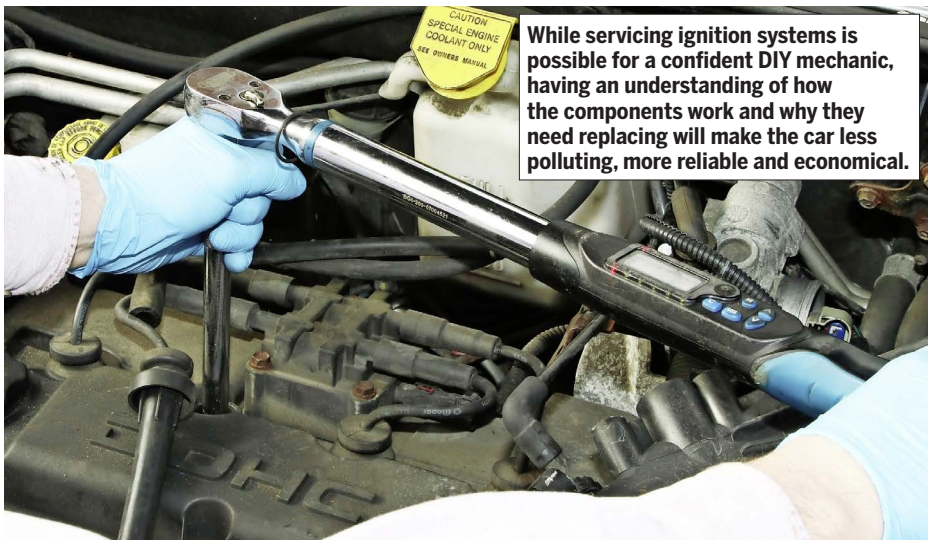
We have IGNITION

Vehicle ignition systems have evolved immeasurably over the years and remain as vital as ever. **Rob Marshall** explains how they work and recommends maintenance and repair tips.



While servicing ignition systems is possible for a confident DIY mechanic, having an understanding of how the components work and why they need replacing will make the car less polluting, more reliable and economical.

Despite huge advances in electronics, the internal combustion engine (ICE) relies still on an ignition source to ignite the fuel/air mixture at precisely the right moment. As their name suggests, petrol, or 'spark ignition' engines, use a high-voltage arc that jumps between two electrodes on a spark plug, located within the cylinder. Diesel, or 'compression ignition' engines, squeeze a volume of air until it reaches a temperature high enough to ignite the heavy oil fuel, but they use glow plugs to facilitate more stable, efficient combustion at start-up and in the initial warm-up phase, especially in cold conditions.

In the early days of spark ignition engines, various means of generating the high voltages to create a spark strong enough to promote combustion were tried, from trembler coil to magneto ignition systems. The history of such systems was investigated in *CM*'s October 2018 issue.

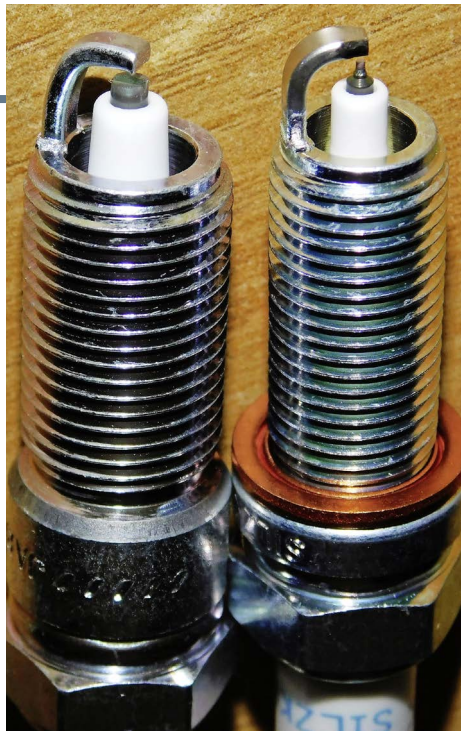
Modern ignition systems are based upon the 'classic' contact-breaker design, which employs both low voltage (or low tension – LT) and high voltage (or high tension – HT) electrical circuits. A coil unit is responsible for generating the necessary high voltage output from a low voltage input. When power to a primary coil of wire within the assembly is cut, the magnetic field collapses, generating HT voltage within a secondary internal coil winding. The spark plug is powered either directly by the coil, or via a series of flexible HT leads, or both. On some cars, up until the early 2000s, a mechanical distributor might be employed, despite having neither vacuum-advance timing mechanisms nor contact breaker points.

