CNG

Compressed natural gas (**CNG**) (methane stored at high pressure) can be used in place of gasoline (petrol), Diesel fueland propane/LPG. CNG combustion produces fewer undesirable gases than the fuels mentioned above. It is safer than other fuels in the event of a spill, because natural gas is lighter than air and disperses quickly when released. CNG may be found above oil deposits, or may be collected from landfills or wastewater treatment plants where it is known as biogas.

CNG is made by compressing natural gas (which is mainly composed of methane, CH_4), to less than 1 percent of the volume it occupies at standard atmospheric pressure. It is stored and distributed in hard containers at a pressure of 20–25 MPa (2,900–3,600 psi), usually in cylindrical or spherical shapes.

ADVANTAGES

- CNG-powered vehicles have lower maintenance costs than other hydrocarbon-fuel-powered vehicles.
- CNG fuel systems are sealed, preventing fuel losses from spills or evaporation.
- Increased life of lubricating oils, as CNG does not contaminate and dilute the crankcase oil.
- Being a gaseous fuel, CNG mixes easily and evenly in air.

LPG

Autogas is the common name for liquefied petroleum gas (LPG) when it is used as a fuel in internal combustion engines invehicles as well as in stationary applications such as generators. It is a mixture of propane and butane.

Autogas is widely used as a "green" fuel, as its use reduces CO_2 exhaust emissions by around 15% compared to petrol. One litre of petrol produces 2.3 kg of CO_2 when burnt, whereas the equivalent amount of autogas (1.33 litre due to lower density of autogas) produces only 1.5 * 1.33 = 2 kg of CO_2 when burnt.

Disadvantages of LPG Uses

The main disadvantage associated with the usage of LPG is to do with the storage and safety. To store LPG, you require very sturdy tanks and cylinders. The gas has to be kept pressurized to accommodate it in 274tines lesser space. This can also be perceived by the number of cases LPG cylinders have exploded and resulted in serious damages to lives and property.

HYDROGEN

A **hydrogen vehicle** is a vehicle that uses hydrogen as its onboard fuel for motive power. Hydrogen vehicles include hydrogen fueled space rockets, as well as automobiles and other transportation vehicles. The power plants of such vehicles convert the chemical energy of hydrogen to mechanical energy either by burning hydrogen in an internal combustion engine, or by reacting hydrogen with oxygen in a fuel cell to run electric motors. Widespread use of hydrogen for fueling transportation is a key element of a proposed hydrogen economy

PRODUCTION

The molecular hydrogen needed as an on-board fuel for hydrogen vehicles can be obtained through many thermochemical methods utilizing natural gas, coal (by a process known as coal gasification), liquefied petroleum gas, biomass (biomass gasification), by a process called thermolysis, or as a microbial waste product calledbiohydrogen or Biological hydrogen production. 95% of hydrogen is produced using natural gas, and 85% of hydrogen produced is used to remove sulfur from gasoline. Hydrogen can also be produced from water by electrolysis at working efficiencies in the 50–60% range for the smaller electrolysers and around 65–70% for the larger plants.

ELECTRIC AND HYBRID VEHICLES

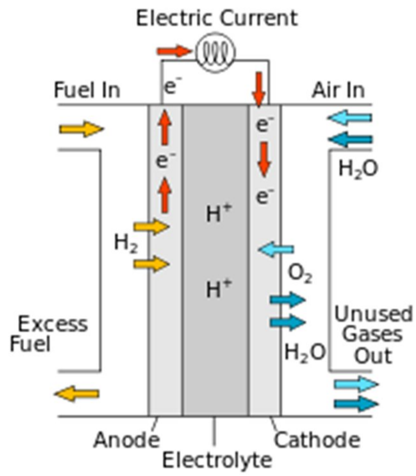
A **hybrid electric vehicle** (**HEV**) is a type of hybrid vehicle and electric vehicle that combines a conventionalinternal combustion engine (ICE) propulsion system with an electric propulsion system (hybrid vehicle drivetrain). The presence of the electric powertrain is intended to achieve either better fuel economy than a conventional vehicle or better performance. There are a variety of HEV types, and the degree to which each functions as an electric vehicle (EV) varies as well. The most common form of HEV is the hybrid electric car, although hybrid electric trucks (pickups and tractors) and buses also exist.

Modern HEVs make use of efficiency-improving technologies such as regenerative brakes, which converts the vehicle's kinetic energy into electric energy to charge the battery, rather than wasting it as heat energy as conventional brakes do. Some varieties of HEVs use their internal combustion engine to generate electricity by spinning an electrical generator (this combination is known as a motor–generator), to either recharge their batteries or to directly power the electric drive motors. Many HEVs reduce idle emissions by shutting down the ICE at idle and restarting it when needed; this is known as a start-stop system. A hybrid-electric produces less emissions from its ICE than a comparably sized gasoline car, since an HEV's gasoline engine is usually smaller than a comparably sized pure gasoline-burning vehicle (natural gas and propane fuels produce lower emissions) and if not used to directly drive the car, can be geared to run at maximum efficiency, further improving fuel economy.

