Gears

Purpose of Gears: Gears improve the speed and agility of your wheels. They can be used to increase or decrease speed and/or power.

How to use Gears:

•The gear you turn (called the driver) causes the other gear (called the follower) to turn also. The driver and the follower turn in opposite directions.

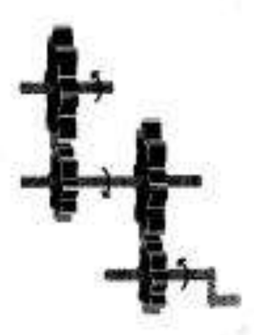
A large driver makes a small follower gear turn faster and decreases the force. This is called gearing up.

A small driver gear makes a large follower gear turn slower and increases the force. This is called gearing down.

An idler gear makes adjacent gears turn in the same direction. A large driver will make a small follower turn faster, regardless of the idler size.

The crown gear can change the rotary motion through a 90-degree angle.

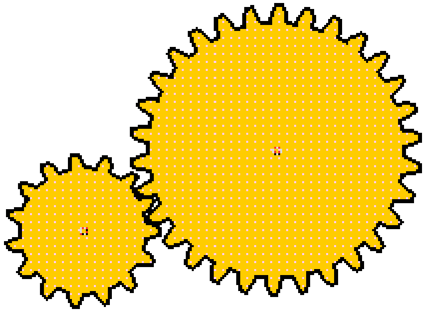
Gears of different sizes on the same axle can be connected to other gears to build more extensive gearing down (and gearing up) arrangements.



A gear ratio is a comparison of the total number of turns of input to the turns of output. For example, a gear ratio of 1:3 (8 toothed gear turning a 24 toothed gear) means that the input axle/shaft must make three revolutions to produce one revolution of the output axle/shaft. This also means that the output speed is three times slower, but the output force is three times greater. (more on gear ratios below)

Involute Curve

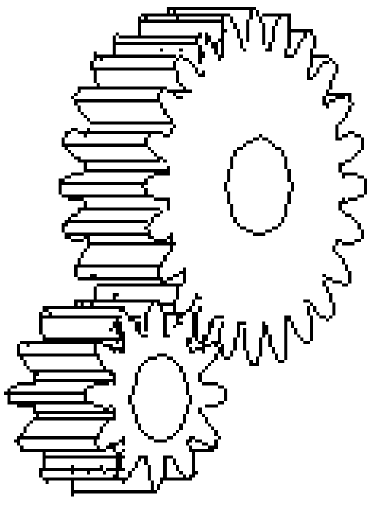
The following examples are involute spur gears. We use the word *involute* because the contour of gear teeth curves inward. Gears have many terminologies, parameters and principles. One of the important concepts is the *velocity ratio,* which is the ratio of the rotary velocity of the driver gear to that of the driven gears.

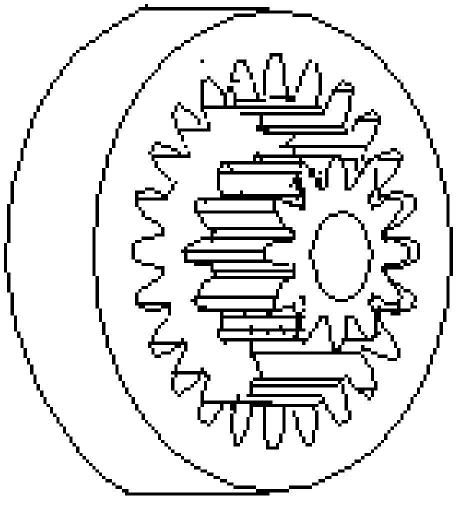


The Design file for these gears is sim/gear 15.30.sim. The number of teeth in these gears are 15 and 30, respectively. If the 15-tooth gear is the driving gear and the 30-teeth gear is the driven gear, their velocity ratio is 2.

Gears for connecting parallel shafts

1.Spur gears





The left pair of gears makes **external contact**, and the right pair of gears makes **internal contact**

Spur gears

•**Parallel helical gears**

Helical Gears

The teeth on **helical gears** are cut at an angle to the face of the gear. When two teeth on a helical gear system engage, the contact starts at one end of the tooth and gradually spreads as the gears rotate, until the two teeth are in full engagement.

Bevel Gears

Bevel gears are useful when the direction of a shaft's rotation needs to be changed. They are usually mounted on shafts that are 90 degrees apart, but can be designed to work at other angles as well.

The teeth on bevel gears can be **straight**, **spiral** or **hypoid**. Straight bevel gear teeth actually have the same problem as straight spur gear teeth -- as each tooth engages, it impacts the corresponding tooth all at once.

Bevel gears

Spiral bevel gears

Hypoid bevel gears in a car differential

The **locking differential** is useful for serious off-road vehicles. This type of differential has the same parts as an open differential, but adds an electric, pneumatic or hydraulic mechanism to lock the two output pinions together.

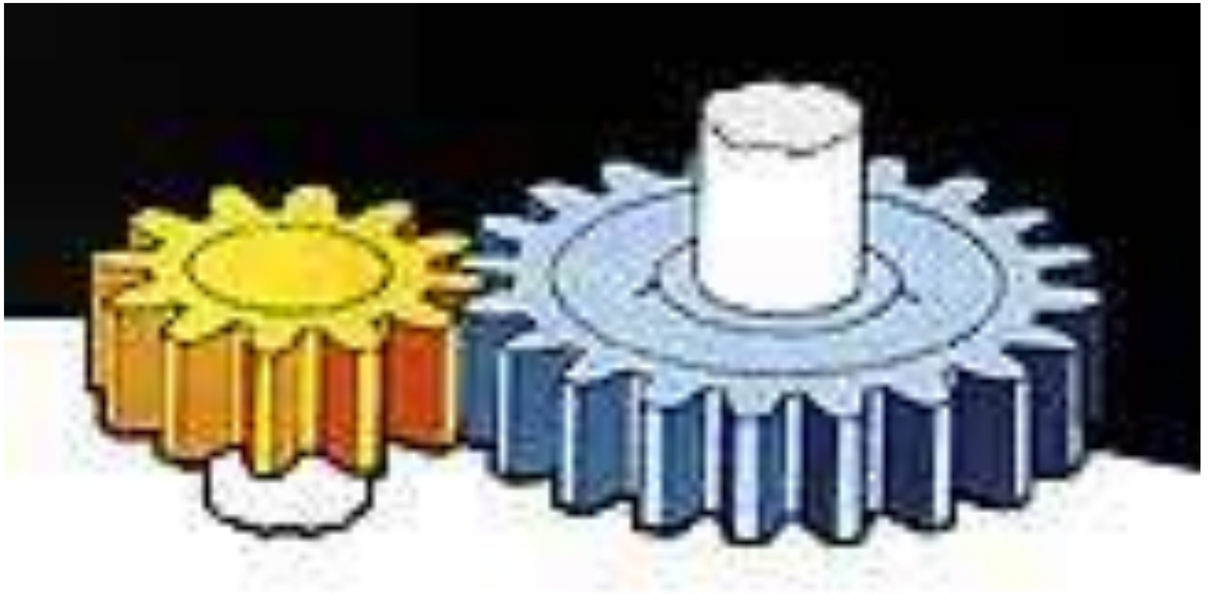
Worm Gears

Worm gears are used when large gear reductions are needed. It is common for worm gears to have reductions of 20:1, and even up to 300:1 or greater.

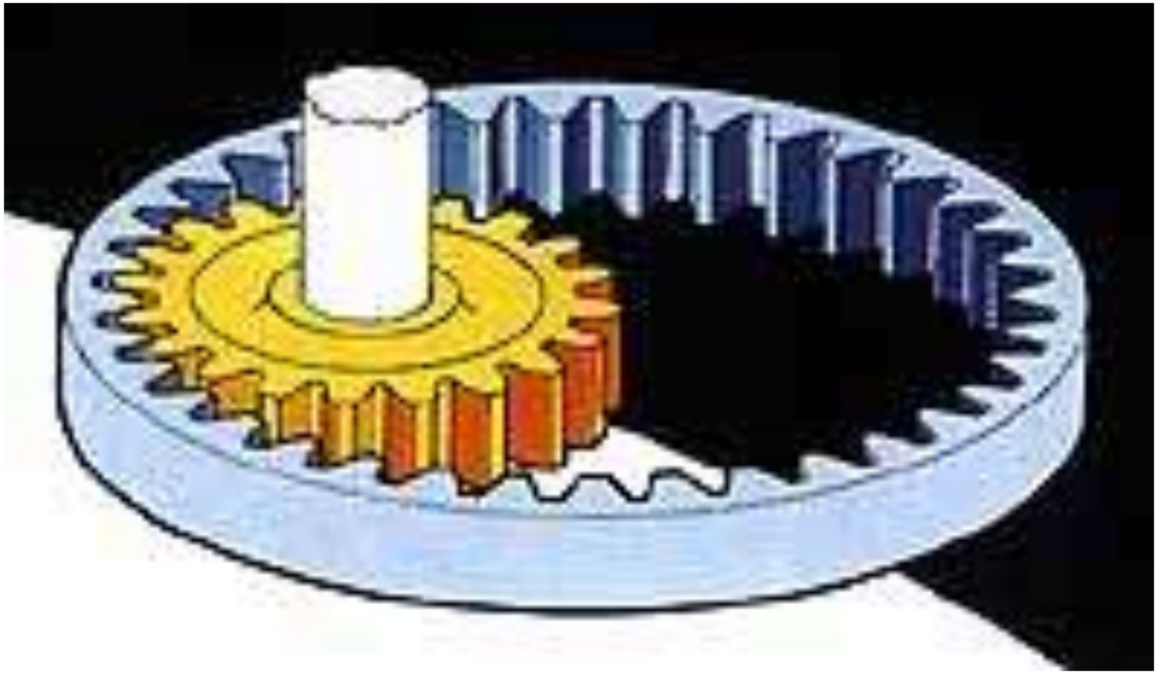
Worm gear

Rack and Pinion Gears

Rack and pinion gears are used to convert rotation into linear motion. A perfect example of this is the steering system on many cars. The steering wheel rotates a gear which engages the rack. As the gear turns, it slides the rack either to the right or left, depending on which way you turn the wheel.



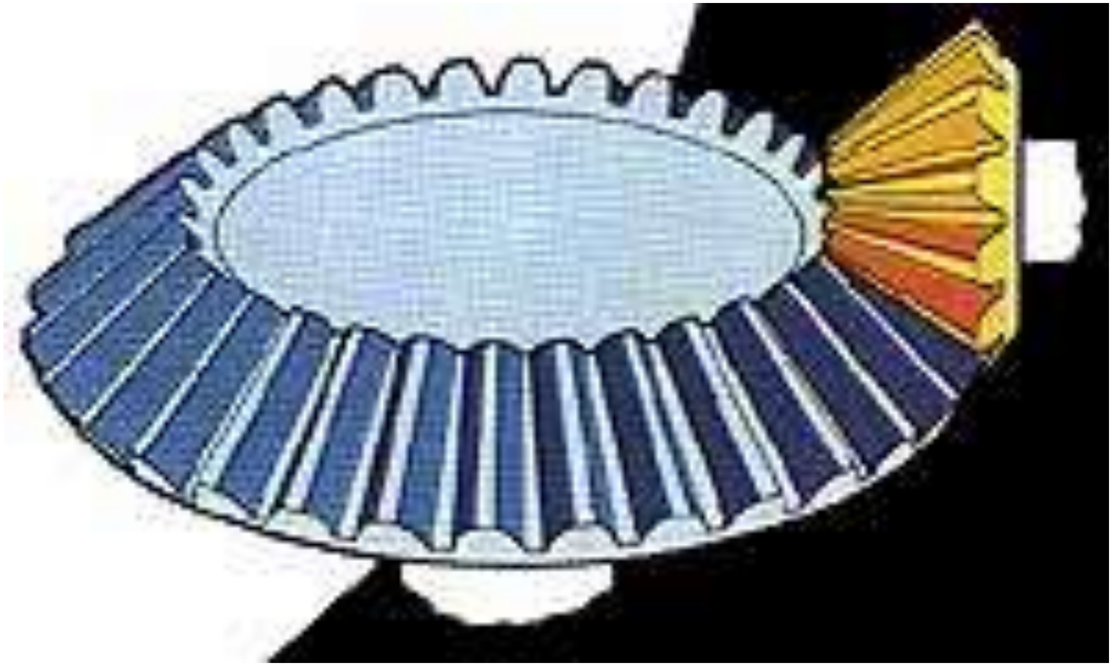
SPUR GEAR is used when shafts (white) must rotate in the same plane. The teeth are straight and parallel to the shaft. The pinion (yellow) is the smaller of a gear pair



INTERNAL GEAR allows the pinion (yellow) to rotate on the inside of a ring type gear with straight teeth on its inner surface. This is a type of spur gear in which both the pinion and the gear turn in the same direction, unlike ordinary spur gears.

