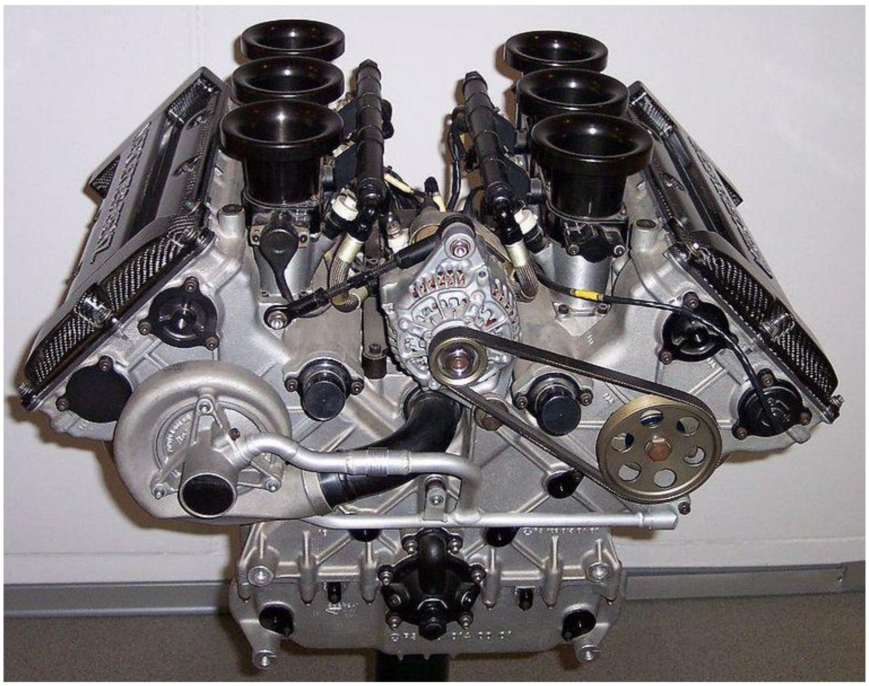
Engine:

This article is about a machine to convert energy into useful mechanical motion. An engine or motor is a machine designed to convert energy into useful mechanical motion Heat engines, including internal combustion engines and external combustion engines (such as steam engines) burn a fuel to create heat which is then used to create motion. Electric motors convert electrical energy in mechanical motion, pneumatic motors use compressed air and others, such as wind-up toys use elastic energy. In biological systems molecular motors like myosins in muscles use chemical energy to create motion.



Mercedes V6 DTM Rennmotor 1996

Terminology:

Originally an engine was a mechanical device that converted force into motion. Military devices such as catapults, battering rams are referred to as siege engines. The term "gin" as in cotton gin is recognized as a short form of the Old French word engine.

In modern usage, the term is used to describe devices capable of performing mechanical work, as in the original steam engine.

In most cases the work is produced by exerting a torque or linear force, which is used to operate other machinery which can generate electricity, pump water, or compress gas.

In common usage, an engine burns or otherwise consumes fuel, and is differentiated from an electric machine (i.e., electric motor) that derives power without changing the composition of matter

A heat engine may also serve as a prime mover, a component that transforms changes in pressure of a fluid into mechanical energy.

An automobile powered by an internal combustion engine may make use of various motors and pumps, but ultimately all such devices derive their power from the engine.

The term motor was originally used to distinguish the new internal combustion engine-powered vehicles from earlier vehicles powered by steam engines, such as the steam roller and motor roller, but may be used to refer to any engine

Automobiles:

The first commercially successful automobile, created by Karl Benz, added to the interest in light and powerful engines. The lightweight petrol internal combustion engine, operating on a four-stroke Otto cycle, has been the most successful for light automobiles, while the more efficient Diesel engine is used for trucks and buses.

Increasing power:

The first half of the 20th century saw a trend to increasing engine power, particularly in the American models. Design changes incorporated all known methods of raising engine capacity, including increasing the pressure in the cylinders to improve efficiency, increasing the size of the engine, and increasing the speed at which power is generated. The higher forces and pressures created by these changes created engine vibration and size problems that led to stiffer, more compact engines with V and opposed cylinder layouts replacing longer straight-line arrangements.

Combustion efficiency:

The design principles favored in Europe. Because of economic and other restraints such as smaller and twister roads, leant toward smaller cars and corresponding to the design principles that concentrated on increasing the combustion efficiency of smaller engines. This produced more economical engines with earlier four-cylinder designs rated at 40 horsepower (30 kW) and six-cylinder designs rated as low as 80 horsepower (60 kW), compared with the large volume V-8 American engines with power ratings in the range from 250 to 350 hp (190 to 260 kW).

