Ignition System

In case of petrol engines during suction operation, charge of air and petrol fuel will be taken in. During compression this charge is compressed by the upward moving piston. And just before the end of compression, the charge of air and petrol fuel will be ignited by means of the spark produced by means of for spark plug. And the ignition system does the function of producing the spark in case of spark ignition engines.

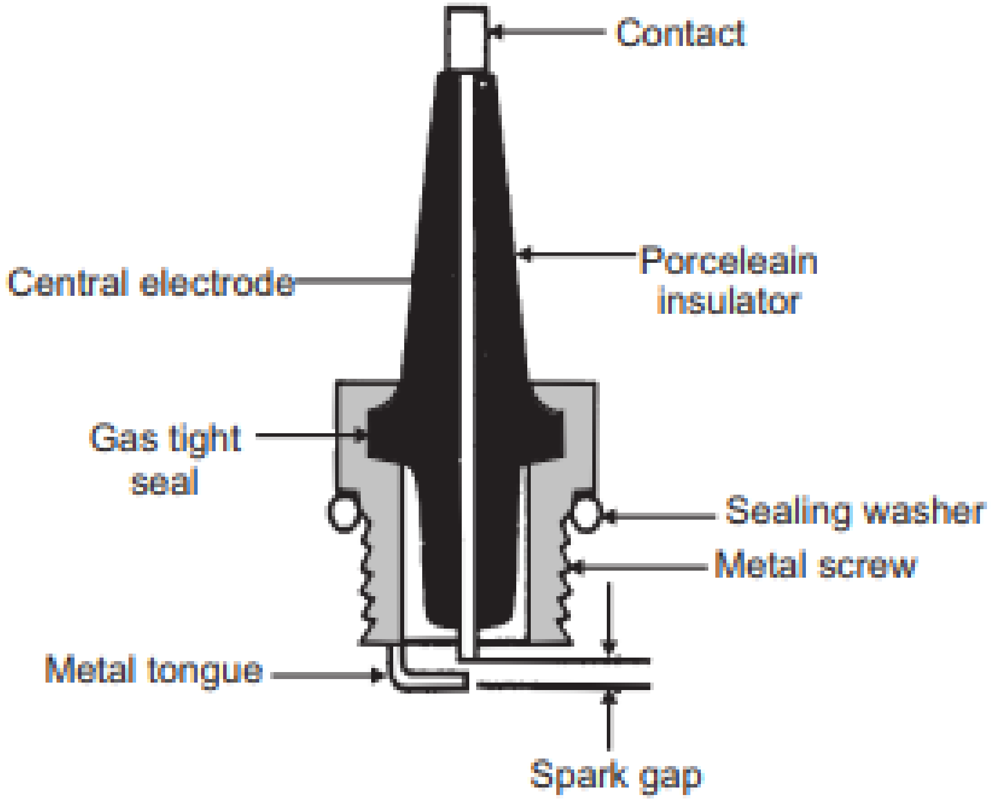


Figure 4.1 : Spark Plug

IGNITION SYSTEM TYPES

Basically Convectional Ignition systems are of 2 types :

(a) Battery or Coil Ignition System, and

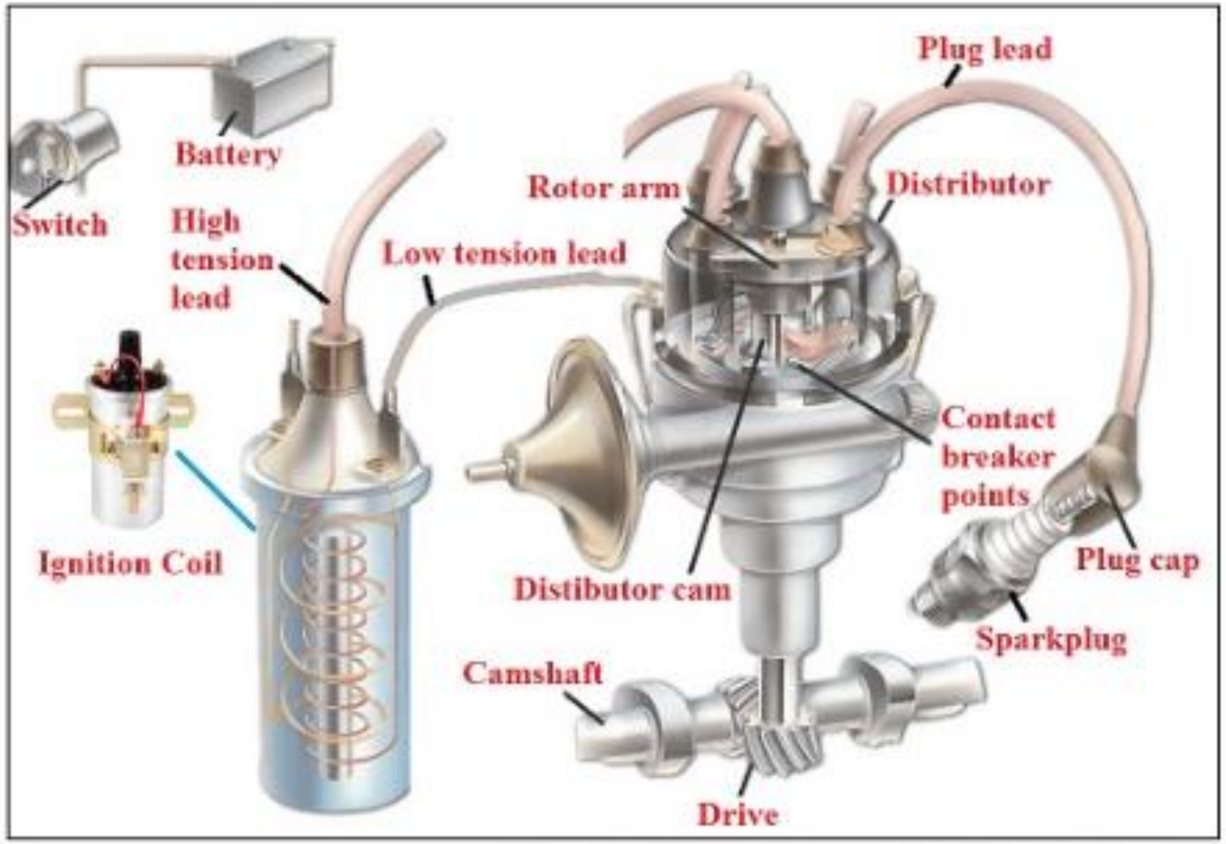
(b) Magneto Ignition System.

