

## IGNITION SYSTEM

Basically Conventional Ignition systems are of 2 types:

- (a) Battery or Coil Ignition System, and
- (b) Magneto Ignition System

Both these conventional, ignition systems work on mutual electromagnetic induction principle.

### **Battery or Coil Ignition System:**

-used in 4-wheelers, but now-a-days it is more commonly used in 2-wheelers also (i.e. Button start, 2-wheelers like Pulsar, Kinetic Honda; Honda-Activa, Scooty, Fiero, etc.)

- The ignition system is divided into 2-circuits:

(i) Primary Circuit:

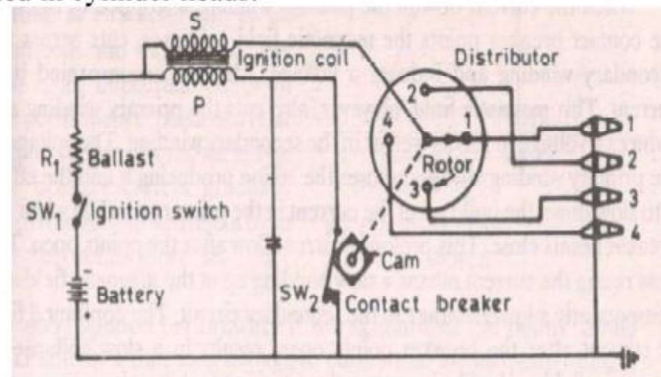
-consists of 6 or 12 V battery, ammeter, ignition switch, primary winding  
-it has 200-300 turns of 20 SWG (Sharps Wire Gauge) gauge wire, contact breaker, capacitor.

(ii) Secondary Circuit:

-consists of secondary winding or coil which have 21000 turns of 40 (S WG) gauge wire.

-bottom end of which is connected to bottom end of primary and top end of secondary winding or coil is connected to centre of distributor rotor.

-distributor rotors rotate and make contacts with contact points and are connected to spark plugs which are fitted in cylinder heads.



C=condenser, P=primary coil, S=secondary coil, R1=ballast resistance, SW1=ignition switch,  
SW2=contact breaker

**Fig. 22. Circuit diagram for a conventional spark ignition system**

Working:

-When the ignition switch is closed and engine is cranked, as soon as the contact breaker closes, a low voltage current will flow through the primary winding. It is also to be noted that the contact breaker cam opens and closes the circuit 4-times (for 4 cylinders) in one

revolution. When the contact breaker opens the contact, the magnetic field begins to collapse. Because of this collapsing magnetic field, current will be induced in the secondary winding. And because of more turns (@ 21000 turns of secondary, voltage goes unto 28000-30000 volts. This high voltage current is brought to centre of the distributor rotor. Distributor rotor rotates and supplies this high voltage current to proper spark plug depending upon the engine firing order. When the high voltage current jumps the spark plug gap, it produces the spark and the charge is ignited-combustion starts-products of combustion expand and produce power.

-The Function of the capacitor is to reduce arcing at the contact breaker (CB) points. Also when the CB opens the magnetic field in the primary winding begins to collapse. When the magnetic field is collapsing capacitor gets fully charged and then it starts discharging and helps in building up of voltage in secondary winding.

-Contact breaker cam and distributor rotor are mounted on the same shaft.

-In 2-stroke cycle engines these are motored at the same engine speed. And in 4-stroke cycle engines they are motored at half the engine speed.

- A good spark is available at low speed also.

- Occupies more space.

- Recharging is a must in case battery gets discharged.

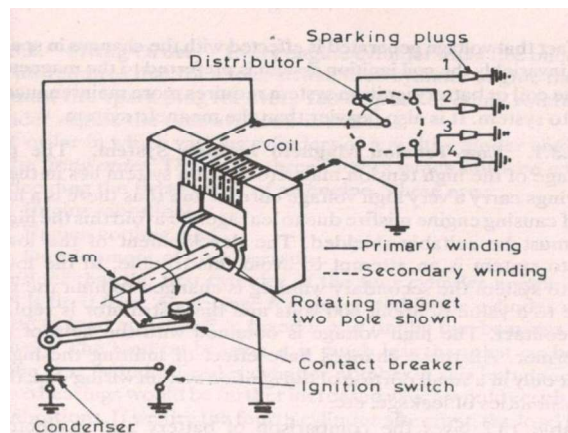
### Magneto Ignition System:

- magneto will produce and supply the required current to the primary winding or coil  
 - rotating magneto with fixed coil or rotating coil with fixed magneto for producing and supplying current to primary, remaining arrangement is same as that of a battery ignition system

-no battery required

-during starting the quality of spark is poor due to slow speed

-very much compact



**Fig. 23. High tension magneto ignition system**

### Disadvantage of conventional ignition systems

Following are the drawbacks of conventional ignition systems:

(a) Because of arcing, pitting of contact breaker point

(b) Poor starting: After few thousands of kilometres of running, the timing becomes inaccurate, which results into poor starting (Starting trouble).

(c) At very high engine speed, performance is poor because of inertia effects of the moving parts in the system.

(d) Sometimes it is not possible to produce spark properly in fouled spark plugs.

