Unit 2 : ENGINE AUXILIARY SYSTEMS

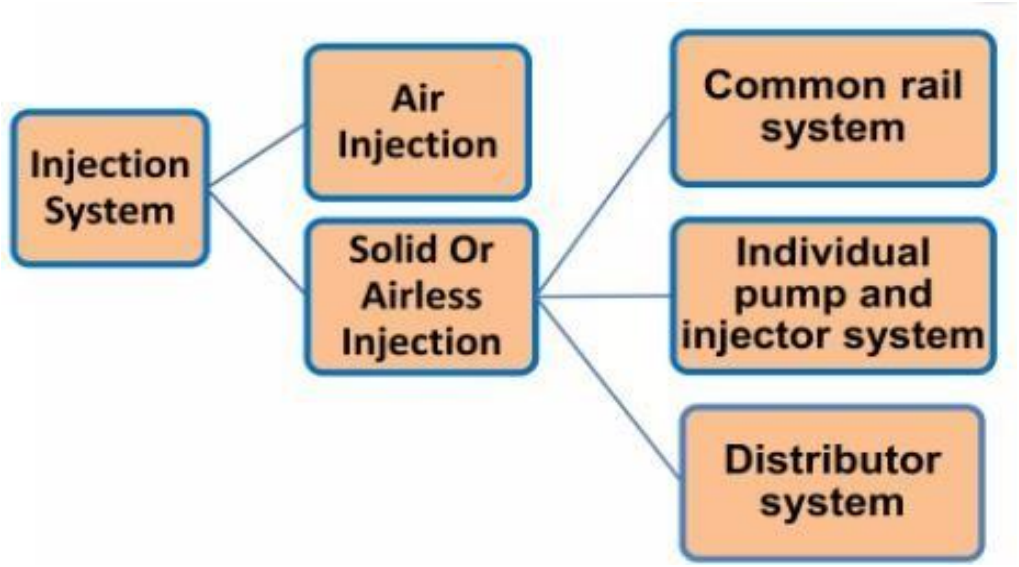
Module 2 : Unit injector system, Rotary distributor typeand common rail direct injection system, Electronic ignition system (Transistorized coil ignitionsystem, capacitive discharge ignition system),

Fuel Injection Systems: There are four primary systems for injecting fuel:

1. Individual pump and injector for each cylinder
2. Combined pump and injector for each cylinder (*unit injector type*)
3. One pump serving injectors for several cylinders (*distributor type*)
4. Pumps in a common housing with injectors for each cylinder (*common rail system*)

- The common rail system is rapidly gaining popularity for on-road applications. The in-line and distributor types are used on off-road vehicles and industrial machines.
- **Fuel Injector:** Diesel fuel injectors are arguably the most important fuel system component. The job of the injectors is to deliver a precise amount of atomized and pressurized fuel into each cylinder. Highly atomized, pressurized fuel distributed evenly throughout the cylinder results in increased power and fuel economy, decreased engine noise, and smoother operation.

Classification of Diesel Injector System



Air Injection system

- In this system fuel is injected along wit high pressure air into combustion chamber. The pressure of this air is about 70 bar. A multistage air compressor is required to supply the blast of air at high pressures. A fuel pump draws fuel from fuel tank through a filter and discharge a definite quantity into an injector. The high pressure air from compressor is also led to the injector valve which force the fuel, through the nozzle, when it is opened mechanically.
- This type of system is not used now-a-days in diesel engines.