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

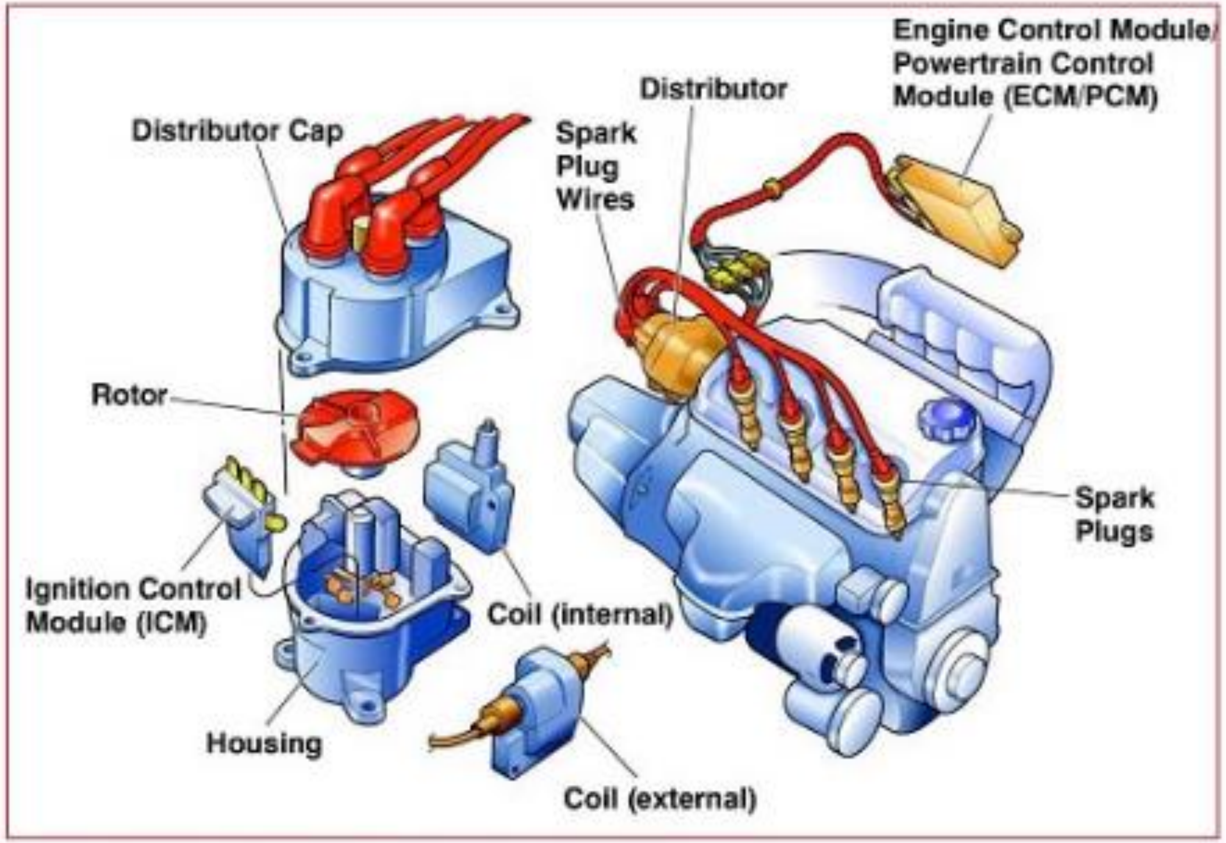
Battery ignition system was generally used in 4-wheelers, but now-a-days it is more commonly used in 2-wheelers also (i.e. Button start, 2-wheelers like Pulsar, Kinetic Honda; Honda-Activa, Scooty, Fiero, etc.). In this case 6 V or 12 V batteries will supply necessary current in the primary winding.

Magneto ignition system is mainly used in 2-wheelers, kick start engines. (Example, Bajaj Scooters, Boxer, Victor, Splendor, Passion, etc.).

In this case magneto will produce and supply current to the primary winding. So in magneto ignition system magneto replaces the battery.



Plug lead
Battery
Switch
Rotor arm
Distributor
High tension lead
Low tension lead
Contact breaker points
Ignition Coil
Plug cap
Distibutor cam
Sparkplug
Camshaft
Drive



Engine Control Module/ Powertrain Control Module (ECM/PCM)
Distributor
Distributor Cap
Spark Plug Wires
Rotor
Spark Plugs
Ignition Control Module (ICM)
Coil (internal)
Housing
Coil (external)

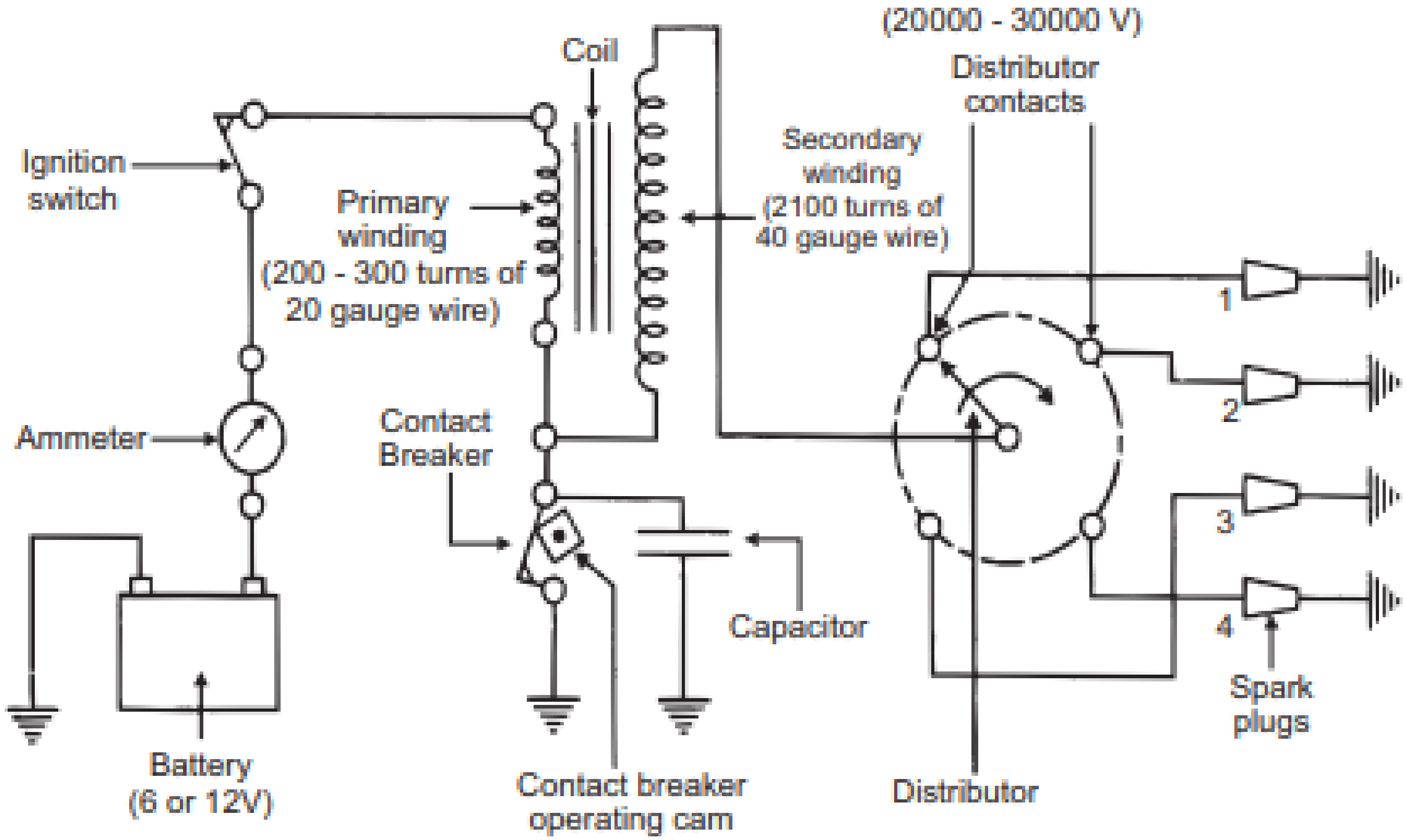


Figure 4.2 : Schematic Diagram of Coil/Battery Ignition System

Figure 4.2 shows line diagram of battery ignition system for a 4-cylinder petrol engine. It mainly consists of a 6 or 12 volt battery, ammeter, ignition switch, auto-transformer (step up transformer), contact breaker, capacitor, distributor rotor, distributor contact points, spark plugs, etc.