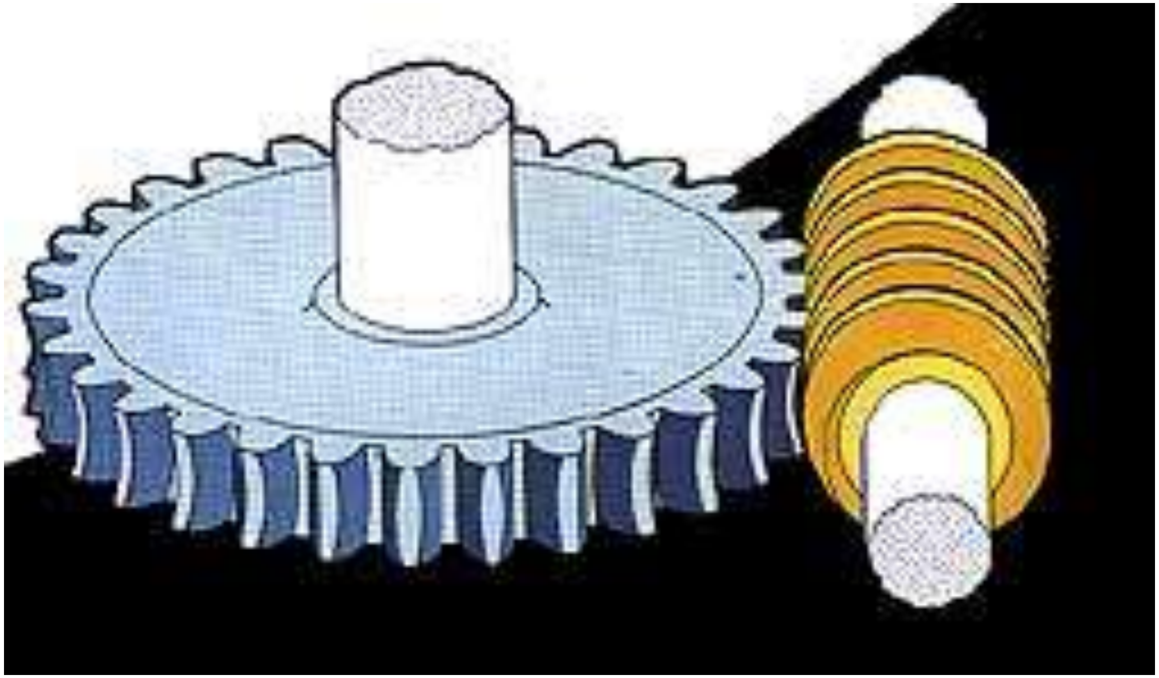
HELICAL GEAR has curved teeth at an angle to the shaft. These teeth grip with less noise than straight teeth, especially when they are turning at high speeds.

HERRINGBONE GEAR has teeth that are V-shaped, like a double helical gear. The shafts rotate in opposite directions as in an ordinary spur gear.

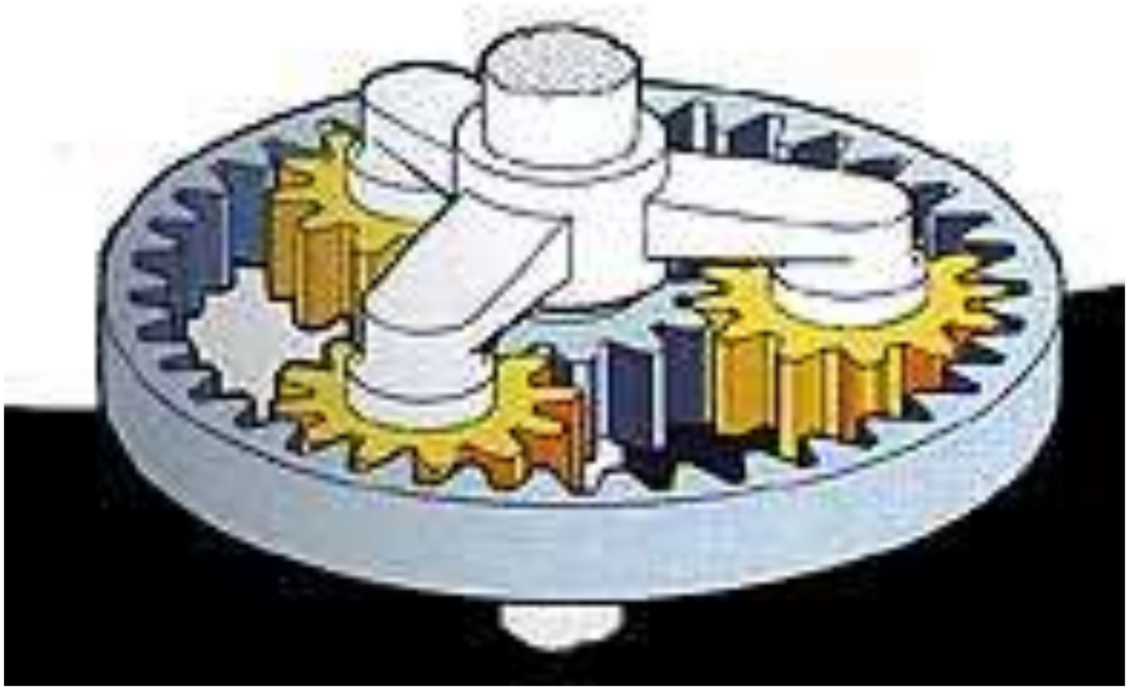


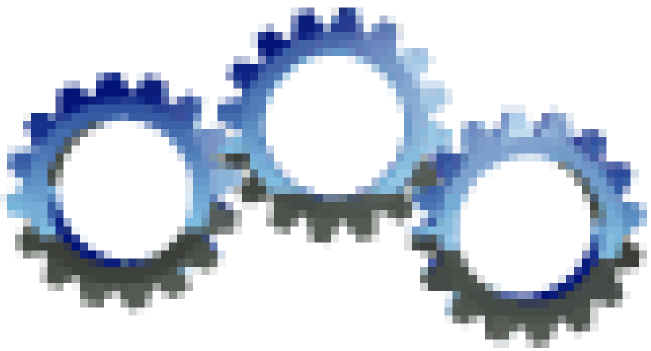
BEVEL GEAR has teeth that slope along one surface of the disc. The pinion (yellow) rolls at an angle to the top of the gear, not along its edge. This type of gear is used when the shafts to be turned meet at an angle.

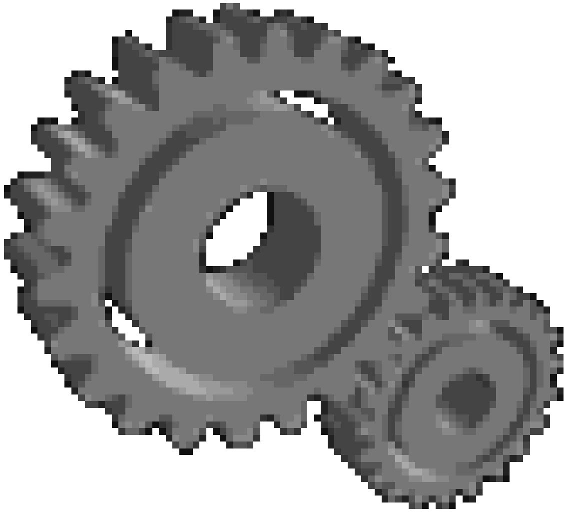
WORM GEAR has a screw pinion (the worm) which turns along a spur gear. Motion can be transmitted between shafts that are at right angles.



PLANETARY GEAR is a system whereby PLANET spur gears turn on a central SUN gear and an internal ring gear. This system is used in automatic cars.

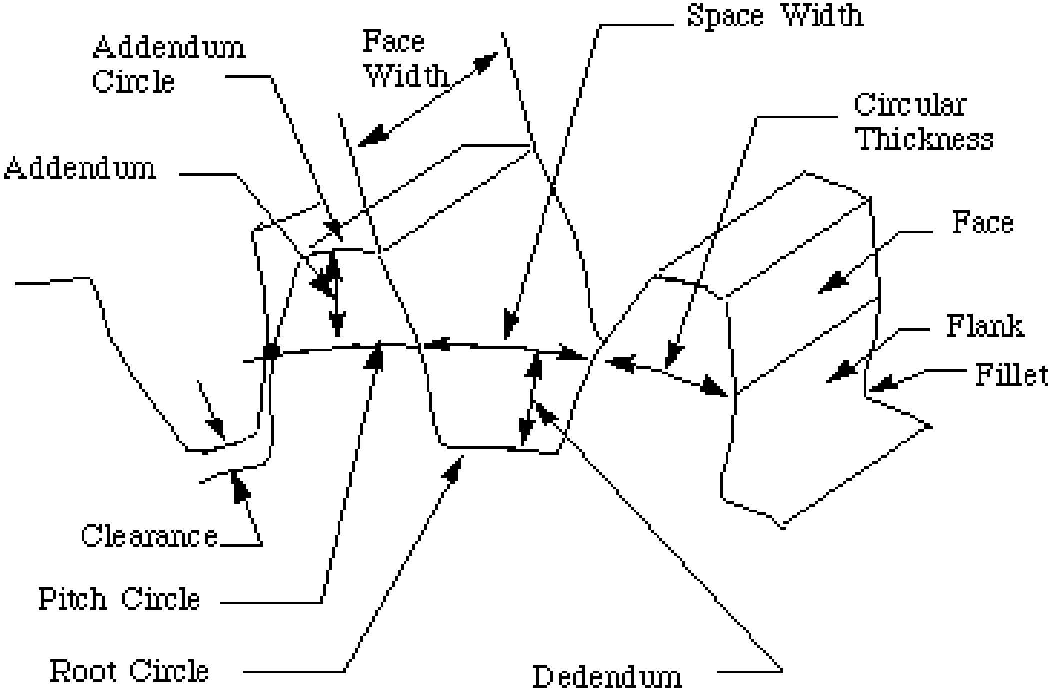






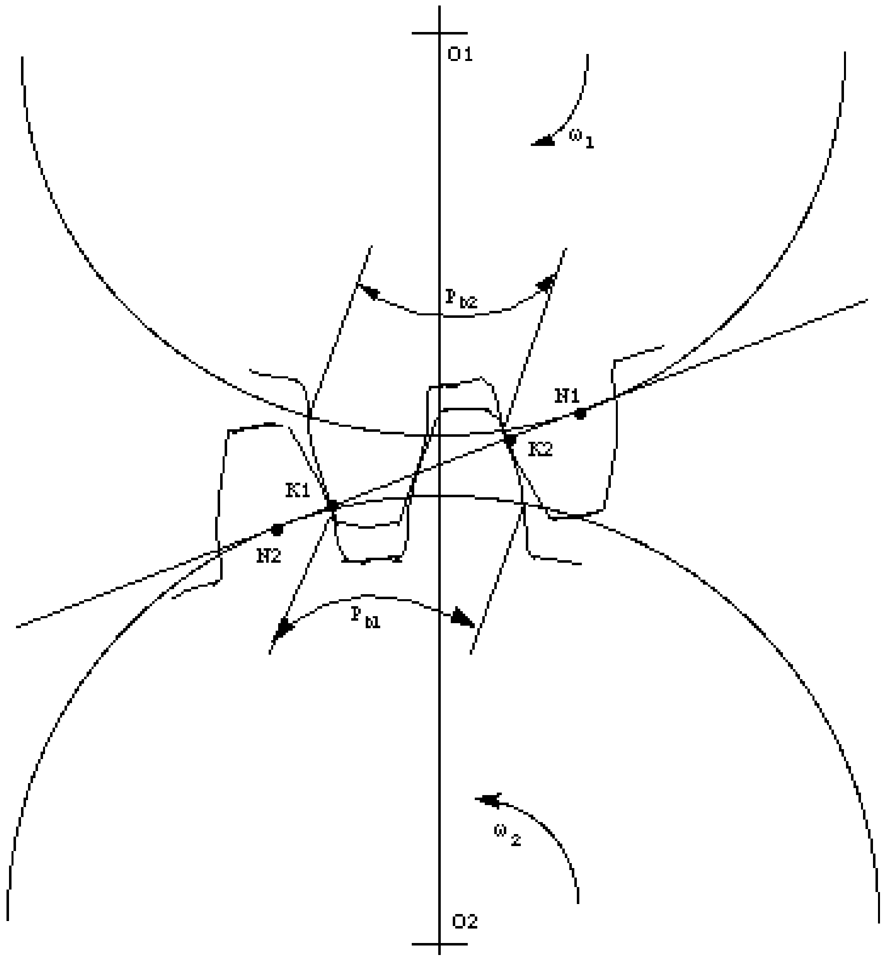
Terminology for Spur Gears

Figure 7-4 shows some of the terms for gears.

