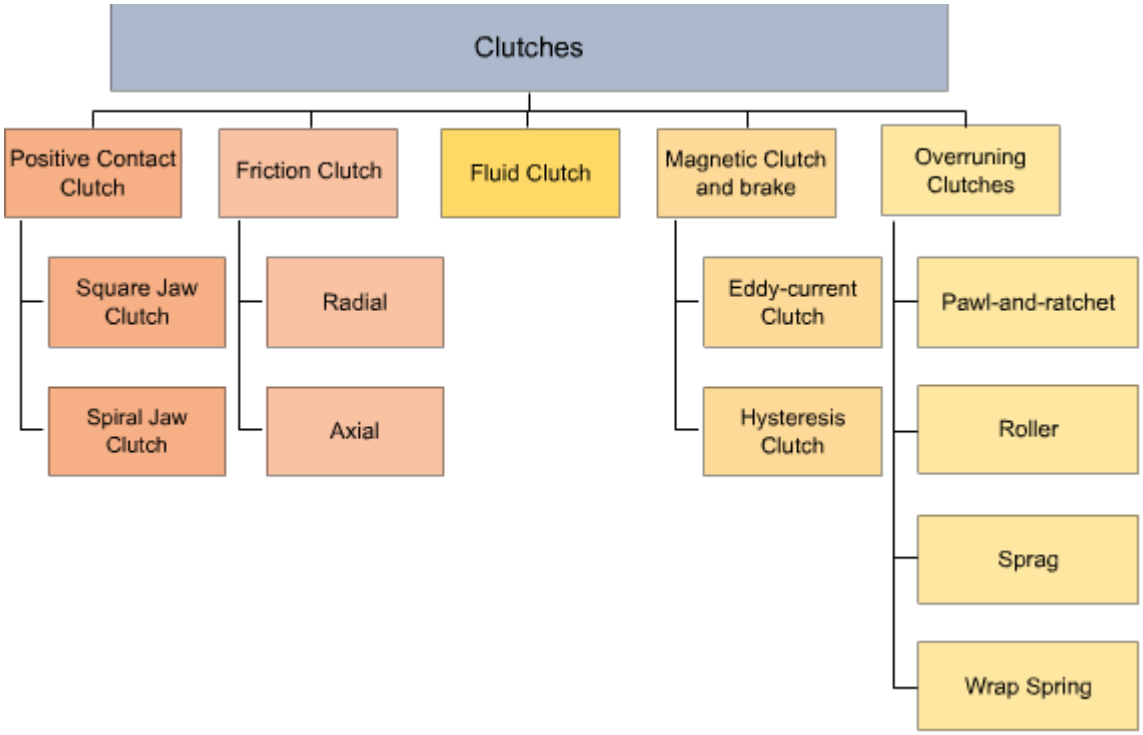
Clutches: Types and Troubleshooting

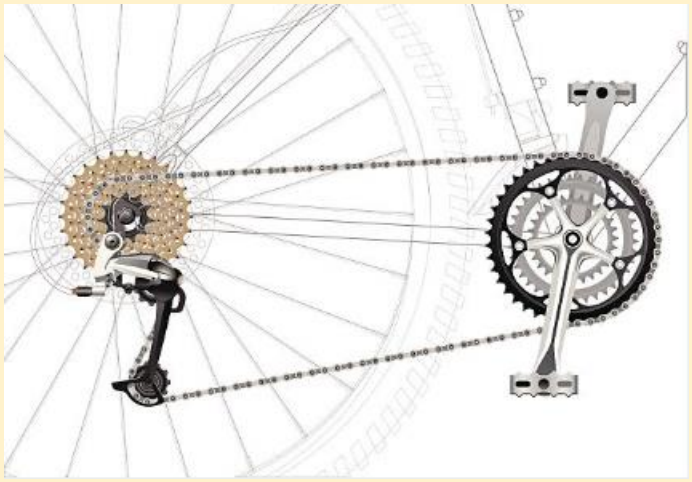
In this document, you will learn about overrunning clutches and their applications. You will also learn some quick troubleshooting for clutches and brakes.



