Relevance/Objective:

- To understand working of modern ignition system.
- To know specification and function of modern ignition system.

Learning Outcome:

- Students will be able to identify, inspect of modern ignition system and prepare line diagram related to ignition system

Relevant CO:

- Explain construction and working of various automotive ignition system.

Introduction:

The fundamental purpose of the ignition system is to supply a spark inside the cylinder, near the end of the compression stroke, to ignite the compressed Charge of air-fuel vapour. The ignition system has to transform the normal battery voltage of 12 V to approximately 8–20 kV and, in addition, has to deliver this high voltage to the right cylinder, at the right time. Some ignition systems will supply up to 40 kV to the spark plugs.

Theory:

Conventional ignition System:

Conventional ignition is the forerunner of the more advanced systems controlled by electronics. It is worth mentioning at this stage that the fundamental operation of most ignition systems is very similar. One winding of a coil is switched on and off causing a high voltage to be induced in a second winding. A coil-ignition system is composed of various components and subassemblies, the actual design and construction of which depend mainly on the engine with which the system is to be used.

Generation of high tension

If two coils (known as the primary and secondary) are wound on to the same iron core then 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 be produced. This is called *transformer action* and is the principle of the 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 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.

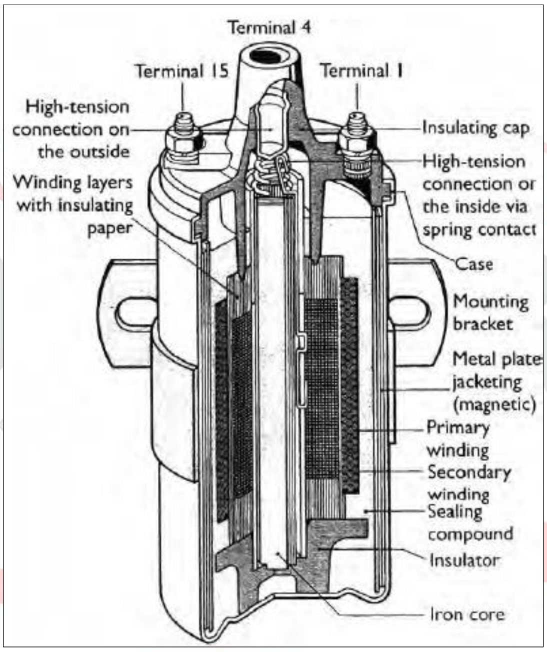


Figure : typical ignition coil section view

Conventional ignition System components

Spark plug	Seals electrodes for the spark to jump across in the cylinder. Must withstand very high voltages, pressures and temperatures.
Ignition coil	Stores energy in the form of magnetism and delivers it to the distributor via the HT lead. Consists of primary and secondary windings.
Ignition switch	Provides driver control of the ignition system and is usually also used to cause the starter to crank.
Contact breakers (breaker points)	Switches the primary ignition circuit on and off to charge and discharge the coil. The contacts are operated by a rotating cam in the distributor.
Capacitor (condenser)	Suppresses most of the arcing as the contact breakers open. This allows for a more rapid break of primary current and hence a more rapid collapse of coil magnetism which produces a higher voltage output.
Distributor	Directs the spark from the coil to each cylinder in a pre-set sequence.
Plug leads	Thickly insulated wires to connect the spark from the distributor to the plugs.
Centrifugal advance	Changes the ignition timing with engine speed. As speed increases the timing is advanced.
Vacuum advance	Changes timing depending on engine load. On conventional systems the vacuum advance is most important during cruise conditions.

Electronic ignition

Electronic ignition is now fitted to almost all spark ignition vehicles. This is because the conventional mechanical system has some major disadvantages.

• Mechanical problems with the contact breakers, not the least of which is the limited lifetime.

• Current flow in the primary circuit is limited to about 4 A or damage will occur to the contacts - or at least the lifetime will be seriously reduced.

• Legislation requires stringent emission limits, which means the ignition timing must stay in tune for a long period of time.

• Weaker mixtures require more energy from the spark to ensure successful
Ignition, even at very high engine speed.