FUEL CELL

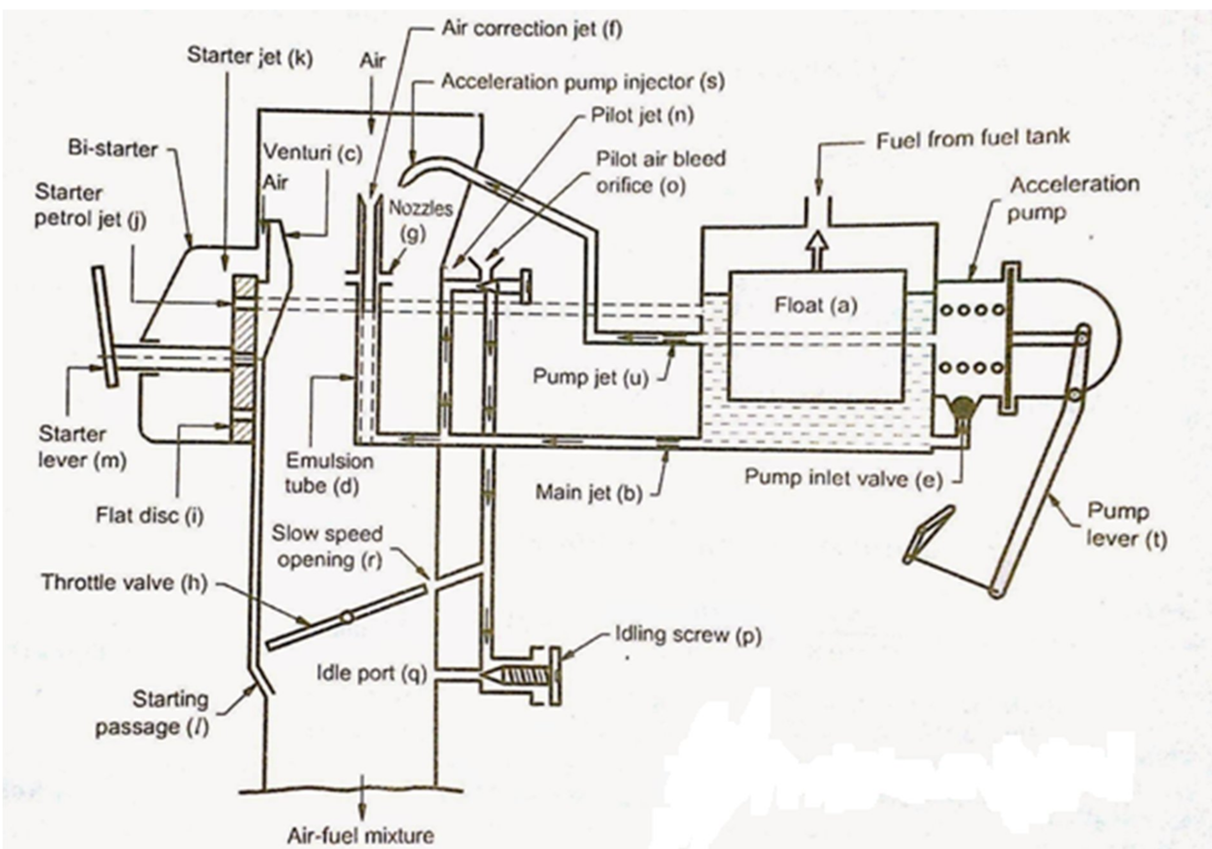
A **fuel cell** is a device that converts the chemical energy from a fuel into electricity through a chemical reaction of positively charged hydrogen ions with oxygen or another oxidizing agent. Fuel cells are different from batteries in that they require a continuous source of fuel and oxygen or air to sustain the chemical reaction, whereas in a battery the chemicals present in the battery react with each other to generate an electromotive force (emf). Fuel cells can produce electricity continuously for as long as these inputs are supplied.

There are many types of fuel cells, but they all consist of an anode, a cathode, and an electrolyte that allows positively charged hydrogen ions (or protons) to move between the two sides of the fuel cell. The anode and cathode contain catalysts that cause the fuel to undergo oxidation reactions that generate positively charged hydrogen ions and electrons. The hydrogen ions are drawn through the electrolyte after the reaction. At the same time, electrons are drawn from the anode to the cathode through an external circuit, producing direct current electricity. At the cathode, hydrogen ions, electrons, and oxygen react to form water. As the main difference among fuel cell types is the electrolyte, fuel cells are classified by the type of electrolyte they use and by the difference in startup time ranging from 1 second for proton exchange membrane fuel cells (PEM fuel cells, or PEMFC) to 10 minutes for solid oxide fuel cells(SOFC). Individual fuel cells produce relatively small electrical potentials, about 0.7 volts, so cells are "stacked", or placed in series, to create sufficient voltage to meet an application's requirements.



proton-conducting fuel cell

SOLEX CARBURETTOR



SOLEX CARBURETTOR

01) Solex Carburetor Starting Circuit

The throttle valve remains in closed position during starting. The petrol is supplied to the starter petrol jet through first passage from the float chamber and the air through the starter air jet for starting operation. Starting Valve which have different sizes hole, is made from flat disc. The position of various holes can be adjusted in front of starter petrol jet by starter lever and then air is mixed coming from starter air jet .This air-fuel mixture, passes through another holes of starter valve, in a passage of the carburetor, below the throttle valve. The suction stroke of the engine sucks this mixture into the cylinder. This mixture is rich enough to start the engine. After the engine starts and speed increases, a weak mixture is required; therefore, a small hole of the starter valve is brought in front of the starter petrol jet by means of starter lever, thereby reducing the quantity of petrol, which weakens the air-fuel mixture. Similarly next smaller hole of the starter valve is brought in front of starter petrol jet till the engine attains its normal speed then the starter valve is closed by bringing the starter lever to its off position.