Overrunning Clutches and Applications

Introduction

An overrunning clutch is a mechanical device that allows rotation and torque to be transmitted in only one direction. These clutches look like bearings.



Let's take an example of a bicycle. With its freewheel mechanism, the rider can pedal to make the rear wheel turn. However, the wheel does not make the pedals turn. This configuration allows the rider to coast downhill without pedaling.

Configurations/Types

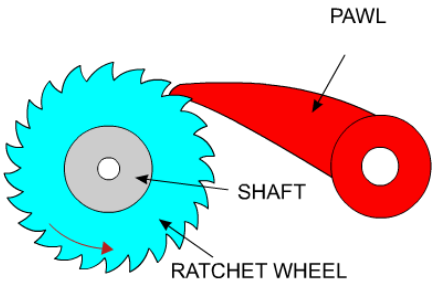
There are four main configurations of an overrunning clutch: Pawl-and-Ratchet, Roller, Sprag, and Wrap Spring. Let's take a look.

Labels (to insert into the graphic):

Pawl: Gravity operated or spring loaded

Ratchet: Specially cut gear to allow the pawl to slide over or lock

Shaft



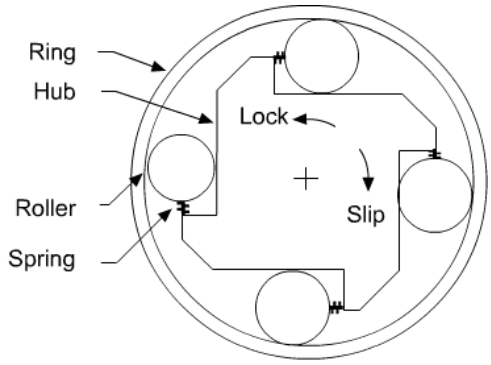
How It Works:

The ratchet allows the pawl to slide over the teeth if it is rotated forward and locks the ratchet if it is reversed.

Pawl-and-Ratchet

Key Features

- One of the first mechanical overrunning clutch designs.
- A similar mechanism is used in older mechanism clocks. The pawl-and-ratchet creates the characteristic tick-tock sound of these clocks.



How It Works

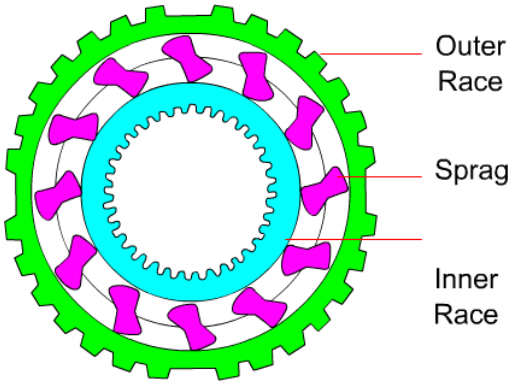
Roller

Key Features

- This spring-loaded ball-and-ramp assembly rotates freely.
- The working of a roller causes very quick operation with less time for the machine to build up dynamic shock.
- When used for backstop application, either the housing or the hub may be locked to the machine frame.

The ball or roller runs up the ramp and wedges if reversed, thus effectively locking the clutch assembly.

The spring keeps the rolling element engaged with both the housing and the hub.



Sprag

Key Features

- Sprags are special camlike pieces.
- The clutch has cylindrical hubs and housings with sprags filling the spaces between them.
- The sprags can be designed to slide from either the hub or the housing, depending on the type of application.

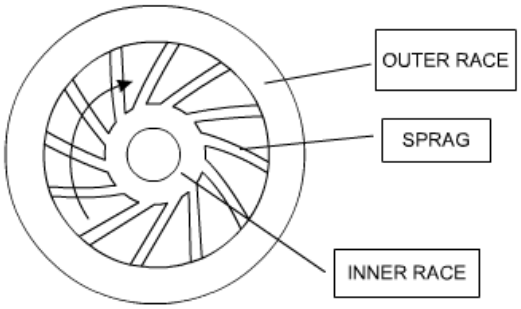
How It Works

The sprags are shaped to slide when rotated and wedge and lock when reversed.

