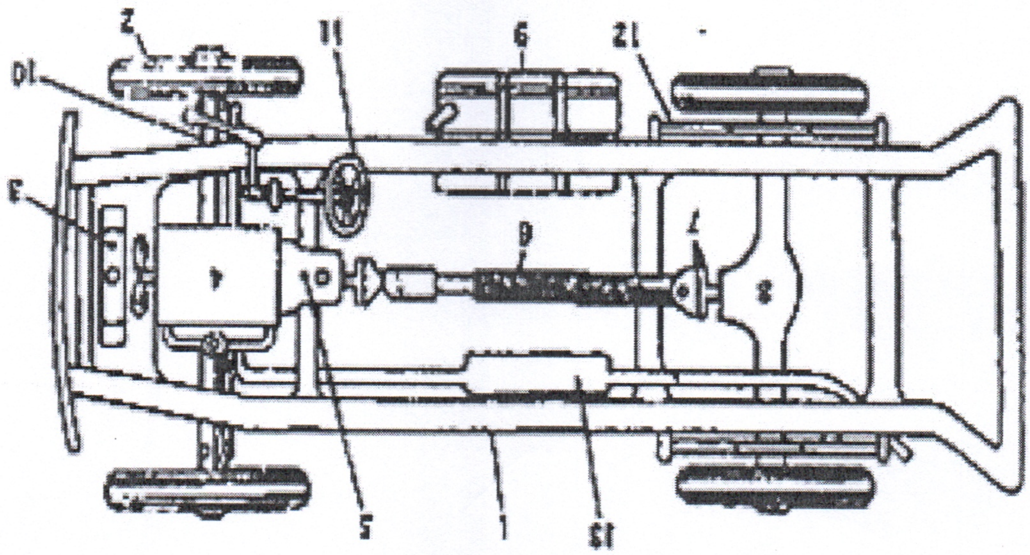
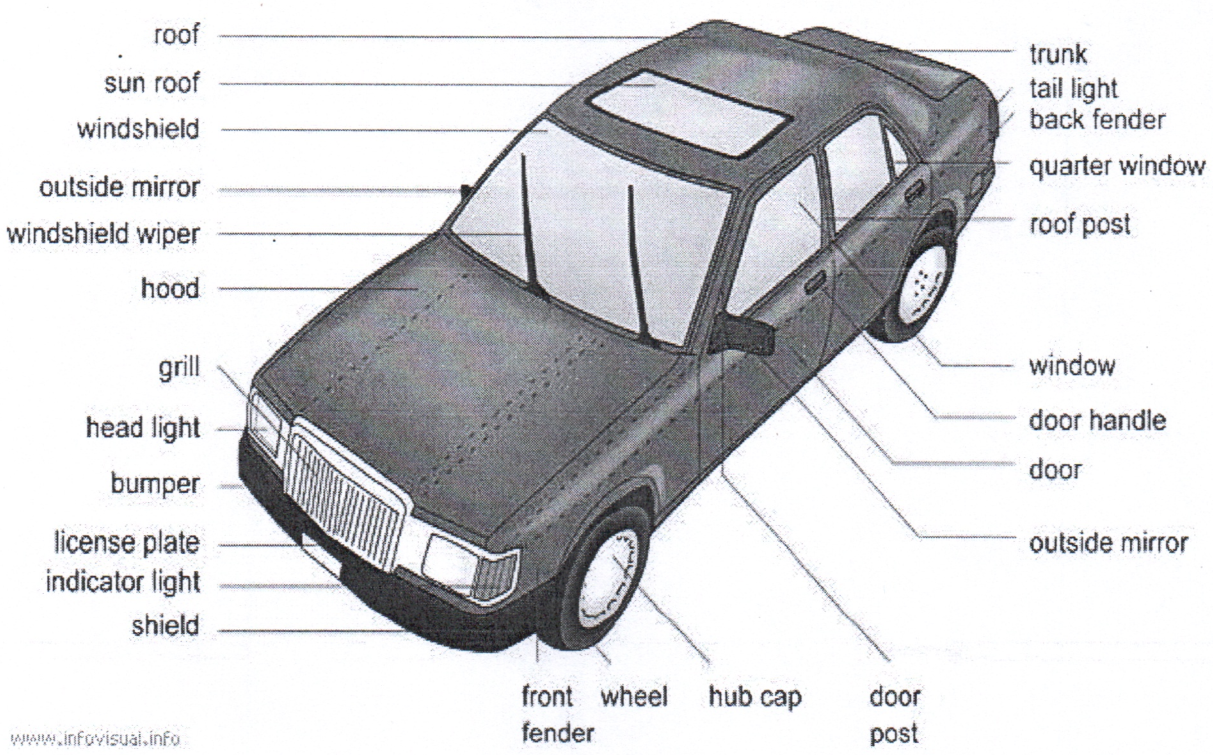
UNIT- I

INTRODUCTION



AUTOMOBILE



Introduction of Automobile or Vehicle:

An Automobile is a self propelled vehicle which contains the power source for its propulsion and is used for carrying passengers and goods on the ground, such as car, bus, trucks, etc.,,

Types of Automobile:

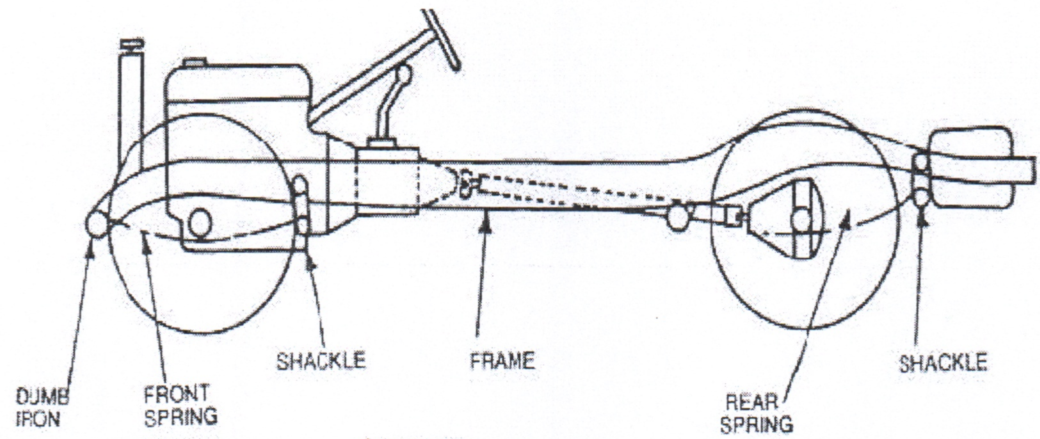
The automobiles are classified by the following ways,