Note that the Figure 4.1 shows the ignition system for 4-cylinder petrol engine, here there are 4-spark plugs and contact breaker cam has 4-corners. (If it is for 6-cylinder engine it will have 6-spark plugs and contact breaker cam will be a perfect hexagon).

The ignition system is divided into 2-circuits :

(i) **Primary Circuit :** It 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 :** It consists of secondary winding. Secondary winding consists of about 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 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 (engine earth).

Components of the Ignition System:

The conventional Ignition System consists of the following parts.

1. Ignition Switch
2. Ignition Coil
3. Distributor
4. High Tension Cables
5. Spark Plugs

Working:

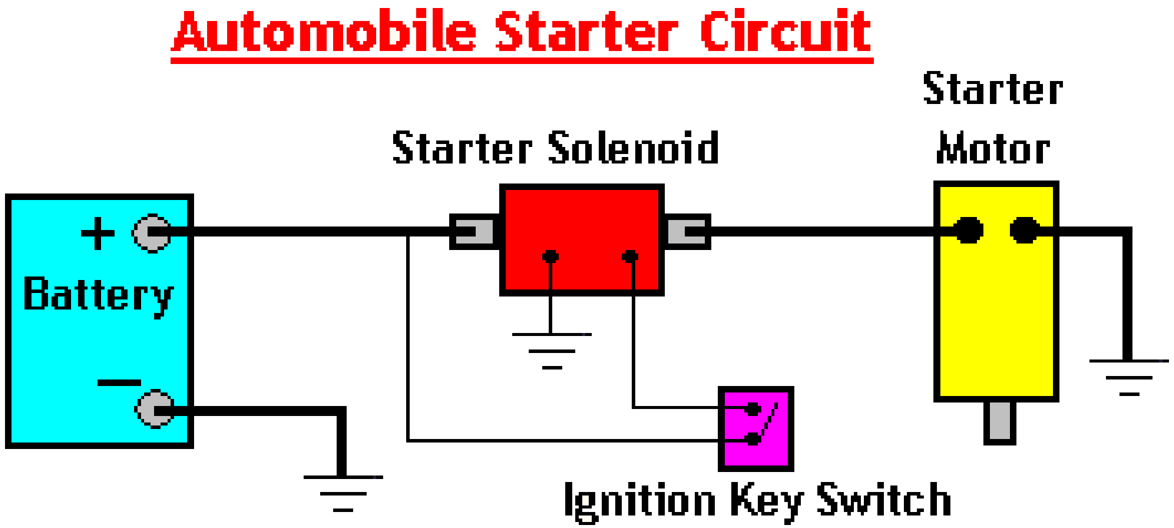
The conventional ignition system consists of two sets of circuits/windings – primary and secondary. The battery supplies 12 volts current to the ignition coil thru' the contact breaker points. It charges the primary windings and also magnetizes the core of the coil. However, the secondary winding is NOT electrically connected to the primary winding. Its one end is grounded and other end passes thru' a heavily insulated cable into the distributor cap. When you turn on the ignition switch, the current passes thru' the primary winding to the ground (earth) thru' the contact points.

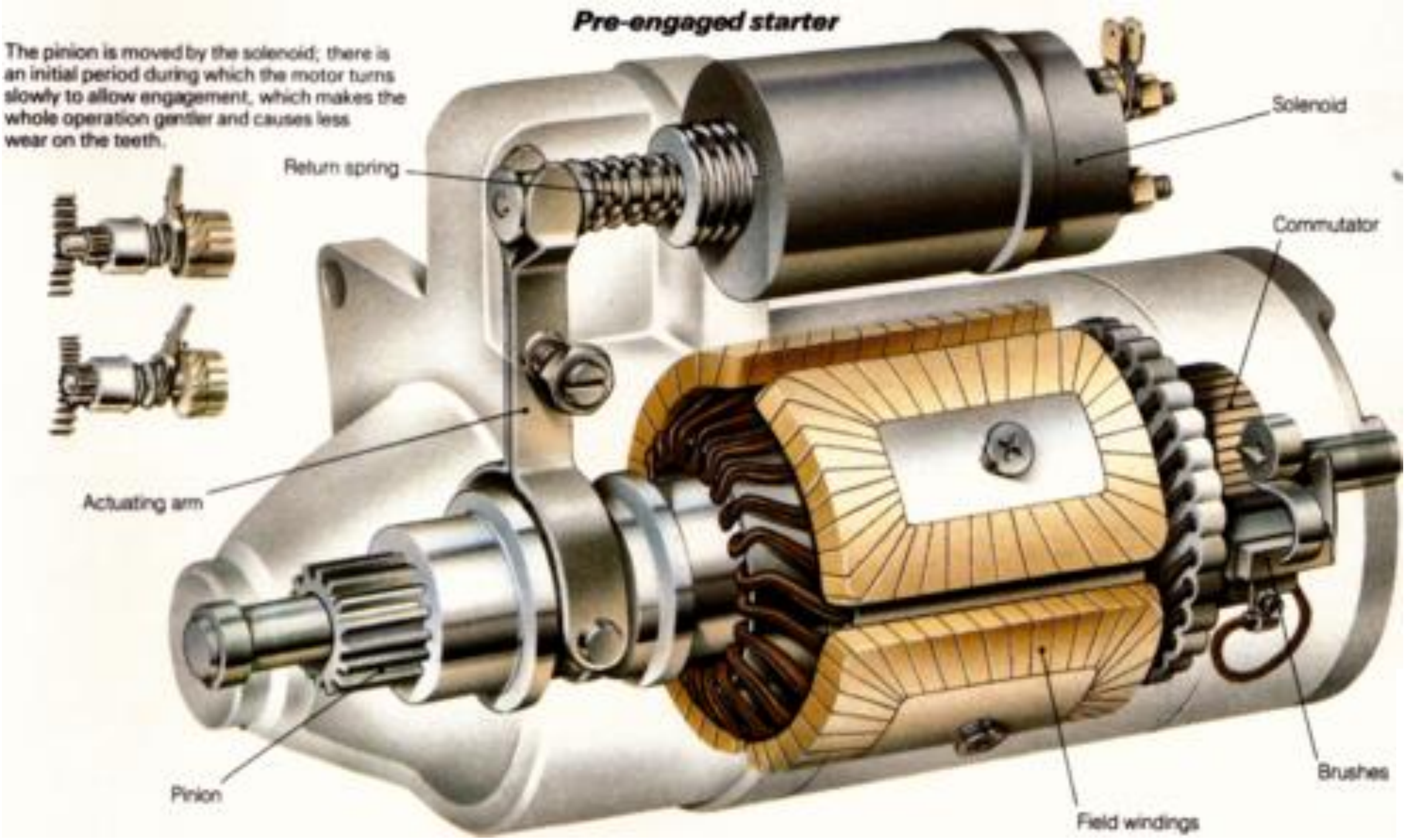
The rotating cam is attached to the distributor's drive-shaft that is driven by the engine. When the drive-shaft rotates, it turns the cam. When the cam pushes the movable breaker arm, it lifts from its seat. Thus, it breaks the contact. As soon as the contacts break, it induces the secondary winding with a high voltage current of around 20,000-25,000 volts.