On most historic vehicles, the LT circuit is connected to contact breaker points, which function essentially as a switch to supply and interrupt the 12V power supply to the coil. The contact breaker points are opened and closed via a cam on the rotating distributor shaft, connected to the engine camshaft. The distributor tended to be mounted in a way that allowed the motorist to adjust ignition timing manually, but as the contact breaker points' surfaces eroded, the timing would drift gradually from its optimum setting. Maintaining the correct 'points' gap was, therefore, critical to engine efficiency, with adjustment (or replacement) necessary at every service. Dwell angle – which can be measured as a percentage of distributor shaft rotation, as well as angle, refers to the amount of time that the contact breaker points are closed, which affects not only timing but also spark strength, because it varies the length of time that the coil is 'charged' via the LT circuit. This explains why older cars tend to feel more responsive after the ignition system has been adjusted.

Transistorised electronic ignition made contact breaker points obsolete, allowing for less frequent maintenance. They not only guaranteed consistent dwell angles to permit maximum spark strength, but could also vary dwell time at higher engine speeds to give stronger sparks. Dwell adjustment is not possible on modern cars, but live diagnostic readings still reveal dwell data. Modern engine management ECUs ensure that the LT voltage is supplied to the appropriate coil by an internal transistor that is controlled by a microprocessor.

The point at which the transistor is activated is not fixed and can depend on other factors, such as the signals received from coolant/air/Lambda/EGR/knock/throttle monitoring sensors. While the modern ECU has reduced the number of serviceable components within the latest ignition systems, they have become more sensitive to low grade replacement parts and poor fitting techniques.

The spark plug



▶ The humble spark plug lies at the heart of the combustion process and its role in ensuring precise ignition is crucial to extract maximum energy from the fuel, as well as keep emissions to a minimum. While their operating principles are fairly straightforward, there is more going on with a typical plug than you might think. Ensuring that you fit the correct plug for your engine, rather than adopting a 'that'll do' approach, is important to not only keep your engine functioning properly but it also will save you money.

Spark plugs work due to tens of thousands of volts, originating from the coil, jumping between the plug's electrodes, resulting in a spark. The resulting heat starts the fuel and air mixture burning at a controlled rate, which spreads outwards throughout the combustion chamber. Presuming correct spark timing, the pressure of the expanding gases pushes the piston downwards.

Each spark plug is fired approximately eight times per second for a typical idling engine, so its construction must combine not only good conductors but also effective insulators to contain voltages that can exceed 30,000V. The materials used must also have high mechanical strength and be able to withstand huge temperature variations, especially when considering that the heat of combustion is followed by an immediate cooling effect from the incoming air (and fuel mix on port/indirect-injection engines), before the next compression stroke. Under extreme conditions, each spark plug can experience forces that equate to 50 times the force of gravity.