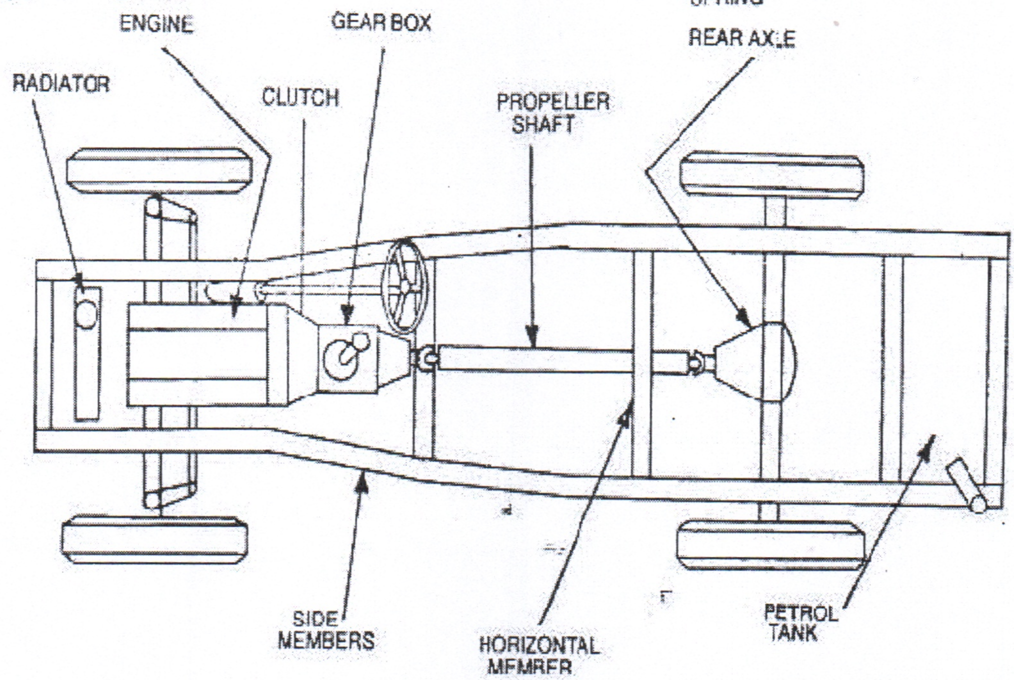
1. **On the Basis of Load:**
   - Heavy transport vehicle (HTV) or heavy motor vehicle (HMV),
   - Light transport vehicle (LTV), Light motor vehicle (LMV),
2. **On the Basis of Wheels :**
   - Two wheeler vehicle, for example : Scooter, motorcycle, scooty, etc.
   - Three wheeler vehicle, for example : Autorickshaw,
   - Three wheeler scooter for handicaps and tempo, etc.
   - Four wheeler vehicle, for example : Car, jeep, trucks, buses, etc.
   - Six wheeler vehicle, for example : Big trucks with two gear axles.
3. **On the basis of Fuel Used:**
   - Petrol vehicle, e.g. motorcycle, scooter, cars, etc.
   - Diesel vehicle, e.g. trucks, buses, etc.
   - Electric vehicle which use battery to drive.
   - Steam vehicle, e.g. an engine which uses steam engine.
   - Gas vehicle, e.g. LPG and CNG vehicles, where LPG is liquefied
4. **On the basis of body style:**
   - Sedan Hatchback car.
   - Coupe car Station wagon Convertible.
   - Van Special purpose vehicle, e.g. ambulance, milk van, etc.
5. **On the basis of Transmission:**
   - Conventional vehicles with manual transmission, e.g. car with 5 gears.
   - Semi-automatic
   - Automatic : In automatic transmission, gears are not required to be changed manually.
6. **On the basis of Drive:**
   - Left hand drive
   - Right hand drive
7. **On the basis of Driving Axle**
   - Front wheel drive
   - Rear wheel drive
   - All wheel drive
8. **Position of Engine:**
   - Engine in Front - Most of the vehicles have engine in the front. Example : most of the cars,
   - Engine in the Rear Side Very few vehicles have engine located in the rear. Example : Nano car.

Vehicle construction and Components;

The main components of an automobile refer to the following components;

- Frame,
- Chassis,
- Body,
- Power unit,
- Transmission system.





An automobile is made up of mainly two units, these are Chassis and Body.

<u>“Frame” + “Base components” = “Chassis”</u>

<u>“Chassis” + “Body” = “Vehicle”</u>

Frame :

The frame is the skeleton of the vehicle. It servers as a main foundation and base for alignment for the chassis.

Types;

- Conventional frame,
- Semi integral frame;
- Integral or untidiest frame.

Chassis;

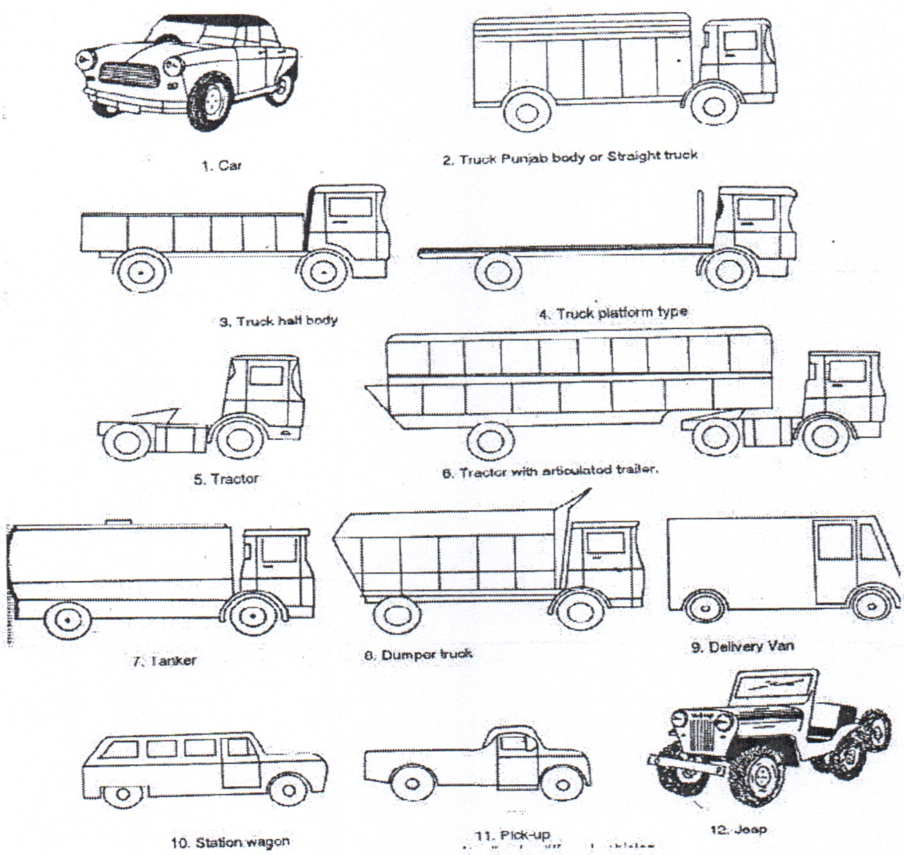
If the frame contains the base components its called as chassis. The components are like Engine, radiator, clutch, gearbox, silencer, road wheels, fuel tank, wirings, differential units, etc..,

Bod:

Body is the superstructure of the vehicle and it is bolted to the chasis.

Types;

- Car,
- Truck,
- Tractor,
- Delivery van,
- Jeep,
- Bus, etc..,



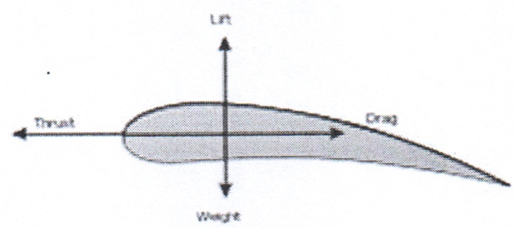
Resistances to vehicle motion and need for a gearbox

Aerodynamics

Aerodynamics, from Greek ἀήρ aer (air) + δυναμική (dynamics), is a branch of dynamics concerned with studying the motion of air, particularly when it interacts with a solid object, such as an airplane wing.

Aerodynamics is a sub-field of fluid dynamics and gas dynamics, and many aspects of aerodynamics theory are common to these fields. The term aerodynamics is often used synonymously with gas dynamics, with the difference being that "gas dynamics" applies to the study of the motion of all gases, not limited to air.

Modern aerodynamics only dates back to the seventeenth century, but aerodynamic forces have been harnessed by humans for thousands of years in sailboats and windmills, and images and stories of flight appear throughout recorded history, such as the Ancient Greek legend of Icarus and Daedalus. Fundamental concepts of continuum, drag, and pressure gradients, appear in the work of Aristotle and Archimedes.