Application

Sprag clutches can be used in overrunning, indexing, or backstopping applications.

A Simpler Version



This version of a sprag clutch was used in wooden wagons to prevent them from rolling backward.

Advantages and Disadvantages

✓ Sprag clutches have an advantage over roller clutches. They can be packed more closely than rollers. More sprags result in more torque being transmitted in the same relative space.

- A sharpened piece of wood or iron was attached to the rear axle and was dragged behind the wagon.
- When the wagon tried to roll backward, the sharp point dug into the dirt and wedged the wagon in place, effectively braking it.

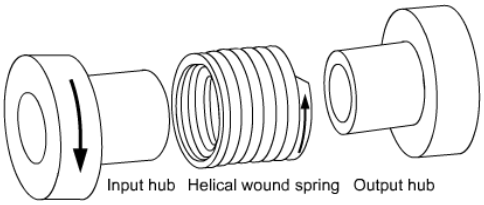
- As sprag clutches operate by sliding instead of rolling, lubrication becomes a critical consideration.

Labels (for graphics):

Input hub

Output hub

Helical wound spring



Wrap Spring

Key Features

- The springs have an inside diameter slightly smaller than the outside diameters of the hubs.
- Increasing torque causes the spring to get even tighter.
- Simple, economical, and reliable.

How It Works

Spring rotated in one direction → Spring tightens on the hub and locks the clutch.

Spring rotated in opposite direction → Spring loosens and slips on the mating hub.

Application

Wrap springs are often used in light-duty, slower-speed applications. Examples: copy machines, packaging machines, and light conveyors.

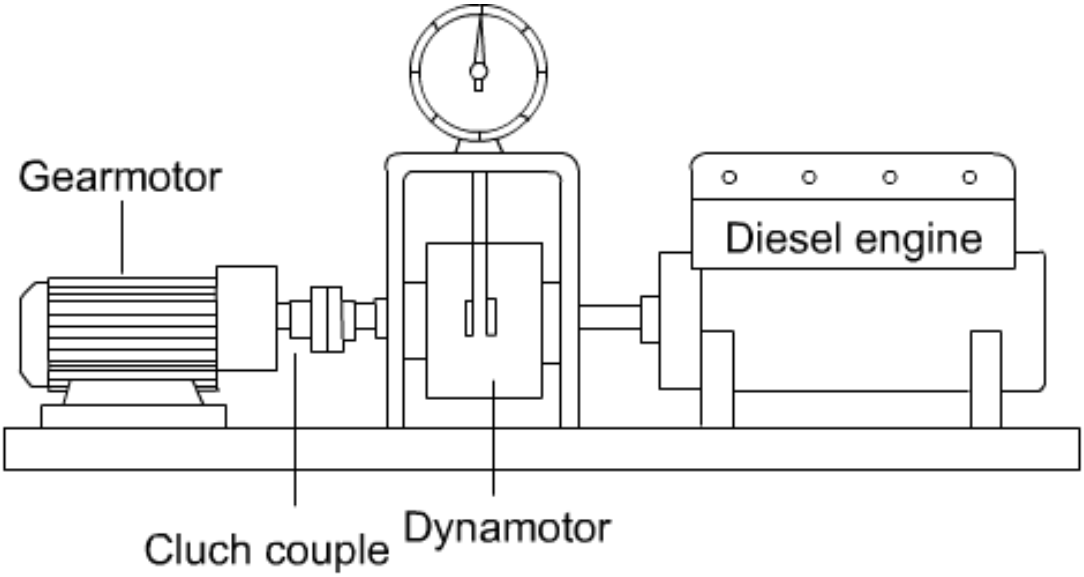
Application

Overrunning clutches have three basic types of applications:

Overrunning	The driven device runs faster than the driver.
Indexing	Reciprocating motion is transformed to intermittent rotating motion in one direction only.
Backstopping	The overrunning clutch prevents rotation in the reverse direction and may be considered a braking application.