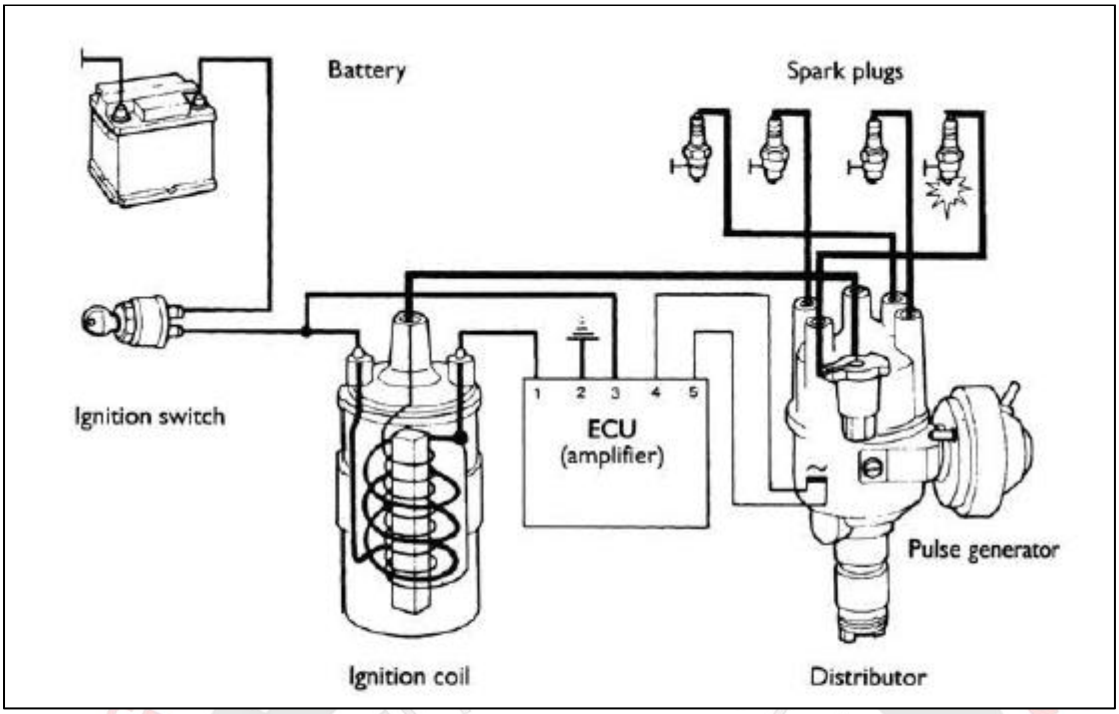


Figure : Electronic Ignition system

Constant dwell systems vs constant energy system

The dwell in conventional systems was simply the time during which the contact breakers were closed. This is now often expressed as a percentage of one charge-discharge cycle. In order for a constant energy electronic ignition system to operate, the dwell must increase with engine speed. This will only be of benefit, however, if the ignition coil can be charged up to its full capacity, in a very short time (the time available for maximum dwell at the highest expected engine speed). To this end, constant energy coils are very low resistance and low inductance.