SPARK PLUG CONSTRUCTION

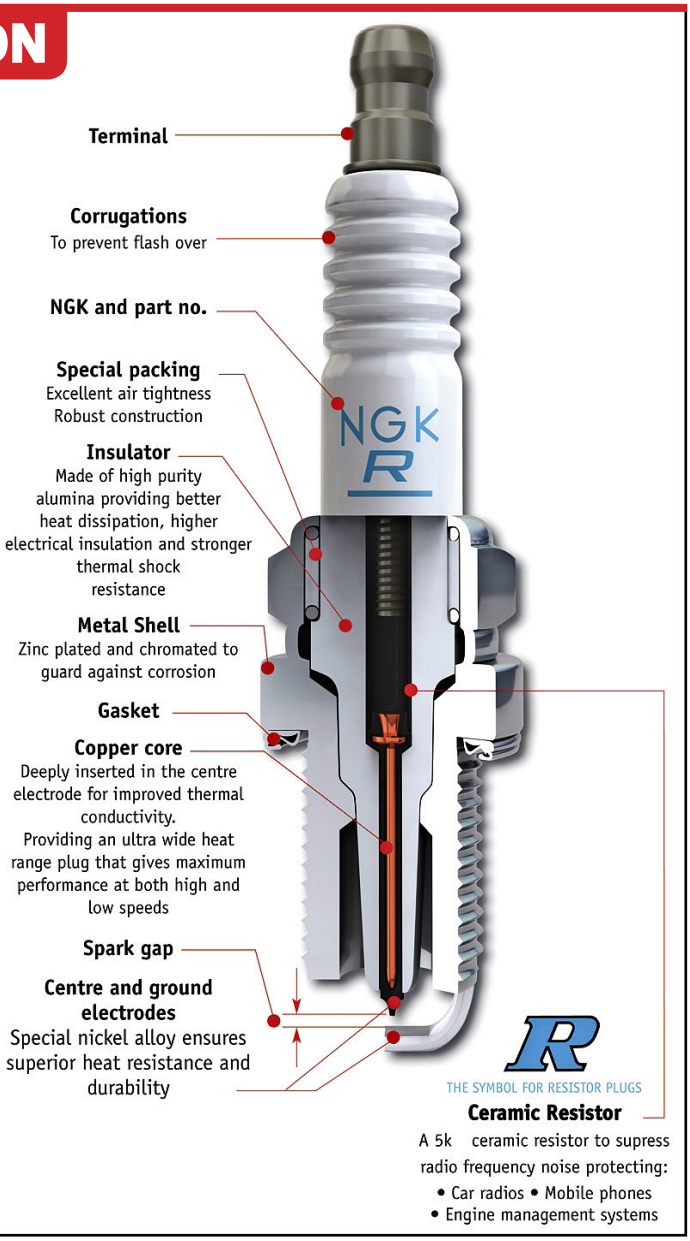
▶ The white base material of the insulator is aluminium oxide, obtained from bauxite, one of the most common compounds found on earth. This aluminium oxide powder is combined with other materials to enhance its mechanical, thermal and dielectric properties. It is then sintered and glazed to produce the familiar hard, smooth form of the plug. The resulting insulator is so good for its intended purpose that it has not changed significantly for many years.

The main electrode is formed from copper and a nickel alloy, which combines good electrical and heat conduction with high wear resistance. To increase anti-wear properties further, especially where very fine electrodes are employed, small chips of semi-precious metals, such as platinum or iridium alloys, are welded to the nickel alloy. Iridium is extremely hard, has a particularly high melting point and is one of the most corrosion-resistant metals available. This allows diameters of 0.4mm to be employed at the centre electrode. Advantages include improved ignition performance and increased service life.

The electrical noise suppression resistor is found within the insulator, 'in series' with the main electrode and, apart from older designs, is formed from a mixture of conductive carbon and insulating glass powder. Varying the proportions of the two materials allows different target resistance values (as required by the car-makers) to be achieved easily without fear of degradation during the life of the plug. The normal target value is 5 kΩ (kiloOhms).

The metal shell that houses the insulator will have one, or more, electrodes welded to it. Depending on application, these may be nickel alloy, or inconel. Inconel tends to be used in applications where special resistance to high temperatures is needed. As a further refinement, a layered copper design can be used.

The sealing washer that is compressed upon installation is usually of a folded mild steel construction, but it can be made from stainless steel, which guards against vibration. Solid copper washers promote good heat transfer, where this is a priority.



Spark plugs: buying advice

ROB'S TOP TIP

When fitting spark plugs into twin-spark cylinderheads (ie, two spark plugs per cylinder), the two plugs can have different thread diameters.

▶ Tim Howes, deputy general manager of the supply chain and technical service department at NGK Spark Plugs, advises: "If the spark plug is the correct one specified for the application, is within its recommended service life and has been installed correctly, it is highly unlikely that the plug is the root cause of any problem."

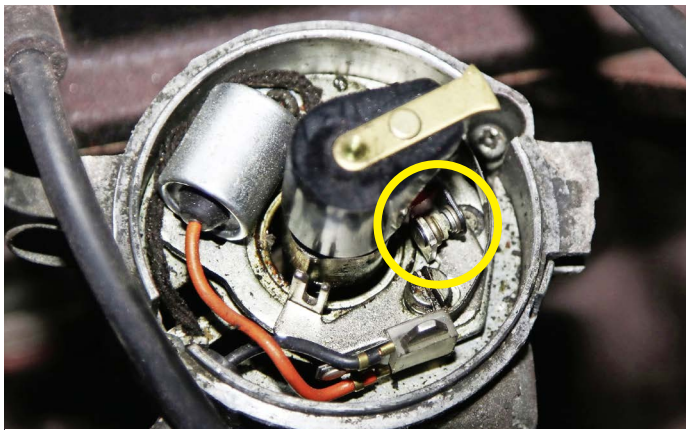
He explains that the plug itself produces neither heat nor deposits; these are the results of the combustion process. However, when a plug's electrical resistance rises, due either to wear, or damage, too wide an electrode gap, the wrong type being used, or oil/water contamination, other ignition components may be placed under additional stress that could curtail their working lives.