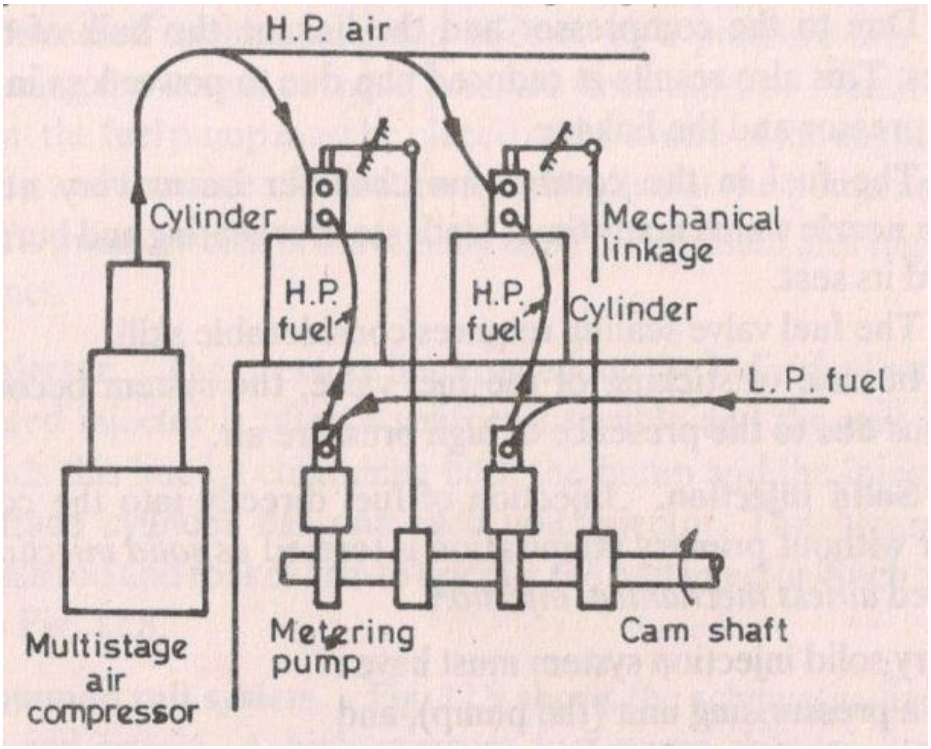


Figure: Air Injection system

Advantages:

1. It provides good atomization and distribution of fuel
2. Fuel pump needs to develop less pressure.

Dis Advantages:

1. It requires high multi stage compressor.
2. Air Compressor needs extra maintenance.

Solid or Airless Injection System

- In solid Injection system , fuel is directly injected into the cylinder without aid of compressed air. That's why this system is called solid or airless injection system.
- Fuel is supplied at very high pressure (about 200 bar) from fuel pump to fuel injector from where it is injected to the combustion chamber with the help of injector.
- There are three types as:
  1. Common rail system
  2. Individual pump and injector
  3. Distributor injection system

Unit Injector System

- Fill phase: The constant stroke pump element on the way up draws fuel from the supply duct in tothe chamber, and as long as electric solenoid valve remains de-energized fuel line is open.

- Spill phase: The pump element is on the way down, and as long as solenoid valve remains de- energized the fuel line is open and fuel flows in through into the return duct.
- Injection phase: The pump element is still on the way down, the solenoid is now energized and fuel line is now closed. The fuel cannot pass back into return duct, and is now compressed by the plunger until pressure exceeds specific "opening" pressure, and the injector nozzle needle lifts, allowing fuel to be injected into the combustion chamber.
- Pressure reduction phase: The plunger is still on its way down, the engine ECU de-energizes the solenoid when required quantity of fuel is delivered, the fuel valve opens, fuel can flow back into return duct, causing pressure drop, which in turn causes the injector nozzle needle to shut, hence no more fuel is injected.