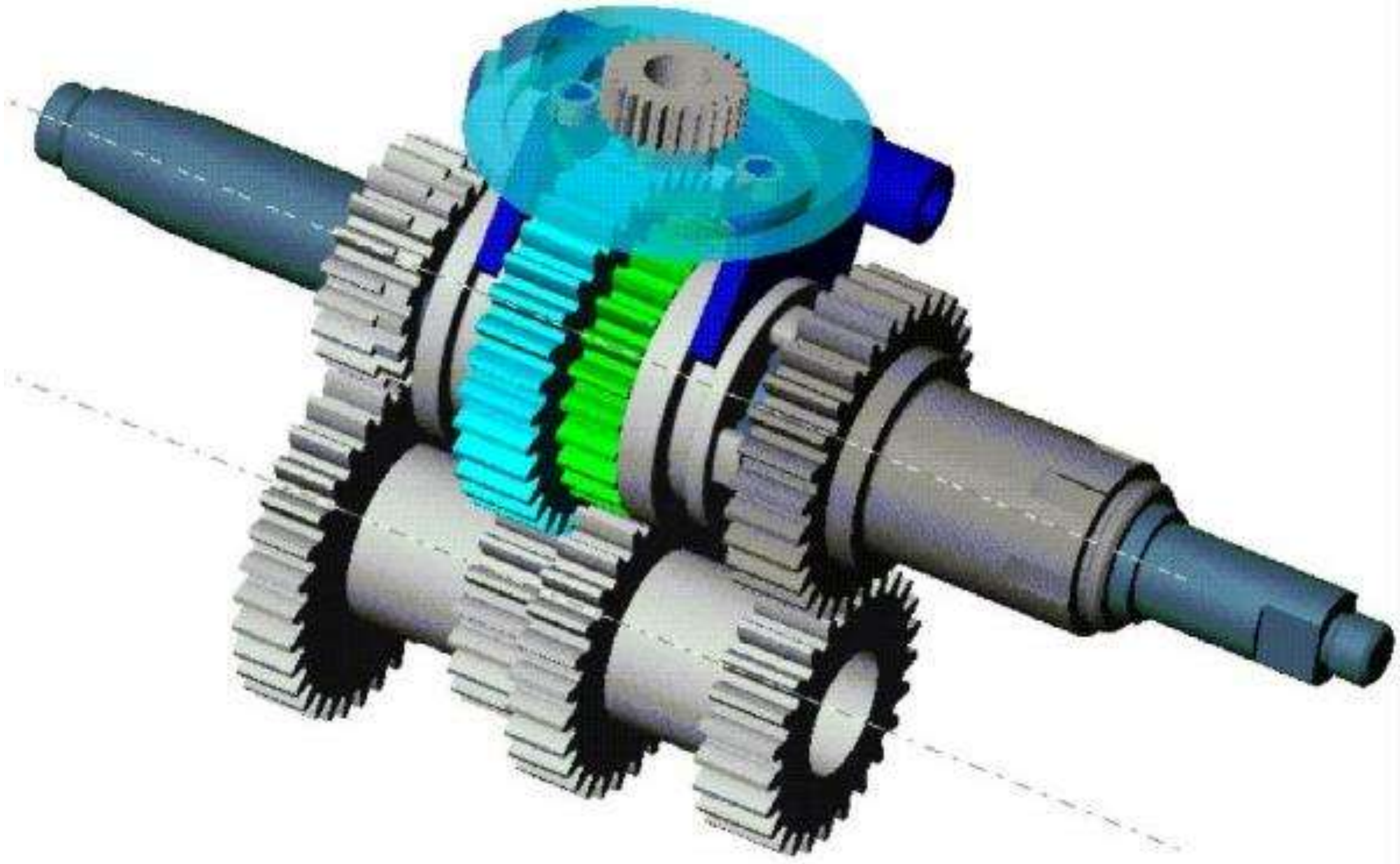


Condition for Correct Meshing

Figure 7-5 shows two meshing gears contacting at point K_1 and K_2.