Pulse generator

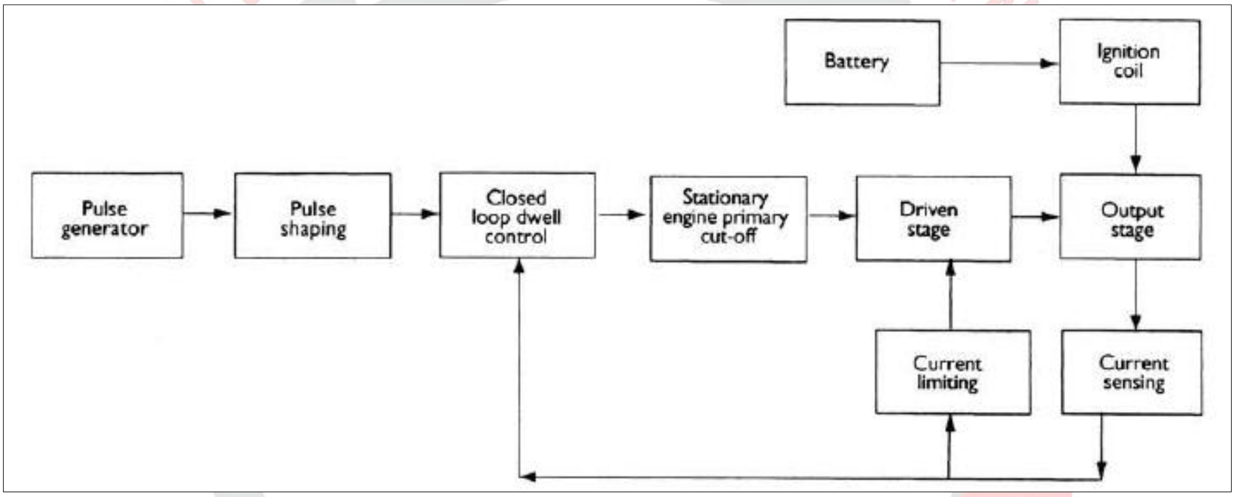
1. **Hall Effect pulse generator**

As the central shaft of the distributor rotates, the vanes attached under the rotor arm alternately cover and uncover the Hall chip. The number of vanes corresponds to the number of cylinders. In constant dwell systems the dwell is determined by the width of the vanes. The vanes cause the Hall chip to be alternately in and out of a magnetic field. The result of this is that the device will produce almost a square wave output, which can then easily be used to switch further electronic circuits.

2. Inductive pulse generator

Inductive pulse generators use the basic principle of induction to produce a signal typical of the one shown in Figure 8.9. Many forms exist but all are based around a coil of wire and a permanent magnet. It has the coil of wire wound on the pick-up and, as the reluctor rotates, the magnetic flux varies due to the peaks on the reluctor. The number of peaks, or teeth, on the reluctor corresponds to the number of engine cylinders. The gap between the reluctor and pick-up can be important and manufacturers have recommended settings

Capacitor discharge ignition



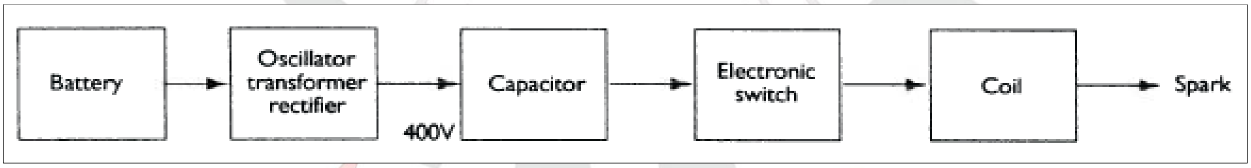


Figure : CDI Ignition system

The CDI works by first stepping up the battery voltage to about 400 V (DC), using an oscillator and a transformer, followed by a rectifier. This high voltage is used to charge a capacitor. At the point of ignition the capacitor is discharged through the primary winding of a coil, often by use of a thyristor. This rapid discharge through the coil primary will produce a very high voltage output from the secondary winding. This voltage has a very fast rise time compared with a more conventional system.

Distributorless Ignition

Distributorless Ignition has all the features of programmed ignition systems but,by using a special type of Ignition coil, outputs to the spark plugs without theneed for an HT distributor. The DIS system consists of three main components: the electronic module, acrankshaft position sensor and the DIS coil. In many systems a manifold absolutepressure sensor is integrated in the module.