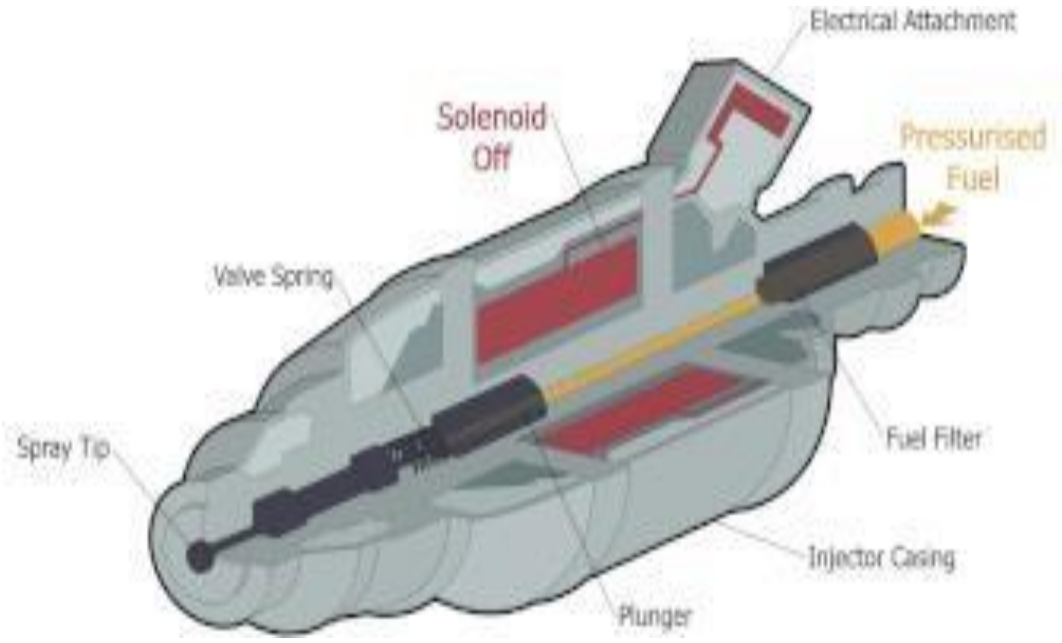


Figure: Unit Injector system

Individual Pump and injector (or) Jerk Pump System

- In this system, each cylinder is provided with one pump and one injector.
- Separate metering and compression pump is provided for each cylinder.
- In high pressure pump , plunger is actuated by a cam & produces the fuel pressure necessary to open the injector valve at the correct time .
- The amount of fuel injected depends on the effective stroke of the plunger.

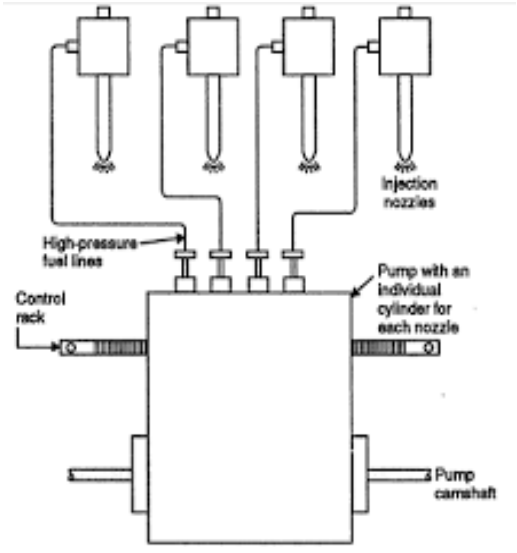


Figure: Individual pump and injector or Jerk Pump System

Distributor System

- In this system the pump which pressurizes the fuel also meters and times it.
- The fuel pump after metering the required amount of fuel supplies it to a rotating distributor at thecorrect time for supply to each cylinder.
- The number of injection strokes per cycle for the pump is equal to the number of cylinders used inthis system.
- Since there is only one metering element, a uniform distribution is automatically ensured.