Forces of flight on an airfoil

Fundamental Concept

Understanding the motion of air around an object (often called a flow field) enables the calculation of forces and moments acting on the object. In many aerodynamics problems, the forces of interest are the fundamental forces of flight: lift, drag, thrust, and weight. Of these, lift and drag are aerodynamic forces, i.e. forces due to air flow over a solid body.

Calculation of these quantities is often founded upon the assumption that the flow field behaves as a continuum. Continuum flow fields are characterized by properties such as velocity, pressure, density and temperature, which may be functions of spatial position and time.

These properties may be directly or indirectly measured in aerodynamics experiments, or calculated from equations for the conservation of mass, momentum, and energy in air flows. Density, velocity, and an additional property, viscosity, are used to classify flow fields.

Components of an Engine;

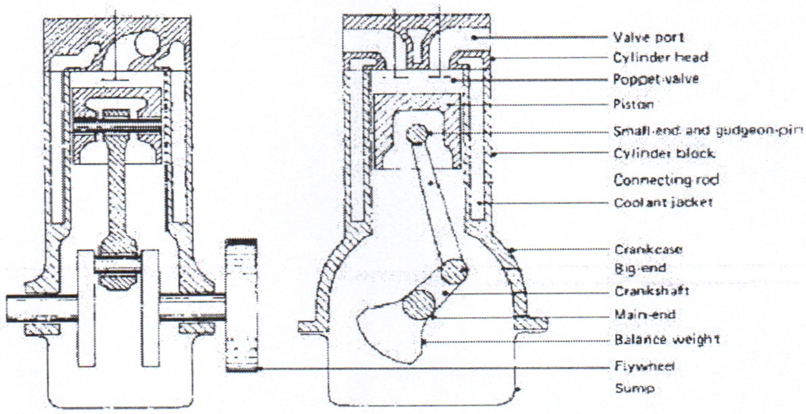
Even though reciprocating internal combustion engines look quite simple, they are highly complex machines. There are hundreds of components that have to perform their functions satisfactorily to produce output power. There are two types of engines, viz., spark ignition (S1) and compression-ignition (CI) engine. Let us now go through the important engine components and the nomenclature associated with an engine.

Terms connected with i.c. engines;

- **Bore:** The inside diameter of the cylinder is called bore
- **Stroke:** The linear distance along the cylinder axis between two limiting position s is called stroke.
- **Top Dead Center (T.D.C.)** : the top most position of the piston towards cover end side of the cylinder is called T.D.C.
- **Bottom dead Center (B.D.C.)** : The lowest position of the piston towards the crank end side of the cylinder is called B.D.C.
- **Clearance Volume** : The volume contained in the cylinder above the top of the piston , when the piston is at top dead center , is called the clearance volume.
- **Swept Volume:** The volume swept through by the piston in moving between T.D.C. and B.D.C, is called swept volume or piston displacement.
- **Compression Ratio:** It is the ratio of Total cylinder volume to clearance volume

Definition of 'Engine'

An engine is a device, which transforms one form of energy into another form. Normally, most of the engines convert thermal energy into mechanical work and therefore they are called 'heat engines'.



Engine Components

The major components of the engine and their functions are briefly described below.

Cylinder Block:

The cylinder block is the main supporting structure for the various components. The cylinder of a multicylinder engine is cast as a single unit, called cylinder block. The cylinder head is mounted on the cylinder block.

The cylinder head and cylinder block are provided with water jackets in the case of water-cooling with cooling fins in the case of air-cooling. Cylinder head gasket is incorporated between the cylinder block and cylinder head. The cylinder head is held tight to the cylinder block by number of bolts or studs. The bottom portion of the cylinder block is called crankcase. A cover called crankcase, which becomes a sump for lubricating oil is fastened to the bottom of the crankcase. The inner surface of the cylinder block, which is machined and finished accurately to cylindrical shape, is called bore or face.

Cylinder

As the name implies it is a cylindrical vessel or space in which the piston makes a reciprocating motion. The varying volume created in the cylinder during the operation of the engine is filled with the working fluid and subjected to different thermodynamic processes. The cylinder is supported in the cylinder block.

Piston

It is a cylindrical component fitted into the cylinder forming the moving boundary of the combustion system. It fits perfectly (snugly) into the cylinder providing a gas-tight space with the piston rings and the lubricant. It forms the first link in transmitting the gas forces to the output shaft.

Combustion Chamber

The space enclosed in the upper part of the cylinder, by the cylinder head and the piston top during the combustion process, is called the combustion chamber. The combustion of fuel and the consequent release of thermal energy results in the building up of pressure in this part of the cylinder.

Inlet Manifold

The pipe which connects the intake system to the inlet valve of the engine and through which air or air-fuel mixture is drawn into the cylinder is called the inlet manifold.

Gudgeon Pin

It forms the link between the small end of the connecting rod and the piston.

Exhaust Manifold

The pipe that connects the exhaust system to the exhaust valve of the engine and through which the products of combustion escape into the atmosphere is called the exhaust manifold.

Inlet and Exhaust Valves

Valves are commonly mushroom shaped poppet type. They are provided either on the cylinder head or on the side of the cylinder for regulating the charge coming into the cylinder (inlet valve) and for discharging the products of combustion (exhaust valve) from the cylinder.

Connecting Rod

It interconnects the piston and the crankshaft and transmits the gas forces from the piston to the crankshaft. The two ends of the connecting rod are called as small end and the big end. Small end is connected to the piston by gudgeon pin and the big end is connected to the crankshaft by crankpin.

Crankshaft

It converts the reciprocating motion of the piston into useful rotary motion of the output shaft. In the crankshaft of a single cylinder engine there is pair of crank arms and balance weights. The balance weights are provided for static and dynamic balancing of the rotating system. The crankshaft is enclosed in a crankcase.

Piston Rings

Piston rings, fitted into the slots around the piston, provide a tight seal between the piston and the cylinder wall thus preventing leakage of combustion gases

Camshaft

The camshaft and its associated parts control the opening and closing of the two valves. The associated parts are push rods, rocker arms, valve springs and tappets. This shaft also provides the drive to the ignition system. The camshaft is driven by the crankshaft through timing gears.

Cams

These are made *as* integral parts of the camshaft and are designed in such a way to open the valves at the correct timing and to keep them open for the necessary duration.

Fly Wheel

The net torque imparted to the crankshaft during one complete cycle of operation of the engine fluctuates causing a change in the angular velocity of the shaft. In order to achieve a uniform torque an inertia *mass* in the form of a wheel is attached to the output shaft and this wheel is called the flywheel.

Basic Parts of the Gasoline Engine:

Basic Parts of the Gasoline Engine are listed below;

- Cylinder block
- Piston
- Piston rings
- Piston pin
- Connecting rod
- Crankshaft
- Cylinder head
- Intake valve
- Exhaust valve
- Camshaft
- Timing gears
- Spark plug

Cylinder Block:

Cylinder Block Basic frame of gasoline engine. Contains the cylinder.

Piston:

Piston A sliding plug that harnesses the force of the burning gases in the cylinder.

Piston Rings:

Piston rings seal the compression gases above the piston keep the oil below the piston rings.

Piston Pins:

Piston Pins Also known as the wrist pin, it connects the piston to the small end of the connecting rod. It transfers the force and allows the rod to swing back and forth.

Connecting Rod:

Connecting Rod Connects the piston and piston pin to the crankshaft.

Crankshaft:

Crankshaft Along the the piston pin and connecting rod it converts the up and down motion (reciprocating) of the engine to spinning (rotary) motion.

Flywheel:

Flywheel Carries the inertia when there is no power stroke.

Cylinder Head:

Cylinder Head Forms the top of the combustion chamber. Contains the valves, the passageways for the fuel mixture to move in and out of the engine.

Intake and Exhaust Valves:

Intake and Exhaust Valves Doorway that lets the gases in and out of the engine.

Camshaft:

Camshaft Through the use of an eccentric the cam lobes push the valves open. The valve springs close them.