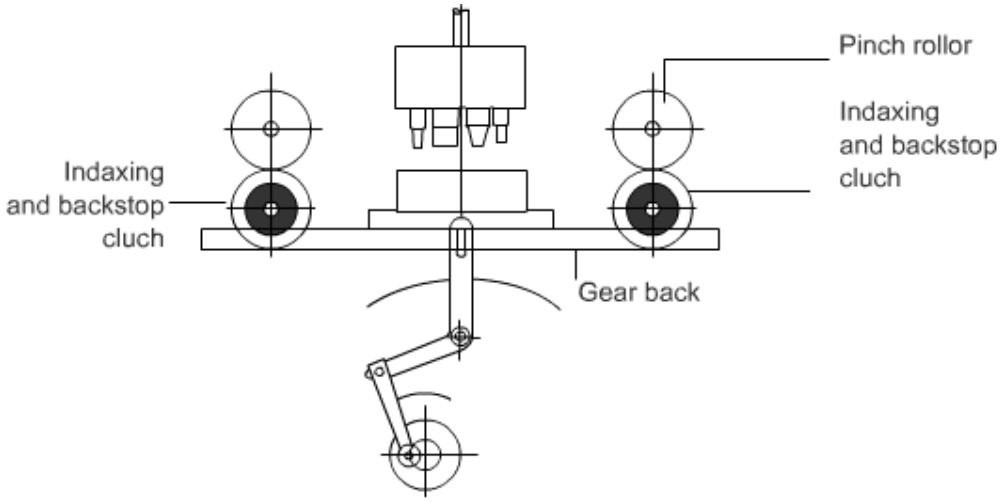
Let's look at a few examples of these applications.

Overrunning



Caption: A typical industrial application using this clutch involves two drivers (gearmotor and driving engine) running a machine. With an overrunning application, either driver could run the machine without the other.

Indexing

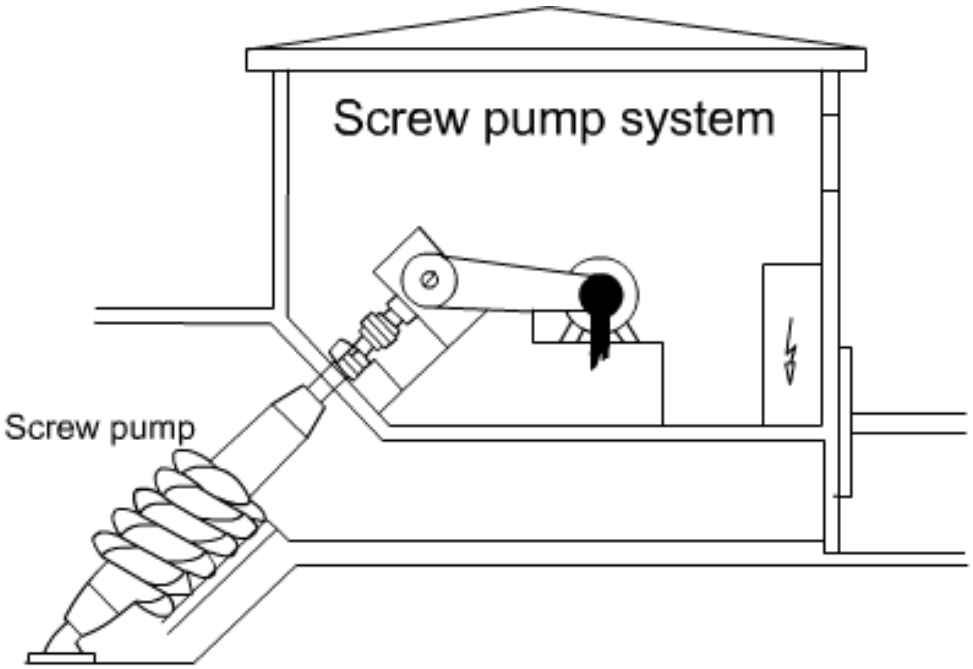


Caption: A pneumatic cylinder indexes a disc with blanks to be stamped one-half turn. While one part is being stamped, the backstopping mechanism stops. The operator can remove a finished part and insert another blank to be stamped.

