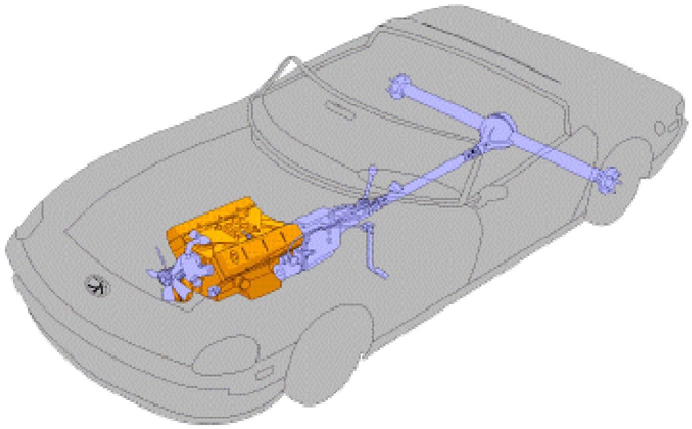
Engine Overview



Below is an overview of this system's operation

The Engine System (An Overview)

The internal combustion engine burns fuel within the cylinders and converts the expanding force of the combustion or "explosion" into rotary force used to propel the vehicle. There are several types of internal combustion engines: two and four cycle reciprocating piston engines, gas turbines, free piston, and rotary combustion engines. The four cycle reciprocating engine has been refined to such a degree that it has almost complete dominance in the automotive field.

The engine is the heart of the automobile. It converts fuel into the energy that powers the automobile. To operate, it requires clean air for the fuel, water for cooling, electricity (which it generates) for igniting the fuel, and oil for lubrication. A battery and electric starter get it going.

Charles and Frank Duryea built the first American automobile in 1892. In the winter of 1895/96 they produced 13 Duryeas, which became the first horseless carriages regularly manufactured in the United States.

In 1900, at the first National Automobile Show in New York City, visitors overwhelmingly chose the electric car. Most people thought the gasoline engine would never last. One critic of the engine wrote that it was noisy, unreliable, and elephantine; that it vibrated so violently as to "loosen one's dentures." He went on to give the opinion that the gasoline motor would never be a factor in America's growing automobile industry. People were afraid that gasoline engines would explode. Motorweek magazine referred to them as "explosives." At the show, a bucket brigade was standing by every time an "explosive," was cranked. However, just three years later, at the same show, the number of cars with four-stroke internal combustion gasoline engines had risen sharply.

Each "cylinder" of the typical car engine has a "piston" which moves back and forth within the cylinder (this is called "reciprocating"). Each piston is connected to the "crankshaft" by means of a link known as a "connecting rod".

Horsepower

Horsepower is a unit of power for measuring the rate at which a device can perform mechanical work. Its abbreviation is hp. One horsepower was defined as the amount of power needed to lift 33,000 pounds one foot in one minute.

Oil Weights

Oil weight, or viscosity, refers to how thick or thin the oil Is. The temperature requirements set for oil by the Society of Automotive Engineers (SAE) is 0 degrees F (low) and 210 degrees F (high).

Oils meeting the SAE's low temperature requirements have a "W" after the viscosity rating (example: 10W), and oils that meet the high ratings have no letter (example SAE 30). An oil is rated for viscosity by heating it to a specified temperature, and then allowing it to flow out of a specifically sized hole. Its viscosity rating is determined by the length of time it takes to flow out of the hole. If it flows quickly, it gets a low rating. If it flows slowly, it gets a high rating.

Engines need oil that is thin enough for cold starts, and thick enough when the engine is hot. Since oil gets thinner when heated, and thicker when cooled, most of us use what are called multi-grade, or multi-viscosity oils. These oils meet SAE specifications for the low temperature requirements of a light oil and the high temperature requirements of a heavy oil. You will hear them referred to as multi-viscosity, all-season and all-weather oils.

When choosing oil, always follow the manufacturer's recommendation.

Gaskets

Gaskets and seals are needed in your engine to make the machined joints snug, and to prevent fluids and gasses (oil, gasoline, coolant, fuel vapor, exhaust, etc.) from leaking.