02) Solex Carburetor Normal Running Circuit

At normal running speed, starting circuit is closed and throttle valve is opened. The normal running circuit consists of main jet which receives the petrol through second passage, from the float chamber as the throttle valve is opened sufficiently; the air is drawn through the venturi where the petrol mixes up with it forming a suitable mixture for the normal running of the engine. In this case, only throttle valve, governed the air-fuel ratio.

03) Solex Carburetor Accelerating Circuit

The engine requires an extra rich mixture, during acceleration period. To obtain extra rich mixture, the fuel is pumped under pressure into the main air passage or in the venturi through an injector. Diaphragm pump is used to create pressure, which is actuated by a lever connected to the accelerator. The pump sucks the petrol from the float chamber through the pump valve and forces it through third passage into the main passage through an injector above the venturi of the carburetor.

04) Solex Carburetor Idling and Slow Running Circuit

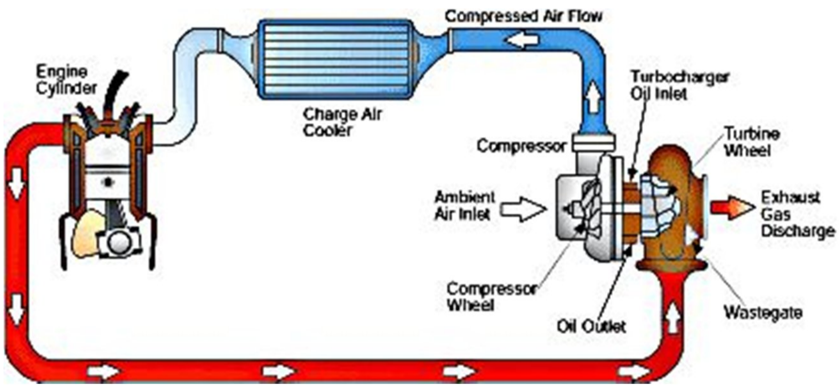
During the idling operation, the throttle valve is kept closed and the engine receives the mixture through a port opening below the throttle valve, whose area can be varied by an idle adjusting screw according to the need of the engine. The petrol is supplied to a pilot petrol jet from the main jet fuel circuit through fourth passage and the air from a pilot air jet .The petrol and air thus supplied mix up in the idle passage and go to a port situated below the throttle valve from where the mixture is sucked by engine.

TURBOCHARGER

A turbocharger is a turbine-driven forced induction device that increases an internal combustion engines efficiency and power output by forcing extra air into the combustion chamber. This improvement over a naturally aspirated engine's power output is because the compressor can force more air—and proportionately more fuel—into the combustion chamber than atmospheric pressure alone.

Turbochargers were originally known as turbo superchargers when all forced induction devices were classified as superchargers. Nowadays the term "supercharger" is usually applied only to mechanically driven forced induction devices. The key difference between a turbocharger and a conventional supercharger is that a supercharger is mechanically driven by the engine, often through a belt connected to the crankshaft, whereas a turbocharger is powered by a turbine driven by the engine's exhaust gas. Compared to a mechanically driven supercharger, turbochargers tend to be more efficient, but less responsive. Twin charger refers to an engine with both a supercharger and a turbocharger.

Turbochargers are commonly used on truck, car, train, aircraft, and construction equipment engines. They are most often used with Otto cycle and Diesel cycle internal combustion engines. They have also been found useful in automotive fuel cells.



TURBOCHARGER

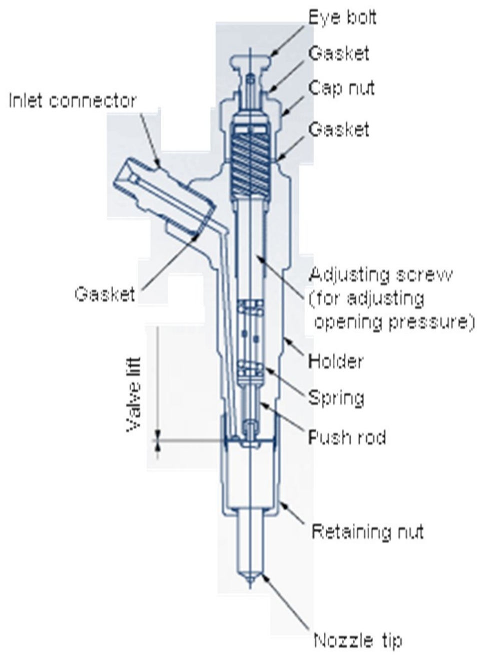
Operating Principle

In normally aspirated piston engines, intake gases are "pushed" into the engine by atmospheric pressure filling the volumetric void caused by the downward stroke of the piston similar to drawing liquid using a syringe. The amount of air actually inspired, compared to the theoretical amount if the engine could maintain atmospheric pressure, is called volumetric efficiency. The objective of a turbocharger is to improve an engine's volumetric efficiency by increasing density of the intake gas (usually air) allowing more power per engine cycle. The turbocharger's compressor draws in ambient air and compresses it before it enters into the intake manifold at increased pressure. This results in a greater mass of air entering the cylinders on each intake stroke. The power needed to spin the centrifugal compressor is derived from the kinetic energy of the engine's exhaust gases. A turbocharger may also be used to increase fuel efficiency without increasing power. This is achieved by recovering waste energy in the exhaust and feeding it back into the engine intake. By using this otherwise wasted energy to increase the mass of air, it becomes easier to ensure that all fuel is burned before being vented at the start of the exhaust stage. The increased temperature from the higher pressure gives a higher Carnot efficiency.