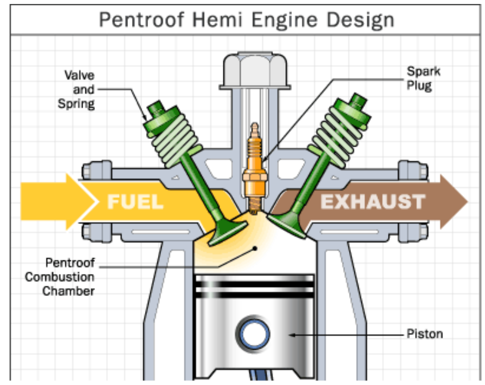
Engine configuration:

Earlier automobile engine development produced a much larger range of engines than is in common use today. Engines have ranged from 1 to 16 cylinder designs with corresponding differences in overall size, weight, piston displacement, and cylinder bores. Four cylinders and power ratings from 19 to 120 hp (14 to 90 kW) were followed in a majority of the models. Several three-cylinder, two-stroke-cycle models were built while most engines had straight or in-line cylinders. There were several V-type models and horizontally opposed two- and four-cylinder makes too. Overhead camshafts were frequently employed. The smaller engines were commonly air-cooled and located at the rear of the vehicle; compression ratios were relatively low. The 1970s and '80s saw an increased interest in improved fuel economy which brought in a return to smaller V-6 and four-cylinder layouts, with as many as five valves per cylinder to improve efficiency. The Bugatti Veyron 16.4 operates with a W16 engine meaning that two V8 cylinder layouts are positioned next to each other to create the W shape sharing the same crankshaft.

The largest internal combustion engine ever built is the Wärtsilä-Sulzer RTA96-C, a 14-cylinder, 2-stroke turbocharged diesel engine that was designed to power the Emma Maersk, the largest container ship in the world. This engine weighs 2300 tons, and when running at 102 RPM produces 109,000 bhp (80,080 kW) consuming some 13.7 tons of fuel each hour.

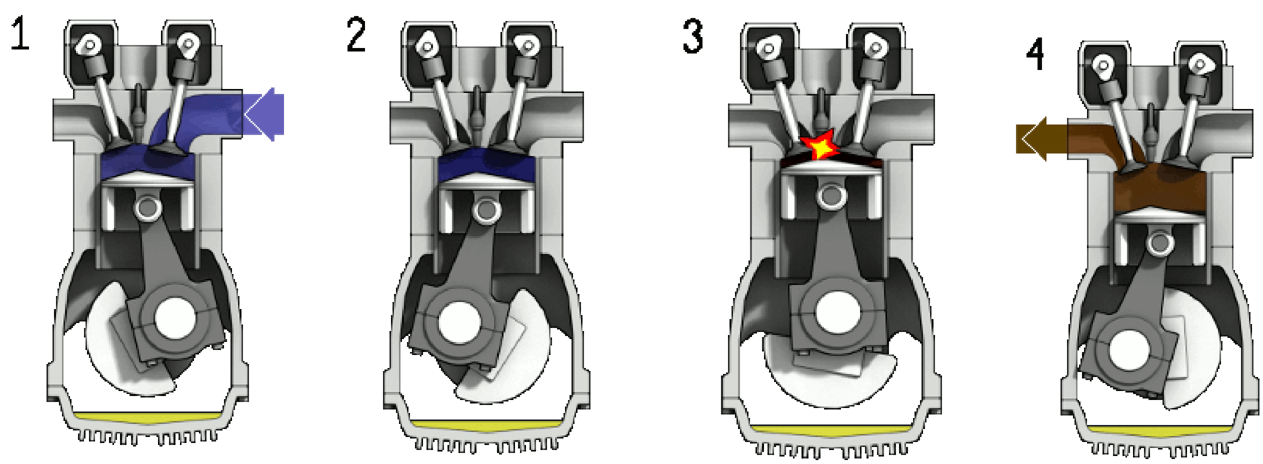
Combustion engine:

Internal combustion engine:



Combustion engines are heat engines driven by the heat of a combustion process.