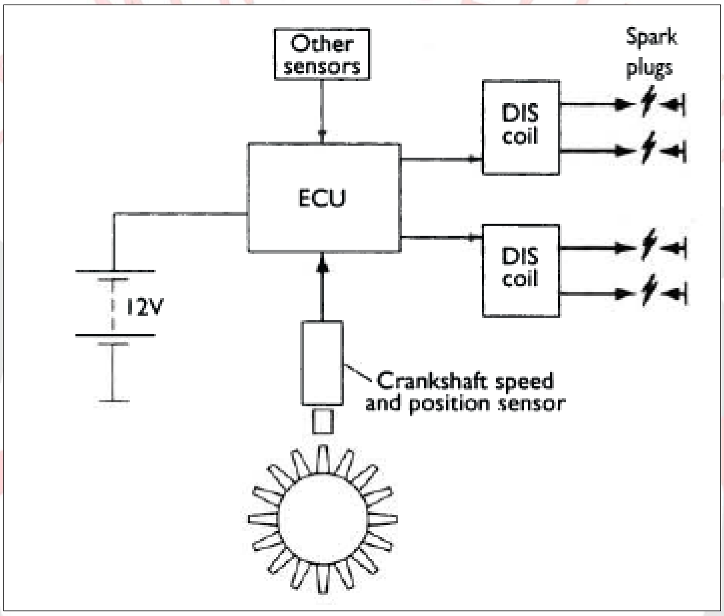


Figure : DIS system

Practical Task:

Identify parts and its function in vehicle	
	

Group Task

1) Prepare a demonstration chart on hard board of DIS physical components with name tag (Batch wise activity)

Assignment Question:

1) Draw a line diagram chart of conventional Ignition system with each component functional requirement.
2) Why Constant dwell system replaced by Constant energy system?
3) Explain Hall effect pulse generator
4) Draw basic line diagram of Ignition system which you have seen in vehicle.
5) List types of sensors and its function used in DIS
6) Write down steps & measurement data collected by you during measuring supply and current drain test using clamp multi meter in ignition system.
7) Write down steps you have followed for timing checking and adjustment using stroboscopic timing gun.

Introduction: - The simple requirement of a spark plug is that it must allow a spark to form within the combustion chamber, to initiate burning. In order to do this the plug has to withstand a number of severe conditions. The spark plug must withstand severe vibration and a harsh chemical environment. Finally, but perhaps most important, the insulation properties must withstand voltage pressures up to 40 kV.

Theory:

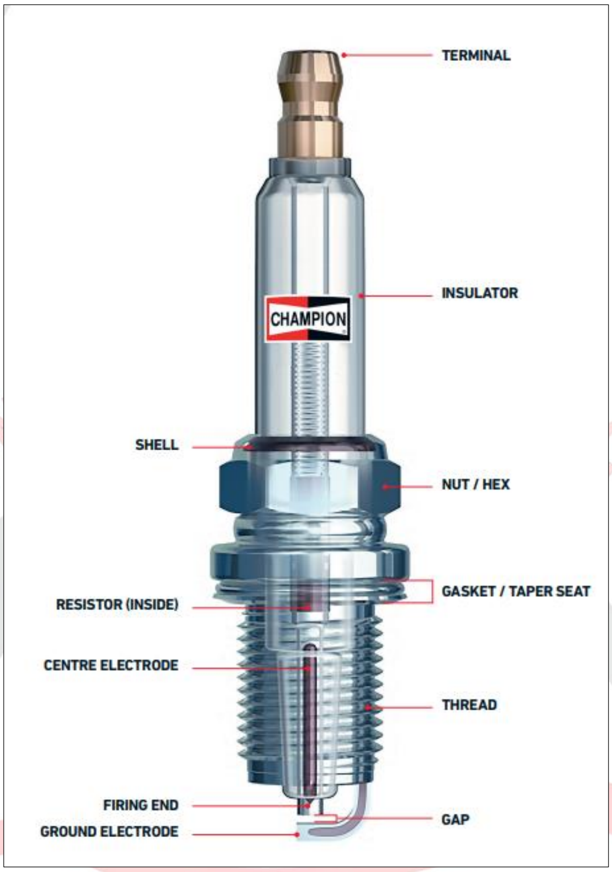


Figure : Spark Plug construction

RESISTOR

Radio Frequency Interference is created by the ignition systems of internal combustion engines. During the microseconds of time that the spark is occurring at the spark plug gap, high frequency bursts of energy are created. These bursts of energy cause static and interference in radios, televisions, telephones and other sensitive electronic devices. A built-in resistor eliminates possible radio frequency interference (RFI). In this way guaranteeing a perfect ignition and trouble-free operation of all electronic on-board systems.