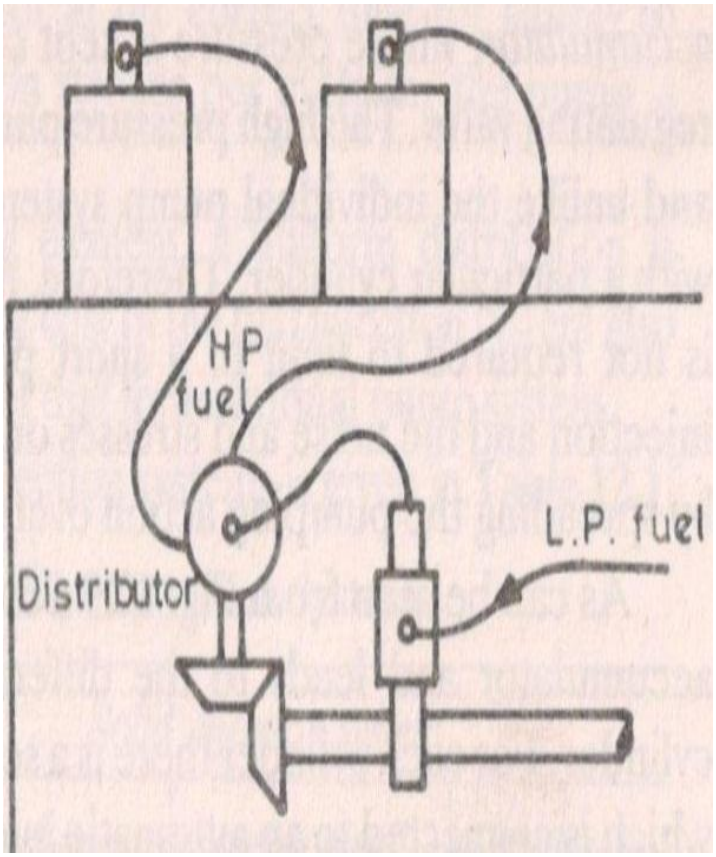


Figure: Distributor system

Common Rail Injector System

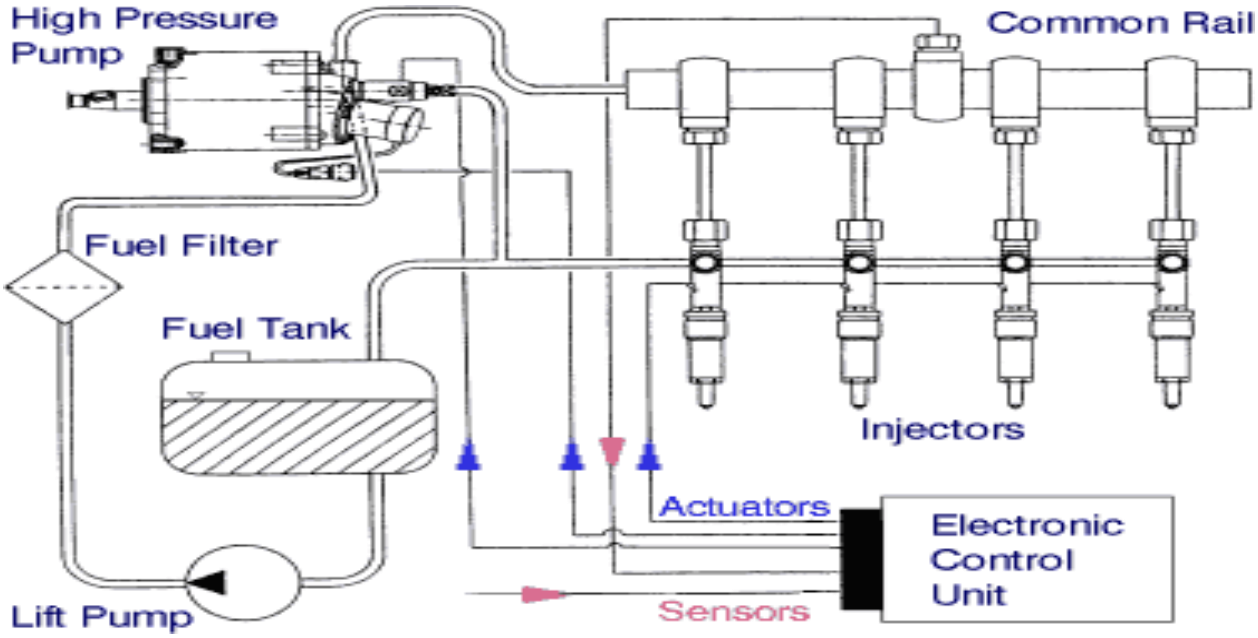


Figure: Common rail injector system

- In this system HP pumps supplies fuel, under high pressure, to a header. High pressure in the header forces the fuel to each nozzles located in the cylinders of this system.
- At that time, a mechanically operated valve allows the fuel to enter the proper cylinder throughthe nozzle.
- By varying the length of the push rod stroke the amount of fuel entering the cylinder is regulated.

Advantages

(i) It delivers 25 % more power and torque than the normal direct injection engine.
(ii) Initial cost is low.
(iii) Superior pick up is possible.
(iv) It maintains lower levels of noise and vibration.
(v) Higher mileage is obtained.
(vi) Emissions are low.
(vii) Fuel consumption is less.
(viii) Improved performance is obtained.