The cylinder head has to keep the water in the cooling system at the same time as it contains the combustion pressure. Gaskets made of steel, copper and asbestos are used between the cylinder head and engine block. Because the engine expands and contracts with heating and cooling, it is easy for joints to leak, so the gaskets have to be soft and "springy" enough to adapt to expansion and contraction. They also have to make up for any irregularities in the connecting parts.

Four-stroke Piston Cycle

In 1876, a German engineer named Dr. Otto produced an engine, that worked, using the four-stroke, or Otto cycle. "Four-stroke" refers to the number of piston strokes required to complete a cycle (a cycle being a sequence of constantly repeated operations). It takes two complete revolutions of the crankshaft to complete the cycle.

The first stroke is the intake stroke. The piston moves down the cylinder and creates a partial vacuum in the cylinder. A mixture of air and fuel is forced through the inlet valve into the cylinder by atmospheric pressure, now greater than the pressure in the cylinder. During this stroke, the exhaust valve stays closed.

The second stroke is the compression stroke. The piston moves up in the cylinder with both valves closed. The air and fuel mixture is compressed and the pressure rises.

The third stroke is the power stroke. Near the end of the compression stroke, the air and fuel mixture is ignited by an electric spark from the spark plug. The combustion that occurs causes a rise in temperature and enough pressure to force the piston down again.

Finally, on the fourth stroke, or exhaust stroke, the piston moves up again and forces the burned gases out of the cylinder and into the exhaust system. This cycle repeats itself the entire time the engine is running.

Engine Configurations

V-Type Engines

The V-type of engine has two rows of cylinders at (usually) a ninety degree angle to each other. Its advantages are its short length, the great rigidity of the block, its heavy crankshaft, and attractive low profile (for a car with a low hood). This type of engine lends itself to very high compression ratios without block distortion under load, resistance to torsional vibration, and a shorter car length without losing passenger room.

In 1914, Cadillac was the first company in the United States to use a V-8 engine in its cars.

In-line engines have the cylinders arranged, one after the other, in a straight line. In a vertical position, the number of cylinders used is usually either four or six, but three cylinder cars are becoming more common.

Rotary Engine

The rotary, or Wankel, engine has no piston, it uses rotors instead (usually two). This engine is small, compact and has a curved, oblong inner shape (known as an "epitrochoid" curve). Its central rotor turns in one direction only, but it produces all four strokes (intake, compression, power and exhaust) effectively.

Flat (Horizontal-Opposed) Engines

A horizontal-opposed engine is like a V-type engine that has been flattened until both banks lie in a horizontal plane. It is ideal for installations where vertical space is limited, because it has a very low height.

Overhead Camshaft (OHC)

Some engines have the camshaft mounted above, or over, the cylinder head instead of inside the block (OHC "overhead camshaft" engines). This arrangement has the advantage of eliminating the added weight of the rocker arms and push rods; this weight can sometimes make the valves "float" when you are moving at high speeds. The rocker arm setup is operated by the camshaft lobe rubbing directly on the rocker. Stem to rocker clearance is maintained with a hydraulic valve lash adjuster for "zero" clearance.

The overhead camshaft is also something that we think of as a relatively new development, but it's not. In 1898 the Wilkinson Motor Car Company introduced the same feature on a car.

Double Overhead Camshaft(DOHC)

The double overhead cam shaft (DOHC) is the same as the overhead camshaft, except that there are two camshafts instead of one.

Overhead Valve (OHV)

In an overhead valve (OHV) engine, the valves are mounted in the cylinder head, above the combustion chamber. Usually this type of engine has the camshaft mounted in the cylinder block, and the valves are opened and closed by push rods.

Multivalve Engines

All engines have more than one valve; "multivalve" refers to the fact that this type of engine has more than one exhaust or intake valve per cylinder.

Timing

Timing refers to the delivery of the ignition spark, or the opening and closing of the engine valves, depending on the piston's position, for the power stroke. The timing chain is driven by a sprocket on the crankshaft and also drives the camshaft sprocket.

