

Chain and Belt Drives

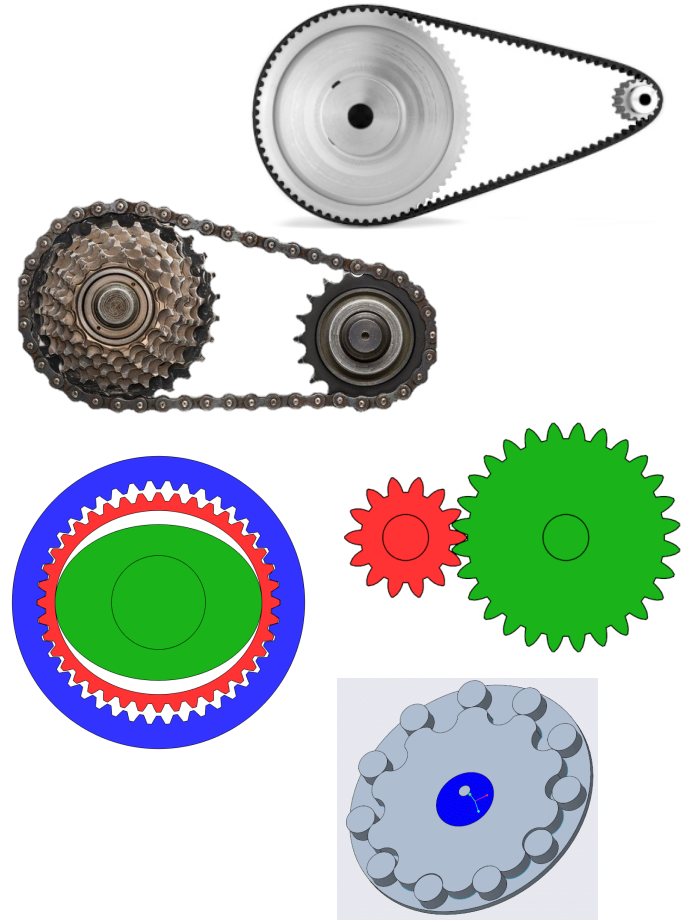


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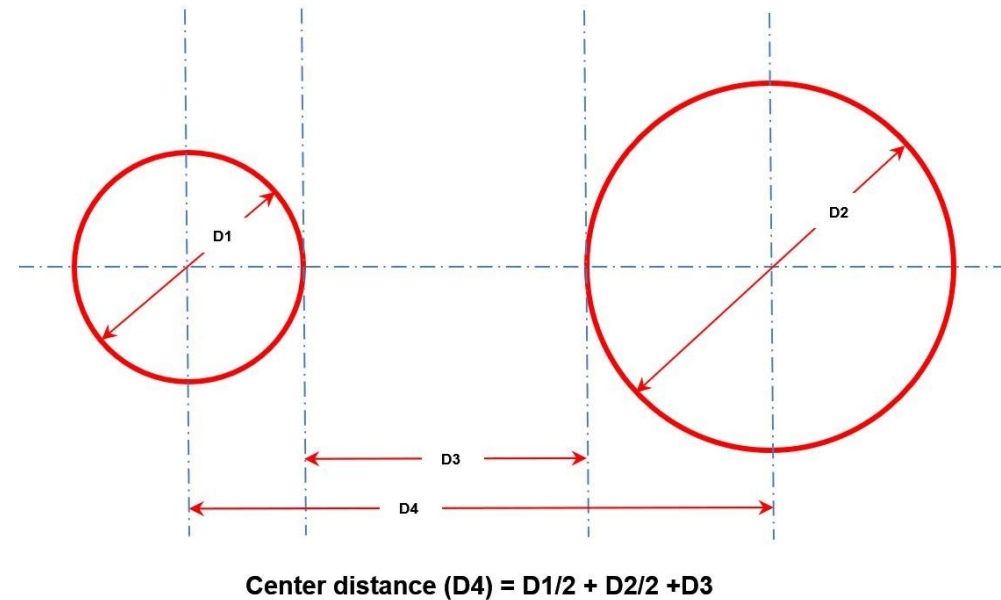
Mechanical power transmission types

- We can split our power transmission based on how it moves:
 - Rotary: circular motion (e.g. motor shaft, gears)
 - Linear: straight-line motion (e.g. piston, actuator)
 - Oscillating: back-and-forth motion (e.g. cam follower, lever)
- But we can also split them on the properties of the transmitter
 - Flexible drives: belts, chains
 - Rigid drives: gears, cams
 - Special drives: harmonic, cycloidal