This is why spark plugs must be replaced at official service intervals with items having the same specifications (or higher) to those fitted originally. Research the type of plug fitted to your vehicle carefully, because leaner air/fuel mixtures that are more common in modern engines are less tolerant of the wrong spark plug specs being used. For example, high-performance and the latest direct-injection petrol (GDI) engines tend to employ more advanced plugs that use platinum and iridium alloys in their electrode construction.

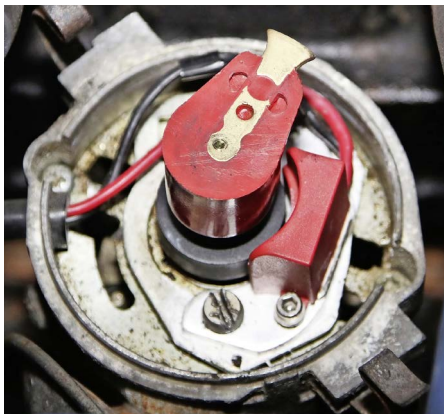
With this in mind, Tim warns against buying generic 'short range' spark plugs that claim to cover up to 95% of the cars on the road. While such a plug might fit physically, its specification is likely to be incorrect. He cites claims of one plug to cover a whole range of different spark plugs, each of which has different design features and heat ranges. The result would be performance, starting, idle stability, engine and catalyser protection, fuel consumption, emissions and durability that are compromised, rather than optimised for a particular application. Such plugs cannot give the specific protection for the catalytic converter that many modern vehicles demand, as well as many of them being unable to provide the necessary cold condition anti-fouling properties required by some GDI engines.

As with an increasing number of replacement components, you should only buy spark plugs from established brands and through trusted sellers. Be wary of cheap, unbranded items, especially from online sources, if you cannot be sure that the vendor is reputable. Tim warns that spark plugs that have not been made to the appropriate quality standards could disintegrate, causing catastrophic engine damage. He also admits to seeing spark plugs sold online as the more expensive precious metal types, but subsequent investigations by NGK's technical experts has shown that they do not contain any precious metal at all.

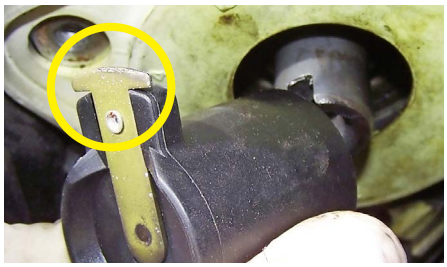
When working on a contact-breaker points ignition system, adjusting the contact-breaker points by assessing the dwell angle is a far more accurate method than using a feeler gauge to measure the gap.



Pictured is a contact-breaker system; the contact-breakers are fitted to the right (circled). The orange wire leads to the condenser (a capacitor), which helps to reduce sparking between the CB points, making them last for longer.



This contact-breaker system has been converted with a maintenance-free PowerSpark ignition module. This replaces the contact-breaker points and condenser with a sealed Hall sensor and transistor, which ensure a constant dwell angle and more powerful sparks at higher engine speeds compared to the old mechanical system.



◀ On mechanical distributors, check the condition of the rotor arm's nose for excessive burns and pitting (circled).

Inspect not only the distributor cap's internal contacts for burns and pits, but also ensure that the centre spring-loaded carbon unit makes contact with the rotor arm.

Water and/or oil contamination at the plugs cause misfires that can damage not only the ignition coils but also the catalytic converter.

Continued on page 10

How to fit spark plugs

ROB'S TOP TIP

The use of dielectric grease within the high-voltage spark plug boot helps to prevent the rubber sticking to the plug as well as flash over.

Avoiding damage to the plugs, when fitting them must be your priority. Yanking HT leads from the plugs, for example, can break them and tools are available to reduce the risk. Should the ignition coil be mounted directly to the spark plug, special tools might be needed to remove them. Before starting work, research if any special equipment is recommended for your particular car model.

