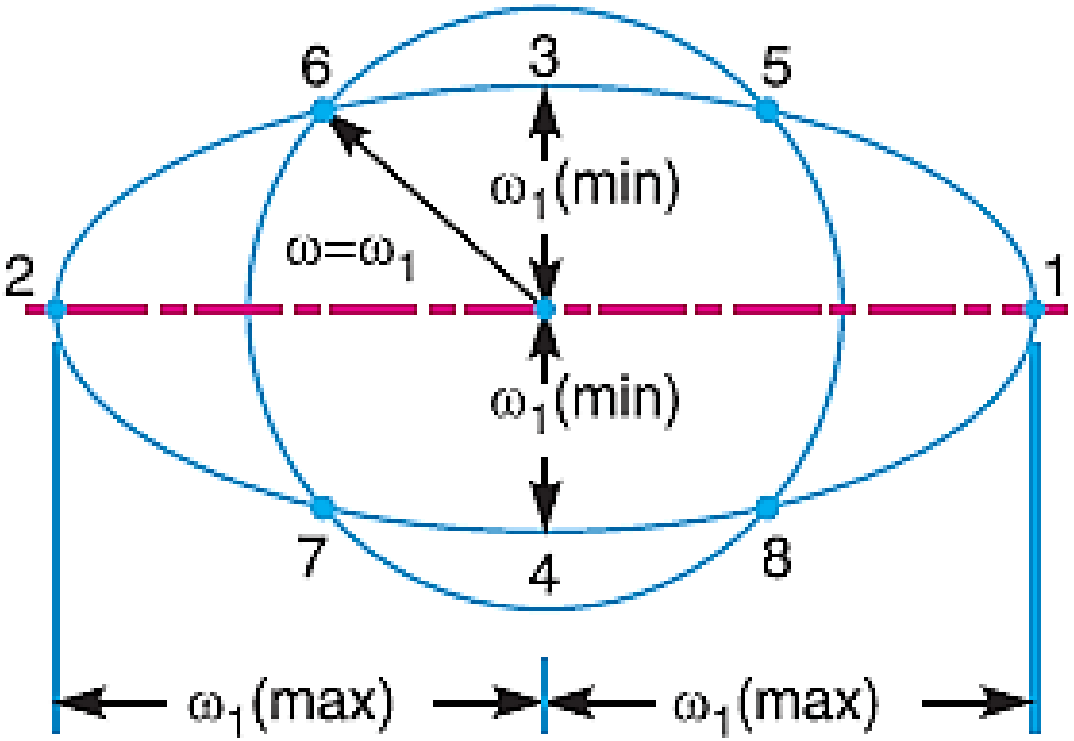


Fig. 9.20. Polar diagram-salient features of driven shaft speed.