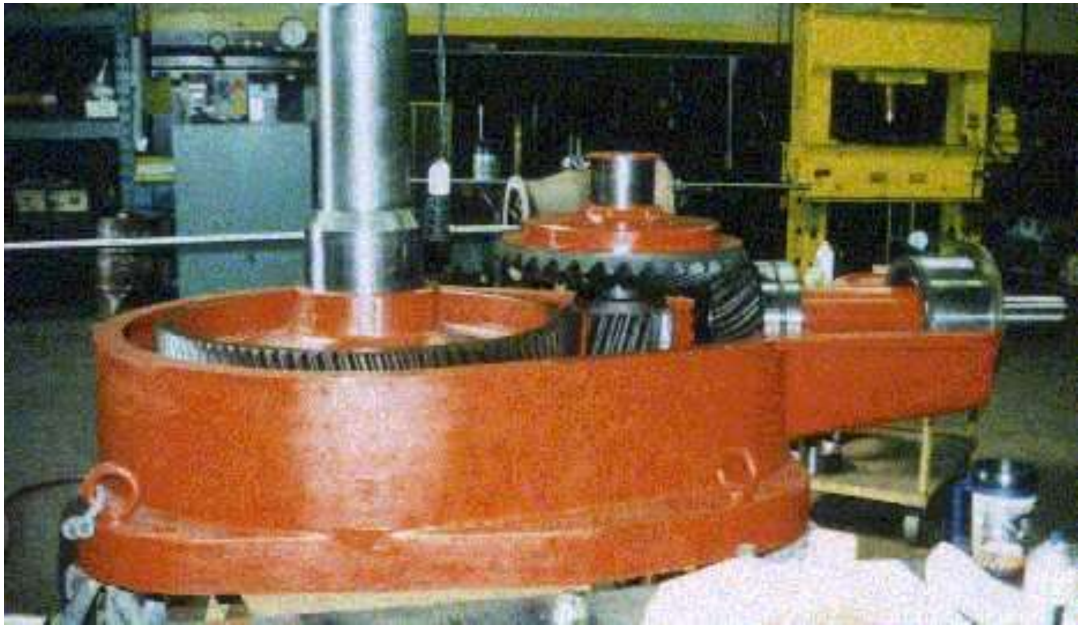
GEAR TRAIN

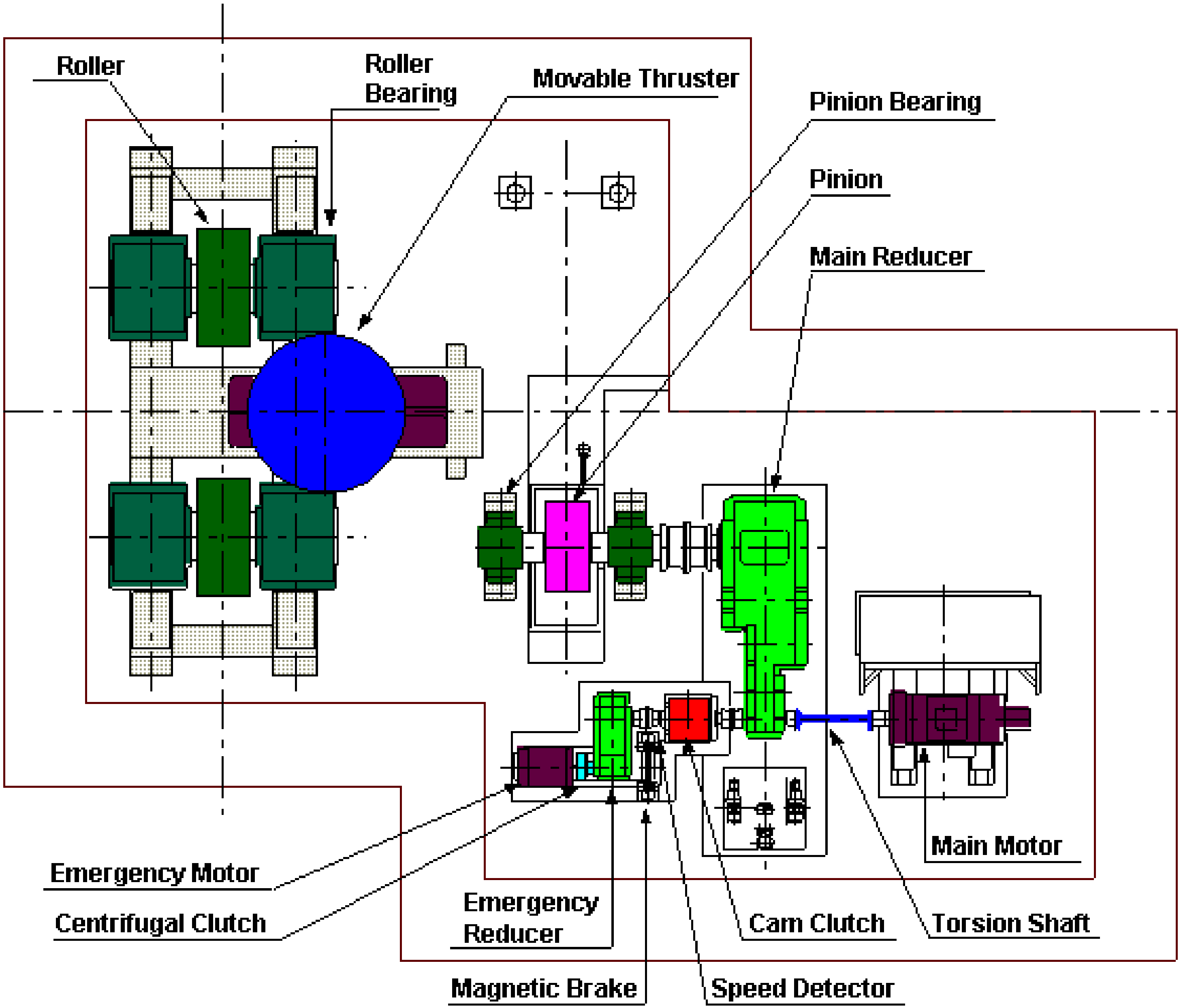


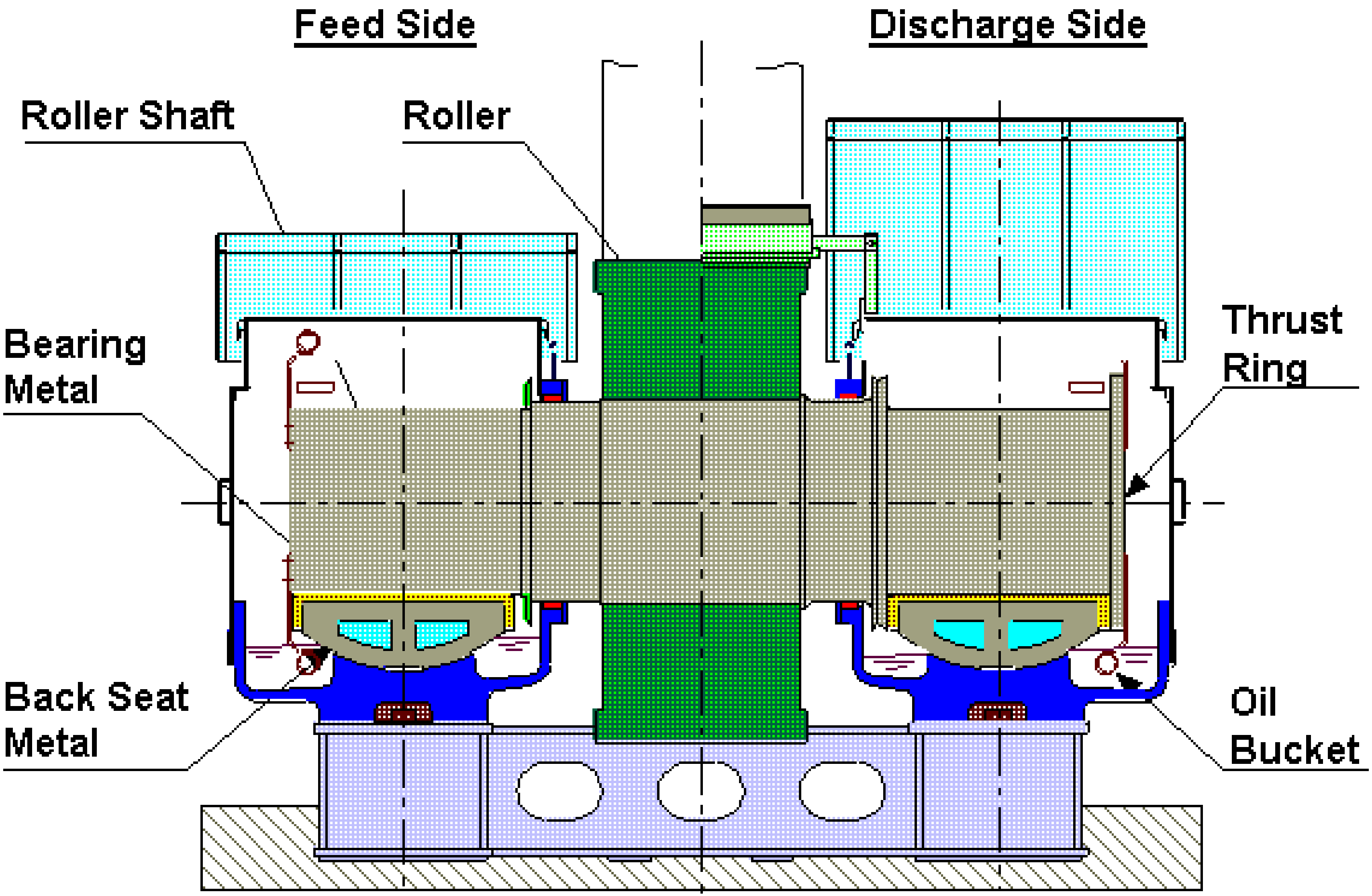
Bolt-On Reduction Gearbox

6:1 OR 2:1 Ratio For Engines up to 16HP

NORAM gearboxes have been designed to allow the OEM or end-user more flexibility in engine choices. Gone are the long lead times and higher prices associated with special make engines. Simply purchase a standard quality engine and attach a NORAM gearbox for your immediate usage. NORAM reduction gearboxes safely increase engine torque while reducing output rpm.




Roller
Roller Bearing
Movable Thruster
Pinion Bearing
Pinion
Main Reducer
Main Motor
Emergency Motor
Centrifugal Clutch
Emergency Reducer
Cam Clutch
Torsion Shaft
Magnetic Brake
Speed Detector


Feed Side
Discharge Side
Roller Shaft
Roller
Thrust Ring
Bearing Metal
Back Seat Metal
Oil Bucket

INTRODUCTION

A Cam is a machine component that either rotates or moves back and forth (reciprocates) to create a prescribed motion in a contacting element known as a follower. The shape of the contacting surface of the cam is determined by the prescribed motion and the profile of the follower; the latter is usually flat or circular.

Cams are made in a variety of forms, such as:

a rotating disk or plate with the required profile;

a plate with a groove cut on its face to fit a roller on the follower (face cam);

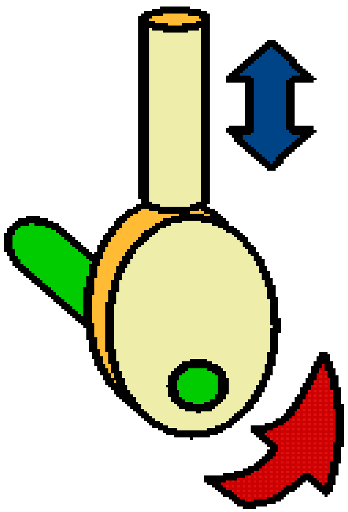
a cylindrical or conical member with a follower groove cut around the surface;

a cylinder with the required profile cut in the end (end cam);

a reciprocating wedge of the required shape.

Cam-follower mechanisms are particularly useful when a simple motion of one part of a machine is to be converted to a more complicated prescribed motion of another part, one that must be accurately timed with respect to the simple motion and may include periods of rest (dwells). Cams are essential elements in automatic machine tools, textile machinery, sewing machines, printing machines, and many others. If the follower is not restrained by a groove on the cam, a spring is necessary to keep the follower in contact with the cam.

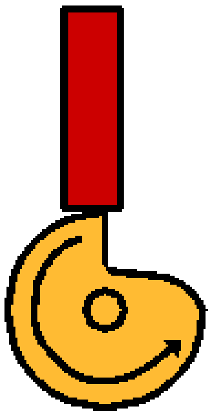
Mechanisms: Cams and Followers



The cam and follower is a device which can convert rotary motion into linear motion (movement in a straight line). A cam is a specially shaped piece of material, usually metal or hard wearing plastic, which is fixed to rotating shaft. The cam can have various shapes eg. round, oval, heart shaped. A follower is a mechanism which is designed to move up and down as it follows the edge of the cam.

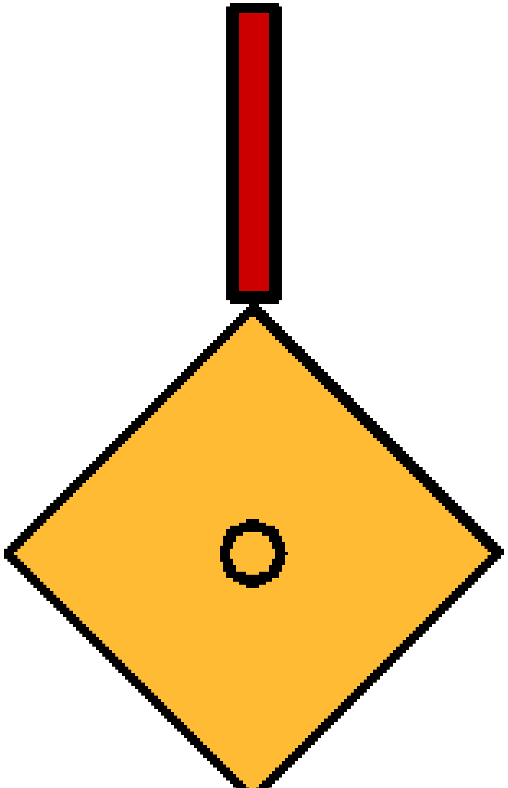
Many machines which have moving parts use cams. A good example is the motor car engine which has cams to open and close valves and contact breaker points and operate fuel pumps.

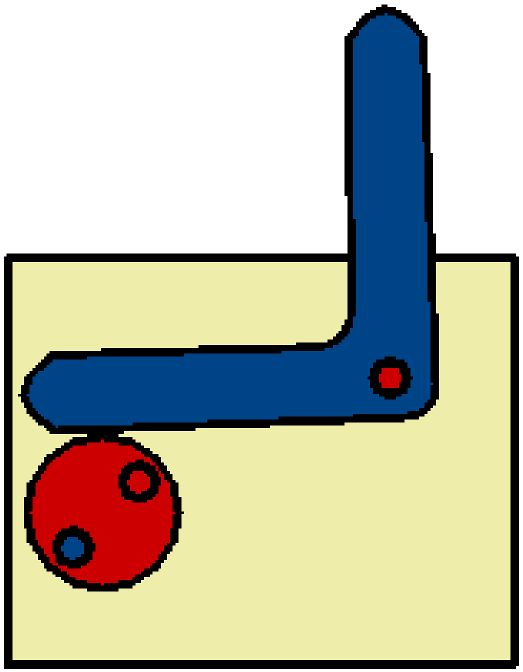
Mechanisms: Rotary Cams



There are several different types of cam but most of these can be placed into two groups - rotary and linear. Rotary cams change rotary motion into reciprocating (backwards and forwards) motion. As the cam rotates, the follower moves accordingly. The exact distance it moves depends on the shape of the cam.

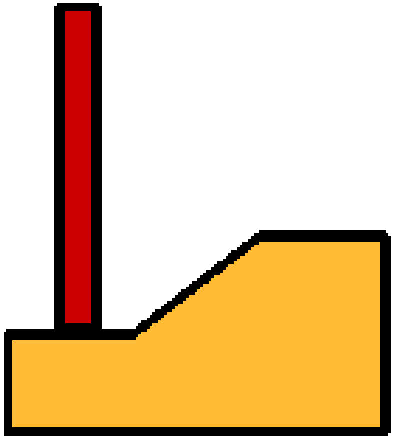
The protrusions on a cam are called lobes. The cams in a car engine have a single lobe - they will move the follower up and down only once per revolution. The square cam illustrated has four lobes, and hence lifts the follower four times per revolution.





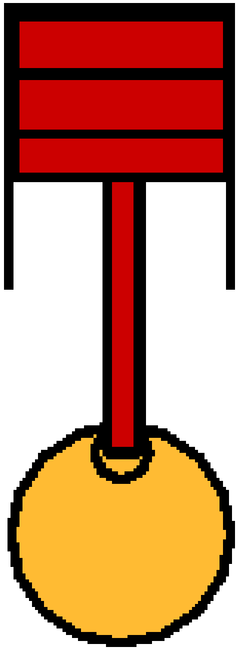
Cams with complicated profiles (the technical term for the shape of a cam) can be complicated to manufacture, particularly with the type of equipment available in the school workshop. However, if all you want to do is produce a single up and down motion for every revolution on the cam, a circular cam rotating about a point offset from its centre (an eccentric), will often suffice. Note that the cam follower need not just move up and down - it can be a lever as illustrated.

Mechanisms: Linear Cams



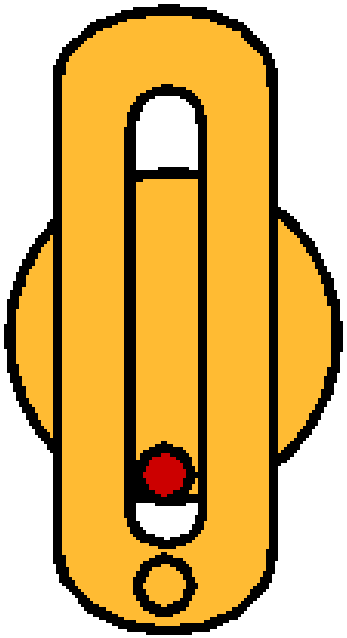
Linear cams change the direction (and magnitude) of reciprocating motion. Unlike rotary cams, the linear cam moves backwards and forwards in a reciprocating motion and the shape of the surface of the cam determines how far the follower moves.

Mechanisms: Crank and Slider



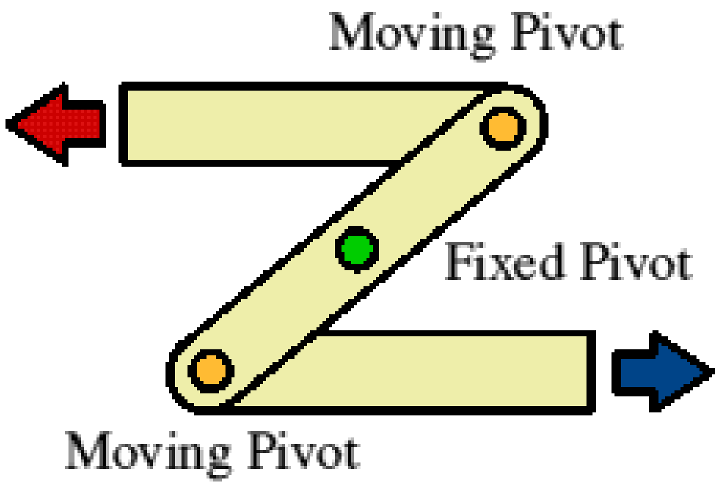
A crank and slider mechanism changes rotary to reciprocal motion or vice versa. In the car engine (illustrated) the reciprocating motion of the piston caused by exploding fuel is converted into rotary motion as the con-rod moves the crankshaft around. An air compressor uses this principal in reverse - an electric motor turns the crankshaft and the piston moves up and down to compress the air.

Mechanisms: Quick return mechanism



The 'Whitworth' quick return mechanism converts rotary motion into reciprocating motion, but unlike the crank and slider, the forward reciprocating motion is at a different rate to the backward stroke. At the bottom of the slotted arm, the peg only has to move through a few degrees to sweep the arm from left to right, but it takes the remainder of the revolution to bring the arm back. This mechanism is most commonly seen as the drive for a shaping machine.