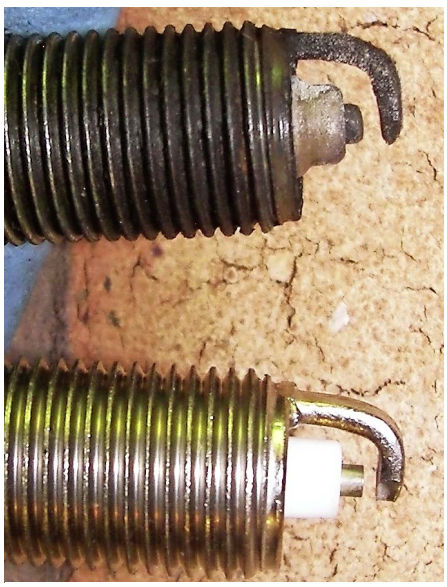
Using a spark plug socket makes removing the plugs easy work, as the rubber insert within the socket should grip the plug sufficiently so that it can be extracted. Once removed, however, ensure that nothing drops into the plug hole. Should the spark plugs be recessed, your extension bar should be as short as possible. Tilting the extension and socket may exert excessive pressure on the plug top, which can crack the brittle insulator.

Most replacement spark plugs for modern engines are pre-gapped at the factory but it is worth double-checking the gap, in case the plug has been dropped in transit. When adjusting the gap, do not place pressure on the centre electrode. On older vehicles, the pre-set factory gap may be too wide, so check and adjust it before installation. If non-LPG spark plugs are used for gas-fuelled cars, upon installation, it may be necessary to reduce the spark gap from the standard specification before fitting them, to reduce the load on the coil. Additionally, re-gapping at service intervals tends to be necessary. In all other instances on modern engines, periodic maintenance should be unnecessary, until the spark plug reaches its replacement interval.

Inspect the state of the old plugs, the deposits on which will tell you a great deal about the mechanical state of the engine. A light brown deposit is what you should seek. Examine the base of the spark plug for evidence of flash over. This is when the spark is discharged between the terminal and the plug's metal body, rather than between the electrodes. While this can indicate a worn, or broken plug, it can also occur if the rubber insulating boots that fit over the white plug insulator have deteriorated. You can identify flash over by looking for black streaks on the plug's insulator, which are formed as the rubber from the cap seal melts, due to the heat from the spark, prior to being deposited on the insulator.

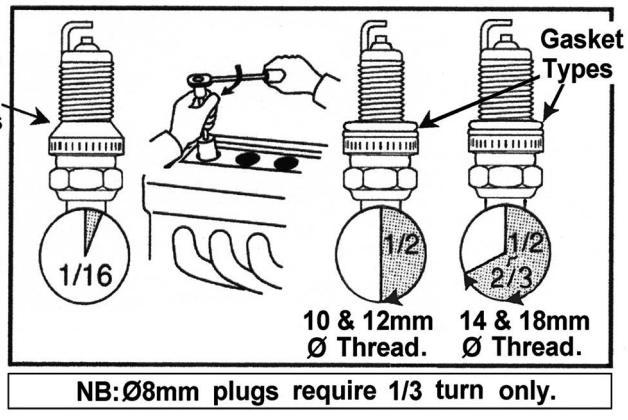
Initial fitting of a new plug should be by hand, to reduce the risk of cross-threading. Correct tightening is commonly overlooked and several spark plug manufacturers told *CM* that under-torqueing plugs is common. The plug's threads and sealing areas play a critical role in absorbing and dispersing heat into the cylinderhead and the cooling system; should the incorrect torque be applied, the plug is more likely to overheat. Engine damage then becomes more likely, because the hot spots can promote pre-ignition. Aside from damaging the cylinderhead threads, over-tightening is a major cause of the plug's metal shell and/or its insulator deforming and fracturing. NGK told us that this type of damage tends to go unnoticed until the plug breaks either while the engine is running, or when the plug is removed. Deformation of the plug's metal shell is virtually impossible to see with the naked eye, but it can interrupt the heat transfer path inside the plug, causing overheating of the centre and ground electrodes, courting severe engine damage. Should you not own a torque wrench, or if access is tricky, an alternative is to refer either to the car-maker's installation instructions, or those displayed on the spark plug packaging. Alternatively, use an angular torque gauge. Precise torque and angle settings vary, depending on engine specification, whether the plug has a sealing washer, or if its seat is tapered.

