Engine Design

Chapter 04-3: IC Engine Balancing

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The concept of balancing

- Any system in pure rotation can be perfectly balanced (theoretically)
- Practically, there will always be some error.
- One can get close with care but only by chance achieve “perfect” balance due to tolerances
- Two types:
  - Static balance: $\Sigma F = 0$
  - Dynamic balance: $\Sigma F = 0$, $\Sigma M = 0$

Static balancing

- Despite the name, it does apply to things in motion.
- Also is called “single-plane balance.”
  - Masses must be in (or nearly in) the same plane.
  - Examples:
    - Bicycle or motorcycle wheel
    - Thin gear, pulley, flywheel, sprocket, etc.
    - Airplane propeller
    - Turbine blade

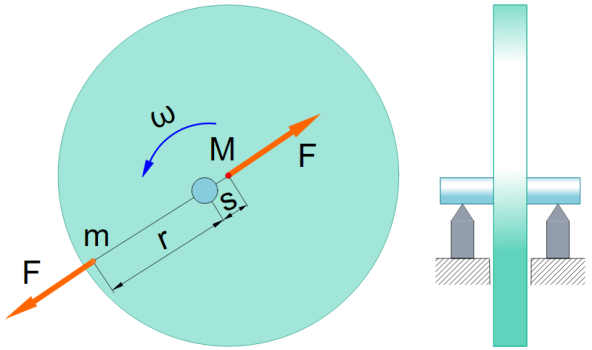

Fig. Static balancing

- Forces the mass center of the link to be at its pivot.
- D’Alembert form of Newton’s equations is used.

Dynamic balancing

- Also called “two-plane balance”
- Required if mass is not in a single plane
  - Masses are axially distributed or in separated planes
    - Shaft, roller
    - Thick gear, pulley, flywheel, sprocket, etc.
    - Automobile or truck wheel
    - Turbine assembly
- D’Alembert form of Newton’s equations used

Dynamic balancing

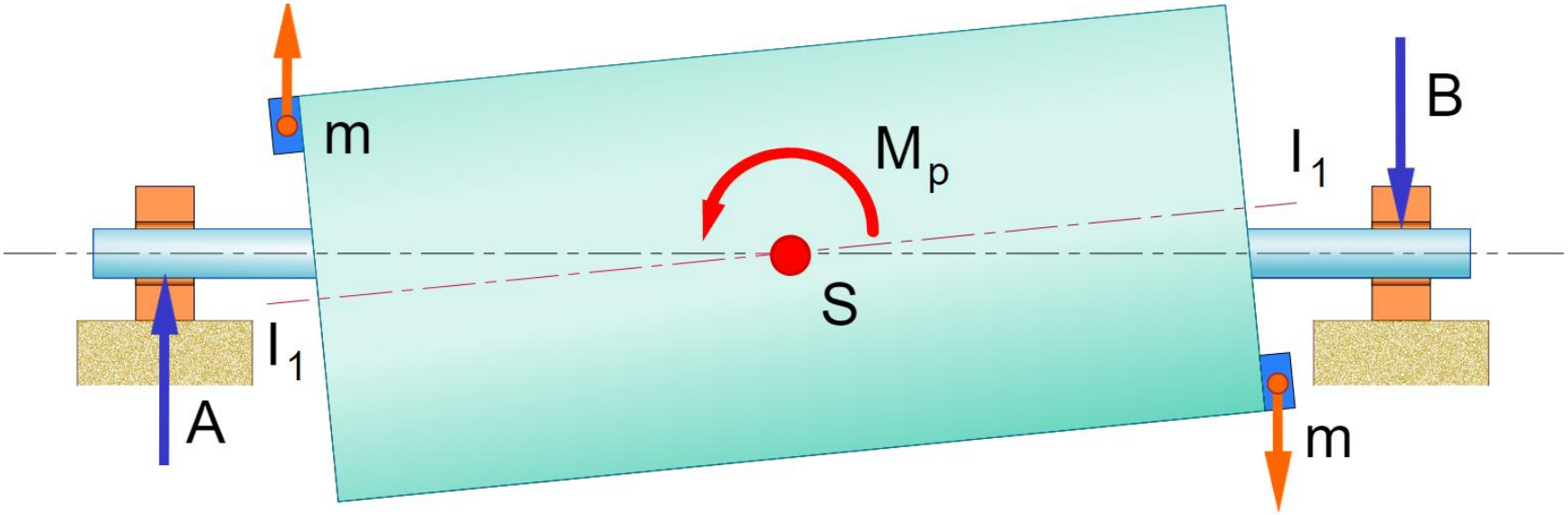

Fig. Dynamic Balancing

Link balancing

- A link in pure rotation can be balanced easily.
  - Simply force the mass center of the link to be at the fixed pivot, which is stationary.
- Links in complex motion present a challenge as they have no fixed pivot.
- Several methods exist for fourbar linkages
  - Exact static balance methods
  - Exact dynamic balance methods
  - Approximate methods

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