Key Concept – Centre Distances

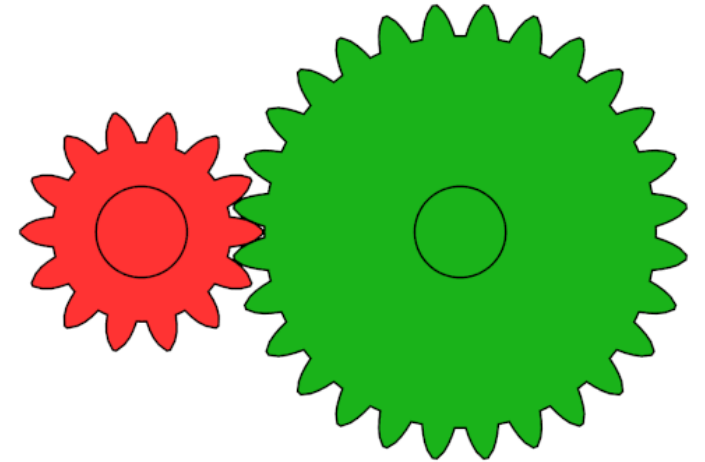
- The centre distance is the distance between the centre of two pulleys/gears
- It affects belt tension, wrap angle, and the overall layout of the drive system.
- Choosing the correct centre distance is important for maintaining grip, reducing wear, and ensuring smooth power transmission.



Positive Engagement vs Friction Drive

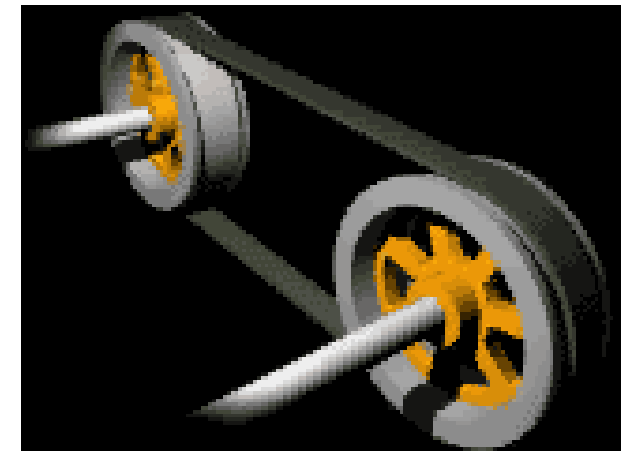
- **Positive Engagement Drive**

- Positive engagement means two components transmit motion through interlocking geometry (not friction).
- Behaves well under high torque scenarios
- Examples include gears, chains and sprockets, or timing belts, where the teeth physically mesh to prevent slip.



- **Friction Drive**

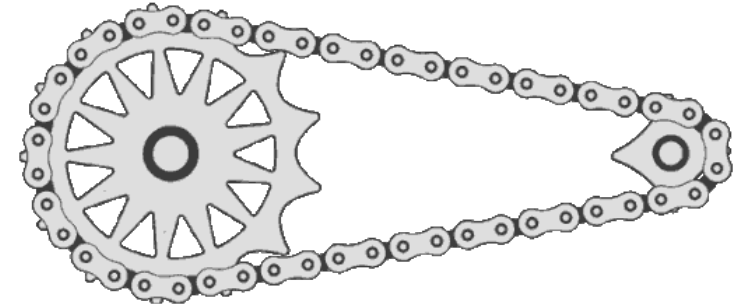
- Friction drives transmit motion by surface contact and grip between components.
- This means they are prone to slipping in high torque scenarios
- Examples include flat or V-belt pulley systems, where friction between the belt and pulley transfers power.



Direction of Rotation

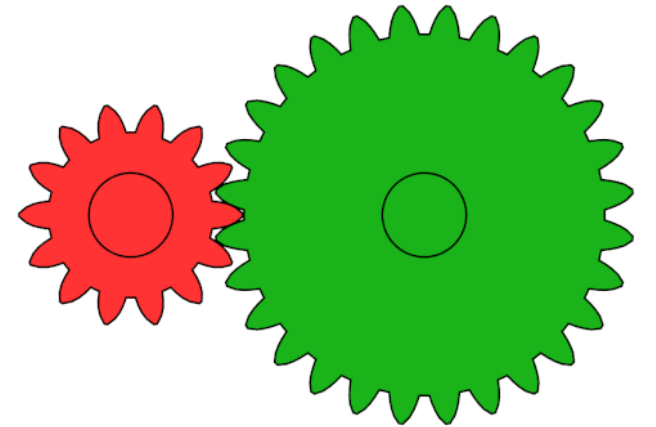
- **Gears:**

- Gears mesh directly, so they reverse the direction of rotation.
- If the driver turns clockwise → the driven turns anticlockwise.
- Each additional gear reverses direction again (odd = reversed, even = same).



