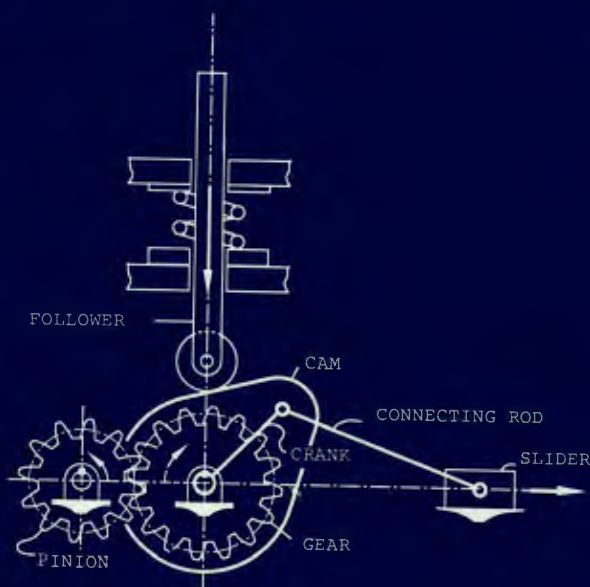


# MECHANISM ANALYSIS

**SIMPLIFIED GRAPHICAL  
AND ANALYTICAL TECHNIQUES**

**SECOND EDITION, REVISED AND EXPANDED**



**LYNDON O. BARTON**

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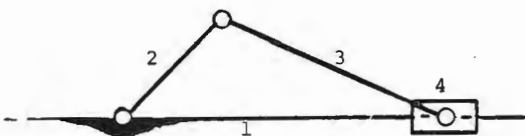
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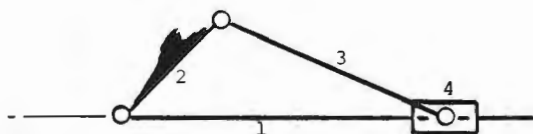
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(a)

SLIDER-CRANK



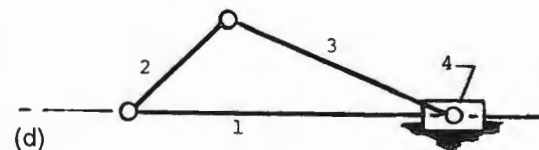
(b)

QUICK-RETURN



(c)

OSCILLATING CYLINDER



(d)

FIXED PISTON

Figure 1.9 Slider-crank chain: (a) Slider crank; (b) quick-return mechanism; (c) oscillating cylinder; (d) fixed piston.

It is important to keep in mind that the inversion of a mechanism does not change the relative motion between the links, but does alter their absolute motions.

## 1.2 MOTION CLASSIFICATION

### *Definitions*

**Motion** is the act of changing position. The change of position can be with respect to some other body that is either at rest or moving.

**Rest** is a state in which the body has no motion.

**Absolute motion** is the change of position of a body with respect to another body at absolute rest.

**Relative motion** is the change of position of a body with respect to another body that is also moving with respect to a fixed frame of reference.

## Types of Motion

### Plane Motion

In plane motion all points on a body in motion move in the same plane or parallel planes. All points of the body or system of bodies remain at a constant distance from a reference plane throughout the motion. Typical examples are the connecting rod on a slider-crank mechanism (Figure 1.1) and the side rod on a locomotive (Figure 1.10). There are three classes of plane motion: (1) rotation, (2) translation, and (3) combined translation and rotation.

1. **Rotation:** When one point in a body remains stationary while the body turns about that point, the body is said to be in rotation. That is, all points in the body describe circular paths about a stationary axis that is perpendicular to the plane of rotation. Crank AB in Figure 1.1 has rotary motion.
2. **Translation:** When a body moves without turning, that body is said to be in translation, or the distances between particles of the body remain unchanged. There are two types of translation:
  - a. **Rectilinear translation**, where all points in the body move along parallel straight paths, such as the slider C in Figure 1.1.