Timing Gears:

Timing Gears These gears drive the camshaft from the crankshaft.

Why not diesel engines are not preferred in commercial?

1. Diesel engines, because they have much higher compression ratios (20:1 for a typical diesel vs. 8:1 for a typical gasoline engine), tend to be heavier than an equivalent gasoline engine.
2. Diesel engines also tend to be more expensive.
3. Diesel engines, because of the weight and compression ratio, tend to have lower maximum RPM ranges than gasoline engines .This makes diesel engines high torque rather than high horsepower, and that tends to make diesel cars slow in terms of acceleration.
4. Diesel engines must be fuel injected, and in the past fuel injection was expensive and less reliable
5. Diesel engines tend to produce more smoke.
6. Diesel engines are harder to start in cold weather, and if they contain glow plugs, diesel engines can require you to wait before starting the engine so the glow plugs can heat up.
7. Diesel engines are much noisier and tend to vibrate.
8. Diesel fuel is less readily available than gasoline

Advantages diesel engines:

The two things working in favor of diesel engines are better fuel economy and longer engine life. Both of these advantages mean that, over the life of the engine, you will tend to save money with a diesel.

However, you also have to take the initial high cost of the engine into account. You have to own and operate a diesel engine for a fairly long time before the fuel economy overcomes the increased purchase price of the engine.

The equation works great in a big diesel tractor-trailer rig that is running 400 miles every day, but it is not nearly so beneficial in a passenger car.

Fuel Injection system for SI engines;

Carburetion

Spark-ignition engines normally use volatile liquid fuels. Preparation of fuel-air mixture is done outside the engine cylinder and formation of a homogeneous mixture is normally not completed in the inlet manifold. Fuel droplets, which remain in suspension, continue to evaporate and mix with air even during suction and compression processes. The process of mixture preparation is extremely important for spark-ignition engines. The purpose of carburetion is to provide a combustible mixture of fuel and air in the required quantity and quality for efficient operation of the engine under all conditions.

Definition of Carburetion;

The process of formation of a combustible fuel-air mixture by mixing the proper amount of fuel with air before admission to engine cylinder is called carburetion and the device which does this job is called a carburetor.

Definition of Carburetor;

The carburetor is a device used for atomizing and vaporizing the fuel and mixing it with the air in varying proportions to suit the changing operating conditions of vehicle engines.

Factors Affecting Carburetion

Of the various factors, the process of carburetion is influenced by
i. The engine speed
ii. The vaporization characteristics of the fuel
iii. The temperature of the incoming air and
iv. The design of the carburetor

Principle of Carburetion

Both air and gasoline are drawn through the carburetor and into the engine cylinders by the suction created by the downward movement of the piston. This suction is due to an increase in the volume of the cylinder and a consequent decrease in the gas pressure in this chamber.

It is the difference in pressure between the atmosphere and cylinder that causes the air to flow into the chamber. In the carburetor, air passing into the combustion chamber picks up discharged from a tube. This tube has a fine orifice called carburetor jet that is exposed to the air path.

The rate at which fuel is discharged into the air depends on the pressure difference or pressure head between the float chamber and the throat of the venturi and on the area of the outlet of the tube. In order that the fuel drawn from the nozzle may be thoroughly atomized, the suction effect must be strong and the nozzle outlet comparatively small. In order to produce a strong suction, the pipe in the carburetor carrying air to the engine is made to have a restriction. At this restriction called throat due to increase in velocity of flow, a suction effect is created. The restriction is made in the form of a venturi to minimize throttling losses.

The end of the fuel jet is located at the venturi or throat of the carburetor. The geometry of venturi tube is as shown in Fig.16.6. It has a narrower path at the center so that the flow area through which the air must pass is considerably reduced. As the same amount of air must pass through every point in the tube, its velocity will be greatest at the narrowest point. The smaller the area, the greater will be the velocity of the air, and thereby the suction is proportionately increased

As mentioned earlier, the opening of the fuel discharge jet is usually loped where the suction is maximum. Normally, this is just below the narrowest section of the venturi tube. The spray of gasoline from the nozzle and the air entering through the venturi tube are mixed together in this region and a combustible mixture is formed which passes through the intake manifold into the cylinders. Most of the fuel gets atomized and simultaneously a small part will be vaporized. Increased air velocity at the throat of the venturi helps he rate of evaporation of fuel. The difficulty of obtaining a mixture of sufficiently high fuel vapour-air ratio for efficient starting of the engine and for uniform fuel-air ratio indifferent cylinders (in case of multi cylinder engine) cannot be fully met by the increased air velocity alone at the venturi throat.

The Simple Carburetor

Carburetors are highly complex. Let us first understand the working principle bf a simple or elementary carburetor that provides an air fuel mixture for cruising or normal range at a single speed. Later, other mechanisms to provide for the various special requirements like starting, idling, variable load and speed operation and acceleration will be included. Figure 3. shows the details of a simple carburetor.

The simple carburetor mainly consists of a float chamber, fuel discharge nozzle and a metering orifice, a venturi, a throttle valve and a choke. The float and a needle valve system maintain a constant level of gasoline in the float chamber. If the amount of fuel in the float chamber falls below the designed level, the float goes down, thereby opening the fuel supply valve and admitting fuel. When the designed level has been reached, the float closes the fuel supply valve thus stopping additional fuel flow from the supply system. Float chamber is vented either to the atmosphere or to the" upstream side of the venturi.During suction stroke air is drawn through the venturi.

As already described, venturi is a tube of decreasing cross-section with a minimum area at the throat, Venturi tube is also known as the choke tube and is so shaped that it offers minimum resistance to the air flow. As the air passes through the venturi the velocity increases reaching a maximum at the venturi throat. Correspondingly, the pressure decreases reaching a minimum. From the float chamber, the fuel is fed to a discharge jet, the tip of which is located in the throat of the venturi. Because of the differential pressure between the float chamber and the throat of the venturi, known as carburetor depression, fuel is discharged into the air stream.

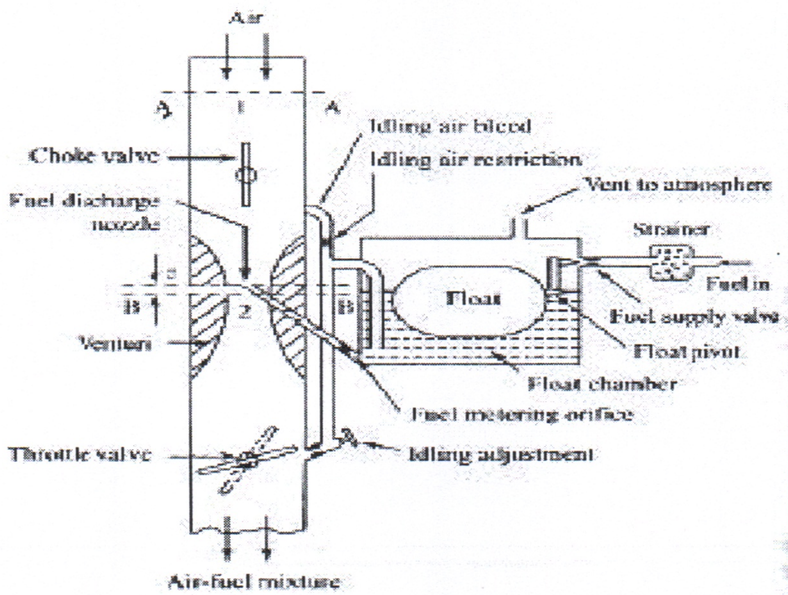


Figure: 3 The Simple Carburetor

The fuel discharge is affected by the size of the discharge jet and it is chosen to give the required air-fuel ratio. The pressure at the throat at the fully open throttle condition lies between 4 to 5 cm of Hg, below atmospheric and seldom exceeds8 cm Hg below atmospheric. To avoid overflow of fuel through the jet, the level of the liquid in the float chamber is maintained at a level slightly below the tip of the discharge jet. This is called the tip of the nozzle. The difference in the height between the top of the nozzle and the float chamber level is marked h in Fig.3.

