

### IS IT A MACHINE, A MECHANISM, OR A STRUCTURE?

The term *machine* is usually applied to a complete product. A *car* is a machine, as is a *tractor*, a *combine*, an *earthmoving machine*, etc. At the same time, each of these machines may have some devices performing specific functions, like a windshield wiper in a car, which are called *mechanisms*. An internal combustion engine is called neither a machine nor a mechanism. It is clear that there is a historically established terminology and it may not be consistent. What is important, as far as the subject of kinematics and dynamics is concerned, is that the identification of something as a machine or a mechanism has no bearing on the analysis to be done. And thus in the following, the term *machine* or *mechanism* in application to a specific device will be used according to the established custom. The distinction between the *machine/mechanism* and the *structure* is more fundamental. The former must have moving parts, since it transforms motion, produces work, or transforms energy. The latter does not have moving parts; its function is purely structural, i.e., to maintain its form and shape under given external loads, like a bridge, a building, or an antenna mast.

Fundamentals of Kinematics and Dynamics of Machines and Mechanisms  
chair, or a solar antenna, may be confusing. Before the folding chair can be used as a chair, it must be *unfolded*. The transformation from a folded to an unfolded state is the transformation of motion. Thus, the folding chair meets two definitions: it is a *mechanism* during unfolding and a *structure* when unfolding is completed. Again, the terminology should not affect the understanding of the substance of the matter.

Definitions : Link or Element, Pairing of Elements with degrees of freedom, Grubler's criterion (without derivation), Kinematic chain, Mechanism, Mobility of Mechanism, Inversions, Machine.

- **Kinematic Chains and Inversions :**

Recall that a kinematic chain becomes a mechanism when one of the links in the chain becomes a frame. The process of choosing different links in the chain as frames is known as *kinematic inversion*. In this way, for an  $n$ -link chain  $n$  different mechanisms can be obtained. An example of a four-link slider-crank chain shows how different mechanisms are obtained by fixing different links functionally.

### Steam engines



Beam engine, with twin connecting rods (almost vertical) between the horizontal beam and the flywheel cranks

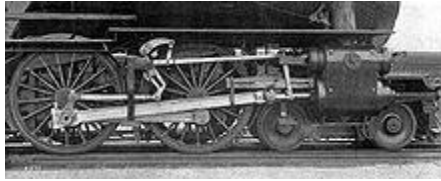
The first steam engines, Newcomen's atmospheric engine, was single-acting: its piston only did work in one direction, and so these used a chain rather than a connecting rod. Their output rocked back and forth, rather than rotating continuously.



Crosshead of a stationary steam engine: piston rod to the left, connecting rod to the right

Steam engines after this are usually double-acting: their internal pressure works on each side of the piston in turn. This requires a seal around the piston rod and so the

hinge between the piston and connecting rod is placed outside the cylinder, in a large sliding bearing block called a crosshead.

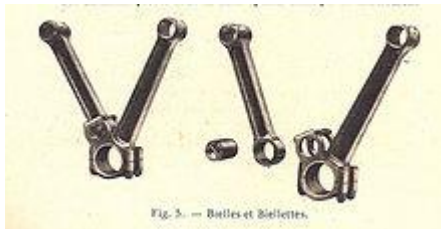


Steam locomotive rods, the large angled rod being the connecting rod

### Internal combustion engines



Compound rods



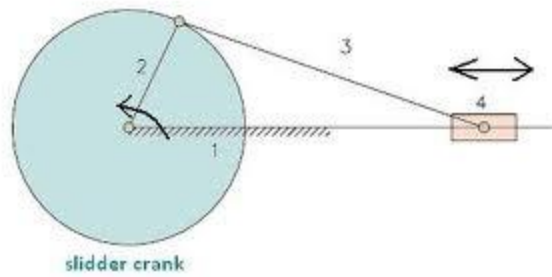
Articulated connecting rods in a WW1 aero-engine



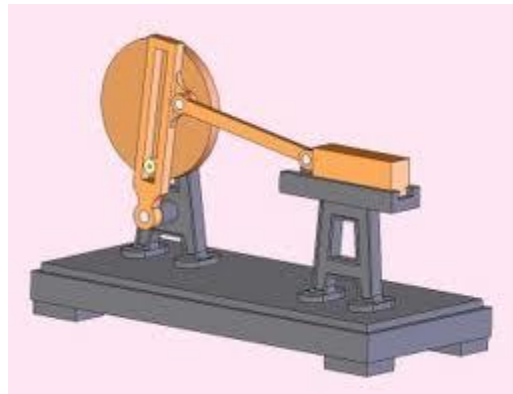
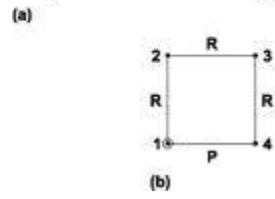
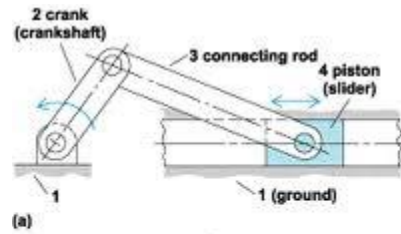
BMW 132 radial engine rods



LINKS



	Revolute	Prismatic
2D		
3D		



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