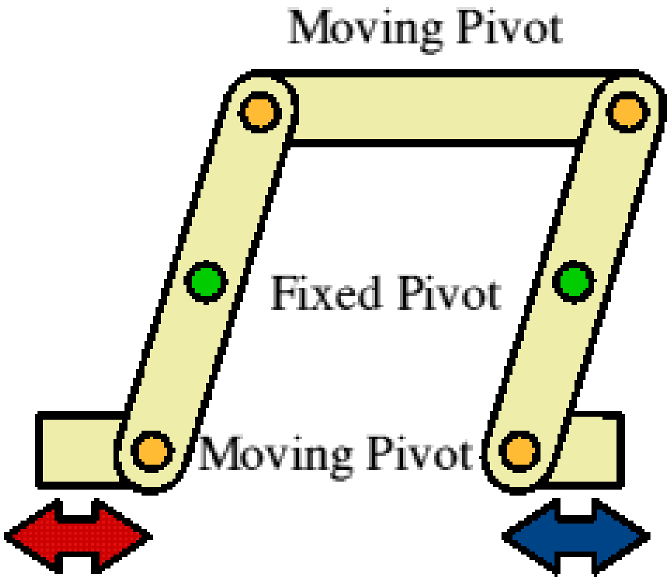
Mechanisms: Reverse Motion Linkage



Linkages can be used to make things move in opposite directions. The movement is reversed by using a lever to form the linkage. If the pivot point (fulcrum) is at the centre of the connecting lever then the output movement will be the same as the input movement but it will act in the opposite direction.

If the pivot point is not in the centre of the connecting lever then the movement of the output will not be equal to the movement of the input. By careful positioning of the fulcrum, it is possible to design a linkage system which moves an exact distance. It is also possible to design the linkage to produce mechanical advantage.

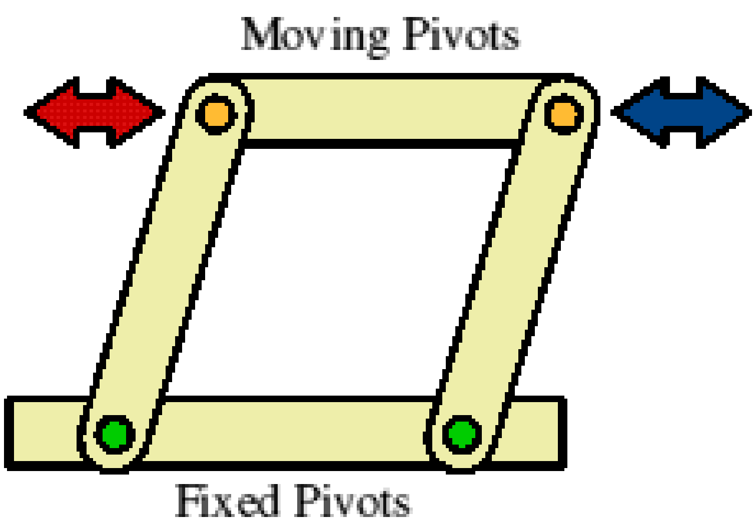
Mechanisms: Push Pull Linkage



If you want the output to move in the same direction as the input, then you would use the push-pull linkage.

This consists of levers connected with two fixed pivot points.

Mechanisms: Parallel Motion Linkage

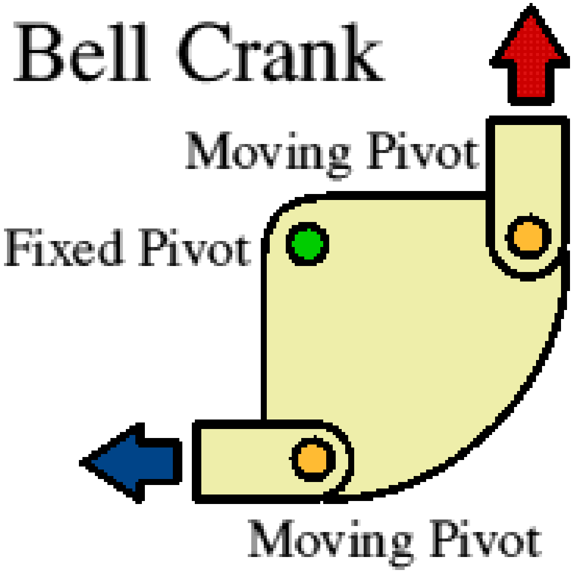


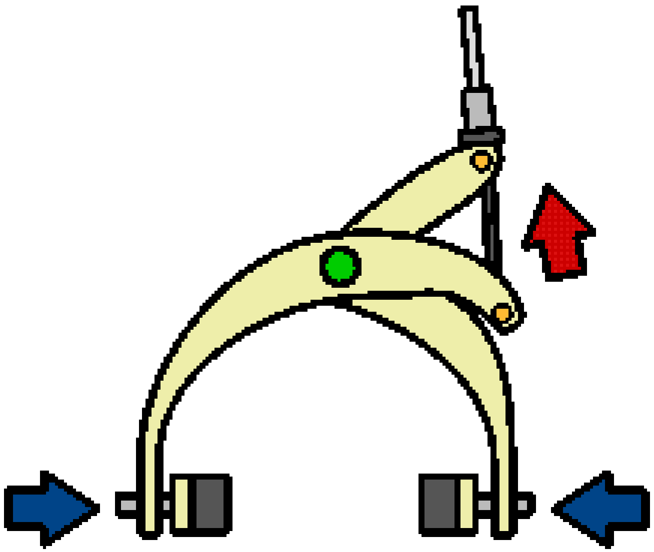
The parallel motion linkage can be used to make things move in the same direction a set distance apart. There are several good examples of these in action. The pantograph is a parallel motion linkage used by electric trains to pick up power from overhead cables. Another use is the pantograph used in drawing to copy sketches. Other uses are in containers such as tool boxes and sewing boxes which open up to reveal multiple shelves and containers which need to be held horizontal.

Parallel motion is only achieved if the levers at opposite sides of the parallelogram are equal in length.

Mechanisms: Bell Crank

If you want to change the direction of movement or force through 90° you can use a linkage device called a bell crank
A common device which uses this mechanism is the brakes of a bicycle. Here the force from the handlebar lever is turned through 90° to squeeze the brake block against the wheel rim.

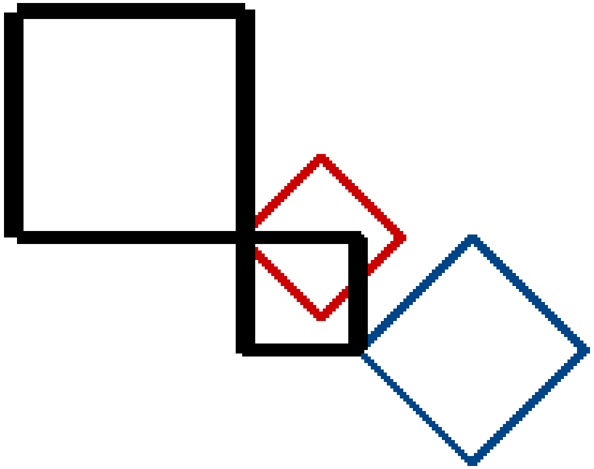


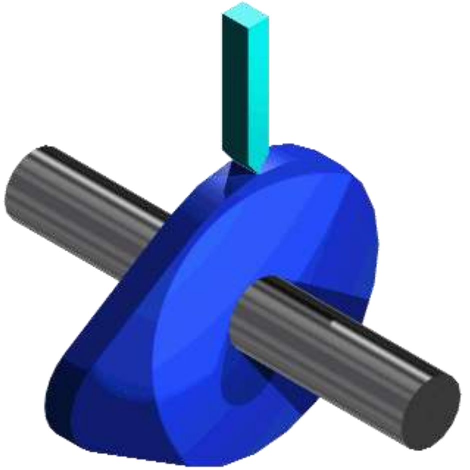


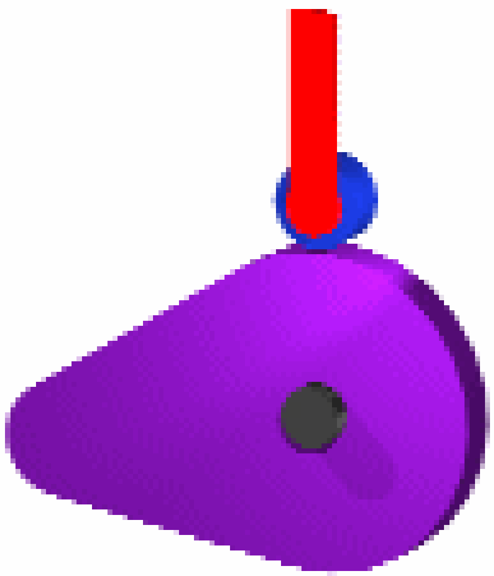
- A Intake Valve, Rocker Arm & Spring
- B Valve Cover
- C Intake port
- D Head
- E Coolant
- F Engine Block
- G Oil Pan
- H Oil Sump
- I Camshaft
- J Exhaust Valve, Rocker Arm & Spring
- K Spark Plug
- L Exhaust Port
- M Piston
- N Connecting Rod
- O Rod Bearing
- P Crankshaft

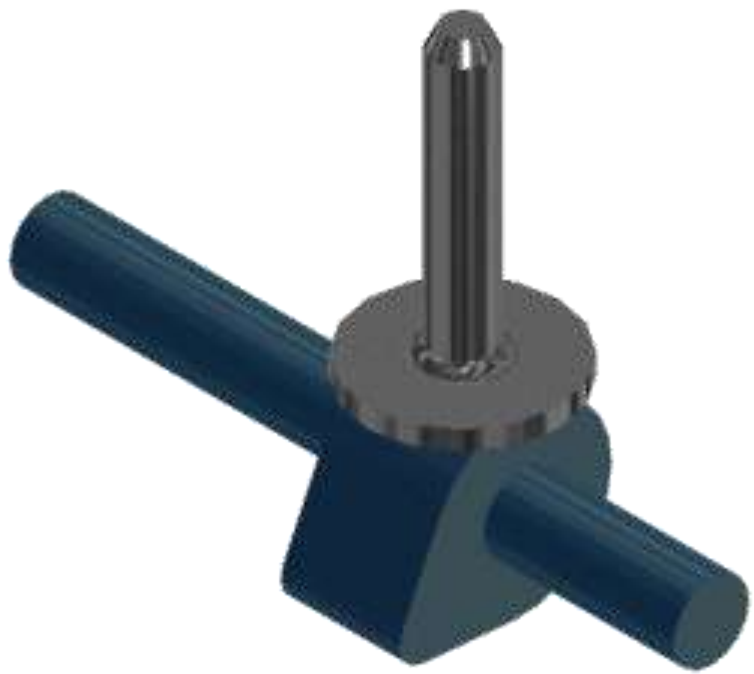
- 1 INTAKE
- 2 COMPRESSION
- 3 COMBUSTION
- 4 EXHAUST
- Spark
- Top Dead Center