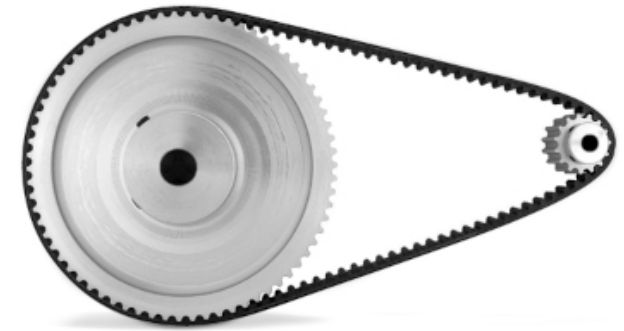
- **Belts and Chains:**

- Belts and chains loop around pulleys or sprockets, so the direction stays the same.
- If the driver turns clockwise → the driven also turns clockwise.
- The same applies if both rotate anticlockwise.



Belt Drives

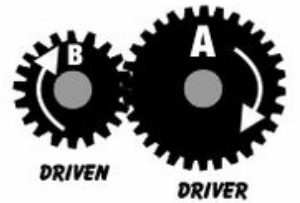
- **Purpose:**
 - Transfer power between rotating shafts using flexible belts and pulleys.
- **How it works:**
 - Power is transmitted by friction between the belt and pulley.
 - The belt wraps around pulleys to change speed, direction, or torque.
- **Types:**
 - Flat Belt
 - V-Belt
 - Timing (synchronous) Belt



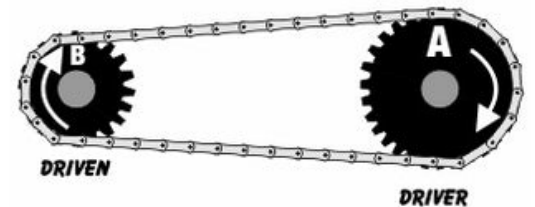
Sprockets

- Sprockets are like gears, but instead of meshing with another gear, they engage with a chain (or occasionally a toothed belt).
- They transmit motion through positive engagement - the sprocket's teeth fit precisely into the chain's rollers or links, ensuring no slip and maintaining a fixed speed ratio.
- Sprocket teeth are shaped specifically to match the chain pitch and roller diameter, not the involute profile used in gears.

Gear



Sprocket



Flat Belts

- Description:
 - A flat, flexible strip of rubber, leather, or fabric that wraps around flat pulleys.
- Power Transmission Method:
 - Relies purely on friction between the belt and pulley.
 - The belt slips slightly under load.
- Typical Uses:
 - Older machinery, fans, small conveyors, textile or woodworking equipment.

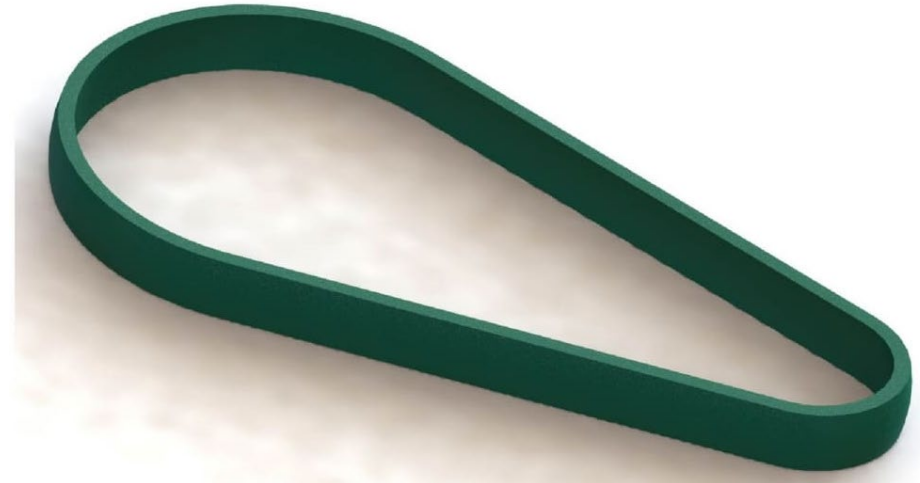
Flat Belt



Flat Belts

- Advantages:
 - Simple, inexpensive, and easy to align.
 - Can run at high speeds and over long distances.
 - Quiet operation and low maintenance.
- Limitations:
 - Can slip under high torque or sudden loads.
 - Requires good tensioning and alignment.
 - Not suitable for precise motion or high-torque transfer.