FUEL INJECTION

The direct introduction of fuel under pressure into the combustion units of an internal-combustion engine. All diesel engines use fuel injection by design. Petrol engines can use gasoline direct injection, where the fuel is directly delivered into the combustion chamber, or indirect injection where the fuel is mixed with air before the intake stroke.

On petrol engines, fuel injection replaced carburetors from the 1980s onward. The primary difference between carburetors and fuel injection is that fuel injection atomizes the fuel through a small nozzle under high pressure, while a carburetor relies on suction created by intake air accelerated through a Venturi tube to draw the fuel into the airstream.



Fuel injector

Benefits

Benefits of fuel injection include smoother and more consistent transient throttle response, such as during quick throttletransitions, easier cold starting, more accurate adjustment to account for extremes of ambient temperatures and changes in air pressure, more stable idling, decreased maintenance needs, and better fuel efficiency.

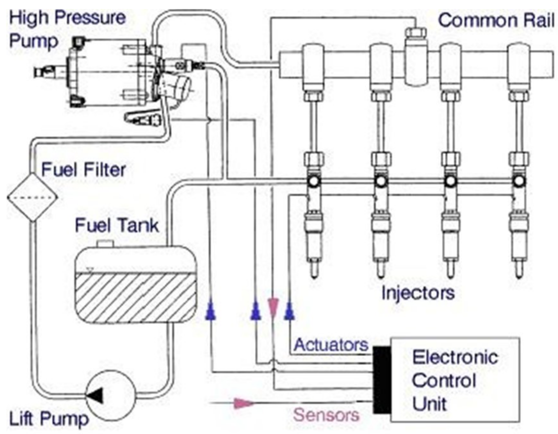
Fuel injection also dispenses with the need for a separate mechanical choke, which on carburetor-equipped vehicles must be adjusted as the engine warms up to normal temperature. Furthermore, on spark ignition engines, (direct) fuel injectionhas the advantage of being able to facilitate stratified combustion which have not been possible with carburetors.

It is only with the advent of multi-point fuel injection certain engine configurations such as inline five cylinder gasoline engines have become more feasible for mass production, as traditional carburetor arrangement with single or twin carburetors could not provide even fuel distribution between cylinders, unless a more complicated individual carburetor per cylinder is used.

Fuel injection systems are also able to operate normally regardless of orientation, whereas carburetors with floats are not able to operate upside down or in zero gravity, such as encountered on airplanes.

CRDI

CRDi stands for Common Rail Direct Injection meaning, direct injection of the fuel into the cylinders of a diesel engine via a single, common line, called the common rail which is connected to all the fuel injectors.



CRDI

'Common Rail Direct Injection' or CRDi is a type of advanced technology used in engine fuel systems. The term 'CRDi' is most commonly referred to diesel engines. There is a similar technology, which is used in petrol engines. It is known as Gasoline Direct Injection (GDI) or Fuel Stratified Injection (FSI). Both these technologies have a similarity in design as they consist of a common "fuel-rail" to supply fuel to injectors. However, they considerably differ from each other in pressures & type of fuel used.

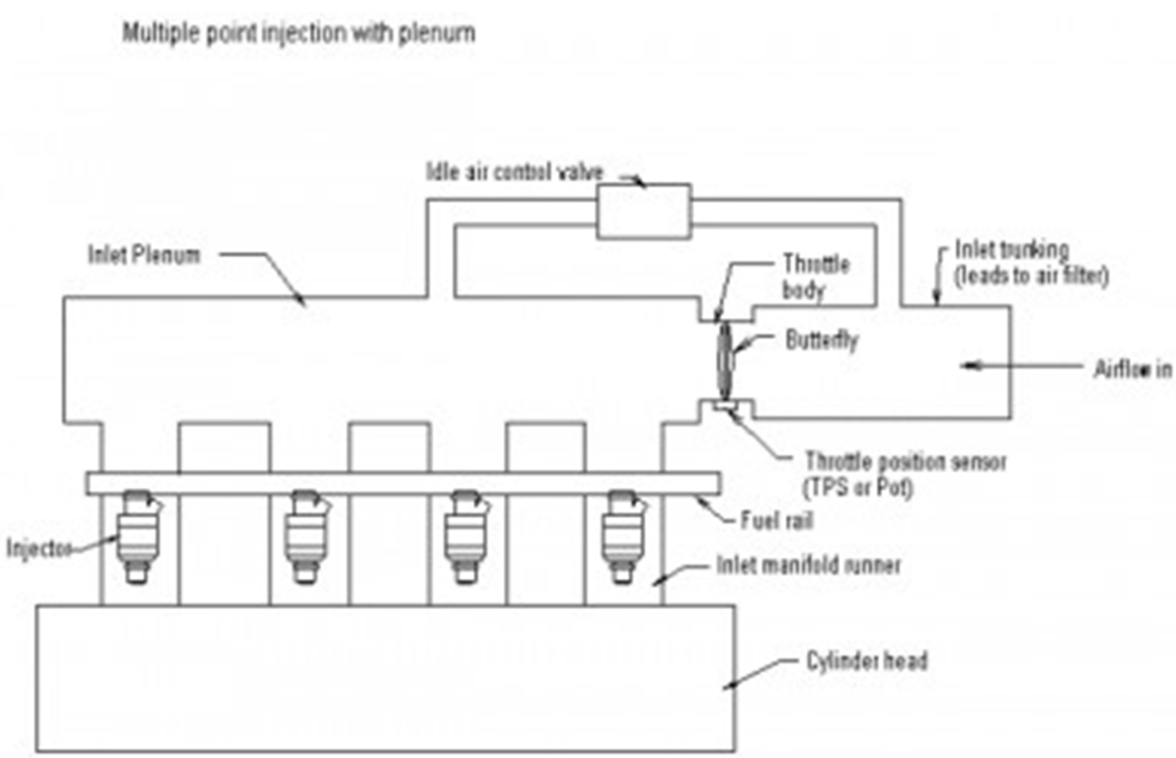
In Common Rail Direct Injection, commencement of combustion takes place directly into the main combustion chamber located in a cavity on the top of the piston crown. Today, CRDi technology is being widely used to overcome some of the deficiencies of conventional diesel engines which were sluggish, noisy and poor in performance; when implemented, especially in passenger vehicles.