Applying a lubricant to spark plug threads tends not to be recommended, because the reduction of friction on the threads renders the official torque values inaccurate and risks overtightening. Should you be refitting used plugs, they tend to require tightening 1/12 of a turn. When fitting spark plugs to some GDI engines, follow the manufacturer's fitting instructions carefully, including torque/angle values, because the final position of the spark plug's ground electrode relative to the fuel injector must be considered. If you disregard the instructions, combustion efficiency could be prejudiced, not only affecting engine performance but also resulting in higher emissions and an illuminated engine management lamp.



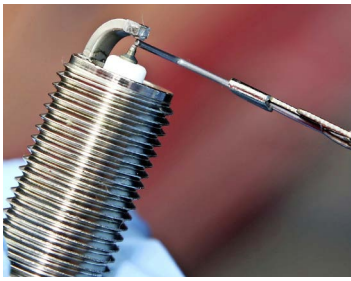
Worn plugs cause the electrode gap to widen, increasing the resistance in the system and putting the coils under additional strain. The difference is that the gap between the worn plug (top) and the new item is noticeable.

Although the 'pin' on this updated iridium-tipped electrode can be just 0.4mm in diameter, it will last longer than a conventional 2.5mm nickel alloy electrode plug, as well as offer superior ignition performance.



Note the washer type used on the plug, which affects the tightening procedure.

A wire gap gauge tends to be preferable to a feeler gauge for iridum plugs, to reduce the risk of damaging the precious metal tips of electrodes.



Upgrading spark plugs

OEM suppliers, such as NGK, adopt a philosophy that a replacement plug should be of the same specification, or higher, than used by the manufacturer. Should you wish to deviate – say, when converting a car to LPG, or if your engine has been modified – seek advice about a different plug specification.

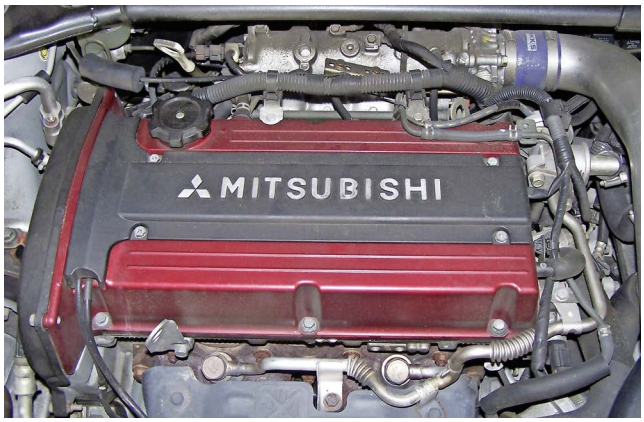
Where spark plug accessibility is a challenge, such as on certain smart cars and Renault V6 applications, you may wish to use long-life alternatives. Multi-electrode plugs distribute wear over a higher number of electrodes, making them last longer, but you should not consider them to be a suitable substitute where fine-wire precious metal plugs are specified. Apart from longer service lives, fine-wire precious metal plugs offer superior performance over conventional nickel-alloy types, due to a more focused and consistent point of ignition, a more efficient burn with fewer emissions, lower voltage demand that places less strain on the coil and a longer service life. Note, though, that many high-performance engines have them fitted as standard, so do not be tempted to replace them with a 'standard' spark plug to save money; downgrading an engine in this way is a false economy.

Spark plug tightening torques *(Courtesy of NGK)*

Spark plug type	Thread diameter	Cast-iron cylinderhead	Aluminium cylinderhead
Flat seat type (with sealing washer)	18mm	35-45Nm 25.3-32.5 lb ft	35-40Nm 25.3-28.9 lb ft
	14mm	25-35Nm 18.0-25.3 lb ft	25-30Nm 18.0-21.6 lb ft
	12mm	15-25Nm 10.8-18.0 lb ft	15-20Nm 10.8-14.5 lb ft
	10mm	10-15Nm 7.2-10.8 lb ft	10-12Nm 7.2-8.7 lb ft
	8mm	– –	8-10Nm 5.8-7.2 lb ft
Conical seat (no sealing washer)	18mm	20-30Nm 14.5-21.6 lb ft	20-30Nm 14.5-21.6 lb ft
	12mm & 14mm	15-25Nm 10.8-18.0 lb ft	10-20Nm 7.2-14.5 lb ft

Using a special tool can prevent damaging the HT leads. Pictured is the Laser 2719 (£22.87).