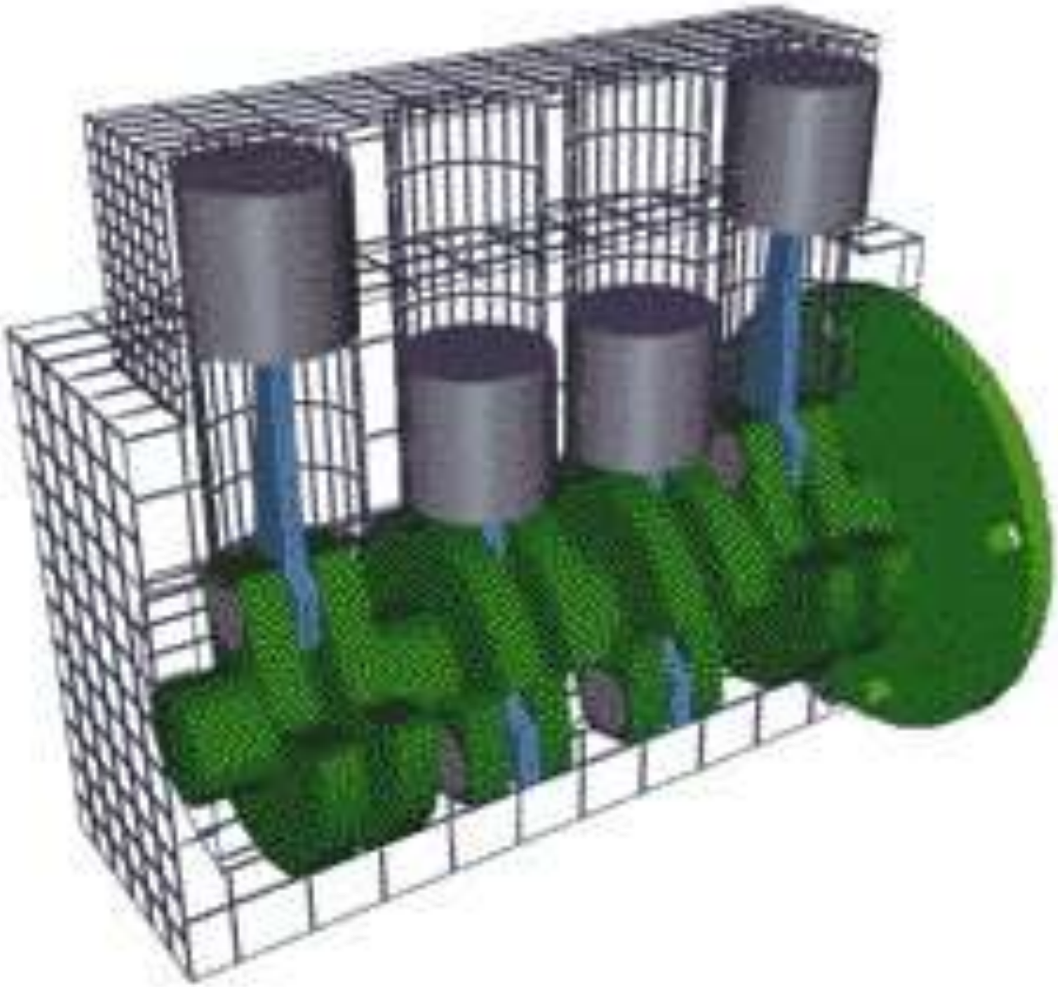
Linkages are also used to make objects move parallel to each other. These are called PARALLEL MOTION LINKAGES and are used in the manufacture of pantographs for drawing instruments, lazy tongs, parallel hinges on a tool box and are used by electric trains to pick up power from overhead cables.