The internal combustion engine is an engine in which the combustion of a fuel (generally, fossil fuel) occurs with an oxidizer (usually air) in a combustion chamber. In an internal combustion engine the expansion of the high temperature and high pressure gases, which are produced by the combustion, directly applies force to components of the engine, such as the pistons or turbine blades or a nozzle, and by moving it over a distance, generates useful mechanical energy.



Four stages of the 4-stroke combustion engine cycle

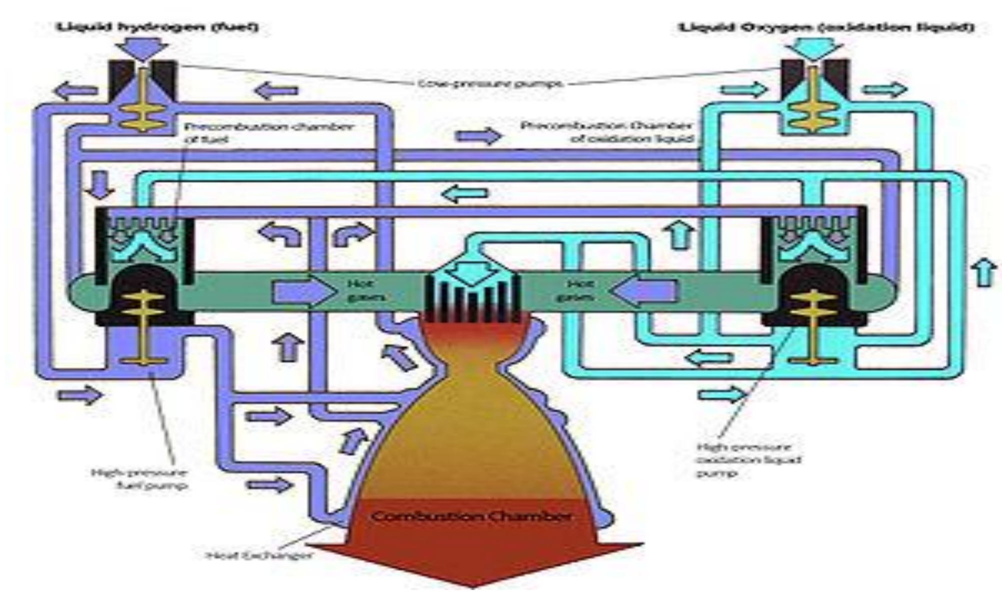
1. Induction (Fuel enters) 2. Compression3. Ignition (Fuel is burnt) 4. Emission (Exhaust out)

External combustion engine:

An external combustion engine (EC engine) is a heat engine where an internal working fluid is heated by combustion of an external source, through the engine wall or a heat exchanger. The fluid then, by expanding and acting on the mechanism of the engine produces motion and usable work. The fluid is then cooled, compressed and reused (closed cycle), or (less commonly) dumped, and cool fluid pulled in (open cycle air engine).

"Combustion" refers to burning fuel with an oxidizer, to supply the heat. Engines of similar (or even identical) configuration and operation may use a supply of heat from other sources such as nuclear, solar, geothermal or exothermic reactions not involving combustion; but are not then strictly classed as external combustion engines, but as external thermal engines.

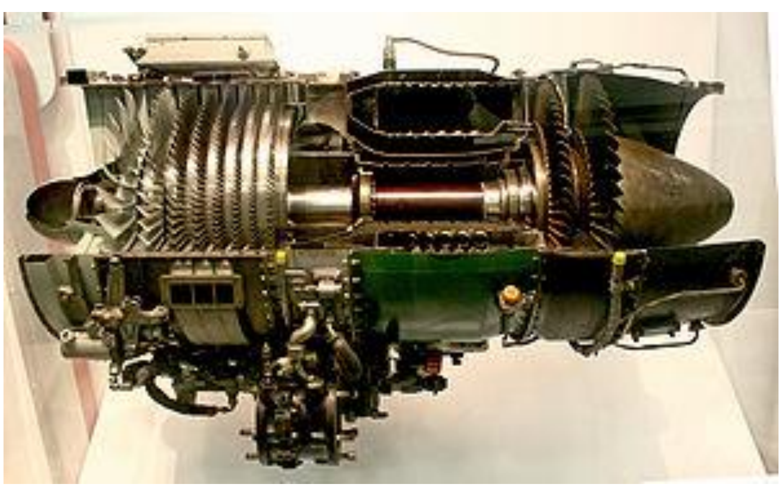
The working fluid can be a gas as in a Stirling engine, or steam as in a steam engine or an organic liquid such as n-pentane in an Organic Rankine Cycle. The fluid can be of any composition; gas is by far the most common, although even single-phase liquid is sometimes used. In the case of the steam engine, the fluid changes phases between liquid and gas.