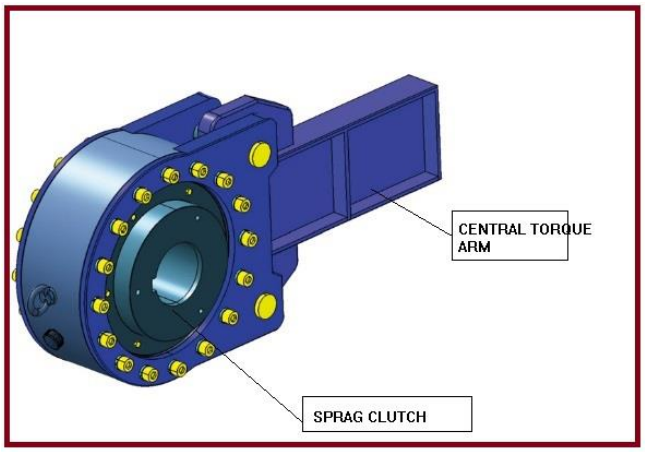
Backstopping

In backstopping application, the housing of the clutch is permanently locked and mounted to the machine frame.

Forward rotation	•Nothing happens.
Reverse rotation	•The clutch locks the shaft instantly and acts as a brake.



Caption: Industrial centrifugal pumps and screw pumps sometimes use backstops to prevent reverse rotation when the motor is stopped and the pumpage may tend to run back through the pump.



Caption: In the case of an inclined conveyor, the function of the backstop is to keep the conveyor loaded with gravel from running backward if a power failure occurs.

Selecting an Overrunning Clutch for Backstopping

Backstops should be selected for the absolute worst-case condition. Usually, there is no problem with stored energy because the clutch does not have to deal with any momentum from the shaft and machinery. However, due to the quick braking action, even small dynamic loads can cause machine damage.

Troubleshooting Clutches and Brakes

What are some of the best practices to be followed for clutch and brake maintenance?

Follow these checks to prevent damage to clutches and brakes.

- ✓ Use correct size of clutches/brakes according to their application.
- ✓ Ensure adequate heat dissipation for longer life and lower maintenance of clutches and brakes.
- ✓ If lubrication of a clutch/brake is required, have it done periodically.
- ✓ Check the components of clutches/brakes for adjustment and water.
- ✓ Keep the clutches/brakes free from debris.

Common Issues and Resolutions

Here is a list of common issues that may arise with clutches and brakes due to excessive slip, along with their resolutions.

Issue	Resolution
Improper adjustment of clutch/brake	Follow manufacturer's adjustment procedures. The clutch/brake may not be fully engaging.
Oil/contaminant on friction surfaces	Clean/replace the surfaces.
Worn-out friction components	Check the components to see if they are within tolerances. Replace the components if necessary.
Worn linkage/parts used in engaging clutch/brake	Adjustment may be inadequate to compensate for the wear. If there is obstruction or corrosion on the moving parts, clean or replace the parts. Check to see if lubrication is required.
Too much torque	Check the machine to determine whether the increased load is permanent or temporary. Depending on the observation, implement the following according to the specifications: • Repair or service the machine to reduce torque. • Replace the clutch/brake with one designed for increased torque loads.
High-frequency cycling or high-inertia loads	• Change to a clutch/brake with higher dissipation ability. • Use a fan/blower to increase air flow and cool the equipment. • Shorten the slipping time during start-up to reduce heat, but make sure that engagement is not so sudden that shock loads are created in the machine.