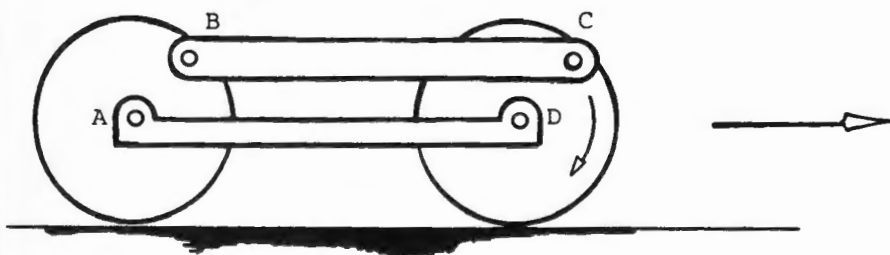


Figure 1.10 Locomotive side rod drive. Link BC undergoes curvilinear motion; link AD undergoes rectilinear translation.

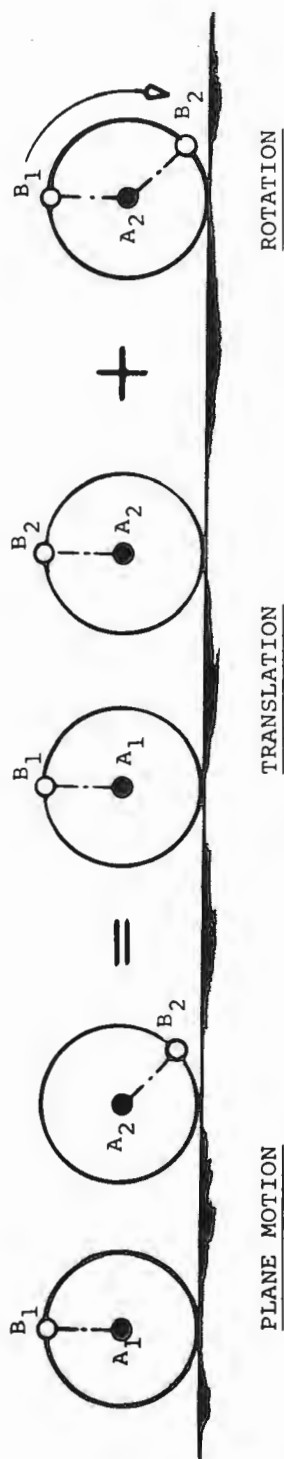


Figure 1.11 Rolling wheel.

- b. **Curvilinear translation**, where all points in the body move along similar (or parallel) curved paths. Curvilinear translation is not to be confused with rotation, where all paths on the body are in the form of concentric circles. A good example is the locomotive side rod in Figure 1.10. Note that the paths of any two points on the rod, say, B and C, have the same curvature.
3. **Combined motion**: When a body undergoes simultaneous translation and rotation, that body is said to be in combined motion. That is, all points in the body change position and all lines turn as the body moves.

A common example of a body that undergoes combined motion is the connecting rod BC in Figure 1.1, where one end B rotates about the crank axle A, whereas the other end C translates along a straight path as defined by the slider motion. Hence, every other point on the member experiences part rotation and part translation.

Another common example is that of the rolling wheel (Figure 1.11), where it can be seen that the resultant motion of point B is the summation of its translation and rotation motions.

### Three-Dimensional Motion

There are two types of three-dimensional motion:

1. **Helical motion**: When a body has rotation combined with translation along the same axis of rotation, that body is said to be in helical motion. The most common example is the turning of a nut on a screw (see Figure 1.12). The nut rotates and at the same time translates along the axis of rotation.

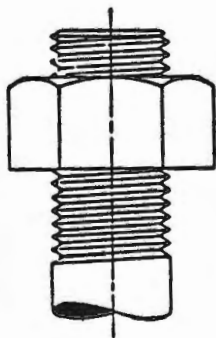


Figure 1.12 Screw and nut.