The CRDi technology works in tandem with the engine ECU, which gets inputs from various sensors to calculate precise quantity of fuel and timing of injection. In CRDi, the fuel system components are more intelligent in nature, which are controlled electrically / electronically. The conventional injectors are replaced with advanced electrically operated solenoid injectors. Injectors are opened with an ECU signal depending upon the variables such as engine speed, load, engine temperature etc.

In a Common Rail system, A 'common-for-all-cylinders' fuel-rail or in simple words a 'fuel distribution pipe' is used to maintain optimum residual fuel pressure. It also acts as a shared fuel reservoir for all the injectors. The fuel is constantly supplied at the required pressure for injection. In modern day engines, high pressure fuel is stored in this single tube; which then supplies it to the solenoid valve injectors, as opposed to the fuel injection pump supplying diesel thru' independent fuel lines to injectors in earlier generation (DI) designs.

MPFI

MPFI is generally used to specify an engine variant used in the petrol vehicles. A small computerized system is used to control the engine of the car. A petrol car will have more than three fuel burning chambers or simply cylinders. The MPFI engine is abbreviated as the Multi point fuel injection engine.



MPFI

Principle behind MPFI

The power is produced in a petrol engine is by burning the fuel. In petrol engine, the petrol is ignited. At first, the petrol is allowed to mix with air. It is then ignited in a cylinder called as the combustion chamber. This combustion of the petrol produces a sufficient energy to run the engine. The Carburetor is being used in the earlier days before the invention of MPFI engine. It is the duty of the carburetor to mix the fuel and air in a fixed air-fuel ratio. The fuel thus mixed in the carburetor is then given to the combustion chamber where this mixture gets ignited. The power thus obtained from the ignition of gas is used to drive the engine. The main disadvantage of the Carburetor is that the mixing of fuel and air is not in the proper ratio which leads to the wastage of fuel and the pollution is high. Since the emission rate is high in carburetor engine, the MPFI engine is being introduced.

Working of MPFI Engine

The MPFI is an advanced version of carburetor engine. As we said earlier that the MPFI engine is having a fuel injector for each cylinder. A computer is used to control each and every fuel injector individually. The computerized system of the car consists of a microcontroller. This microcontroller monitors each fuel injectors and keeps on telling each injector about the amount of fuel to be injected to the cylinder so that the fuel wastage can be reduced. Since there is a controlled fuel usage, the engine is known for its fuel efficiency.

There are a number of sensors used in the MPFI engine. At the time when the inputs are given to the car's computer, it begins to read the given sensors. The things which can be known from the sensors are listed below:

The engine temperature of the vehicle.

The speed at which the engine is running.

The engine load.