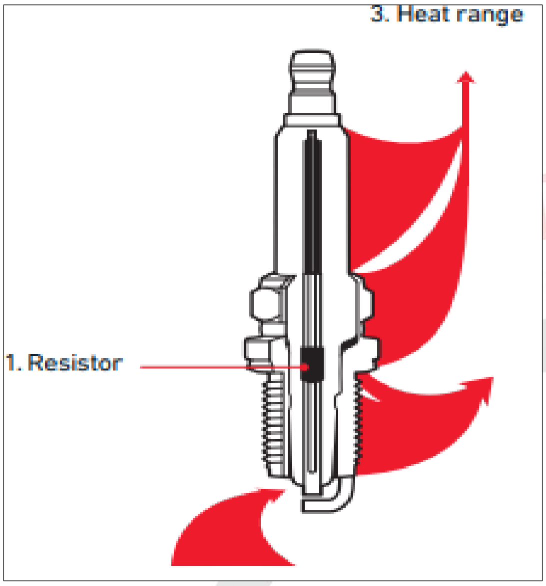
1. In today's plugs, a resistor is built in to eliminate radio frequency interference.

2. The shell is a threaded metal hex (made from extruded steel) that seals the combustion and makes it possible to install or remove the plug.

3. Each spark plug has its particular heat range. The insulator prevents secondary ignition voltage grounding anywhere else — other than the gap — and it moves the heat from the combustion process to the cylinder head (and into the cooling system).

4. The ground and centre electrodes position the spark in the ignition chamber.

5. The gap is the distance between the centre and the ground electrode. This is what the ignition spark must jump across. Finally, the terminal connects the plug to the ignition system