Dis Advantages

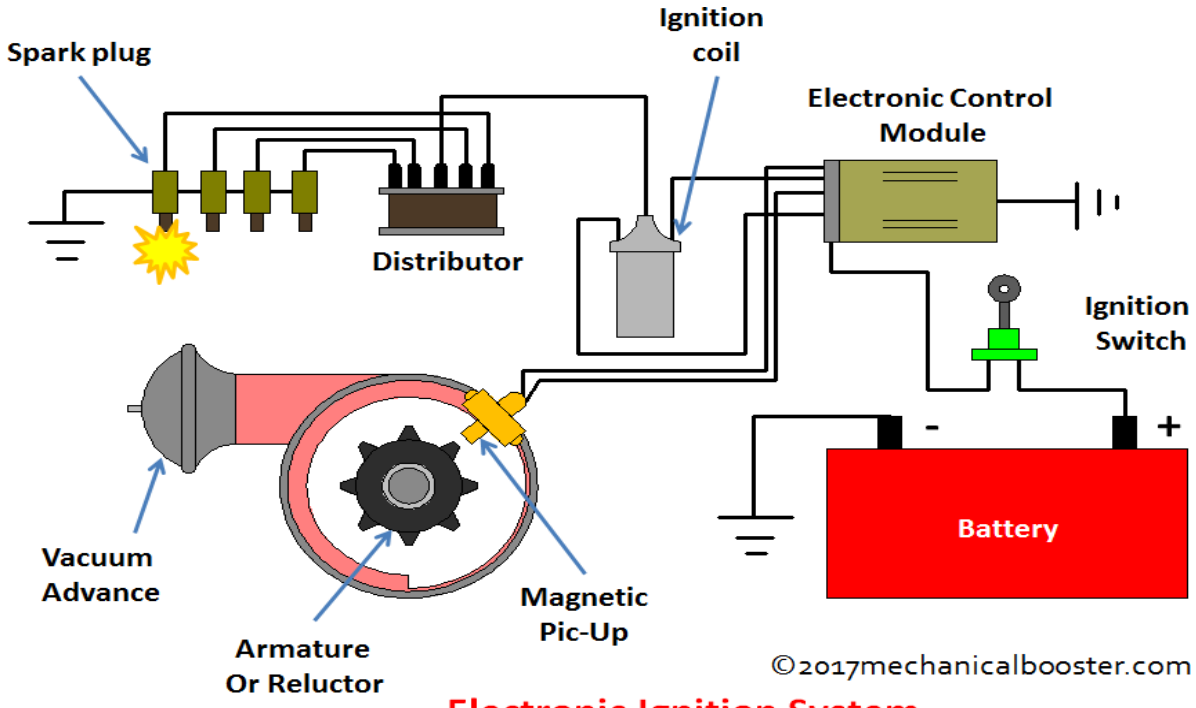
(i) Many parts involve the complicated design.
(ii) Production cost is high.
(iii) High degree of engine maintenance is required.

Electronic Ignition System

- An electronic ignition system is a type of ignition system that works electronic circuits, usually bytransistors. The transistors are controlled by sensors to generate

electric pulses which then generate a high voltage spark that can burn the lean mixture and provide a better economy and lower emission.

- The electronic ignition system is vastly used in aircraft engines, bikes, motorcycles, and cars as it performs the same purpose as other types of ignition systems on them.
- The function of an electronic ignition system is remaining the same as it produces a high voltage spark to the spark plug so that the fuel-air mixture can be burn or ignite. Because sensors are used in the system, it improves reliability and mileage and decreases emission.



Electronic Ignition System

Components of Electronic Ignition System

- Battery
- Ignition Switch
- Electronic Control Module
- Armature
- Ignition Coil
- Distributor
- Spark Plug

Working Principle of Electronic Ignition system

- When switching on the ignition switch, just after that battery starts and it supplies current to the system.