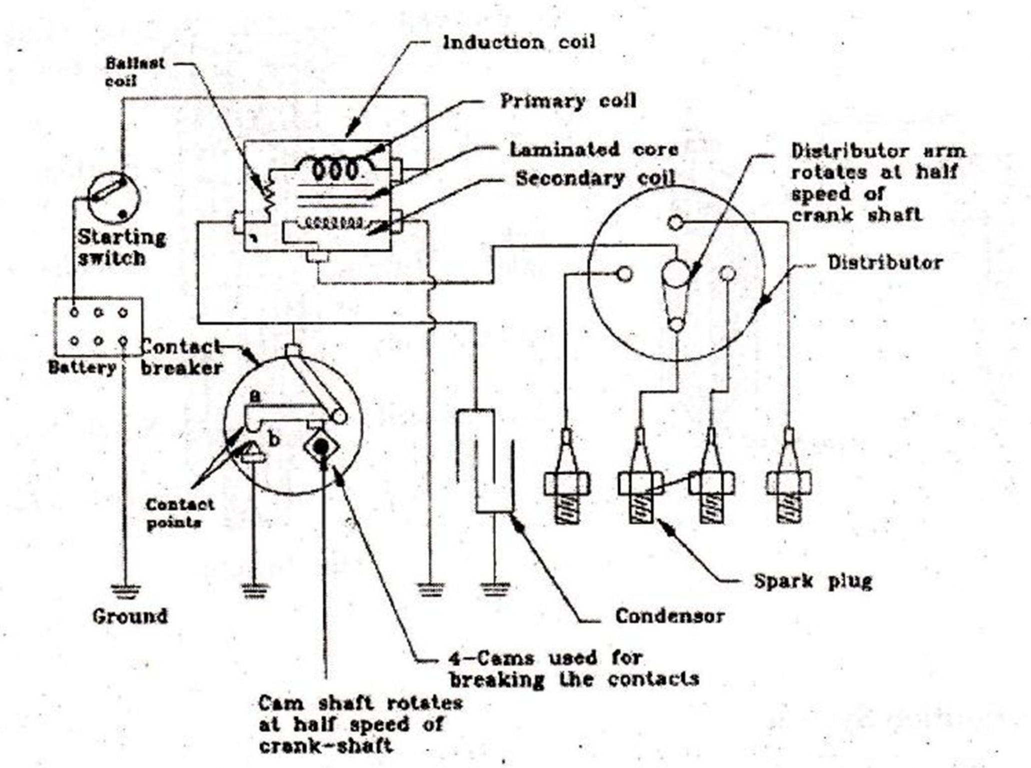
The position of the accelerator.

The cylinder's air-fuel pressure.

The rate of exhaust.

BATTERY IGNITION SYSTEM

A battery ignition system has a 6- or 12-volt battery charged by an engine-driven generator to supply electricity, an ignition coil to increase the voltage, a device to interrupt current from the coil, a distributor to direct current to the correct cylinder, and a spark plug projecting into each cylinder. Current goes from the battery through the primary winding of the coil, through the interrupting device, and back to the battery.



Battery Ignition System

The Ignition Coil and Distributor

The primary winding consists of wire coiled around an iron core. Over this is a secondary winding of many more turns of finer wire attached to the distributor. Current flowing through the primary winding creates a magnetic field. When the breaker cam opens the breaker points or the reluctor delivers its signal, the circuit is broken and current stops. The magnetic field collapses, inducing in the secondary winding a much higher voltage that is led to the distributor. Inside the distributor a moving finger rotates at half engine speed. As it rotates it touches contacts, each of which runs to a different cylinder. Rotation is timed so that when the finger is touching the contact for a particular cylinder, a high voltage has just been induced in the secondary winding of the ignition coil and the piston has almost reached the top of the compression stroke. Thus a high voltage is impressed across the spark plug gap.

The Spark Plug

The spark plug consists of a center electrode imbedded in insulating ceramic. Around the outside is a threaded metal shell that screws into a hole in the top of the cylinder. A ground electrode extends from the shell over the end of the center electrode. Between the two electrodes there is a small gap of .015–.040 in. (.038–.102 cm). At about 8,000 volts a spark jumps the gap and ignites the air-gasoline mixture. A centrifugal advance makes the spark fire earlier at high engine speeds; a vacuum advance makes it fire earlier at small throttle openings above idle.

IGNITION TIMING

Ignition timing, in a spark ignition internal combustion engine (ICE), is the process of setting the angle relative to piston position and crankshaft angular velocity that a spark will occur in the combustion chamber near the end of the compression stroke.

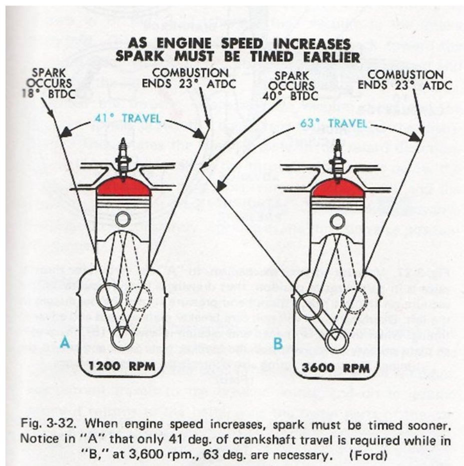


Fig. 3-32. When engine speed increases, spark must be timed sooner. Notice in "A" that only 41 deg. of crankshaft travel is required while in "B," at 3,600 rpm., 63 deg. are necessary. (Ford)

Ignition Timing

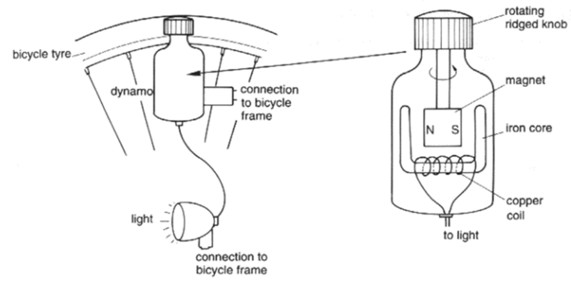
Ignition timing, in a spark ignition internal combustion engine (ICE), is the process of setting the angle relative to piston position and crankshaft angular velocity that a spark will occur in the combustion chamber near the end of the compression stroke.