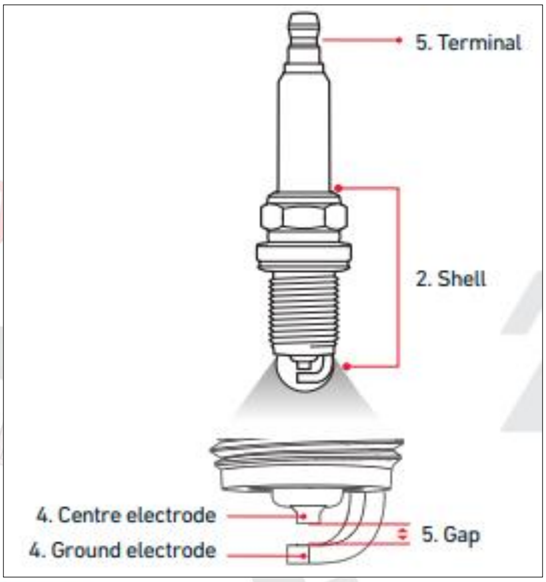


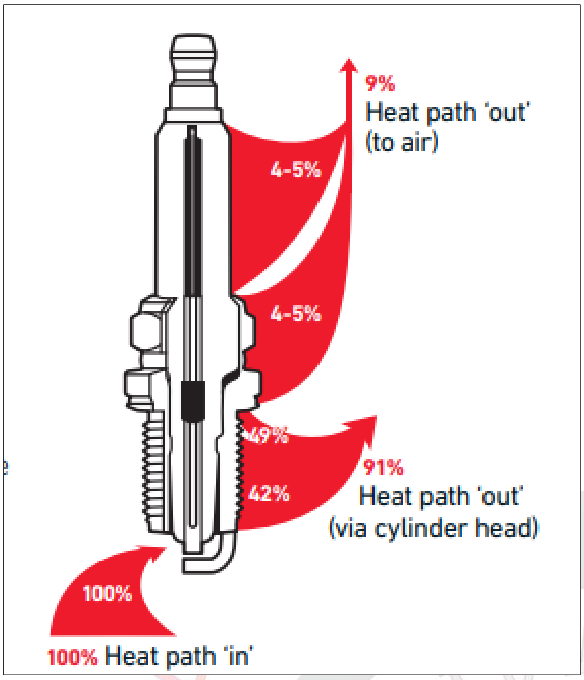
Figure : Spark Plug terminology

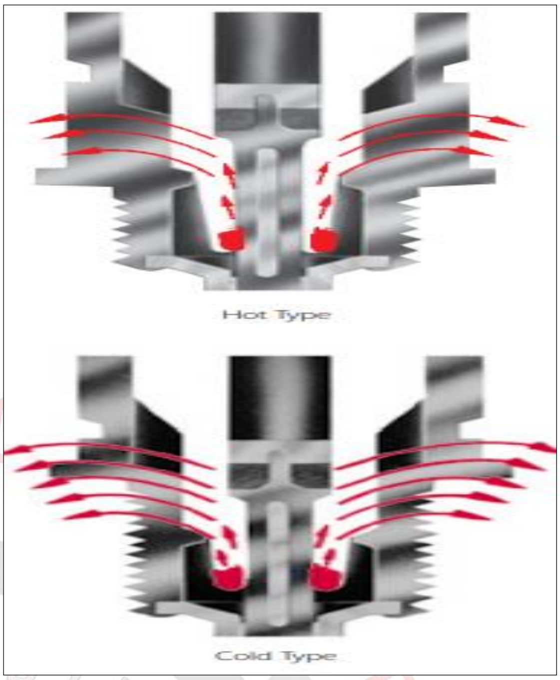
SHELL

The metal seat withstands the torque of tightening, conducts heat from the insulator to the cylinder head and provides a ground for the sparks

HEAT RANGE

The heat range indicates the speed of which a plug can transfer heat from the combustion chamber to the engine head. The heat range of the plug is determined by the dimensions of the insulator and the seat. Spark plugs with short insulators are usually 'cooler' plugs, while 'hotter' plugs have a lengthened path to the metal seat. The thermally conductive metal core and the type of material of which the electrodes are made also influences the heat. A hot-type spark plug has a longer core nose and transfers heat more slowly than a cold-type plug.