- Current passes through the ignition switch and move toward the ignition coil on the system then, start passing through the primary winding of the coil.
- As the current passes through the primary coil, the pick-up coil got activated which is in the armature. It receives current as a voltage on the pick-up. Just after receiving voltage, the reluctor starts rotating which consists of the tooth.
- When the tooth comes in front of the pick-up coil exactly at the same time the pick-up coil starts sending a signal to the electronic control module.
- After receiving a voltage signal, it stops the current supply from the battery up to the primary coil.When the tooth deviates from the point, it senses the change in voltage, and then again it sends a signal of change in voltage to the electronic control module.
- We all know that the electronic control system is already a programmed system, so exactly after sending a signal of change in voltage it again starts supplying the current in the primary winding.
- Because of this continuous make and break of the current circuit, it creates a magnetic field inside the ignition coil because of that; the secondary winding emf is induced.
- This emf increases voltage up to 50000 V. The voltage is supplied to the distributor.
- It consists of a rotating rotor and distributor points, which is programmed as per the ignition. When there is a jump of voltage between the air gap of the rotator and the distributor of high voltage, after that it reaches to spark plug through high tension wire.
- Spark is generated because of the voltage difference between the central electrode and the ground electrode because the combustion is possible in air-fuel.

Application of Electronic Ignition System:

- The electronic ignition system has a lot of applications in the 21st century.
- It is mostly used in modern and hyper cars.
- It is mostly used in Audi, Mahindra XUV, KTM bikes, Ducati, and many more.
- It is also used in aircraft engines.

Advantages

- These are low maintenance systems as compared to others like Battery Ignition System, Glow plug ignition system, and Magneto Ignition System.
- It has no moving parts because it is controlled by the electronic control unit(ECV).
- Emission is less as compared to other means because this system is environmentally friendly.
- It increases the efficiency of the engine and also it is fuel-efficient.
- It is more accurate as compared to the magneto system.

- The vehicles having this system have a long life and also reliable.

Dis Advantages

- The cost of the system is very expensive

Transistorised Coil Ignition System

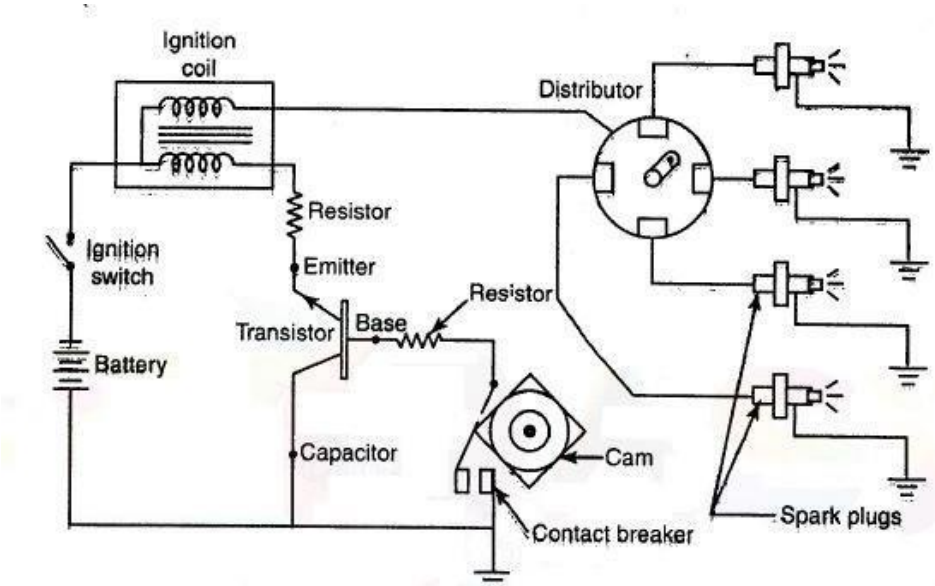


Figure: Transistorised Coil Ignition System

Components of Transistorised Coil Ignition System

- Battery
- Ignition Switch
- Ignition Coil
- Transistor
- Collector
- Emitter
- Blast resister
- Contact breaker
- Distributor
- Spark Plug

Working Principle of Transistorised Coil Ignition System

- The cam in the distributor is rotated by the engine. It opens and closes the contact breaker points.When the contact breaker points are closed:

1.A small current flows in the base circuit of the transistor.
2.A large current flows in the emitter or collector circuit of the transistor and the primary winding of theIgnition coil due to the normal transistor action.
3. A magnetic field is set up in the primary winding of

the coil.When the contact breaker points are Open :