Vacuum System (Importance of)

Engines run on a vacuum system. A vacuum exists in an area where the pressure is lower than the atmosphere outside of it. Reducing the pressure inside of something causes suction. For example, when you drink soda through a straw, the atmospheric pressure in the air pushes down on your soda and pushes it up into your mouth. The same principal applies to your engine. When the piston travels down in the cylinder it lowers the atmospheric pressure in the cylinder and forms a vacuum. This vacuum is used to draw in the air and fuel mixture for combustion. The vacuum created in your engine not only pulls the fuel into the combustion chamber, it also serves many other functions.

The running engine causes the carburetor and the intake manifold to produce "vacuum power," which is harnessed for the operation of several other devices.

Vacuum is used in the ignition-distributor vacuum-advance mechanism. At part throttle, the vacuum causes the spark to give thinner mixtures more time to burn.

The positive crankcase ventilating system (PCV) uses the vacuum to remove vapor and exhaust gases from the crankcase.

The vapor recovery system uses the vacuum to trap fuel from the carburetor float bowl and fuel tank in a canister. Starting the engine causes the vacuum port in the canister to pull fresh air into the canister to clean out the trapped fuel vapor.

Vacuum from the intake manifold creates the heated air system that helps to warm up your carburetor when it's cold.

The EGR valve (exhaust-gas recirculation system) works, because of vacuum, to reduce pollutants produced by the engine.

Many air conditioning systems use the vacuum from the intake manifold to open and close air-conditioner doors to produce the heated air and cooled air required inside your vehicle.

Intake manifold vacuum also is used for the braking effort in power brakes. When you push the brake pedal down, a valve lets the vacuum into one section of the power-brake unit. The atmospheric pressure moves a piston or diaphragm to provide the braking action.

Rotary Engine

One alternative to conventional automobile power is the rotary (or Wankel) engine. Although it is widely known that Felix Wankel built a rotary engine in 1955, it is also a fact that Elwood Haynes made one in 1893!

Dispensing with separate cylinders, pistons, valves and crankshaft, the rotary engine applies power directly to the transmission. Its construction allows it to provide the power of a conventional engine that is twice its size and weight and that has twice as many parts. The Wankel burns as much as 20%% more fuel than the conventional engine and is potentially a high polluter, but its small size allows the addition of emission-control parts more conveniently than does the piston engine. The basic unit of the rotary engine is a large combustion chamber in the form of a pinched oval (called an epitrochoid). Within this chamber all four functions of a piston take place simultaneously in the three pockets that are formed between the rotor and the chamber wall. Just as the addition of cylinders increases the horsepower of a piston-powered engine, so the addition of combustion chambers increases the power of a rotary engine. Larger cars may eventually use rotaries with three or four rotors.

Combustion Chamber

The combustion chamber is where the air-fuel mixture is burned. The location of the combustion chamber is the area between the top of the piston at what is known as TDC (top dead center) and the cylinder head. TDC is the piston's position when it has reached the top of the cylinder, and the center line of the connecting rod is parallel to the cylinder walls.

The two most commonly used types of combustion chamber are the hemispherical and the wedge shape combustion chambers.

The hemispherical type is so named because it resembles a hemisphere. It is compact and allows high compression with a minimum of detonation. The valves are placed on two planes, enabling the use of larger valves. This improves "breathing" in the combustion chamber. This type of chamber loses a little less heat than other types. Because the hemispherical combustion chamber is so efficient, it is often used, even though it costs more to produce.

The wedge type combustion chamber resembles a wedge in shape. It is part of the cylinder head. It is also very efficient, and more easily and cheaply produced than the hemispherical type.

Intake Stroke

The first stroke is the intake stroke. The piston moves down the cylinder and creates a partial vacuum in the cylinder. A mixture of air and fuel is forced through the inlet valve into the cylinder by atmospheric pressure, now greater than the pressure in the cylinder. During this stroke, the exhaust valve stays closed.

Compression Stroke

The second stroke is the compression stroke. The piston moves up in the cylinder with both valves closed. The air and fuel mixture is compressed and the pressure rises.

Power Stroke

The third stroke is the power stroke. Near the end of the compression stroke, the air and fuel mixture is ignited by an electric spark from the spark plug. The combustion that occurs causes a rise in temperature and enough pressure to force the piston down again.

Exhaust Stroke

On the fourth stroke, or exhaust stroke, the piston moves up again and forces the burned gases out of the cylinder and into the exhaust system.