The gasoline engine is quantity governed, which means that when power output is to be varied at a particular speed, the amount of charge delivered to the cylinder is varied. This is achieved by means of a throttle valve usually of the butterfly type that is situated after the venturi tube.

As the throttle is closed less air flows through the venturi tube and less is the quantity of air-fuel mixture delivered to the cylinder and hence power output is reduced. As the" throttle is opened, more air flows through the choke tube resulting in increased quantity of mixture being delivered to the engine. This increases the engine power output. A simple carburetor of the type described above suffers from a fundamental drawback in that it provides the required A/F ratio only at one throttle position.

At the other throttle positions the mixture is either leaner or richer depending on whether the throttle is opened less or more. As the throttle opening is varied, the air flow varies and creates a certain pressure differential between the float chamber and the venturi throat. The same pressure differential regulates the flow of fuel through the nozzle. Therefore, the velocity of flow of air II and fuel vary in a similar manner.

The Choke and the Throttle

When the vehicle is kept stationary for a long period during cool winter seasons, may be overnight, starting becomes more difficult. *As* already explained, at low cranking speeds and intake temperatures a very rich mixture is required to initiate combustion. Some times air-fuel ratio as rich as 9:1 is required. The main reason is that very large fraction of the fuel may remain as liquid suspended in air even in the cylinder. For initiating combustion, fuel-vapour and air in the form of mixture at a ratio that can sustain combustion is required.

It may be noted that at very low temperature vapour fraction of the fuel is also very small and this forms combustible mixture to initiate combustion. Hence, a very rich mixture must be supplied. The most popular method of providing such mixture is by the use of choke valve. This is simple butterfly valve located between the entrance to the carburetor and the venturi throat as shown in Fig.3.

When the choke is partly closed, large pressure drop occurs at the venturi throat that would normally result from the quantity of air passing through the venturi throat. The very large depression at the throat inducts large amount of fuel from the main nozzle and provides a very rich mixture so that the ratio of the evaporated fuel to air in the cylinder is within the combustible limits. Sometimes, the choke valves are spring loaded to ensure that large carburetor depression and excessive choking does not persist after the engine has started, and reached a desired speed.

This choke can be made to operate automatically by means of a thermostat so that the choke is closed when engine is cold and goes out of operation when engine warms up after starting. The speed and the output of an engine is controlled by the use of the throttle valve, which is located on the downstream side of the venturi.

The more the throttle is closed the greater is the obstruction to the flow *of* the mixture placed in the passage and the less is the quantity *of* mixture delivered to .the cylinders. The decreased quantity *of* mixture gives a less powerful impulse to the pistons and the output *of* the engine is reduced accordingly. As the throttle is opened, the output *of* the engine increases. Opening the throttle usually increases the speed *of* the engine. But this is not always the case as the load on the engine is also a factor. For example, opening the throttle when the motor vehicle is starting to climb a hill may or may not increase the vehicle speed, depending upon the steepness *of* the hill and the extent *of* throttle opening. In short, the throttle is simply a means to regulate the output *of* the engine by varying the quantity *of* charge going into the cylinder.

Compensating Devices

An automobile on road has to run on different loads and speeds. The road conditions play a vital role. Especially on city roads, one may be able to operate the vehicle between 25 to 60% of the throttle only. During such conditions the carburetor must be able to supply nearly constant air-fuel ratio mixture that is economical (16:1).However, the tendency of a simple carburetor is to progressively richen the mixture as the throttle starts opening.

The main metering system alone will not be sufficient to take care of the needs of the engine. Therefore, certain compensating devices are usually added in the carburetor along with the main metering system so as to supply a mixture with the required air-fuel ratio. A number of compensating devices are in use. The important ones are

i. Air-bleed jet
ii. Compensating jet
iii. Emulsion tube
iv. Back suction control mechanism
v. Auxiliary air valve
vi. Auxiliary air port

As already mentioned, in modern carburetors automatic compensating devices are provided to maintain the desired mixture proportions at the higher speeds. The type of compensation mechanism used determines the metering system of the carburetor. The principle of operation of various compensating devices are discussed briefly in the following sections.

Air-bleed jet

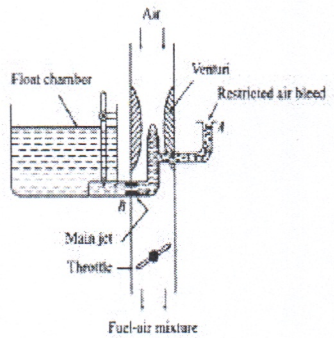


Figure: 4 Air bleed principle in a typical carburetor

Figure 4. illustrates a principle of an air-bleed system in atypical modern downdraught carburetor. As could be seen it contains an air-bleed into the main nozzle. An orifice restricts the flow of air through this bleed and therefore it is called restricted air-bleed jet that is very popular. When the engine is not operating the main jet and the air bleed jet will be filled with fuel. When the engine starts, initially the fuel starts coming through the main as well as the air bleed jet (A). As the engine picks up, only air starts coming through the air bleed and mixes with fuel at B making a air fuel emulsion.

Thus the fluid stream that has become an emulsion of air and liquid has negligible viscosity and surface tension. Thus the flow rate of fuel is augmented and more fuel is sucked at low suctions. 'By proper design of hole size at B compatible with the entry hole at A, it is possible to maintain a fairly uniform mixture ratio for the entire power range of the operation of an engine. If the fuel flow nozzle of the air-bleed system is placed in the centre of the venturi, both the air-bleed nozzle and the venturi are subjected to same engine suction resulting approximately same fuel-air mixture for the entire power range of operation.

Compensating Jet

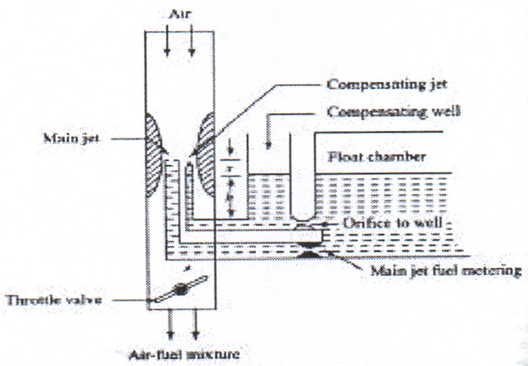


Figure: 5 Compensating Jet device

The principle of compensating jet device is to make the mixture leaner as the throttle opens progressively. In this method, as can be seen from Fig.5 in addition to the main jet, a compensating jet is incorporated. The compensating jet is connected to the compensation well. The compensating well is also vented to atmosphere like the main float chamber.

The compensating well is supplied with fuel from the main float chamber through a restricting orifice. With the increase in airflow rate, there is decrease of fuel level in the compensating well, with the result that fuel supply through the compensating jet decreases. The compensating jet thus progressively makes the mixture leaner as the main jet progressively makes the mixture richer. The main jet curve and the compensating jet curve are more or less reciprocals of each other.

Emulsion Tube

The mixture correction is attempted by air bleeding in modern carburetor. In one such arrangement as shown in Fig.6, the main metering jet is kept at a level of about 25 mm below the fuel level in the float chamber. Therefore, it is also called submerged jet. The jet is located at the bottom of a well. The sides of the well have holes. As can be seen from the figure these holes are in communication with the atmosphere. In the beginning the level of petrol in the float chamber and the well is the same.