Gas turbine:

A gas turbine is internal combustion in the sense that the combustion takes place in the working fluid, but external combustion in the sense that the combustion is not fully closed in and is outside the actual moving turbine section. Traditionally, "internal combustion" usually includes gas turbines, jets and rockets.

The Gas turbine from MGB 2009



A typical axial-flow gas turbine turbojet, the J85, sectioned for display. Flow is left to right, multistage compressor on left, combustion chambers center, two-stage turbine on right

Environmental effects:

Operation of engines typically has a negative impact upon air quality and ambient sound levels. There has been a growing emphasis on the pollution producing features of automotive power systems. This has created new interest in alternate power sources and internal-combustion engine refinements. Although a few limited-production battery-powered electric vehicles have appeared, they have not proved to be competitive owing to costs and operating characteristics. In the 21st century the diesel engine has been increasing in popularity with automobile owners. However, the gasoline engine, with its new emission-control devices to improve emission performance, has not yet been significantly challenged.

Air quality:

Exhaust from a spark ignition engine consists of the following: nitrogen 70 to 75% (by volume), water vapor 10 to 12%, carbon dioxide 10 to 13.5%, hydrogen 0.5 to 2%, oxygen 0.2 to 2%, carbon monoxide: 0.1 to 6%, unburnt hydrocarbons and partial oxidation products (e.g. aldehydes) 0.5 to 1%, nitrogen monoxide 0.01 to 0.4%, nitrous oxide <100 ppm, sulfur dioxide 15 to 60 ppm, traces of other compounds such as fuel additives and lubricants, also halogen and metallic compounds, and other particles. Carbon monoxide is highly toxic, and can cause carbon monoxide poisoning, so it is important to avoid any build-up of the gas in a confined space. Catalytic converters can reduce toxic emissions, but not completely eliminate them. Also, resulting greenhouse gas emissions, chiefly carbon dioxide, from the widespread use of engines in the modern industrialized world is contributing to the global greenhouse effect – a primary concern regarding global warming.

Reciprocating engine:

A reciprocating engine, also often known as a piston engine, is a heat engine that uses one or more reciprocating pistons to convert pressure into a rotating motion. This article describes the common features of all types. The main types are: the internal combustion engine, used extensively in motor vehicles; the steam engine, the mainstay of the Industrial Revolution; and the niche application Stirling engine.

Internal combustion piston engine:

Components of a typical, four stroke cycle, internal combustion piston engine.

E - Exhaust camshaft

I - Intake camshaft

S - Spark plug

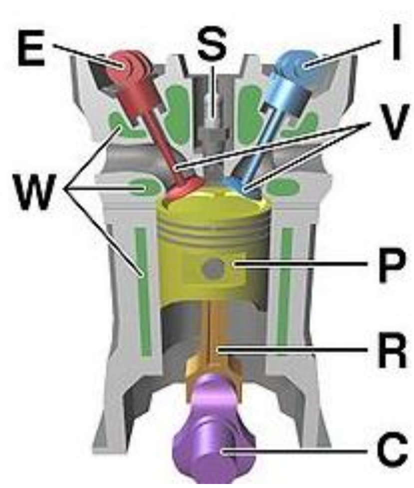
V - Valves

P - Piston

R - Connecting rod

C - Crankshaft

W - Water jacket for coolant flow



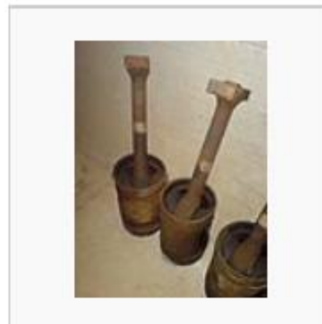
Common features in all types:

There may be one or more pistons. Each piston is inside a cylinder, into which a gas is introduced, either already hot and under pressure (steam engine), or heated inside the cylinder either by ignition of a fuel air mixture (internal combustion engine) or by contact with a hot heat exchanger in the cylinder (Stirling engine).

The hot gases expand, pushing the piston to the bottom of the cylinder. The piston is returned to the cylinder top (Top Dead Centre) either by a flywheel or the power from other pistons connected to the same shaft. In most types the expanded or "exhausted" gases are removed from the cylinder by this stroke. The exception is the Sterling engine, which repeatedly heats and cools the same sealed quantity of gas.

