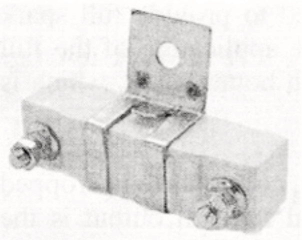
The Ballast Resistor

For Inductive Discharge Ignition Systems

The coil, capacitor (condenser), and resister form a tuned oscillator circuit. When the coil is completely discharged, the capacitor is completely charged. Now, the capacitor will try to discharge to the coil. Without resistance, there is nothing to limit the coil or capacitor discharge current, and the cycle will repeat, i.e., the coil will charge, then discharge to the capacitor, which will charge, then discharge to the coil, etc. With the resistance, however, the current is dampened, and the amplitude of the oscillating current is reduced rapidly, dropping to negligible within 3-4 cycles.



When the engine is running, you can get by just fine with a lot less current at the points. That's the purpose of the ballast resistor. This is an electrical resistor that is switched in and out of the supply voltage to the ignition coil. The resistor is current limiting as well as voltage dropping. Part of its function is to protect the points. Some ignition systems use dual resistors.

The ballast resistor lowers voltage after the engine is started to reduce wear on ignition components. If the points were to receive full battery current/voltage at all times, they would only last a few hundred miles before needing replacement.

It also makes the engine much easier to start by effectively doubling the voltage provided to the ignition coil when the engine is being cranked. This provides a much better spark just when the car needs it most. When starting a cold engine, the plugs and the air are cold, the cylinder pressure is up, and the fuel/air mixture is poorly controlled. The oil is thick, the battery is cold, and its voltage drops as much as 60% because of the high current drained by the starter motor. It's a wonder the car starts at all. Therefore, a 12-volt ignition system is only used for starting.

A nominally 6 - 9 volt coil is used in a ballasted ignition system.

When cranking the starter, a separate wire gives the points the full 12 volts, bypassing the ballast resistor. When you release the key or starter button, all the power to the points now has to flow through the ballast resistor, thus protecting the points.

On early models, however, there is no separate wire. The points get current directly through the ballast. In order to provide the full 12 volts during a cold start, the ballast is also cold and has nil resistance. As the ballast heats up (some of them can get very hot) the resistance gradually climbs up to 1.5 - 1.9 ohms, thus reducing current to the points.

Some wisenheimer said that to create a hotter spark, bypass the ballast resistor. For the miniscule performance gain, it's not worth running your coil on 12 volts when it's only designed for 9 volts max. You won't blow it right off the bat, but you will shorten its life.

As mentioned in a previous article, the coil will only produce as much spark as the engine demands. Not even an engine modified for racing will notice much gain from a higher output coil. A high output coil (25K+ volts) will give you easier starting, better drivability, and increased overall performance provided the rest of the system is up to snuff.

Other than that, a high output coil just ain't worth the extra bucks for an older car engine. Because of their reciprocating mass, intake systems, and valve train limitations, you'll seldom push it over 5,500+ rpm for very long.

An engine kept in good tune will never require more than 25kV to ignite the air/fuel mix. Only when the engine has been modified (reciprocating mass lightened, valve train improved, induction/exhaust system improved, etc.) will the benefits of the higher reserve capacity offered by a high voltage coil be realized.

An ignition coil does not produce a hotter spark as demands such as higher rpm or increased cylinder pressure are placed on the system. The output voltage of the coil will actually drop as rpm increases past 4500. This is a result of the shorter amount of time the primary circuit has to build the required magnetic field. This is the point of diminishing returns. Obviously, you'll hit a point where the collapse of the magnetic fields occurs so fast as to decrease voltage.

At around 6,000 rpm (3,000 rpm distributor speed) a conventional breaker point or electronic ignition is just about done. Only a magneto, being a small generator in itself, will provide a voltage increase as rpms rise past this point.