The need for advancing the timing of the spark is because fuel does not completely burn the instant the spark fires, the combustion gasses take a period of time to expand, and the angular or rotational speed of the engine can lengthen or shorten the time frame in which the burning and expansion should occur. In a vast majority of cases, the angle will be described as a certain angle advanced before top dead center (BTDC). Advancing the spark BTDC means that the spark is energized prior to the point where the combustion chamber reaches its minimum size, since the purpose of the power stroke in the engine is to force the combustion chamber to expand. Sparks occurring after top dead center (ATDC) are usually counter-productive (producing wasted spark, back-fire, engine knock etc.) unless there is need for a supplemental or continuing spark prior to the exhaust stroke.

Setting the correct ignition timing is crucial in the performance of an engine. Sparks occurring too soon or too late in the engine cycle are often responsible for excessive vibrations and even engine damage. The ignition timing affects many variables including engine longevity, fuel economy, and engine power. Modern engines that are controlled in real by an engine control unit use a computer to control the timing throughout the engine's RPM and load range. Older engines that use mechanical spark distributors rely on inertia (by using rotating weights and springs) and manifold vacuum in order to set the ignition timing throughout the engine's RPM and load range.

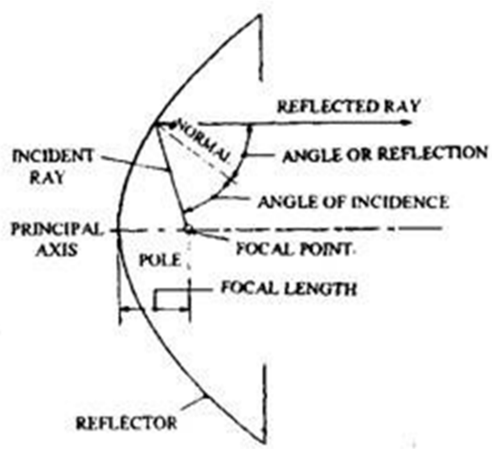
DYNAMO

A dynamo is an electrical generator that produces direct current with the use of a commutator. Dynamos were the first electrical generators capable of delivering power for industry, and the foundation upon which many other later electric-power conversion devices were based, including the electric motor, the alternating-current alternator, and the rotary converter. Today, the simpler alternator dominates large scale power generation, for efficiency, reliability and cost reasons. A dynamo has the disadvantages of a mechanical commutator. Also, converting alternating to direct current using power rectification devices (vacuum tube or more recently solid state) is effective and usually economical.



Dynamo

HEADLAMP REFLECTOR



Head lamp reflector

A headlamp is a lamp attached to the front of a vehicle to light the road ahead. While it is common for the term headlight to be used interchangeably in informal discussion, headlamp is the term for the device itself, while headlight properly refers to the light produced and distributed by the device.

The headlight reflector directs the random light rays of the light bulb into a concentrated beam of light. It is consisted of a layer of silver, chrome, or aluminum deposited on a smooth and polished brass or glass surface. The outer surface of this layer soon tarnishes in air. Therefore for a glass reflector, the surface in contact with the glass is used as the reflector and its back face is usually painted with shellac varnish or something similar for protection of the coating.

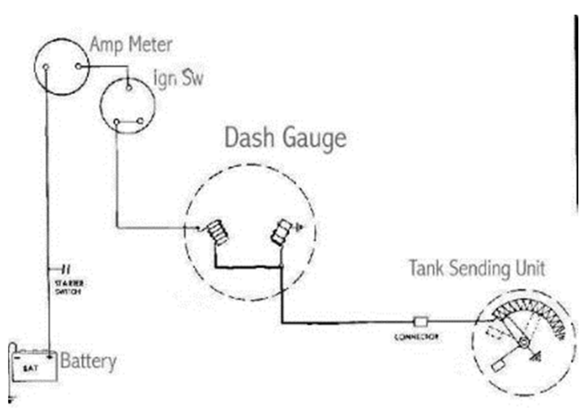
FUEL GAUGE

A fuel gauge (or gas gauge) is an instrument used to indicate the level of fuel contained in a tank.

Commonly used in most motor vehicles, these may also be used for any tank including underground storage tanks.

As used in vehicles, the gauge consists of two parts:

- The sensing unit
- The indicator



Fuel gauge

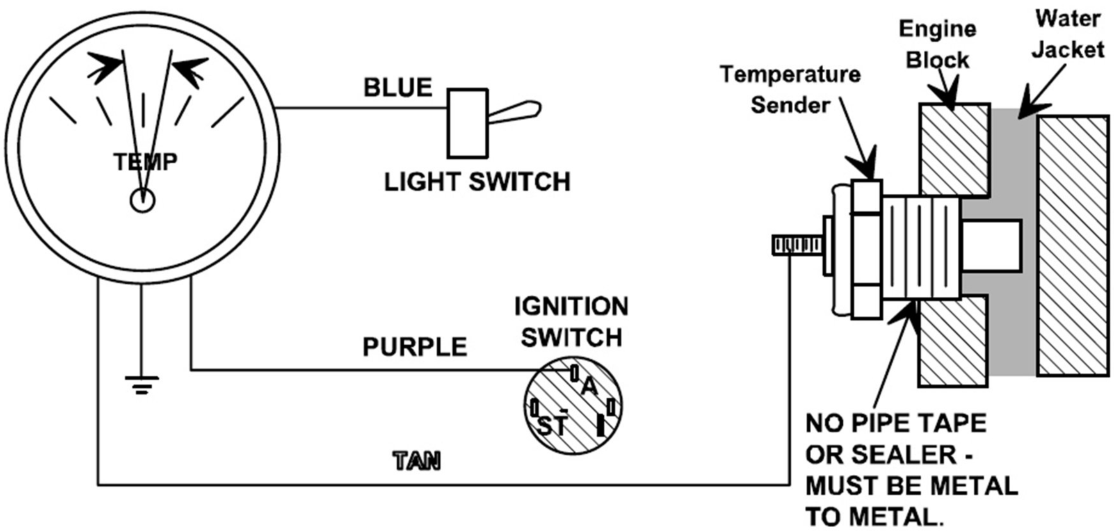
The sensing unit usually uses a float connected to a potentiometer, typically printed ink design in a modern automobile. As the tank empties, the float drops and slides a moving contact along the resistor, increasing its resistance. In addition, when the resistance is at a certain point, it will also turn on a "low fuel" light on some vehicles.