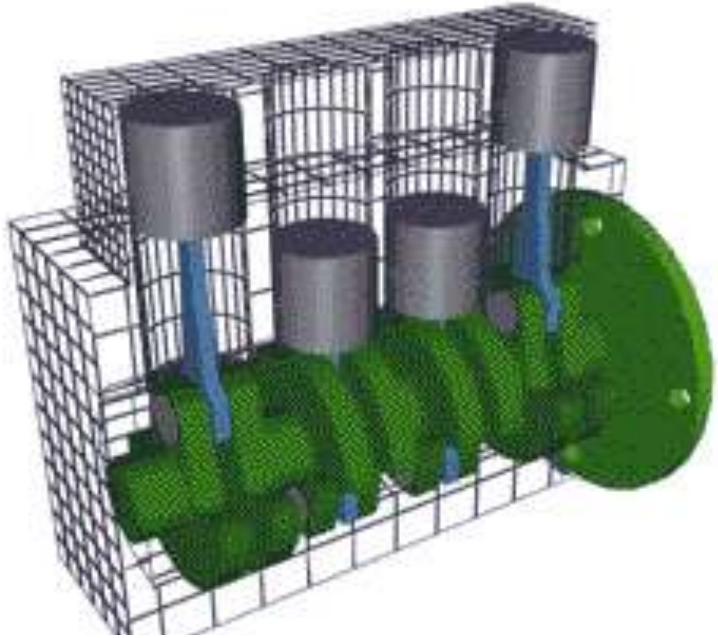


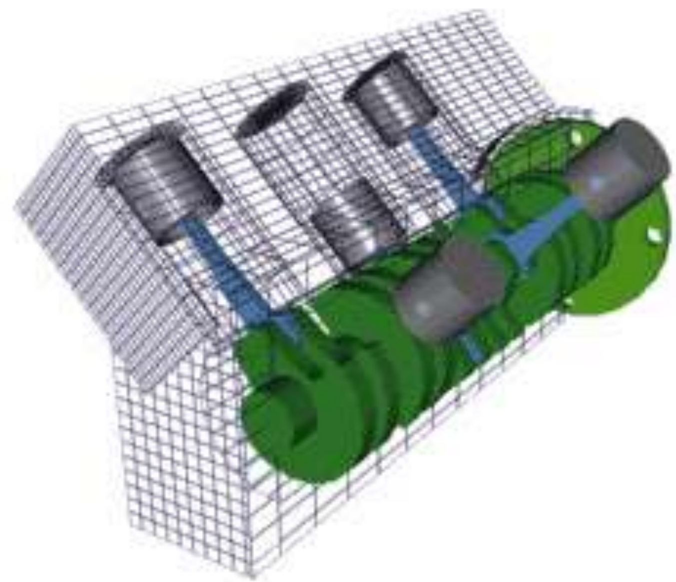


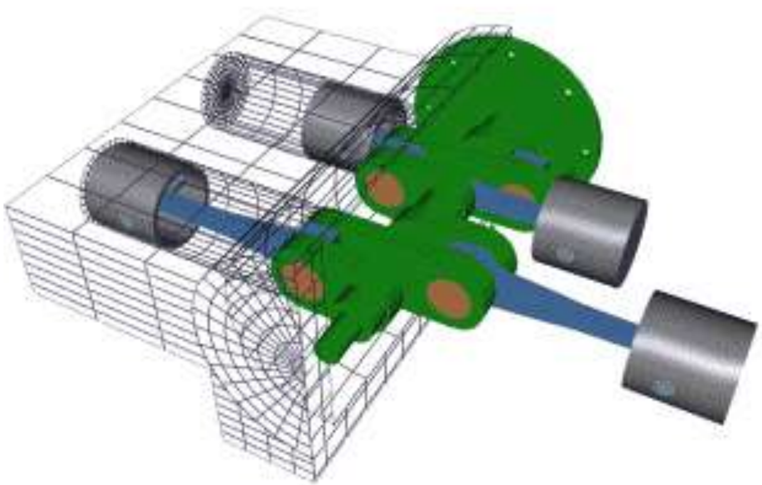


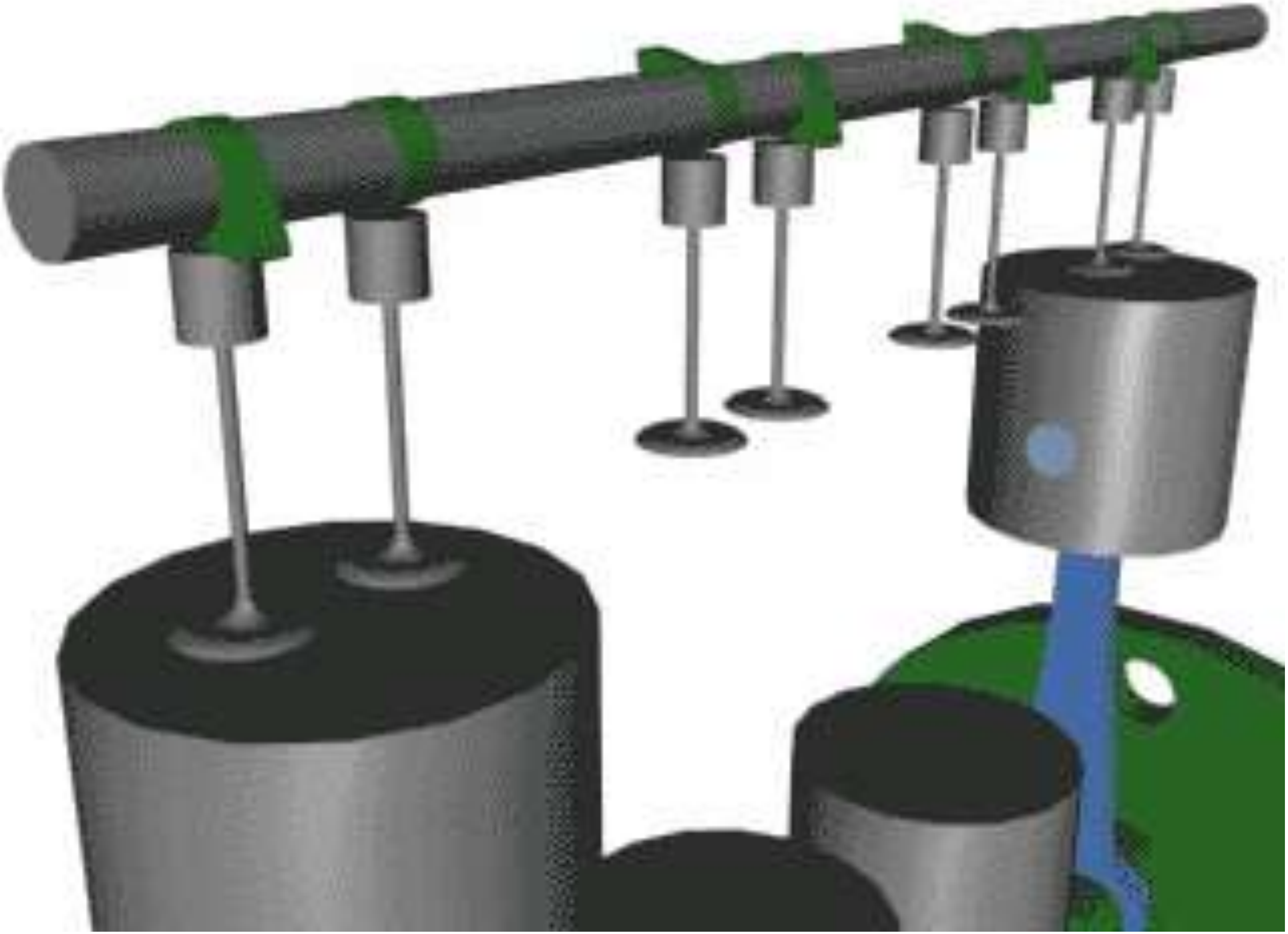


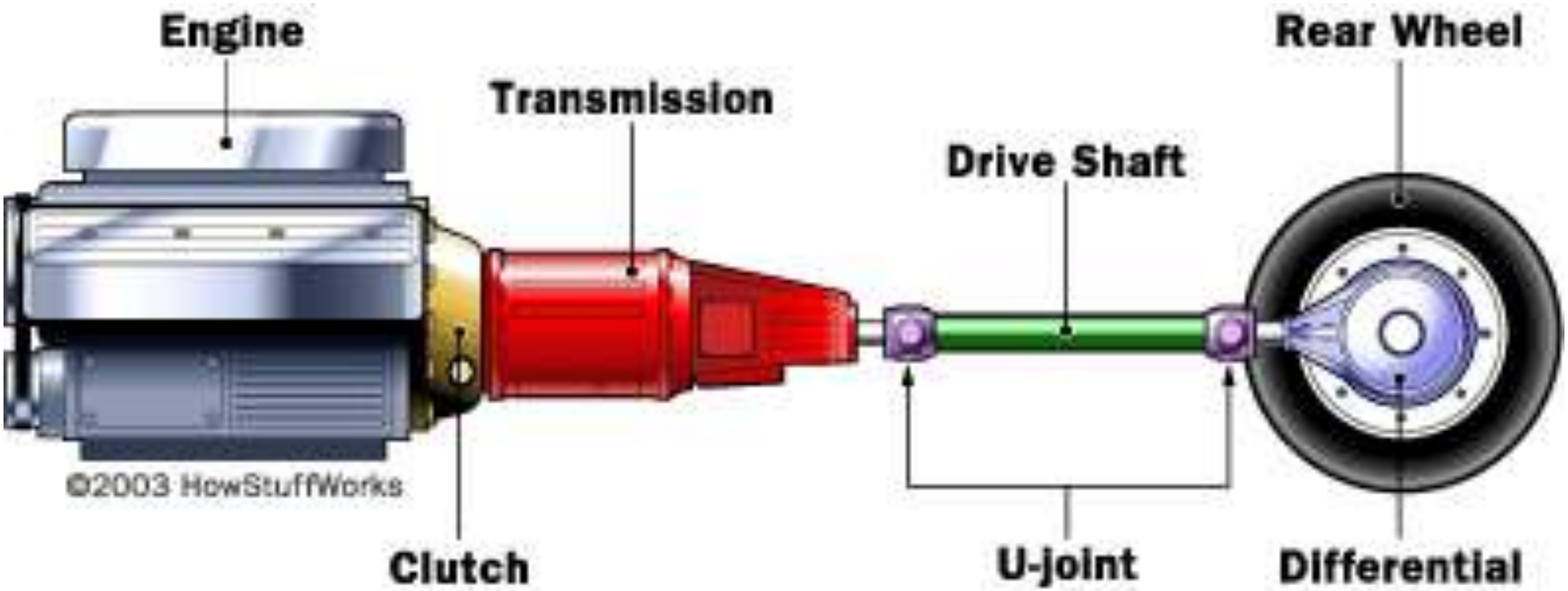


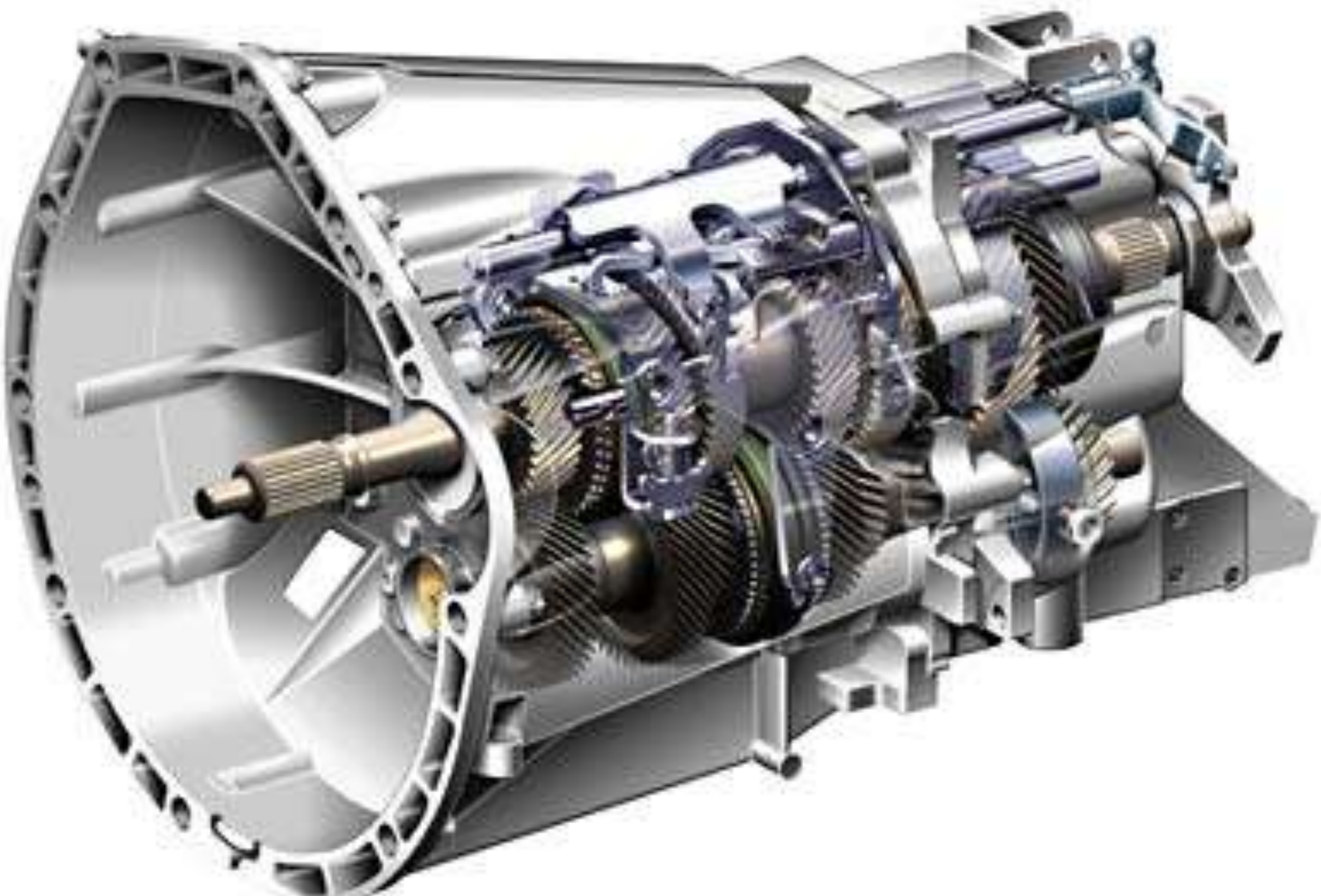




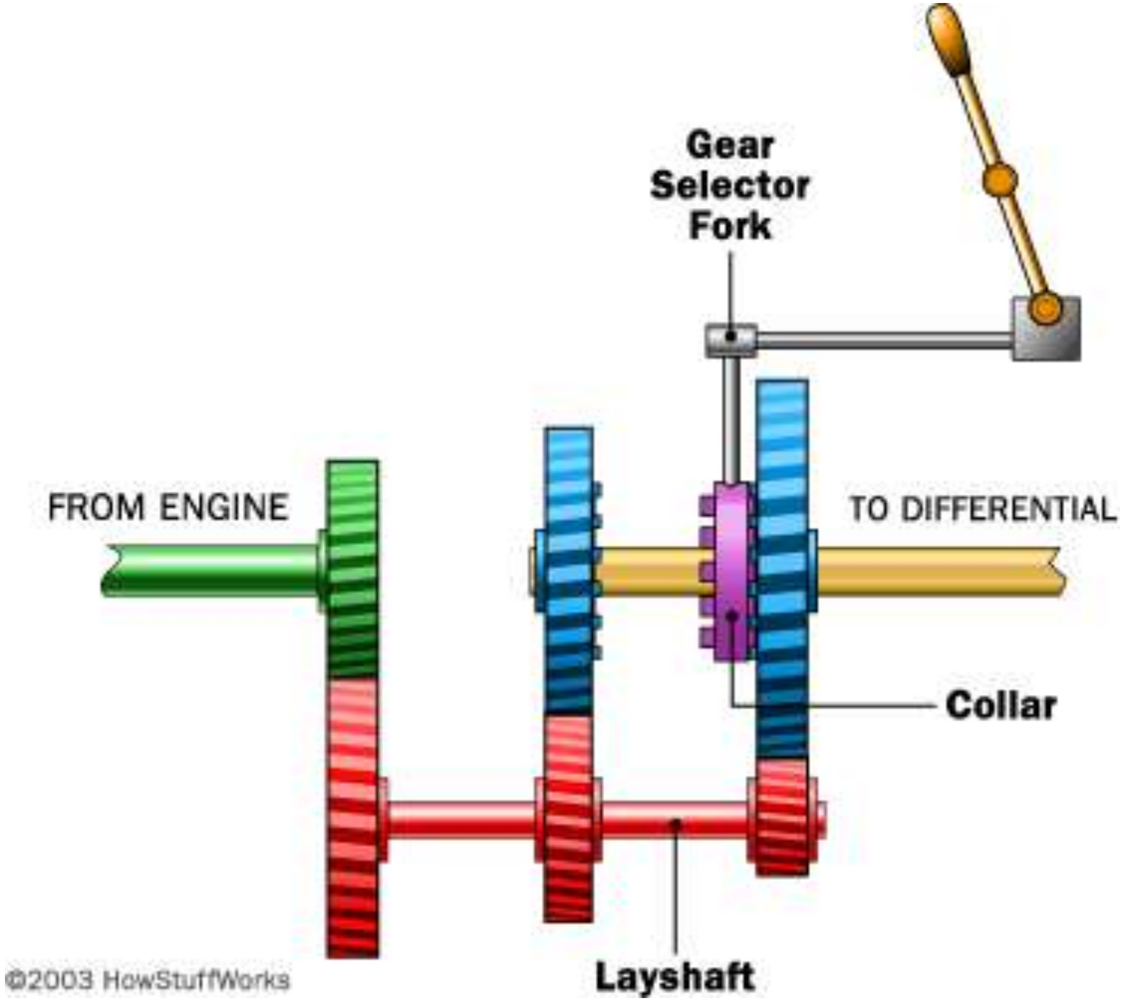


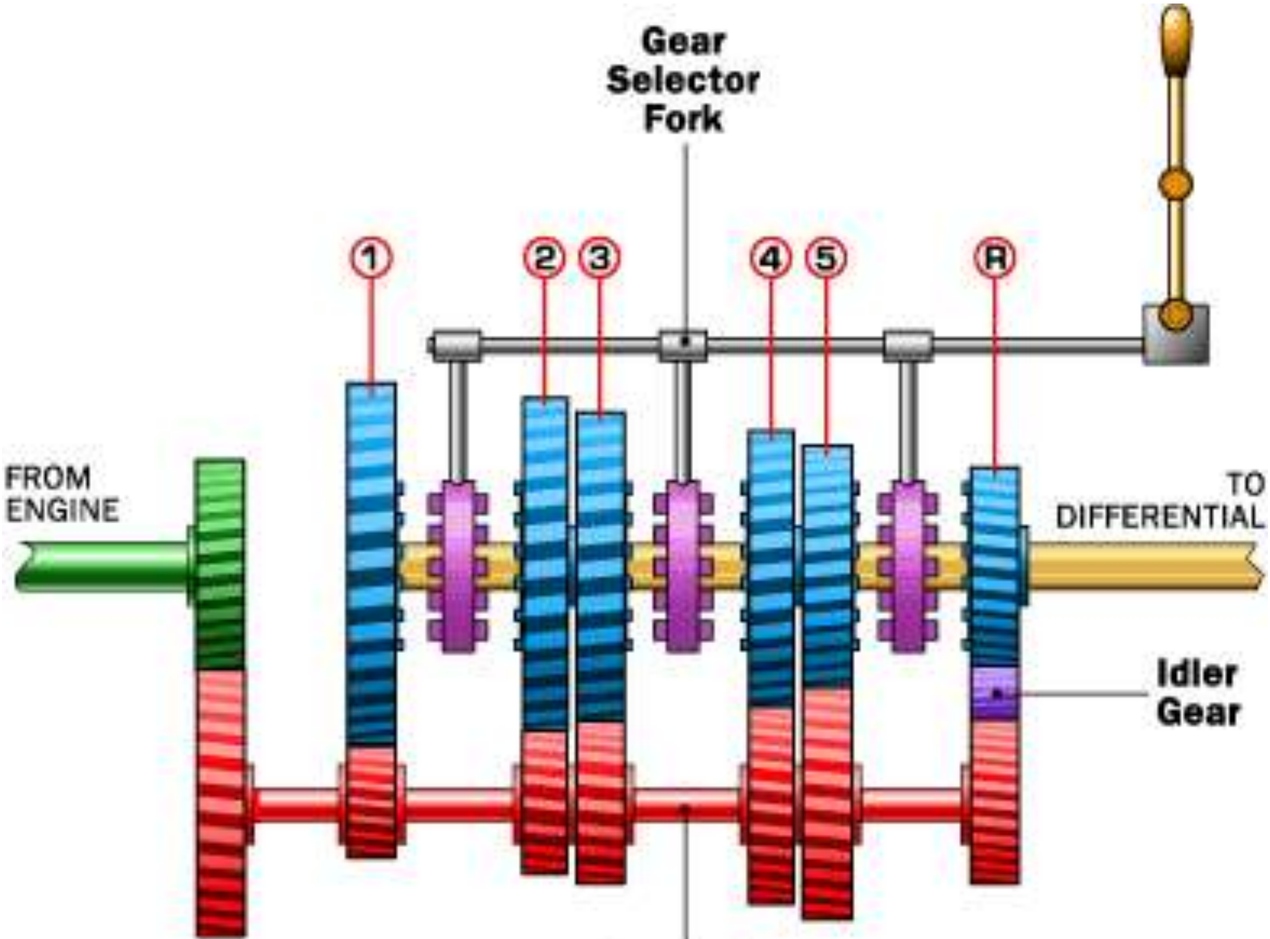



Engine
Transmission
Drive Shaft
Rear Wheel
©2003 HowStuffWorks
Clutch
U-joint
Differential