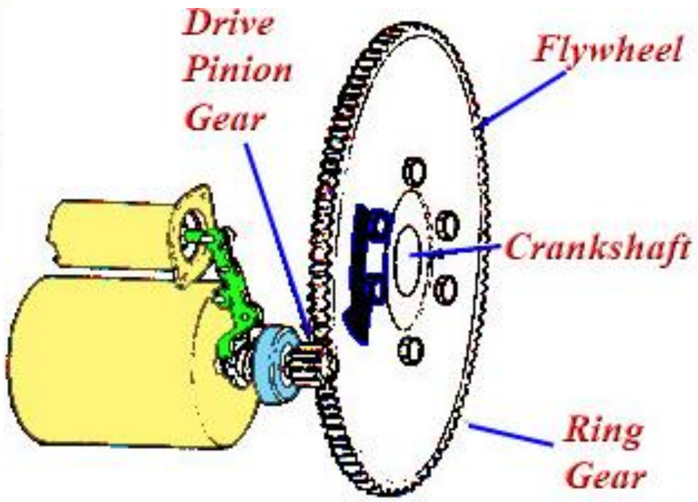
This high voltage current then passes thru' the high tension cable and reaches the top of the distributor cap. The distributor cap sits on the distributor's drive shaft and rotates in the direction of the drive-shaft. While doing so, it aligns with the high tension cables corresponding to each spark-plug. The engineers design the alignment of the drive-shaft with the engine in such a way that the lobes of the cam open the contact points at the end of the compression stroke of each cylinder. Then, the high voltage current passes on to the respective spark plug that creates the spark.

Ignition Switch

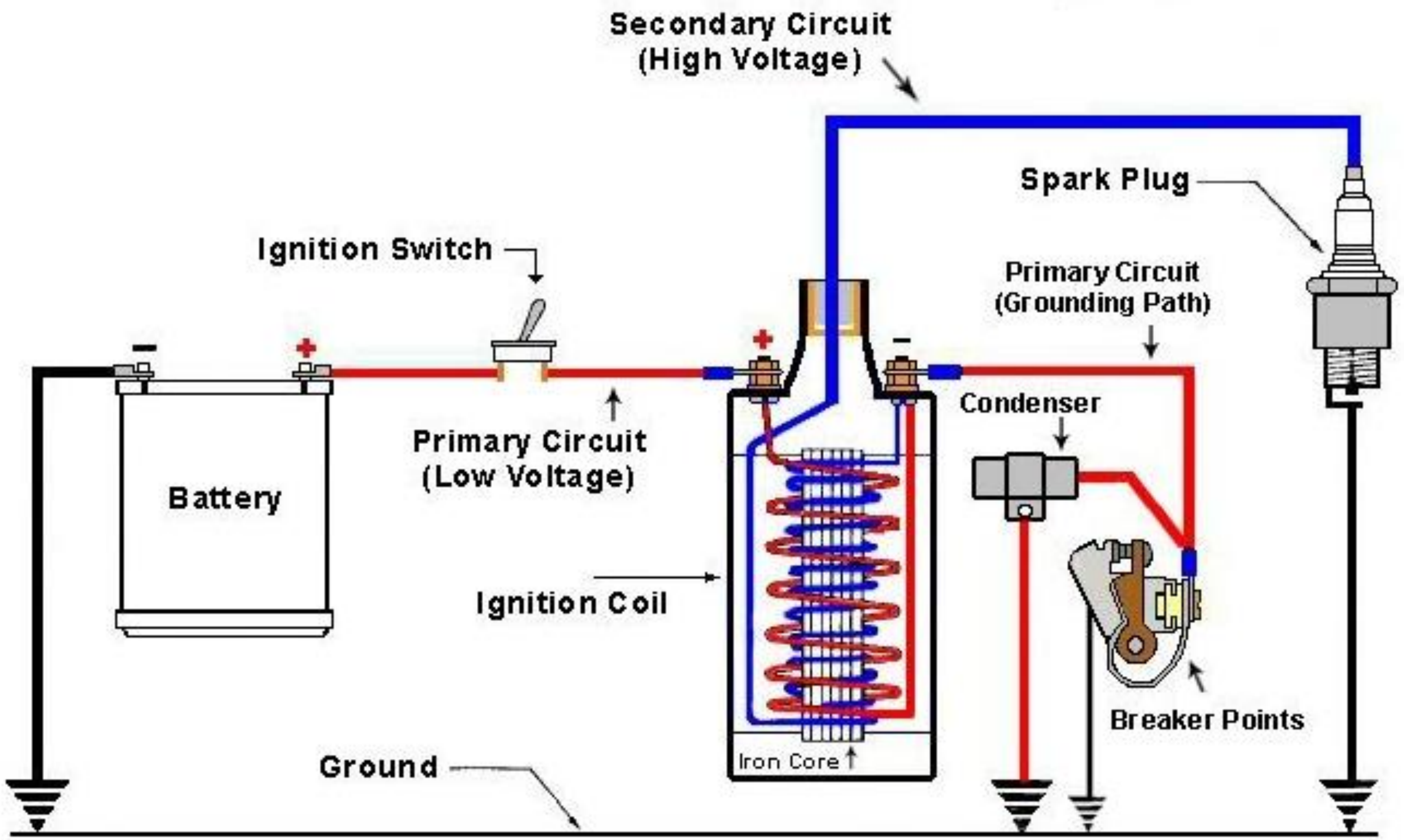
In modern cars with internal combustion engines, the ignition switch provides the required power to the starter solenoid and the other components within the starter system, like the engine control unit and the ignition coil.