Due to above problem electronic ignition system is used.

**Following are the advantages of electronic ignition system:**

- (a) Moving parts are absent-so no maintenance.
- (b) Contact breaker points are absent-so no arcing.
- (c) Spark plug life increases by 50% and they can be used for about 60000 km without any problem.
- (d) Better combustion in combustion chamber, about 90-95% of air fuel mixture is burnt compared with 70-75% with conventional ignition system.
- (e) More power output.
- (f) More fuel efficiency.

**Firing order:**

The order or sequence in which the firing takes place, in different cylinders of a multi-cylinder engine is called Firing Order.

In case of SI engines the distributor connects the spark plugs of different cylinders according to Engine Firing Order.

Advantages

- (a) A proper firing order reduces engine vibrations
- (b) Maintains engine balancing.
- (c) Secures an even flow of power.
  - Firing order differs from engine-to-engine.
  - Probable firing orders for different engines are :
    - 3 cylinder = 1-3-2
    - 4 cylinder engine (inline) = 1-3-4-2  
1-2-4-3
    - 4 cylinder horizontal opposed engine = 1-4-3-2  
(Volkswagen engine)
    - 6-cylinder in line engine = 1-5-3-6-2-4  
(Crank in 3 pairs) 1-4-2-6-3-5  
1-3-2-6-4-5  
1-2-4-6-5-3
    - 8 cylinder in line engine 1-6-2-5-8-3-7-4  
1-4-7-3-8-5-2-6
    - 8 cylinder V type 1-5-4-8-6-3-7-2  
1-5-4-2-6-3-7-8  
1-6-2-5-8-3-7-4  
1-8-4-3-6-5-7-2

Cylinder 1 is taken from front of inline and front right side in V engines.

**Ignition timing:**

It is very important, since the charge is to be ignited just before (few degrees before TDC) the end of compression, since when the charge is ignited, it will take some time to come to the required rate of burning.

### Ignition Advance:

The purpose of spark advance mechanism is to assure that under every condition of engine operation, ignition takes place at the most favourable instant in time i.e. most favourable from a standpoint of engine power, fuel economy and minimum exhaust dilution. By means of these mechanisms the advance angle is accurately set so that ignition occurs before TDC point of the piston. The engine speed and the engine load are the control quantities required for the automatic adjustment of the ignition timing. Most of the engines are fitted with mechanisms which are integral with the distributor and automatically regulate the optimum spark advance to account for change of speed and load. The two mechanisms used are:

- (a) Centrifugal advance mechanism, and
- (b) Vacuum advance mechanism

### Factors affecting energy requirement of ignition system

(a) Effect of series resistance:

- Energy dissipated during discharge and hence circuit energy stored in capacitance is more
- longer discharge time

(b) Effect of electrode material:

- ignition energy for electrode gaps larger than the quenching distance varies with materials for the electrode and increases with any change to material having higher boiling point

(c) Effect of spray inductance:

- presence of small stray inductance cause oscillatory discharge
- larger resistance, minimum inductance longer the discharge time

(d) Effect of electrode configuration:

- reduction in the capacitance reduces the discharge time and increase in the gas resistance which reduces the diameter of the spark channel
- increase the electrode gap means supply of ignition energy over interval of time decreases and spark channel also reduces

### \*Stages of SI engine combustion

In SI engine homogeneous mixture of vaporised fuel, air and residual gases is ignited by a single intense and high temperature spark between the spark plug electrode (electrodes exceeds 10,000 °C) and generate pre-flame which spreads to envelope of mixture for combustion.

Three stages of combustion in SI engine are,

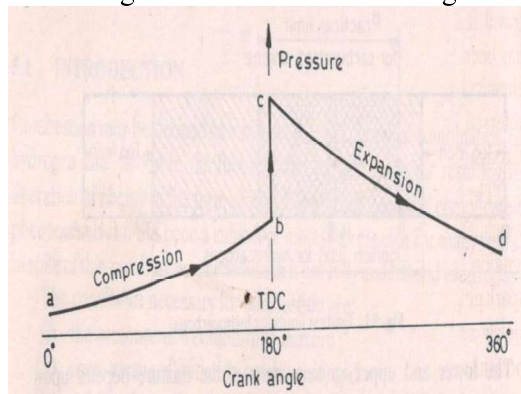


Fig. 24. Theoretical p-θ diagram

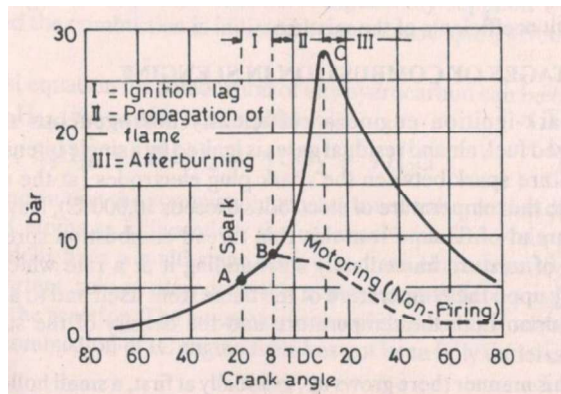


Fig. 25. Stages of combustion in SI engine