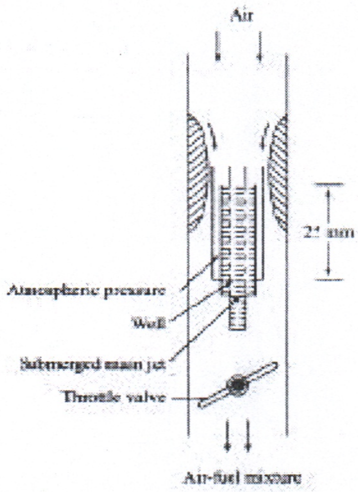


Figure: 6 Emulsion Tube

When the throttle is opened the pressure at the venturi throat decreases and petrol is drawn into the air stream. This results in progressively uncovering the holes in the central tube leading to increasing air-fuel ratios or decreasing richness of mixture when all holes have been uncovered. Normal flow takes place from the main jet. The air is drawn through these holes in the well, and the fuel is emulsified and the pressure differential across the column of fuel is not as high as that in simple carburetor.

Acceleration Pump System

Acceleration is a transient phenomenon. In order to accelerate the vehicle and consequently its engine, the mixture required is very rich and the richness of the mixture has to be obtained quickly and very rapidly. In automobile engines situations arise when it is necessary to accelerate the vehicle. This requires an increased output from the engine in a very short time.

If the throttle is suddenly opened there is a corresponding increase in the air flow. However, because of the inertia of the liquid fuel, the fuel flow does not increase in proportion to the increase in air flow. This results in a temporary lean mixture ca1 1singtheengine to misfire and a temporary reduction in power output.

To prevent this condition, all modern carburetors are equipped with an accelerating system. Figure 7. illustrates simplified sketch of one such device. The pump comprises of a spring loaded plunger that takes care of the situation with the rapid opening of the throttle valve. The plunger moves into the cylinder and forces an additional jet of fuel at the venturi throat.

When the throttle is partly open, the spring sets the plunger back. There is also an arrangement which ensures that fuel in the pump cylinder is not forced through the jet when valve is slowly opened or leaks past the plunger or some holes into the float chamber.

Mechanical linkage system, in some carburetor, is substituted by an arrangement where by the pump plunger is held up by manifold vacuum. When this vacuum is decreased by rapid opening of the throttle, a spring forces the plunger down pumping the fuel through the jet.

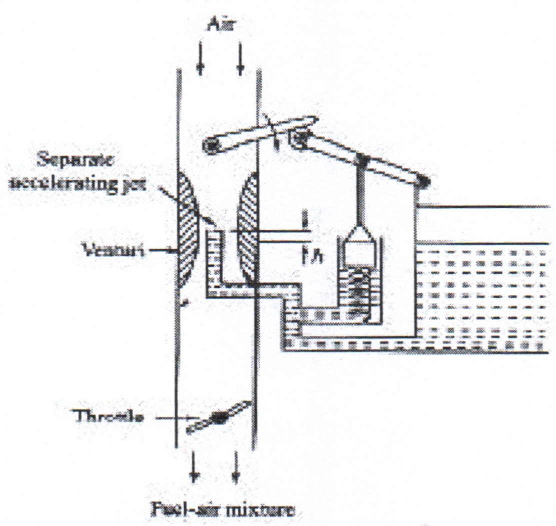


Figure: 7 Acceleration pump system

Types of Carburetors

There are three general types of carburetors depending on the direction of flow of air. The first is the up draught type shown in Fig.8(a) in which the air enters at the bottom and leaves at the top so that the direction of its flow is upwards. The disadvantage of the up draught carburetor is that it must lift the sprayed fuel droplet by air friction. Hence, it must be designed for relatively small mixing tube and throat so that even at low engine speeds the air velocity is sufficient to lift and carry the fuel particles along. Otherwise, the fuel droplets tend to separate out providing only a lean mixture to the engine. On the other hand, the mixing tube is finite and small then it cannot supply mixture to the engine at a sufficiently rapid rate at high speeds.

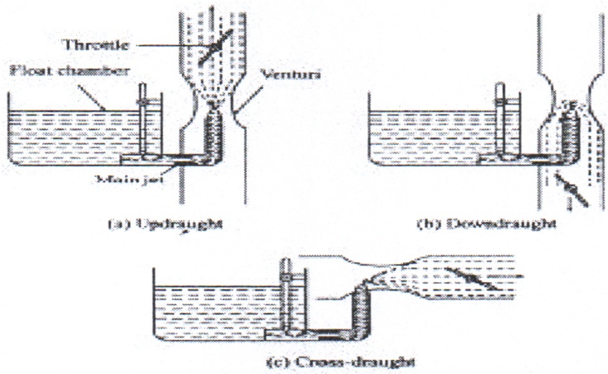


Figure: 8 Types of Carburetors

In order to overcome this drawback the downdraught carburetor [Fig.8 (b)] is adopted. It is placed at a level higher than the inlet manifold and in which the air and mixture generally follow a downward course. Here the fuel does not have to be lifted by air friction as in the up draught carburetors but move into the cylinders by gravity even if the air velocity is low. Hence, the mixing tube and throat can be made large which makes high engine speeds and high specific outputs possible.

Constant Choke Carburetor:

In the constant choke carburetor, the air and fuel flow areas are always maintained to be constant. But the pressure difference or depression, which causes the flow of fuel and air, is being varied as per the demand on the engine. Solex and Zenith carburetors belong to this class.

Constant Vacuum Carburetor:

In the constant vacuum carburetor, (sometimes called variable choke carburetor) air and fuel flow areas are being varied as per the demand on the engine, while the vacuum is maintained to be always same. The S.U. and Carter carburetors belong to tills class.

Multiple Venturi Carburetor:

Multiple venturi system uses double or triple venturi. The boost venturi is located concentrically within the main venturi.The discharge edge of the boost venturi is located at the throat of the main venturi. The boost venturi is positioned upstream of the throat of the larger main venturi. Only a fraction of the total air flows though the boost venturi. Now the pressure at the boost venturi exit equals the pressure at the main venturi throat. The fuel nozzle is located at the throat of the boost venturi.

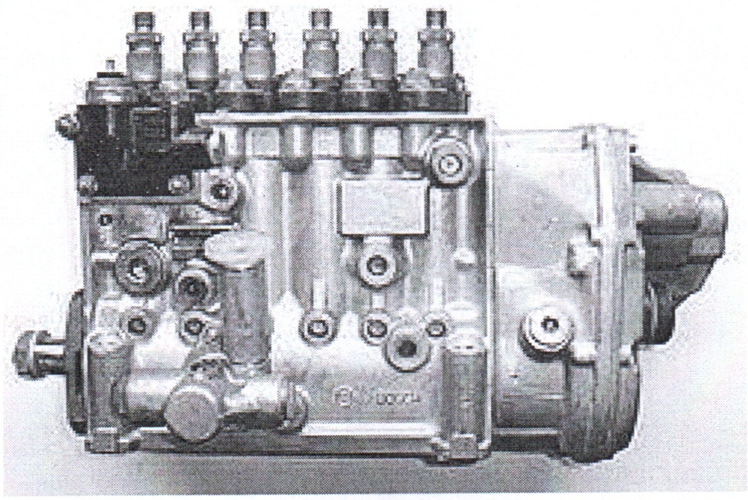
Fuel Injection system for C I engines;

Fuel system components FUEL INJECTION PUMP - Fuel injection pump sucks fuel from the tank , pressurizes the fuel to approx. 600 - 1000 bar and sends it to the injectors. Inline FIP - Has separate pumping chambers for each cylinder Rotary FIP (Distributor pump) - Has one pumping chamber and the pump distributes to each cylinder as per sequence- firing order INJECTORS - Inject the high pressure fuel in to each cylinder. FUEL FILTER - Filters the fuel from dirt & sediments, since the Fuel injection pump requires clean fuel.

Injection system In the C.I. engine the fuel is injected into the combustion chamber, it the has to mix thoroughly with the air, ignite and burn all at the same time. To insure this happens, two types of combustion chamber have been developed. Direct Injection Indirect Injection

Electronic Diesel Control

Electronic Diesel Control is a diesel engine fuel injection control system for the precise metering and delivery of fuel into the combustion chamber of modern diesel engines used in trucks and cars.