It's harder to ignite a high rpm air/fuel mix because:

A. Higher RPMs create more cylinder turbulence. A weak flame front can actually be blown-out by this turbulence.
B. High RPM air/fuel mixtures are harder to ignite because less time between power-strokes means less time to re-load the cylinder with fresh air/fuel mix and less time to remove the burned air/fuel mix.

Many British car owners feel it necessary to replace their standard coil with the Lucas Sport Coil (Part Number: DLB105, $39) to get a hotter spark, up to 40kV. Often, though, they neglect to reset the spark plug gaps and install solid (non-resistor) spark plug wire. Resistor spark plugs and wire ends are not recommended, either. It is also necessary to bypass the ballast resistor used on some of the later models. Failure to do this will negate the benefit of using the hotter coil, as the Sport Coil is supposed to be used without a ballast resistor.

What is the difference between a ballast and non-ballast coil? A non-ballast coil is designed to produce full spark output with 12 volts on the input terminal. A ballast coil is designed to produce the same spark output, but with only 6 to 9 volts on the input terminal.

With a non-ballast coil, the input to the coil is the same 12 volts, whether the engine is running or being cranked by the starter motor. With a ballast coil, the starter relay bypasses the ballast resister when the starter motor is spinning the engine and applies the full 12 volts to the coil. Since the coil is designed to provide full spark with reduced voltage, the application of the full 12 volts produces a much hotter spark, which is an aid in starting.

After the engine starts, coil voltage is dropped to the lower voltage, and the coil output is the same as for a non-ballast coil. The reason the ballast type coil is not run at the full 12 volts (for a hotter spark) is to prevent damage to both the coil and the points.

Now for a bit of redundancy, mostly for those of you who are slaves to old British iron and those who wish they were. With a non-ballast coil, power is applied to the coil directly from the ignition switch. Power to the ballast coil comes from the ignition switch to a resistance wire and then to the coil.

When the starter relay operates, power from the battery is routed through the contacts of the relay to the coil. This shorts out the resistor wire, by placing 12 volts on both ends of the wire. With the same voltage on both ends, no current flows, so no heat is generated. The current flow is shunted around the resistor wire. This bypassing of the resistor wire places the full 12 volts on the coil.

To switch from a ballast coil to a non-ballast coil on, say, a Triumph, merely run a wire from the most convenient white wire you can find (try the fuse box) directly to the + terminal of the coil. You don't even have to remove the resistance wire because it is now bypassed, just like when cranking.

This trick works with any model Triumph, but there is an even easier way with a 1974 - '75 TR6. Remove the resistor bypass wire from the starter relay to the coil (white/yellow) at the relay terminal, and move it to the fuse box terminal where the white wire is attached. The relay is located very close to the fuse box, and there is a spare terminal by the white wire that can be used.

The ballast resistor will need to be bypassed for any coil that is supposed to be used without one, whether it is a high performance coil or just a replacement. For example, in the TR6 the ballast resistor was used only from 1974 on. Why? Mandatory modifications to meet environmental issues made them hard to start, so the ballast type coil was used to get an extra hot spark during starting. Other British motorcars made the changeover around this time, too. However, starting places the most stringent demands on the ignition system.

Bypassing the resistor is only one of the changes necessary to utilize the full advantage of the Sport Coil or any other high output coil for that matter. Unless you also increase the spark plug gap, the plugs will continue to fire at more or less the same coil secondary voltage as before and will not give a hotter spark.

The voltage rise at the output of the coil secondary, although rapid, is not instantaneous. The voltage rises from zero, and as soon as it reaches the value high enough to jump the plug gap, it will. Since the plugs were firing at 20,000 volts with the old coil, they will continue firing at that voltage level regardless of the maximum voltage potential of the new coil. As soon as they fire and the arc begins, the voltage drops to zero.

By widening the gap, the voltage must rise to a higher value to jump the gap. Ideally, the plugs should be gapped to the widest setting that will still allow them to fire under all engine operating conditions. 0.035"-0.040" seems to work best for me.

Usually the coil manufacturer will give a recommended gap setting, but it should be used only as the starting point and be adjusted from there until you find a happy setting. S.K.