A piston and its connecting rod.

CAD drawing of crankshaft and pistons.



Large pistons (over 0.5 m incl. connecting rod).

Sterling piston engine:

Rhombic Drive – Beta Sterling Engine Design showing the second displacer piston (green) within the cylinder which shunts the working gas between the hot and cold ends, but produces no power itself.

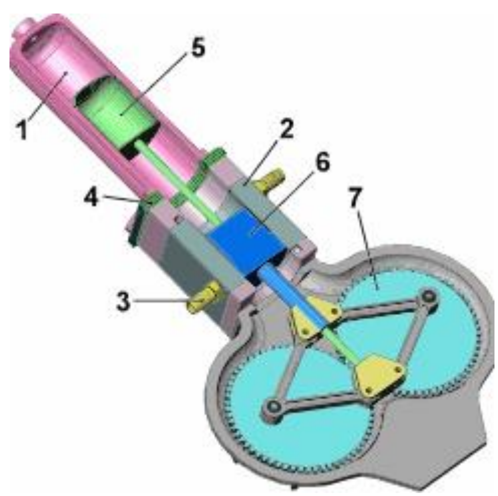
1 – Hot cylinder wall

2 – Cold cylinder wall

5 – Displacer piston

6 – Power piston

7 – Flywheels



Crankshaft:

The crankshaft, sometimes casually abbreviated to crank, is the part of an engine which translates reciprocating linear piston motion into rotation. To convert the reciprocating motion into rotation, the crankshaft has "crank throws" or "crankpins", additional bearing surfaces whose axis is offset from that of the crank, to which the "big ends" of the connecting rods from each cylinder attach.

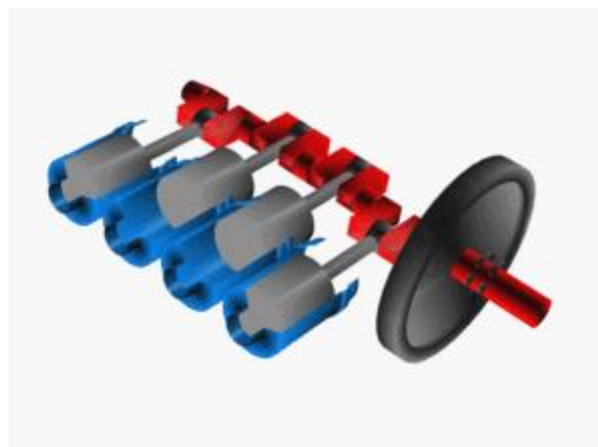
It typically connects to a flywheel, to reduce the pulsation characteristic of the four-stroke cycle, and sometimes a torsional or vibrational damper at the opposite end, to reduce the torsion vibrations often caused along the length of the crankshaft by the cylinders farthest from the output end acting on the torsional elasticity of the metal.

Crankshaft (red),

Pistons (gray)

In their cylinders (blue),

Flywheel (black)



Poppet valve:

A poppet valve (also called mushroom valve) is a valve consisting of a hole, usually round or oval, and a tapered plug, usually a disk shape on the end of a shaft also called a valve stem. The shaft guides the plug portion by sliding through a valve guide. In most applications a pressure differential helps to seal the valve and in some applications also open it.

Presta and Schrader valves used on pneumatic tires are examples of poppet valves. The Presta valve has no spring and relies on a pressure differential for opening and closing while being inflated.

Operation:

The operating principle of poppet valves is described in "How Poppet Valves Work".In most cases it is beneficial to have a "balanced poppet" in a direct-acting valve. Less force is needed to move the poppet because all forces on the poppet are nullified by equal and opposite forces. The solenoid coil has to counteract only the spring force

Applications:

Poppet valves are used in many industrial processes, from controlling the flow of milk to isolating sterile air in the semiconductor industry. However, they are most well known for their use in internal combustion and steam engines, as described below.

Camshaft:

A camshaft is a shaft to which a cam is fastened or of which a cam forms.

Uses:

In internal combustion engines with pistons, the camshaft is used to operate poppet valves. It then consists of a cylindrical rod running the length of the cylinder bank with a number of oblong lobes protruding from it, one for each valve. The cams force the valves open by pressing on the valve, or on some intermediate mechanism as they rotate.