EDC injection inline pump

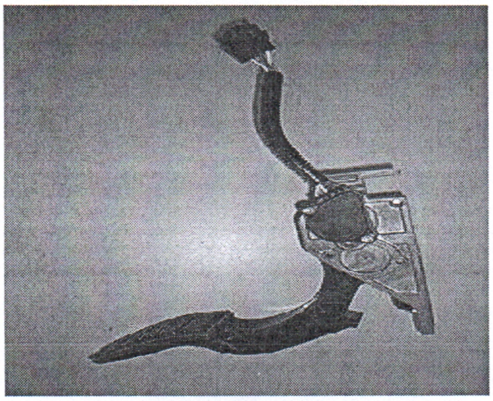
The mechanical fly-weight governors of inline and distributor diesel fuel injection pumps used to control fuel delivery under a variety of engine loads and conditions could no longer deal with the ever increasing demands for efficiency, emission control, power and fuel consumption.

These demands are now primarily fulfilled by the Electronic Control, the system which provides greater ability for precise measuring, data processing, operating environment flexibility and analysis to ensure efficient diesel engine operation. The EDC replaces the mechanical control governor with an electro-magnetic control device.

Components in Electronically controlled Diesel Supply;

The EDC is divided into these main groups of components.

- Electronic sensors for registering operating conditions and changes. A wide array of physical inputs is converted into electrical signal outputs.
- Actuators or solenoids which convert the control unit's electrical output signal into mechanical control movement.
- ECM (Electronic Control Module) or Engine ECU (Electronic Control Unit) with microprocessors which process information from various sensors in accordance with programmed software and outputs required electrical signals into actuators and solenoids.



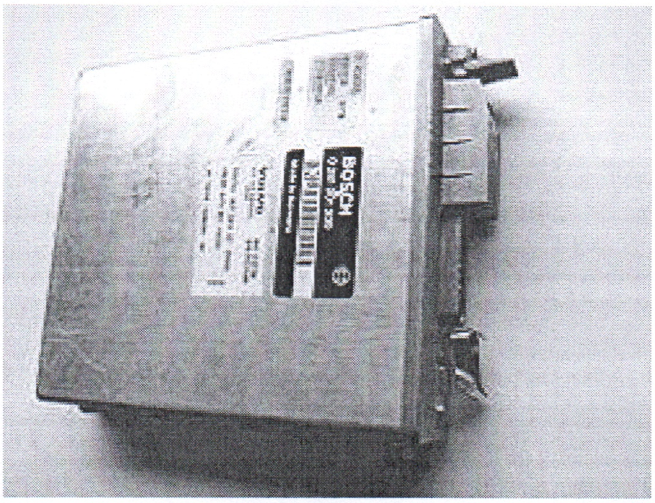
EDC accelerator pedal assembly

1. Electronic sensors;

- Injection pump speed sensor - monitors pump rotational speed
- Fuel rack position sensor - monitors pump fuel rack position
- Charge air pressure sensor - measures pressure side of the turbocharger
- Fuel pressure sensor
- Air cleaner vacuum pressure sensor
- Engine position sensor
- Temperature sensors - measure various operating temperatures

  - Intake temperature
  - Charge air temperature
  - Coolant temperature
  - Fuel temperature
  - Exhaust temperature (Pyrometer)
  - Ambient temperature
- Vehicle speed sensor - monitors vehicle speed
- Brake pedal sensor - operates with cruise control, exhaust brake, idle control
- Clutch pedal sensor - operates with cruise control, exhaust brake, idle control
- Accelerator pedal sensor.

2. Electronic Control Unit;



EDC control unit

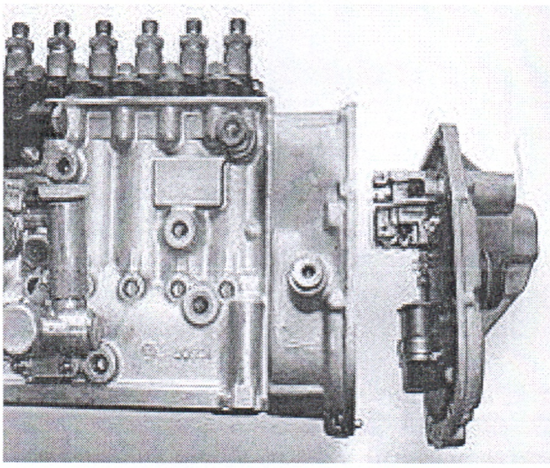
The ECU collects and processes signals from various on-board sensors. AnECU electronic module contains microprocessors, memory units, analog to digital converters and output interface units. Depending upon the parameters, a number of different maps can be stored in the onboard memory.

This allows the ECU to be tailored to the specific engine and vehicle requirements, depending on the application. The operating software of the ECU can be adapted for a wide variety of engines and vehicles without the necessity of hardware modification.

The ECU is usually located in the cab or in certain cases, in a suitable position in the engine bay where additional environmental conditions might require cooling of the ECU as well as a requirement for better dust, heatand vibrations insulation .

3. Actuators and Solenoids

Electro-magnetic actuators are usually located on the fuel pump to transfer electrical signals into mechanical action in this case fuel rack actuator and or fuel stop solenoid which means that depending on requests from control unit full fuel or no fuel quantity.



EDC pump actuator

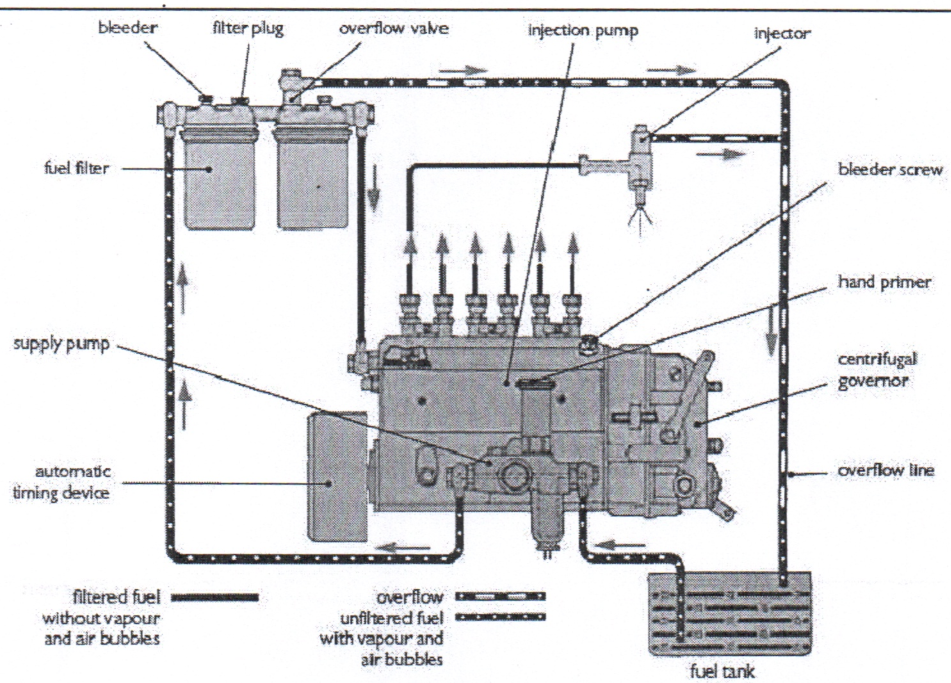
- Injectors
- Boost-pressure actuator
- Intake-duct switchoff
- Throttle-valve actuator
- Exhaust-gas recirculation actuator
- Auxiliary heating
- A/C compressor.
- Radiator fan
- Electronic shutoff valve
- Rail-pressure control valve
- Diagnosis lamp

Working Principle;

The injection of fuel or the quantity of injected fuel has a decisive influence on engine starting, idling, power and emissions. The engine ECU is programmed ("mapped") with relevant data to where the fuel rack position has an equivalent signal for the amount of fuel beinginjected.

