IGNITION SYSTEMS

The ignition system must provide an adequate voltage to initiate a discharge across the spark plug electrodes and supply sufficient energy to ignite the air-fuel mixture. This must occur for all engine operating conditions and at the appropriate time on thecompression stroke.

Since 1965, new requirements for ignition systems have come up which could not bemet by the conventional inductive ignition system. The introduction of new exhaust emission criteria in 1965 and the demand for improved fuel economy in 1975, has forced designers to turn to electronic for providing a system to satisfy the statutory requirements for an automobile. Legislative requirements and driver demand for better engine performance, added to the manufacturers need to offer a more sophisticated vehicle to counter a competitor's product all show why electronic innovation in this field is taking place.

On modern engines, it is normal for the ignition system to form a subsection of an integrated management system, sharing sensors and circuits, with fuelling and(occasionally) transmission control systems.

IGNITION FUNDAMENTALS

Functional Requirements

The ignition system supplies a spark inside the cylinder, near the end of the compression stroke, to ignite the compressed charge of air-petrol vapour. Under normal atmospheric (101 k Pa) conditions a voltage of 2 to 3 kV is required for a sparkto jump across an air gap of 0.6 mm. For a spark to jump across a similar gap in an engine cylinder, having a compression ratio of 8:1 approximately 8 kV is required andfor higher compression ratios and weaker mixtures, a voltage up to 20 kV may be required. Therefore, ignition system transforms the normal battery voltage of 12 V toapproximately 8-20 kV and delivers it to the right cylinder, at the right time. Some ignition systems are capable of supplying up to 40 kV to the spark plugs. The fundamental operation of most ignition systems is very similar. Conventional ignition is the precursor of the more advanced electronic systems. A coil ignition system is composed of various components and sub-assemblies. The actual design and construction of this depend mainly on the engine with which the system is associated. While designing an ignition system the most important factors to be considered include:

(i) Combustion chamber design.

(ii) Air-fuel ratio.
(iii) Engine speed range.
(iv) Engine load.
(v) Engine combustion temperature.
(vi) Intended use.
(vii) Emission regulations.

Various Types

The conventional (mechanical) and electronic ignition are the two basic types of ignition system. Programmed ignition, distributor less ignition and direct ignition can be considered as the advancement of basic systems. The basic choice for various types of ignition system is classified as follows:

Type	Conventional	Electronic	Programmed	Distributor
Trigger	Mechanical	Electronic	Electronic	Electronic
Advance	Mechanical	Mechanical	Electronic	Electronic
Voltage source	Inductive	Inductive	Inductive	Inductive
Distribution	Mechanical	Mechanical	Mechanical	Electronic

Generation of high tension

If two coils (known as the primary and secondary) are wound on to the same iron corethen any change in magnetism of one coil will induce a voltage into the other. This happens when a current is switched on and off to the primary coil. If the number of turns of wire on the secondary coil is more than the primary, a higher voltage can beproduced. This is called transformer action and is the principle of the ignition coil.

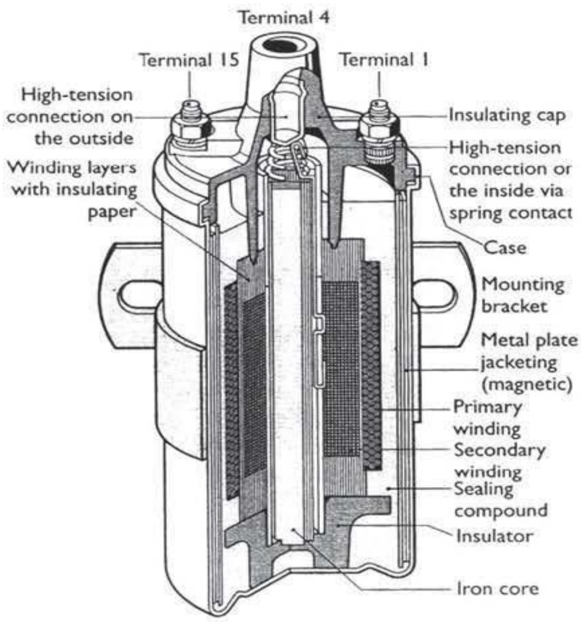

Figure 1. Ignition Coil

The value of this ‘mutually induced’ voltage depends upon:

- The primary current.
- The turns ratio between the primary and secondary coils.
- The speed at which the magnetism changes.

Figure 1 shows a typical ignition coil in section. The two windings are wound on a laminated iron core to concentrate the magnetism. Some coils are oil filled to assist with cooling.

Ignition Advance Angle

The ideal ignition timing is dependent mainly on engine speed and engine load. Withthe increase in engine speed, the ignition timing is required to be advanced. It is because the cylinder charge or air-fuel mixture requires a certain time to burn, and hence it is necessary to ignite it earlier at higher engine speeds. The ignition advanceangle for optimum efficiency should be sufficient to cause the maximum combustion pressure to occur about 10 degrees after TDC. A change in timing due to engine loadis also required. Since the weaker mixture used in low load condition burns at a slowerrate, ignition advance is necessary. A change in residual gas content and a lower charge in the cylinder cause a longer ignition delay and lower combustion rate in themixture, thereby requiring the ignition angle to be advanced.

Spark advance is achieved in a number of ways, the simplest of which is a mechanicalsystem consisting of centrifugal advance mechanism and a vacuum control unit. The manifold pressure is proportional to the engine load. Electronic ignition systems may also adjust the timing in relation to the temperature and mixture strength. The valuesof all ignition timing functions are considered and combined either mechanically or electronically to obtain the ideal ignition point. The ignition coil stores energy in the form of a magnetic field. A dual period is incorporated to ensure that the coil is chargedbefore the ignition point.

Fuel Consumption and Exhaust Emissions

The spark time is critical for maximum power and economy. The ignition timing has aconsiderable effect on fuel consumption, torque, driveability and exhaust emissions. Out of the three most important pollutants of exhaust emissions, hydrocarbons (HC), carbon monoxide (CO) and nitrogen oxides (NOx), the emissions of HC increase as timing is advanced. NOx emissions also increase with advanced timing because of the higher combustion temperature. CO changes insignificantly with timing and is mostlydependent on air-fuel ratio.

A change in timing required to improve exhaust emissions also increases fuel consumption. A larger advance is necessary with the leaner mixtures used nowadays, to compensate for the slower burning rate. This provides lower consumption and hightorque but the mixture must be controlled accurately to achieve the best compromisewith regard to emissions.