Material:

Camshafts can be made out of several different types of material. These include:

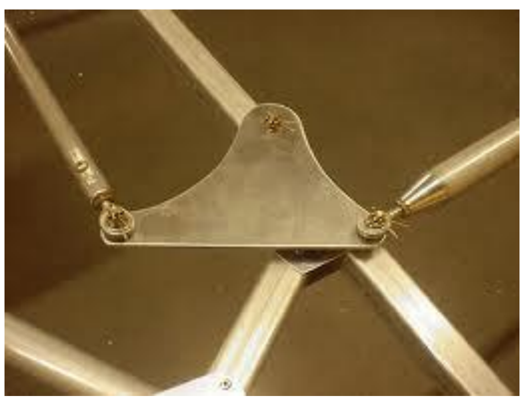
Chilled iron castings: this is a good choice for high volume production. A chilled iron camshaft has a resistance against wear because the camshaft lobes have been chilled, generally making them harder. When making chilled iron castings, other elements are added to the iron before casting to make the material more suitable for its application.

Billet Steel: When a high quality camshaft is required, engine builders and camshaft manufacturers choose to make the camshaft from steel billet. This method is also used for low volume production. This is a much more time consuming process, and is generally more expensive than other methods. However the finished product is far superior. When making the camshaft, CNC lathes, CNC milling machines and CNC camshaft grinders will be used.

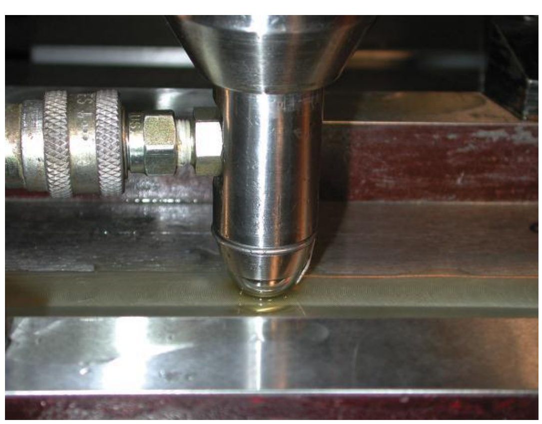
Bearing (ball, roller, and spherical shown) (n) The part of a machine within which a rotating or sliding shaft is held. In some bearing types, balls or rollers are used between the bearing surfaces to reduce rolling friction.



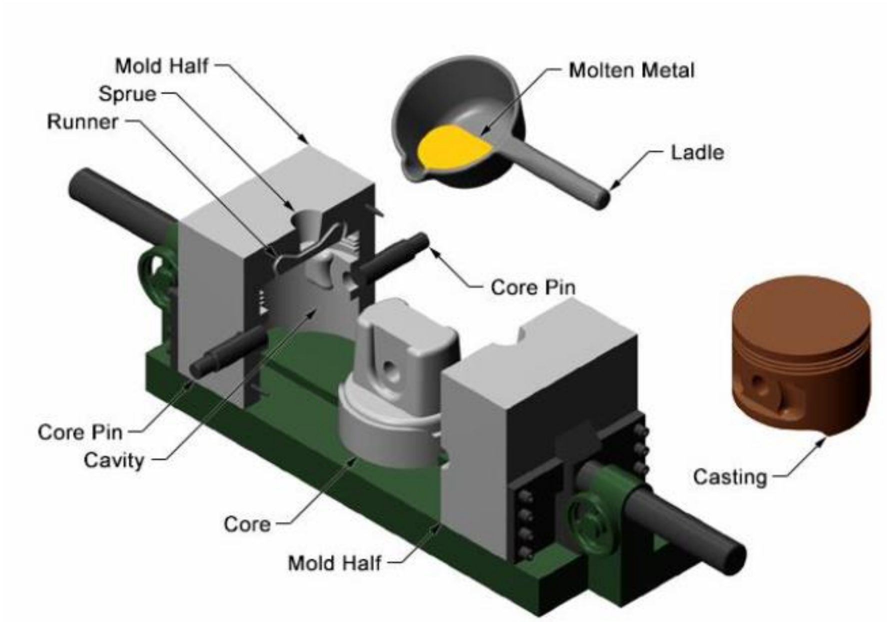
Bell crank (n) a pivoting double lever used to change the direction of applied motion.



Burnish (v) To smooth or polish by a rolling or sliding tool under pressure.



Casting (n) Any object made by pouring molten metal into a mold.



Idler (n) A mechanism used to regulate the tension in belt or chain. Or, a gear used between a driver and follower gear to maintain the direction of rotation.