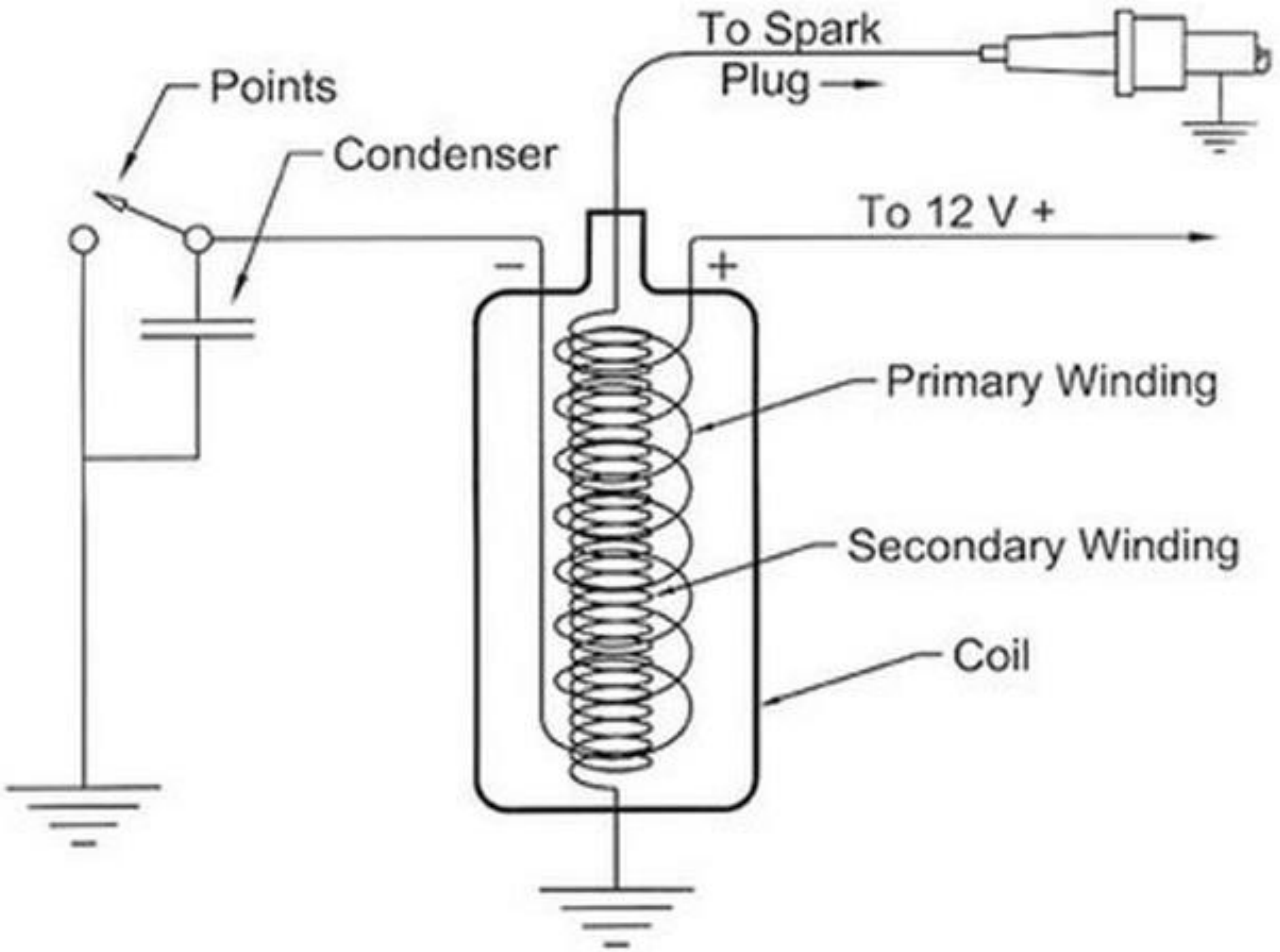



Pre-engaged starter
The pinion is moved by the solenoid; there is an initial period during which the motor turns slowly to allow engagement, which makes the whole operation gentler and causes less wear on the teeth.
Return spring
Solenoid
Commutator
Actuating arm
Pinion
Field windings
Brushes

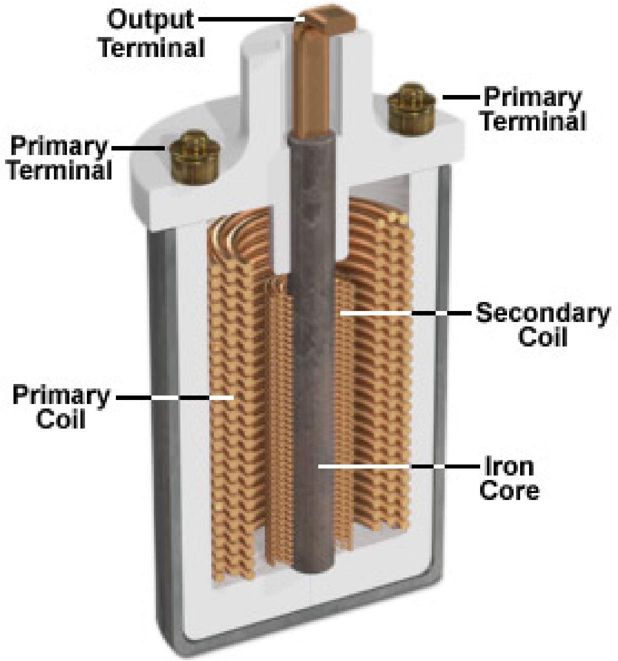

Drive Pinion Gear
Flywheel
Crankshaft
Ring Gear

Ignition Coil




To Spark
Plug
Points
Condenser
To 12 V +
−
+
Primary Winding
Secondary Winding
Coil

Electric, solar-powered and alternate fuel vehicles may be the wave of the future, but for now most automobiles run on gasoline, which they burn in an internal combustion engine to convert into motion. For combustion to take place, a spark is needed to ignite the fuel mixture in the engine. The vehicle's ignition system is designed so that a 12-volt battery can generate the very high voltage required to create such a discharge. The heart of this system is a device called an **ignition coil**.



This coil is a kind of transformer. Transformers transfer voltage from one circuit to another, either as a higher voltage (as in a step-up transformer, of which the ignition coil is an example), or a lower voltage (a step-down transformer). The key principle that makes transformers work is electromagnetic induction: A moving magnetic field, or a change in a stationary magnetic field (the case in our ignition coil), can induce a current in a wire exposed to that field.

This ignition coil is a pulse-type transformer. Like other transformers, it consists, in part, of two coils of wire, as shown in the diagram at right. These are both wrapped around the same iron core. Because this is a step-up transformer, the secondary coil has far more turns of wire than the primary coil, which is wrapped around the secondary. In fact, the secondary coil has several thousand turns of thin wire, whereas the primary coil has just a few hundred. In your car, this allows some 40,000 volts of electricity to be generated by a modest battery, ~~as the tutorial below illustrates~~.

Distributor

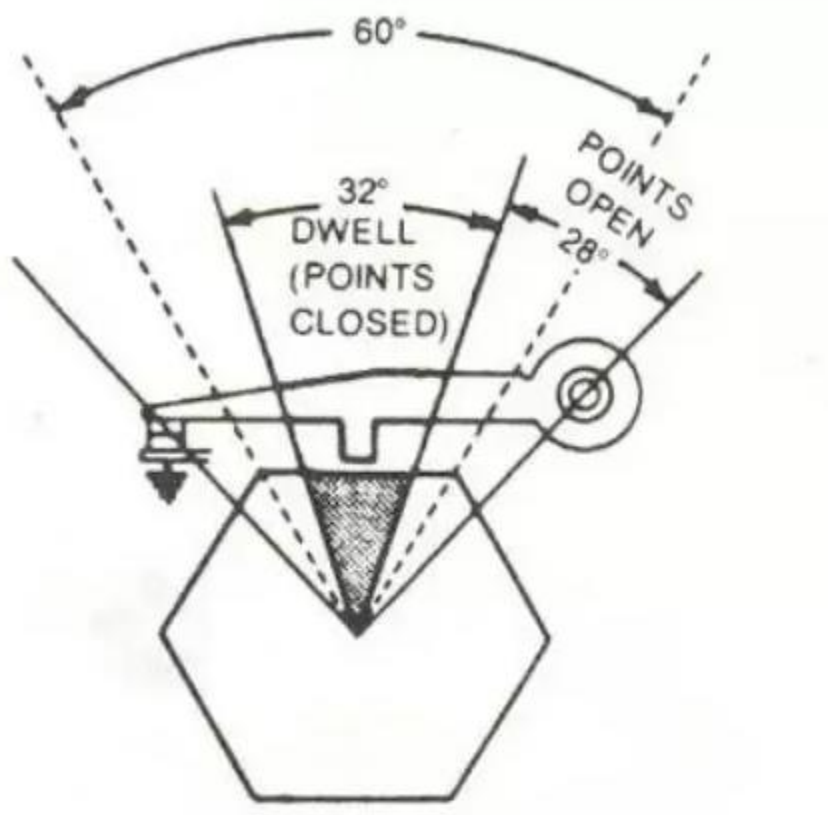
The distributor is the nerve center of the mechanical ignition system and has two tasks to perform. First, it is responsible for triggering the ignition coil to generate a spark at the precise instant that it is required (which varies depending how fast the engine is turning and how much load it is under). Second, the distributor is responsible for directing that spark to the proper cylinder (which is why it is called a