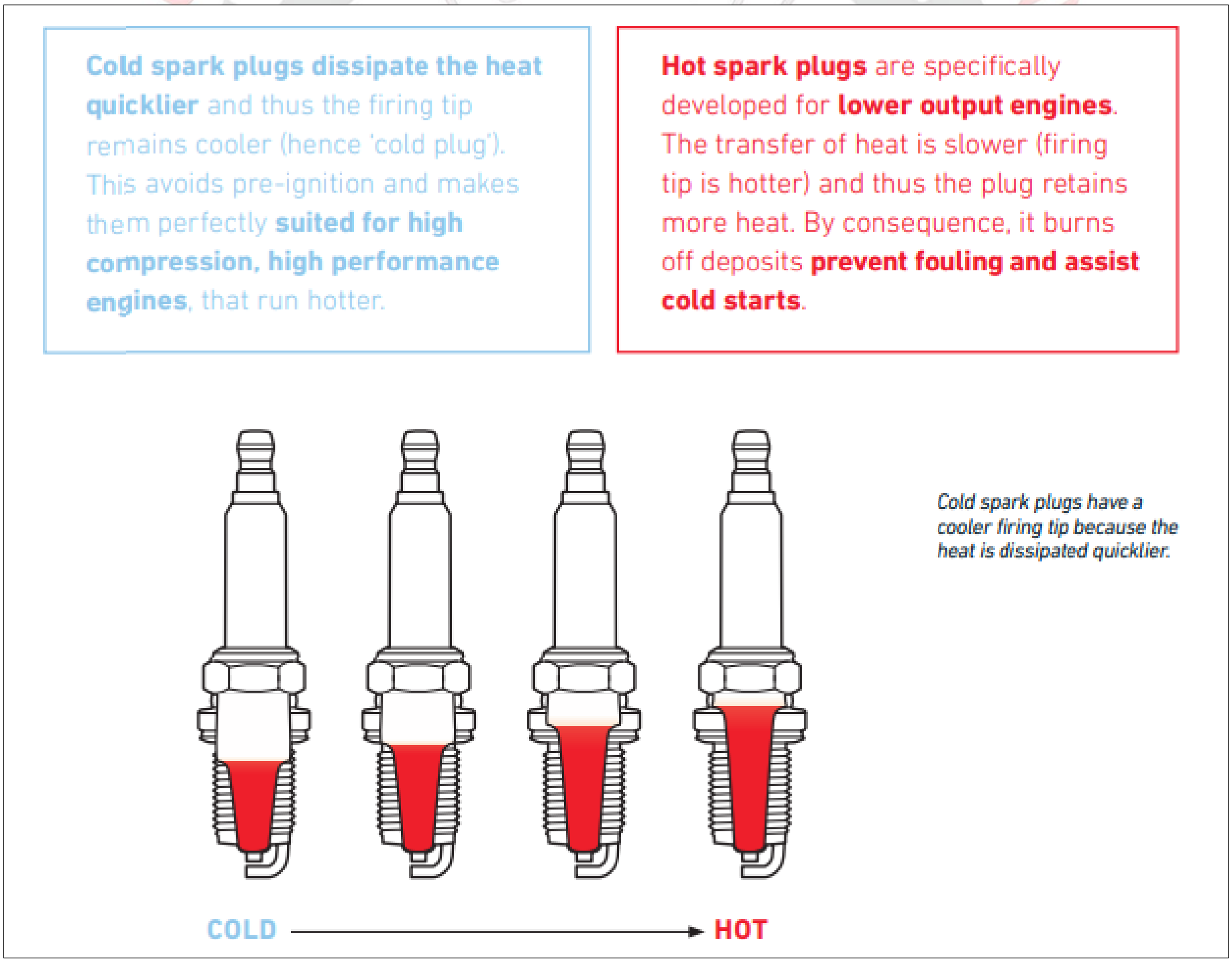


Figure 8.3: HOT & COLD Spark Plug Explanation

ELECTRODES

The centre electrode is connected directly to the terminal. This can be made of (a combination of) copper, nickel-iron, chromium or noble metals like platinum, iridium. These are used because of their higher durability rather than their electric conductivity. Normally, it's the centre electrode that ejects the electrons, as it is the hottest of the two. The projection of a spark plug is the distance from the end of the metal shell to the tip of the ceramic 'nose'. The ground electrode (or side electrode) is mostly made from nickel-steel, in some cases with a copper core to increase heat conduction. This electrode is welded to the metal shell. Champion spark plugs with a Multi Ground Electrode have a copper cored nickel centre electrode, coupled with 2-3-4 nickel ground electrodes. Multiple ground electrodes generally provide longer life. Because when the spark gap widens due to electric discharge wear, the spark can move to another closer ground electrode.

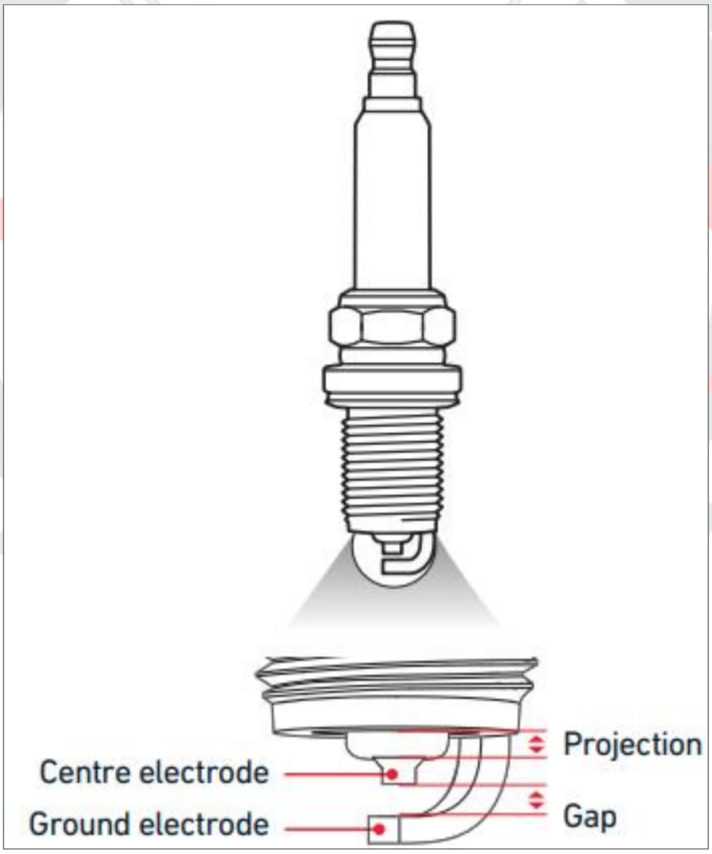


Figure : Spark Plug Gap

TERMINAL AND GAP

A terminal is placed on top of each spark plug. Its role is to serve as a connector to the ignition system of the vehicle. When developing plugs with car manufacturers, Champion always finds the best solution for each engine. Depending on the engine head and multiple other determining factors, different terminals & gaps are developed and produced following the prescriptions of the OE engines. The gap is the distance between the end of the centre electrode and the ground electrode. The distance is crucial to the spark plug performance as the slightest alteration could influence the proper functioning.