Meanwhile, the indicator unit (usually mounted on the dashboard) is measuring and displaying the amount of electric current flowing through the sending unit. When the tank level is high and maximum current is flowing, the needle points to "F" indicating a full tank. When the tank is empty and the least current is flowing, the needle points to "E" indicating an empty tank.

The system can be fail-safe. If an electrical fault opens, the electrical circuit causes the indicator to show the tank as being empty (theoretically provoking the driver to refill the tank) rather than full (which would allow the driver to run out of fuel with no prior notification). Corrosion or wear of the potentiometer will provide erroneous readings of fuel level. However, this system has a potential risk associated with it. An electric current is sent through the variable resistor to which a float is connected, so that the value of resistance depends on the fuel level. In most automotive fuel gauges such resistors are on the inward side of the gauge, i.e., inside the fuel tank. Sending current through such a resistor has a fire hazard and an explosion risk associated with it. These resistance sensors are also showing an increased failure rate with the incremental additions of alcohol in automotive gasoline fuel. Alcohol increases the corrosion rate at the potentiometer, as it is capable of carrying current like water. Potentiometer applications for alcohol fuel use a pulse-and-hold methodology, with a periodic signal being sent to determine fuel level decreasing the corrosion potential. Therefore, demand for another safer, non-contact method for fuel level is desired.

TEMPERATURE GAUGE

±15°F from actual temperature.

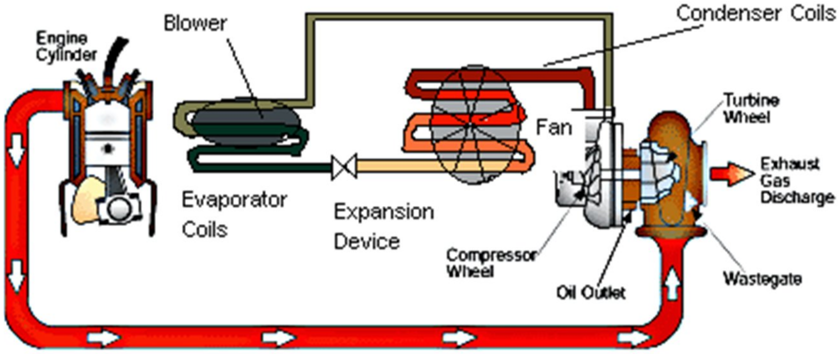


Temperature measuring gauge

In the mechanical gauge, the sensing element was a metal bulb, containing a fluid that had a high coefficient of expansion and a low freezing point, connected by a capillary tube directly to a diaphragm or Bourdon tube. When heated, the fluid expanded, causing the gauge pointer, connected to the diaphragm or tube, to move across a short scale. An amplifying mechanical linkage could be included in the instrument case so that a longer, circular scale could be employed. The electrical gauge used a thermister bead, also mounted in a metal bulb, as the sensing element, or transmitter.

AUTOMOBILE AIR CONDITIONING SYSTEM

Air conditioning like it says 'conditions' the air. It not only cools it down, but also reduces the moisture content, or humidity. All air conditioners work the same way whether they are installed in a building, or in a car. Air conditioning's main principles are Evaporation and Condensation, then Compression and Expansion.



Air conditioning unit

In the refrigeration cycle, heat is transported from the passenger compartment to the environment. A refrigerator is an example of such a system, as it transports the heat out of the interior and into its environment (i.e. the room).

Circulating refrigerant gas vapor enters the gas compressor in the engine bay and is compressed to a higher pressure, resulting in a higher temperature as well. The hot, compressed refrigerant vapor is now at a temperature and pressure at which it can be condensed and is routed through a condenser, usually in front of the car's radiator. Here the refrigerant is cooled by air flowing across the condenser coils and condensed into a liquid. Thus, the circulating refrigerant rejects heat from the system and the heat is carried away by the air.

The condensed and pressurized liquid refrigerant is next routed through a thermal expansion valve where it undergoes an abrupt reduction in pressure. That pressure reduction results in flash evaporation of a part of the liquid refrigerant, lowering its temperature. The cold refrigerant is then routed through the evaporator coil in the passenger compartment. The air (which is to be cooled) blows across the evaporator, causing the liquid part of the cold refrigerant mixture to evaporate as well, further lowering the temperature. The warm air is therefore cooled.

To complete the refrigeration cycle, the refrigerant vapor is routed back into the compressor.

The compressor can be driven by the car's engine (e.g. via a belt) or by an electric motor.