When you remove the distributor cap from the top of the distributor, you will see the points and condenser. The condenser is a simple capacitor that can store a small amount of current. When the points begin to open, the current flowing through the points looks for an alternative path to ground. If the condenser were not there, it would try to jump across the gap of the points as they begin to open. If this were allowed to happen, the points would quickly burn up and you would hear heavy static on the car radio. To prevent this, the condenser acts like a path to ground. It really is not, but by the time the condenser is saturated, the points are too far apart for the small amount of voltage to jump across the wide point gap. Since the arcing across the opening points is eliminated, the points last longer and there is no static on the radio from point arcing.

The points require periodic adjustments in order to keep the engine running at peek efficiency. This is because there is a rubbing block on the points that is in contact with the cam and this rubbing block wears out over time changing the point gap. There are two ways that the points can be measured to see if they need an adjustment. One way is by measuring the gap between the open points when the rubbing block is on the high point of the cam. The other way is by measuring the dwell electrically. The dwell is the amount, in degrees of cam rotation, that the points stay closed.

Typical
4 cylinder
Distributor

Dwell angle is **the amount of time, measured as degrees of rotation, that contact breakers close in a distributor**. Unless dwell angle is accurate, ignition timing won't be accurate. The period, measured in degree of cam rotation, during which the contact points remain closed is called the dwell angle.



Ignition Timing

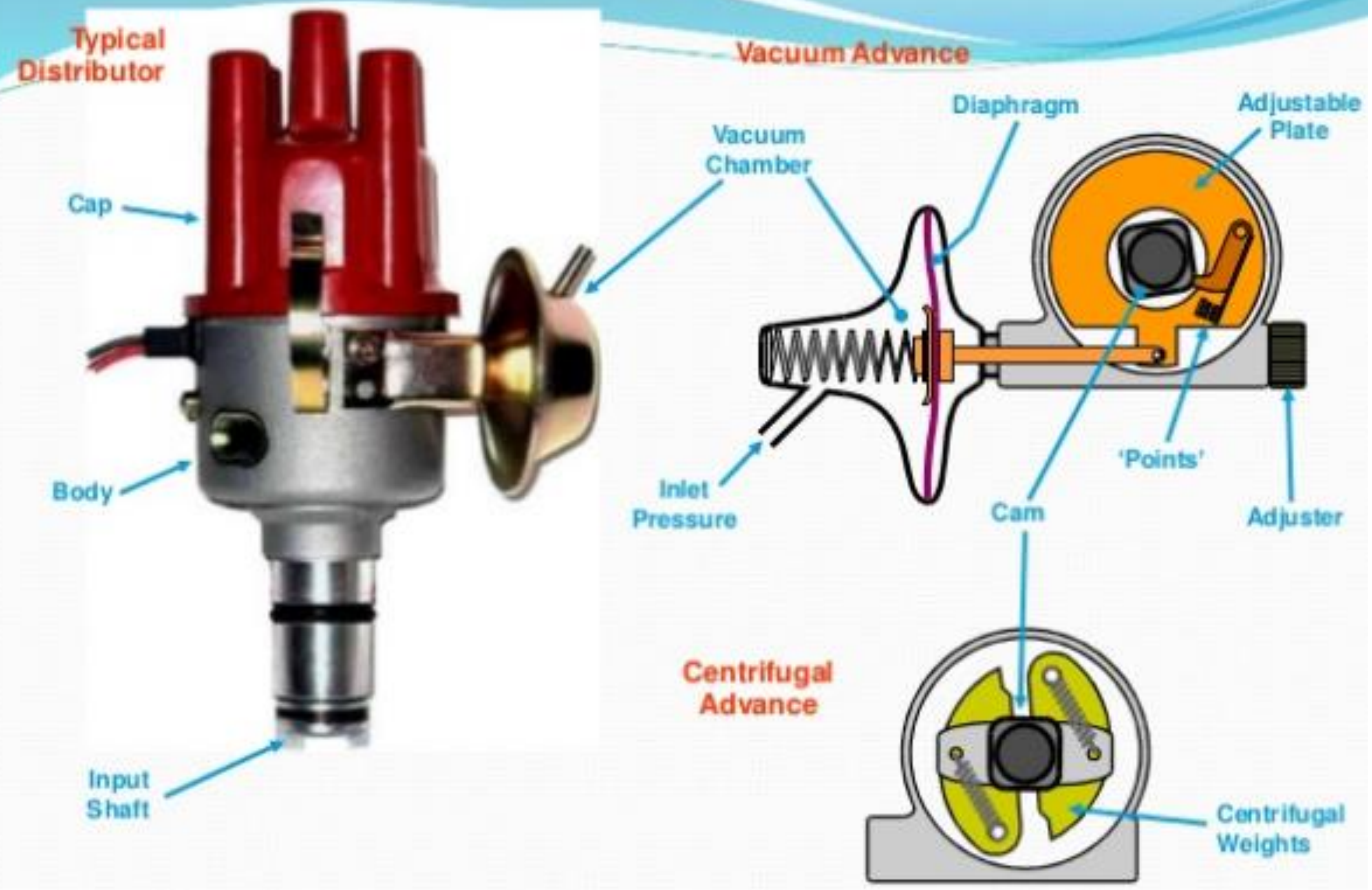
The timing is set by loosening a hold-down screw and rotating the body of the distributor. Since the spark is triggered at the exact instant that the points begin to open, rotating the distributor body (which the points are mounted on) will change the relationship between the position of the points and the position of the distributor cam, which is on the shaft that is geared to the engine rotation.

While setting the initial, or base timing is important, for an engine to run properly, the timing needs to change depending on the speed of the engine and the load that it is under. If we can move the plate that the points are mounted on, or we could change the position of the distributor cam in relation to the gear that drives it, we can alter the timing dynamically to suit the needs of the engine.

Why do we need the timing to advance when the engine runs faster?

When the spark plug fires in the combustion chamber, it ignites whatever fuel and air mixture is present at the tip of the spark plug. The fuel that surrounds the tip is ignited by the burning that was started by the spark plug, not by the spark itself. That flame front continues to expand outward at a specific speed that is always the same, regardless of engine speed. It does not begin to push the piston down until it fills the combustion chamber and has no where else to go. In order to maximize the amount of power generated, the spark plug must fire before the piston reaches the top of the cylinder so that the burning fuel is ready to push the piston down as soon as it is at the top of its travel. The faster the engine is spinning, the earlier we have to fire the plug to produce maximum power.