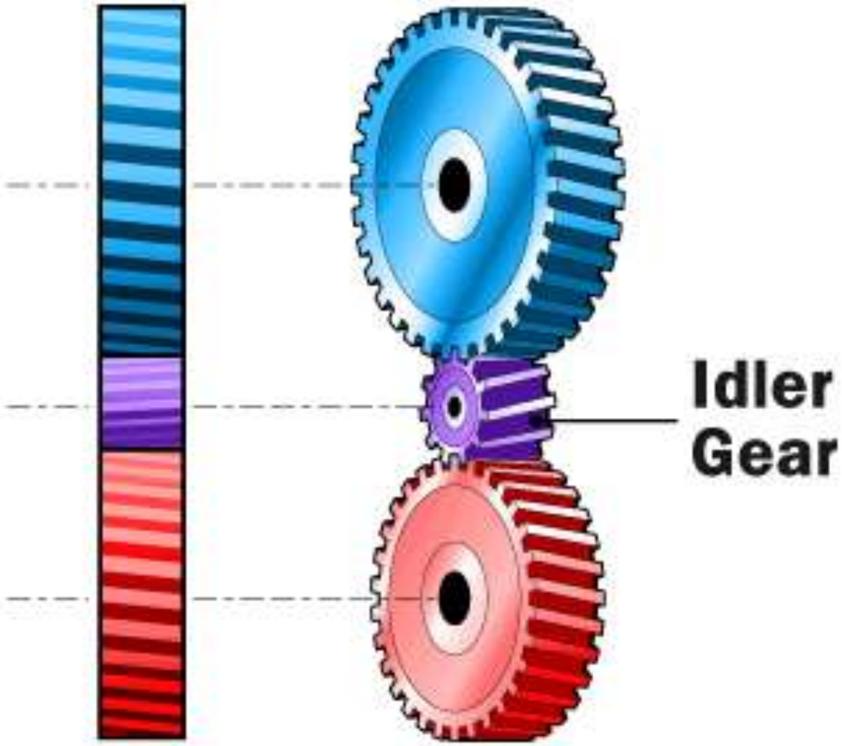


The picture below shows how, when shifted into first gear, the collar engages the blue gear on the right:



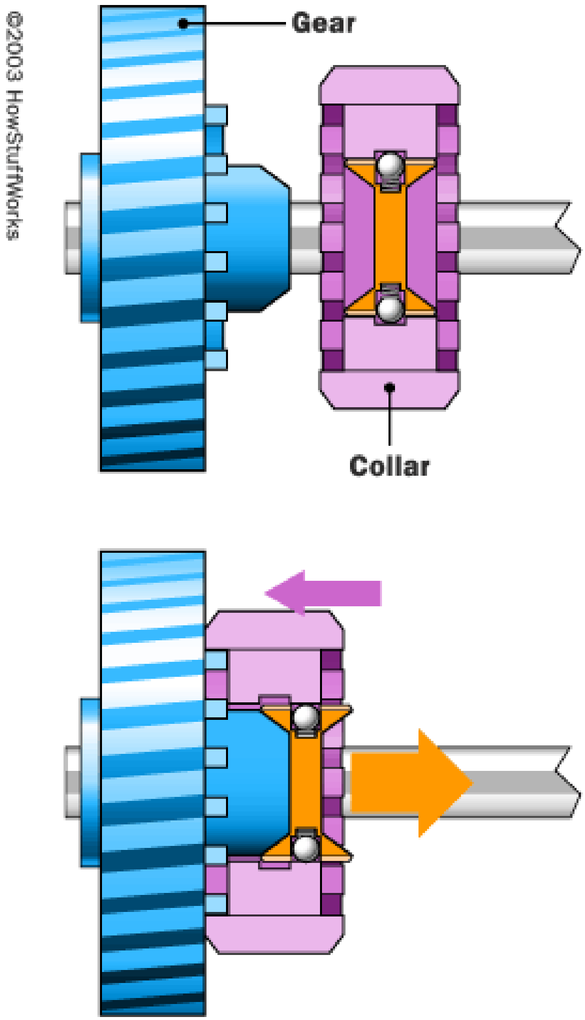


Gear Selector Fork
1
2
3
4
5
R
FROM ENGINE
TO DIFFERENTIAL
Idler Gear
Layshaft


Idler
Gear

Synchronizers

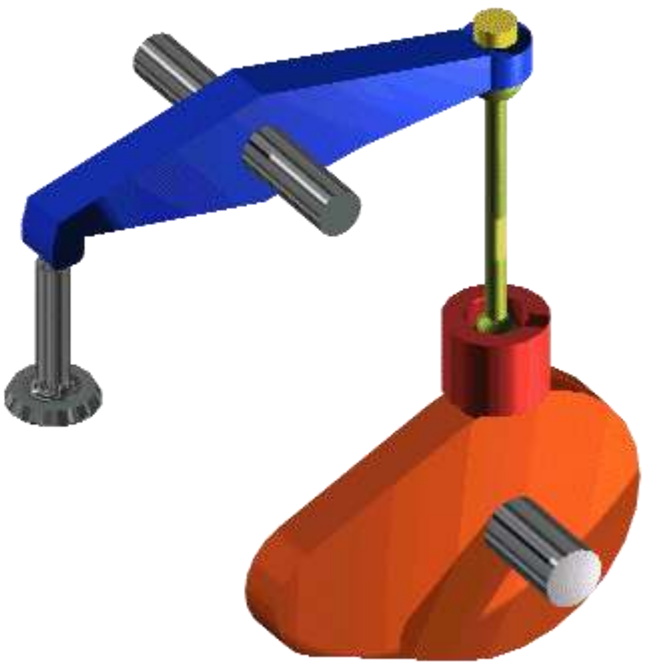
Manual transmissions in modern passenger cars use **synchronizers** to eliminate the need for double-clutching. A synchro's purpose is to allow the collar and the gear to make frictional contact before the dog teeth make contact. This lets the collar and the gear synchronize their speeds before the teeth need to engage, like this:

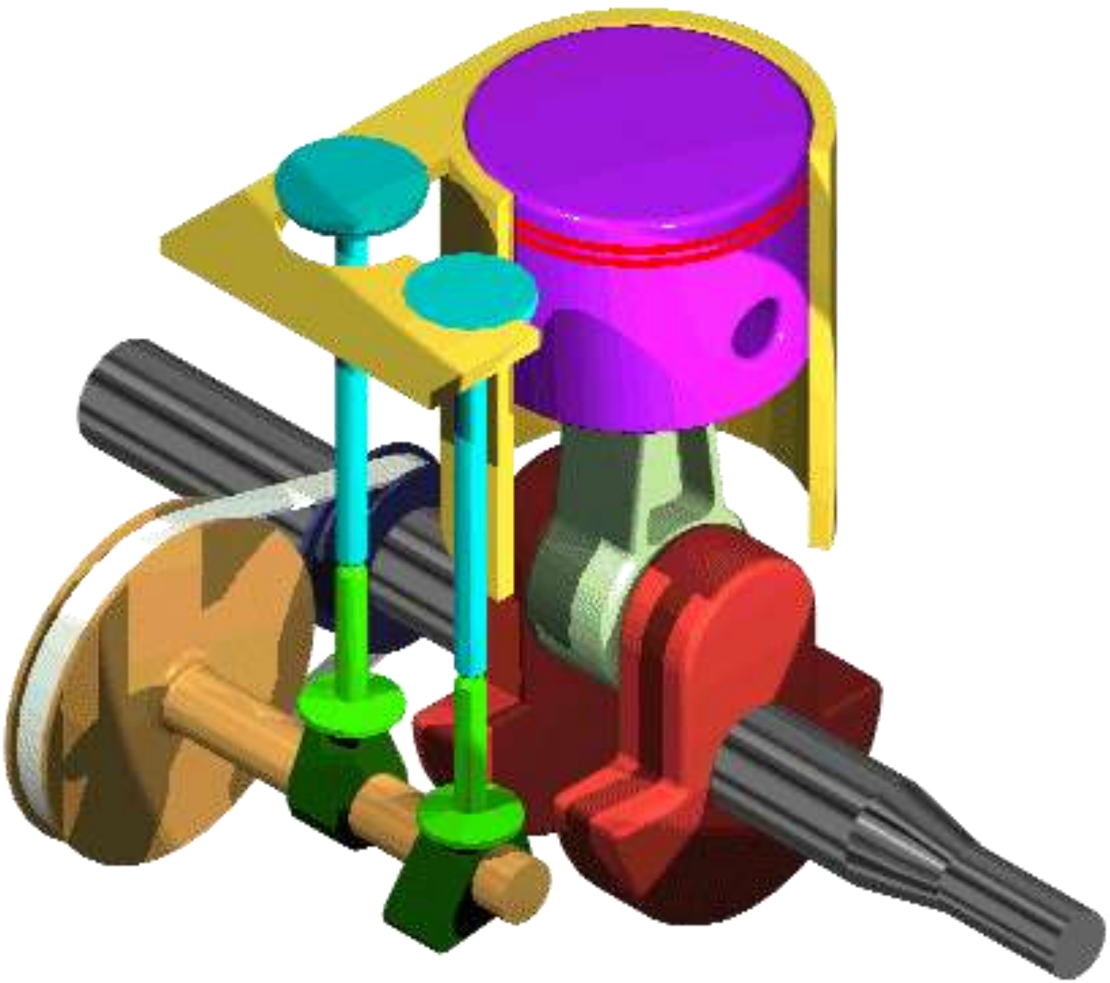


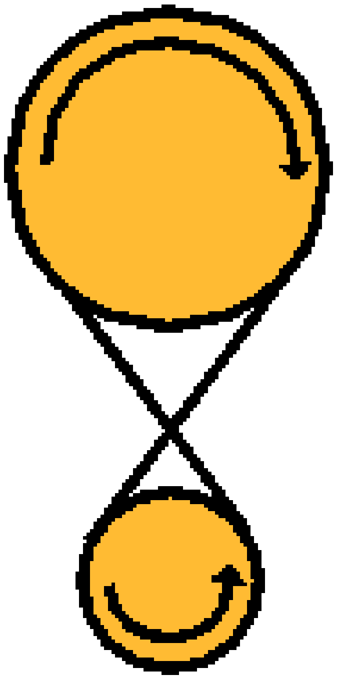
The cone on the blue gear fits into the cone-shaped area in the collar, and friction between the cone and the collar synchronize the collar and the gear. The outer portion of the collar then slides so that the dog teeth can engage the gear.

Camshaft of an Engine

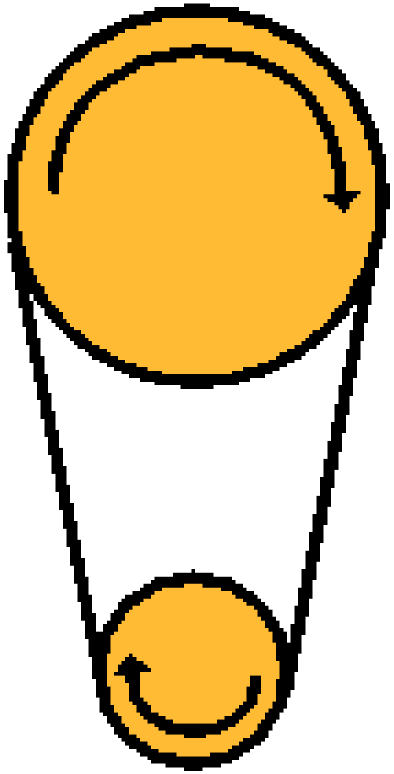
The use of cam and follower systems are vital in engines, where they are used to open and close the inlet valve and the exhaust valve to the cylinder head. The diagram shown opposite shows us a typical camshaft that could be found in a lawnmower engine. The cam and follower system is a plate cam and flat follower system, and of course the function of the system is to open and close the valves at the correct time during the four stroke cycle of the engine (this will be dealt with in more depth later). If you examine the image close you will see that the peaks of the cams are offset by approximately 120 degrees. These ensures that the both valves aren't fully open at the same time.







If the belt is crossed, then the driven pulley will rotate in the opposite direction to the driving pulley. The velocity ratio of a pulley system is given by dividing the diameter of the driven pulley by the diameter of the driving pulley. Sometimes the pulleys and the belt are toothed to help prevent slippage. The sprocket and chain arrangement (as found on bicycles) is effectively a pulley system that can withstand very high loads without slippage.



Pulleys are used to transfer rotating motion, via a belt, from one shaft to another. The vacuum cleaner uses a pulley to transmit power from the electric motor to the rotating brushes. If both pulleys are the same diameter, then they will both rotate at the same speed. If one pulley is larger than another then mechanical advantage and velocity ratio are introduced. A large drive pulley will cause a smaller driven pulley to rotate faster.