The driver requests the torque or engine speed requirements via accelerator pedal potentiometer thereby sending a signal to the engine ECU which then, depending on its *mapping* and data collected from various sensors, calculates in real time the quantity of injected fuel required, thus altering the fuel rack to the required position. The driver can also input additional commands such as idle speed increase to compensate e.g. for PTO operation which can be either variably set or has a preset speed which can be recalled.

The road speed function can be used to evaluate vehicle speed and possibly activate a speed limiter (Heavy Vehicles), or maintain or restore a set speed (cruise control). Further functions can include exhaust brake operation which, when activated, will result in the fuel pump rack position being set to zero delivery or idle. The engine ECU can also interface with various other vehicle systems e.g. traction control and carries out self monitoring duties and self diagnostic functions to keep the system working at an optimal level. To ensure the safe operation in case of failure, the limp home mode functions are also integrated into the system, for e.g. should the pump speed sensor fail the ECU can use an alternator speed signal function for engine RPMs counter as a backup signal.

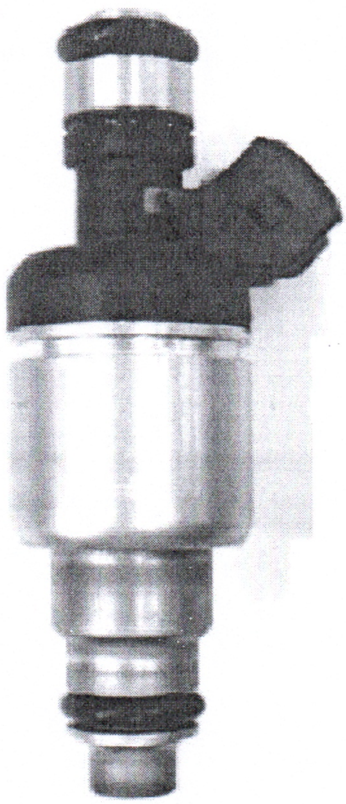


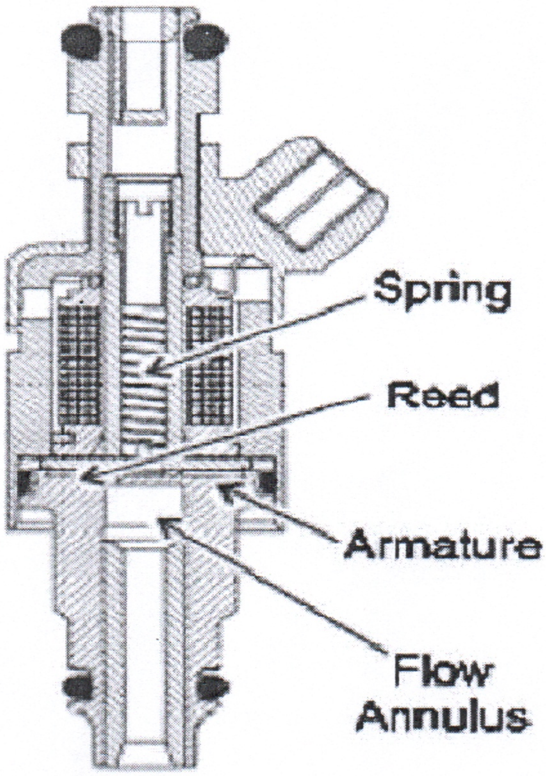
Fuel Injector:

Fuel injection is a system for admitting fuel into an internal combustion engine. It has become the primary fuel delivery system used in automotive engines, having replaced carburetors during the 1980s and 1990s. A variety of injection systems have existed since the earliest usage of the internal combustion engine.

The primary difference between carburetors and fuel injection is that fuel injection atomizes the fuel by forcibly pumping it 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.

Modern fuel injection systems are designed specifically for the type of fuel being used. Some systems are designed for multiple grades of fuel (using sensors to adapt the tuning for the fuel currently used). Most fuel injection systems are for gasoline or diesel applications.





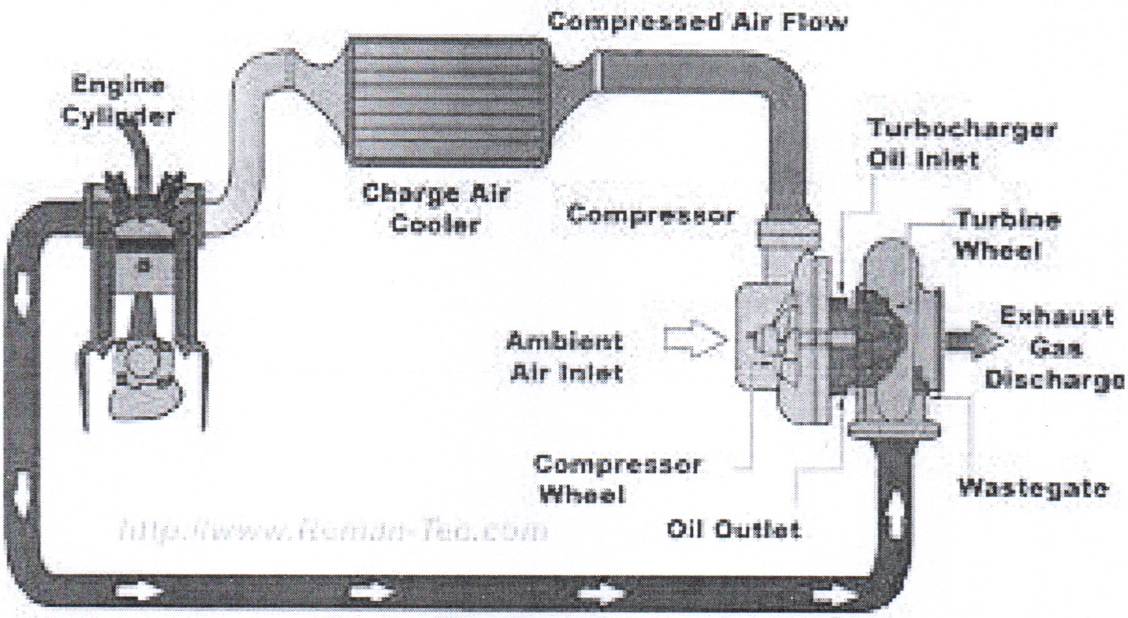
Turbocharger:

The turbo charger utilizes the wasted heat energy in the exhaust system, to run a compressor which compresses the intake air. Compressed intake air has more density and hence more fuel can be injected increasing the power of the engine. Turbo charging is an ideal way to increase the engine power without increasing the engine size.

A turbocharger, or turbo (colloquialism), from Greek "τύρβη" ("wake"), (also from Latin "turbo" ("spinning top"), is a turbine-driven forced induction device that increases an engine's efficiency and power by forcing extra air into the combustion chamber. This improvement over a naturally aspirated engine's output results because the turbine can force more air, and proportionately more fuel, into the combustion chamber than atmospheric pressure alone.

Turbochargers were originally known as turbosuperchargers when allforced induction devices were classified as superchargers. Nowadays the term "supercharger" is usually applied to only mechanically driven forced induction devices. The key difference between a turbocharger and a conventional supercharger is that the latter 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'sexhaust gas. Compared to a mechanically driven supercharger, turbochargers tend to be more efficient, but less responsive. Twincharger 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.


Compressed Air Flow
Engine
Cylinder
Charge Air
Cooler
Compressor
Turbocharger
Oil Inlet
Turbine
Wheel
Ambient
Air Inlet
Exhaust
Gas
Discharge
Compressor
Wheel
Oil Outlet
Wastegate
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