There are two mechanisms that allow the timing to change: Centrifugal Advance and Vacuum Advance.



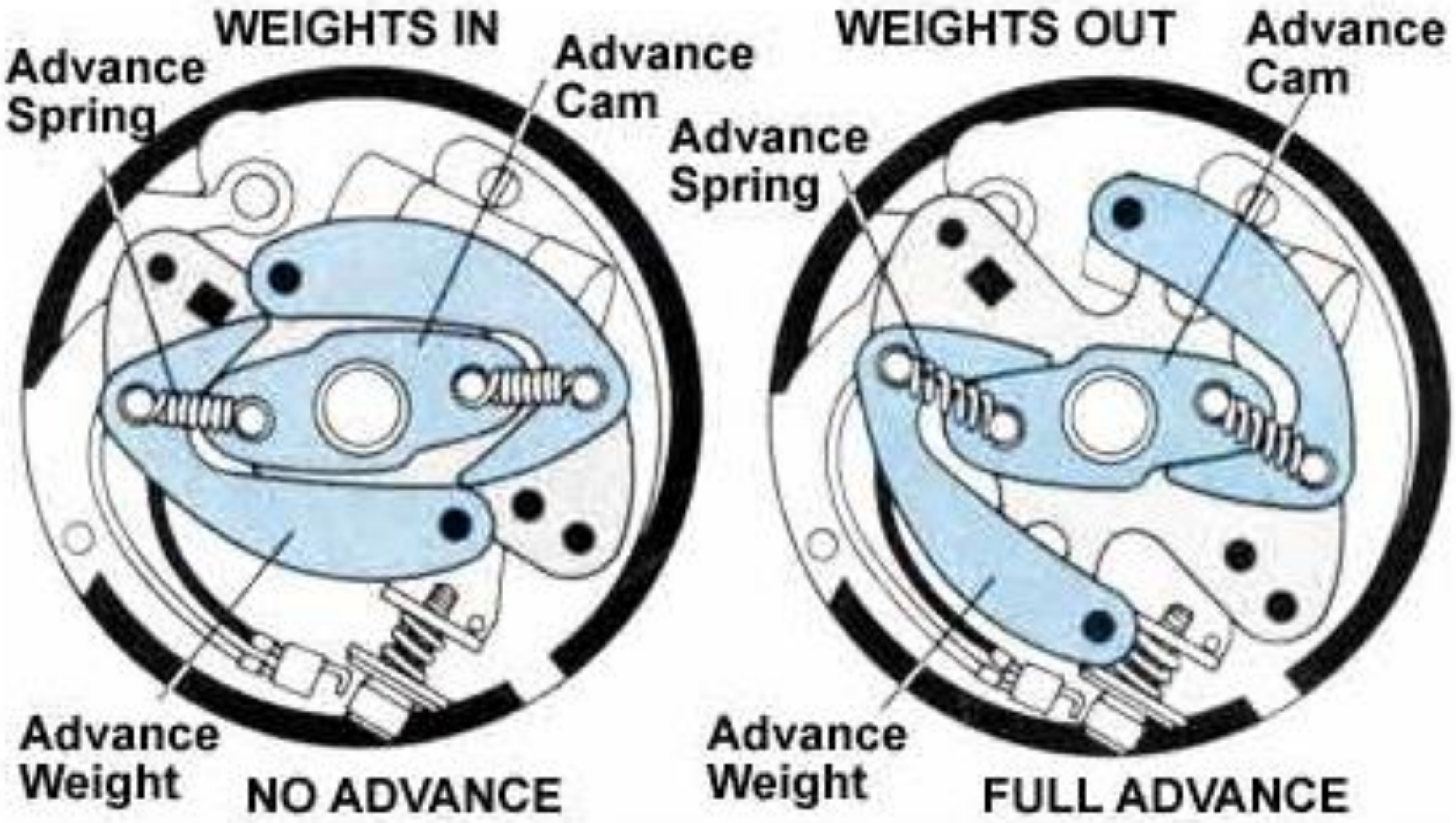
IGNITION SYSTEM – Distributor

Centrifugal Advance

Centrifugal advance makes the ignition coil and spark plugs fire sooner as engine speed increases, using spring-loaded weights, centrifugal force, and lever action to rotate the distributor cam or trigger wheel. Spark timing is advanced by rotating the distributor cam or trigger wheel against distributor shaft rotation. This action helps correct ignition timing for maximum engine power. Basically the centrifugal advance consists of two advance weights, two springs, and a advance lever.

During periods of low engine speed, the springs hold the advance weights inward towards the distributor cam or trigger wheel. At this time there is not enough centrifugal force to push the weights outward. Timing stays at its normal initial setting.

As speed increases, centrifugal force on the weights moves them outwards against spring tension. This movement causes the distributor cam or trigger wheel to move ahead. With this design, the higher the engine speed, the faster the distributor shaft turns, the farther out the advance weights move, and the farther ahead the cam or trigger wheel is moved forward or advanced. At a preset engine speed, the lever strikes a stop and centrifugal advance reaches maximum.