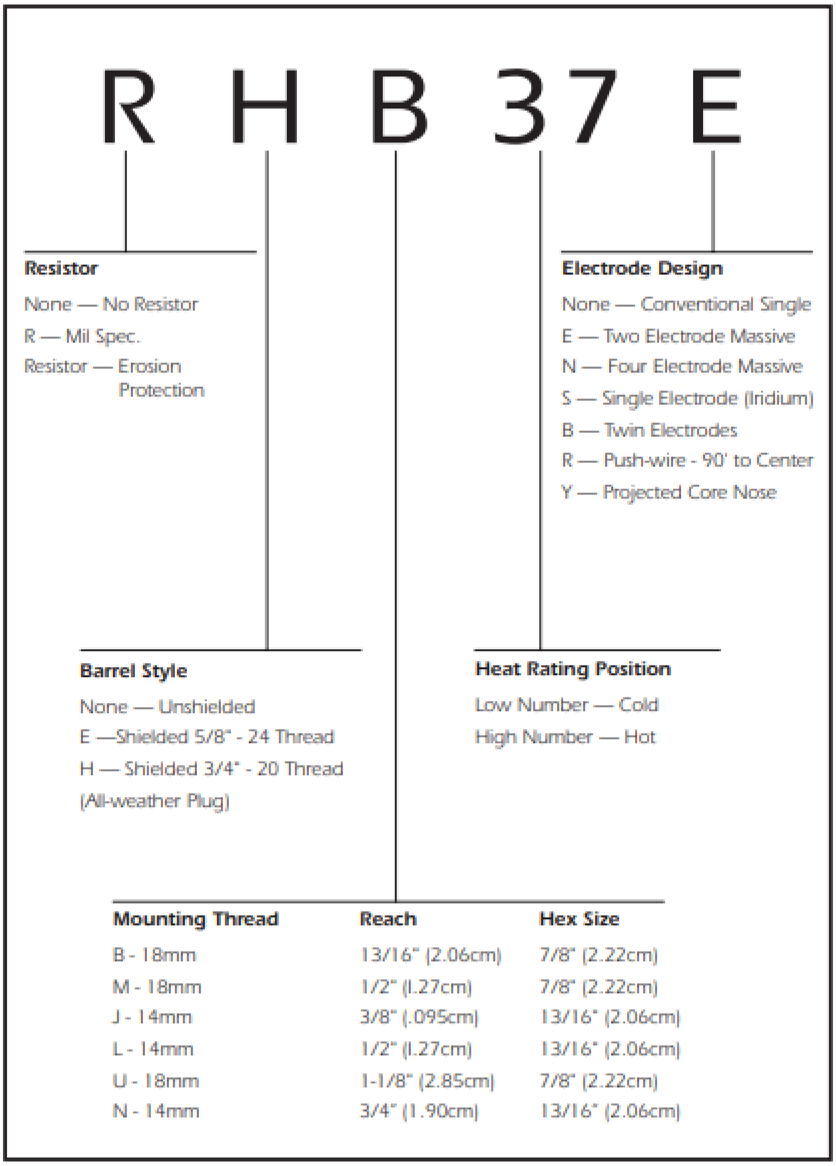


Figure : Typical Spark Plug Number with Symbol Explanation

task:

1. Note down specification of given spark plug at least three

Spark Plug	Specification

2. Spark plug material details

Spark plug assembly	Material	Property & advantage
Insulator		
Packing washer		
Center shaft (stem)		
Ground electrode		
Center Electrode		

Assignment questions:

1. Based on given Lab task note down Specification & technical code with each details as per manufacturer specifications.
2. In brief note down benefits of multi electrode spark plug.

3. Write in your own words importance of Spark plug gap and its impact on spark intensity.