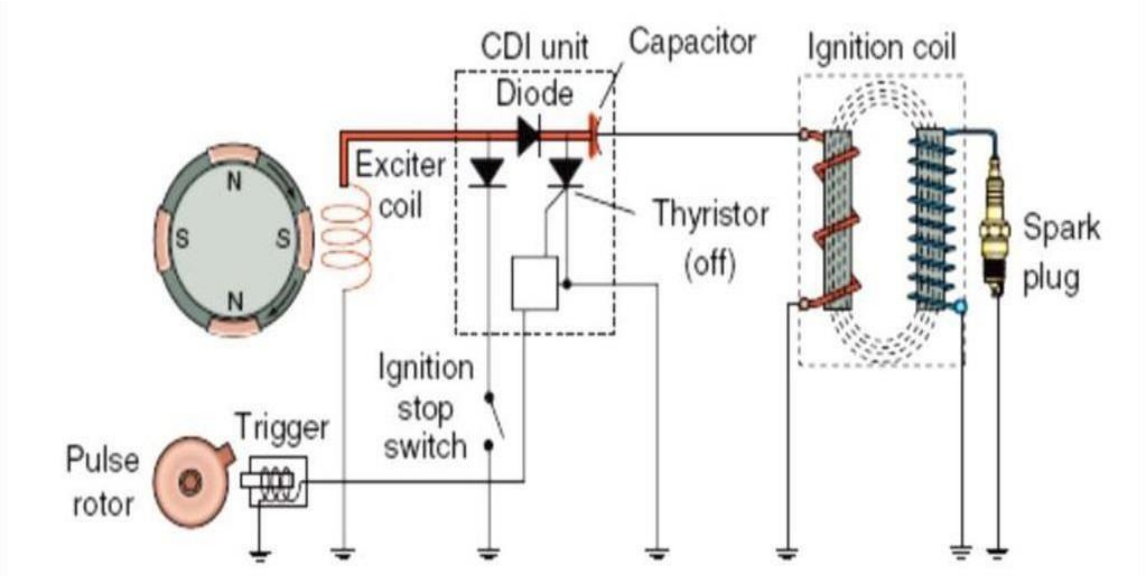
1. The current flow in the base circuit is stopped.
2. The primary current and the magnetic field in the coil collapse suddenly due to immediate reverting ofthe transistor to the non-conductive state.
3. It produces a high voltage in the secondary circuit.
4. This high voltage is directed to the respective spark plugs through tho rotor of the distributor.
5. This high voltage produces a spark when it is tried to jump the spark plug gap. It ignites air-fuelmixture in the cylinder.

Advantages

- It increases the life of contact breaker points.
- It gives high ignition voltages.
- It gives longer duration of spark .
- It has very accurate control of timing.
- It needs less maintenance.

Dis Advantages

- More mechanical points are needed similar to a conventional system.
- It has a tendency to side tracking.



Capacitive Discharge Ignition System

Figure: Capacitive Discharge Ignition System

Working principle

- The CDI system consists of two coils that are trigged by the magnets in the flywheel/rotor, thelarger coil is called as charging or Exciter coil and the smaller coil is called as Trigger coil.
- As the flywheel rotates past the exciter coil, the AC produced by the exciter coil is changed to DCby the diode in the CDI unit.
- The capacitor in CDI unit stores the energy until its needed to fire the spark plug.
- As the flywheel/rotor magnet rotates past the trigger coil, a low voltage in the trigger coil, whichactivates the electronic switch in CDI unit.
- The electronic switch acts as power source to the primary side of the circuit, this completedprimary circuit which allows the energy stored by the capacitor to pass through the primarywinding of the ignition coil.
- The transformer action of the ignition coil causes high voltage to be induced in the secondarywinding of the ignition coil, which fires the spark plug.

Advantages of the CDI system:

- Insensitive to electrical shunts resulting from spark plug fouling.
- This system is suited to an application where insufficient dwell time is available because thecapacitor can be fully charged in a very short time.
- Short transient response.
- A fast voltage rise and shorter spark duration.

Disadvantages of the CDI system:

- The spark is strong but short in order to 0.1 to 0.3 ms which leads to ignition failure during leanmixture operating conditions because of fast capacitive discharge.
- This system generates a huge electro-magnetic noise so CDI is rarely used by automobilemanufacturers