Flat Belt



V-Belts

- **Description:**

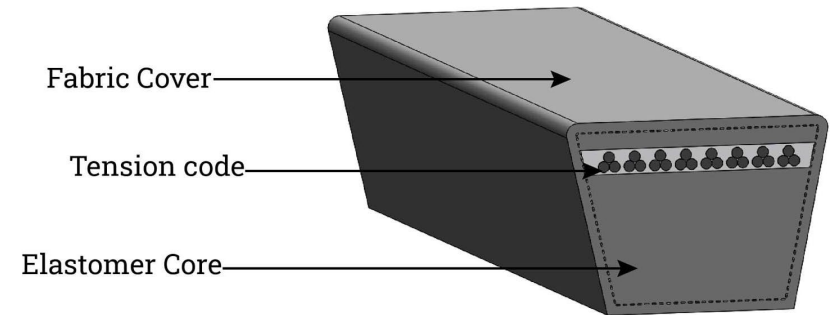
- A belt with a trapezoidal cross-section that fits into a matching V-shaped pulley groove.

- **Power Transmission Method:**

- Uses wedging action for friction.
- As tension increases, the belt wedges deeper into the pulley groove, increasing grip.

- **Typical Uses:**

- Automotive alternators and compressors, industrial machines, HVAC blowers, small mechanical drives.



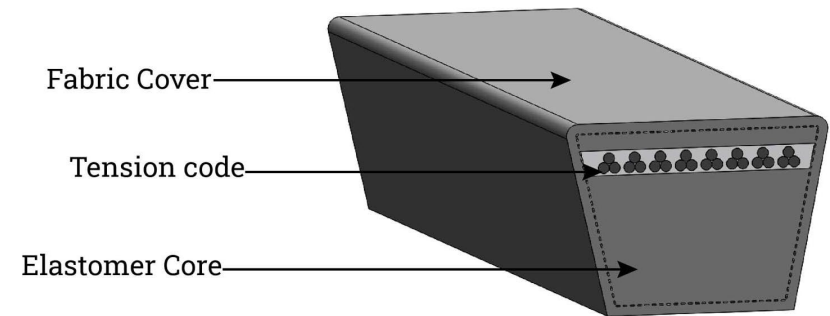
V-Belts

- **Advantages:**

- Higher torque capacity than flat belts.
- Less slippage due to wedge effect.
- Compact and efficient for short-distance drives.

- **Limitations:**

- Generates more heat at high speeds.
- Not ideal for very long centre distances.
- Still subject to some slip, so not suitable for precision timing.



Timing Belts (Toothed Belts or Synchronous Belts)

- **Description:**

- A rubber or polymer belt with moulded teeth that mesh with matching grooves on the pulley.

- **Power Transmission Method:**

- The teeth on the belt mesh with the sprocket/pulley making sure there is no slip

- **Typical Uses:**

- Robotics, 3D printers, CNC machines, automotive camshafts, timing systems where position accuracy matters.



Timing Belts (Toothed Belts or Synchronous Belts)

- **Advantages:**

- Precise synchronization between shafts (constant speed ratio).
- High efficiency and quiet operation.
- No lubrication required.

- **Limitations:**

- Limited torque capacity compared to chains or gears.
- Sensitive to debris or wear that can damage teeth.
- More expensive than friction belts.



Chain Drives

- **Purpose:**
 - Transmit power between rotating shafts using a linked chain and sprockets
- **How It Works:**
 - Power is transmitted by positive engagement between chain links and sprocket teeth — no slip.
 - The centre distance between sprockets determines chain length and tension.
 - Used where consistent speed ratio and higher torque are required.
- **Key Features:**
 - Roller Chain is most common (bushings, rollers, and pins).
 - Chains can connect parallel or offset shafts.
 - Direction and speed depend on sprocket sizes (like gears).



Chain Drives

- **Advantages:**
 - Maintains accurate speed ratio with no slip.
 - Handles high torque and load.
 - Simple to replace or reconfigure for different ratios.
- **Limitations:**
 - Needs proper lubrication and alignment.
 - Chain wear can cause backlash over time.
 - Generates more noise and vibration than belts.