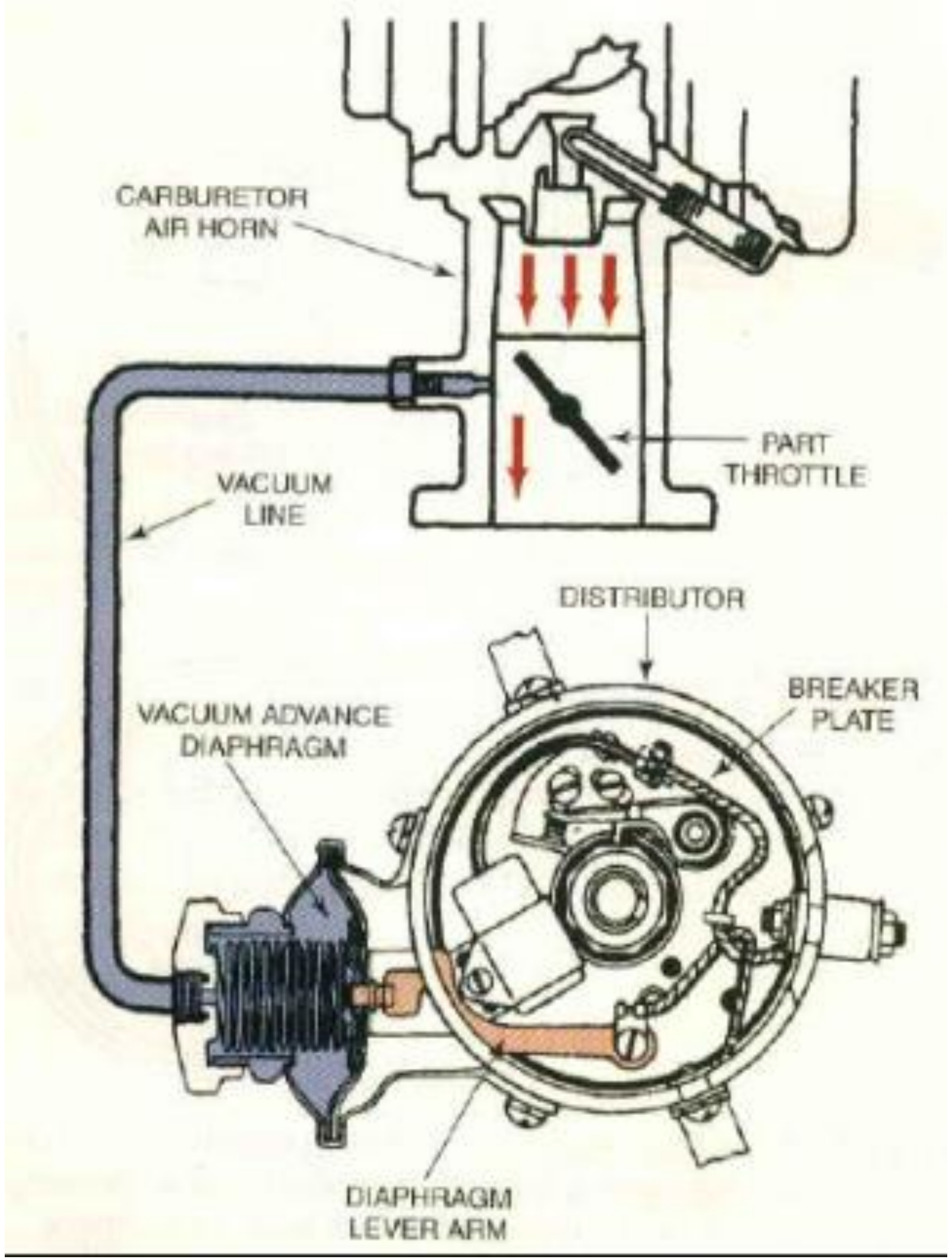

WEIGHTS IN
Advance Spring
Advance Cam
Advance Weight
NO ADVANCE
WEIGHTS OUT
Advance Cam
Advance Spring
Advance Weight
FULL ADVANCE

Vacuum Advance

The vacuum advance provides additional spark advance when engine load is low at part throttle position. It is a method of matching ignition timing with engine load. The vacuum advance increases FUEL ECONOMY because it helps maintain idle fuel spark advance at all times. A vacuum advance consists of a vacuum diaphragm, link, movable distributor plate, and a vacuum supply hose.

At idle, the vacuum port from the carburetor or throttle body to the distributor advance is covered, thereby NO vacuum is applied to the vacuum diaphragm, and spark timing is NOT advanced. At part throttle, the throttle valve uncovers the vacuum port and the port is exposed to engine vacuum. The vacuum pulls the diaphragm outward against spring force. The diaphragm is linked to a movable distributor plate, which is rotated against distributor shaft rotation and spark timing is advanced.

The vacuum advance does not produce any advance at full throttle. When the throttle valve is wide open, vacuum is almost zero. Thus vacuum is NOT applied to the distributor diaphragm and the vacuum advance does NOT operate.


CARBURETOR
AIR HORN
PART
THROTTLE
VACUUM
LINE
DISTRIBUTOR
BREAKER
PLATE
VACUUM ADVANCE
DIAPHRAGM
DIAPHRAGM
LEVER ARM

Ignition Wires

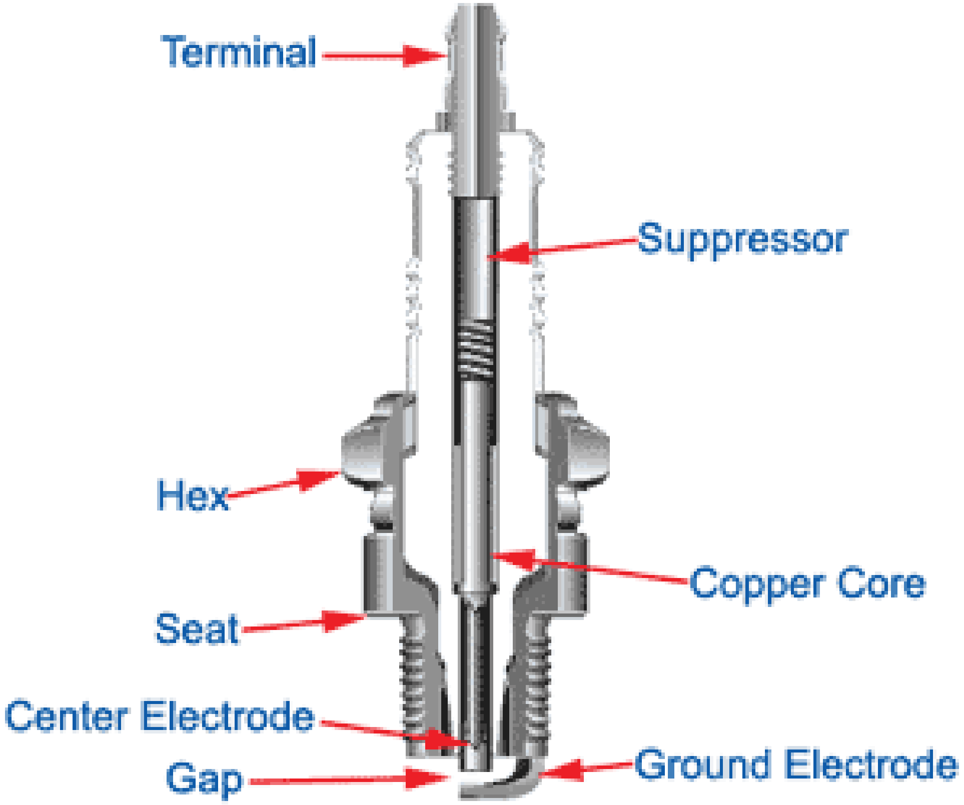
These cables are designed to handle 20,000 to more than 50,000 volts, enough voltage to toss you across the room if you were to be exposed to it. The job of the spark plug wires is to get that enormous power to the spark plug without leaking out. Spark plug wires have to endure the heat of a running engine as well as the extreme changes in the weather. In order to do their job, spark plug wires are fairly thick, with most of that thickness devoted to insulation with a very thin conductor running down the center. Eventually, the insulation will succumb to the elements and the heat of the engine and begins to harden, crack, dry out, or otherwise break down. When that happens, they will not be able to deliver the necessary voltage to the spark plug and a misfire will occur. That is what is meant by "Not running on all cylinders". To correct this problem, the spark plug wires would have to be replaced.

Spark plug wires are routed around the engine very carefully. Plastic clips are often used to keep the wires separated so that they do not touch together. This is not always necessary, especially when the wires are new, but as they age, they can begin to leak and crossfire on damp days causing hard starting or a rough running engine.

The next thing we need to know is what direction the distributor is rotating in, clockwise or counter-clockwise, and which terminal on the distributor cap that #1 cylinder is located. Once we have this information, we can begin routing the spark plug wires.

If the wires are installed incorrectly, the engine may backfire, or at the very least, not run on all cylinders. It is very important that the wires are installed correctly.

Spark Plugs



The ignition system's sole reason for being is to service the spark plug. It must provide sufficient voltage to jump the gap at the tip of the spark plug and do it at the exact right time, reliably on the order of thousands of times per minute for each spark plug in the engine.

The modern spark plug is designed to last many thousands of miles before it requires replacement. These electrical wonders come in many configurations and heat ranges to work properly in a given engine.