These special testers allow you to establish whether, or not, a spark is present without removing the spark plugs. A set of four is available from The Tool Connection (part no 2780) for £22.03.



Even on this elderly Mitsubishi Evolution engine, upgraded platinum/iridium spark plugs that need to be changed every 45,000 miles are recommended. The 4G63 installation here employs wasted-spark ignition, where the plugs are fired in pairs. This arrangement avoids the complication of the mechanical distributor and pre-dates the pencil coil-on-plug system (see page 12).

Do not presume that the gaps set on new plugs are correct – adjust them according to the specifications provided in the handbook or on the vehicle.

PRE-IGNITION

Known also as 'pinking', or 'pinging', this metallic rattle occurs when the fuel/air mixture is ignited before the spark jumps across the plug's electrodes. Rather than burning smoothly, the fuel can explode and the resultant long-term mechanical damage can be catastrophic, including holed pistons. On older cars, this could be caused by a variety of factors, such as incorrect timing, inappropriate-specification spark plug heat ratings, excessive carbon build-up and low octane petrol.

Improvements in fuel, lubricants, engine design and electronic management, especially with the arrival of the knock sensor that prompted retardation of the ignition timing if detonation was detected, consigned pre-ignition to the history books, until recently. Low Speed Pre-Ignition (LSPI) has become a known problem with highly-tuned, turbocharged, small capacity direct-injection petrol engines (GDI), in particular. Occurring mainly at low engine speeds, but high load conditions, it is thought to be promoted by the small amount of calcium anti-friction additive from the engine oil that is present on the cylinder walls. Obviously, the ignition system cannot compensate for this. The main advice we can offer is to be vigilant about using the correct engine oil, which tends to be of an ACEA C5 category, that keeps additives that promote LSPI to an absolute minimum.

ROB'S TOP TIP

The newer an engine, the less likely it is to be tolerant of parts that deviate from the specifications dictated by the manufacturer.

Ignition coils

As with spark plugs, ignition coils have evolved to keep up with the efficiency, power, reliability and emissions demands of modern engine designs. Apart from looking very different to their predecessors, the modern pencil coil-on-plug coil weighs 50 times less than the magneto device from the early 20th century. Yet, you are unlikely to encounter a universal design, as they vary depending on the vehicle and manufacturer. Whichever type you encounter, be extremely wary of any high voltage systems on the HT circuit and take the necessary safety precautions, including using insulated gloves and tools, if necessary.

As high resistance in the HT circuit can reduce the life of ignition coils significantly, correct spark plug maintenance is essential. Should the plugs be close to, or over, their gapping/replacement intervals, voltage demand increases markedly. If a misfire occurs, where the plug is so worn that the spark does not jump across its electrodes' gap, the pent-up energy within the coil is released as heat, which can promote failure. A further consequence is that unburned fuel can enter the catalytic converter, increasing the risk of melting its precious-metal-coated internal honeycomb. Faults in other components that result in high resistance, such as worn rotor arm/distributor cap contacts, corroded/loose/contaminated HT leads and even faulty fuel injectors, can all affect the coil's longevity.

Maintenance

As part of routine maintenance, check all wiring for corrosion, cracks, loose connections and evidence of overheating. Should the coil be mounted directly to the plug, it will need to be removed to gain access. Check for perishing, or contamination, of the rubber components. Current leakage tends to manifest itself as a thin line, known as 'tracking', evident from the positive source to the earth. Even if the engine management warning light has not illuminated, interrogate the ECU diagnostically for any historical issues that may have been recorded and might indicate a failing coil pack. This tends to be beyond the capabilities of basic fault code readers and demands more sophisticated equipment.

Diagnosis

An illuminated engine management light, difficulties starting, misfires, poor acceleration/lack of power, or 'limp-home' mode being activated are all typical symptoms of coil pack failure. Aside from the visual checks described above, you should confirm a stable 12-volt input and verify the resistance of the primary and secondary coils, to ascertain their integrity. To do this, use a multimeter and vehicle-specific data that provides details of what each connector/pin does and the relevant resistance values. Should the data not be available, reference values of 0.5-2.0 Ω for the primary and 8.0-19.0 kΩ can be expected with a sound older-style 'can' coil. Expect 0.3-1.0 Ω for the primary and 8.0-15.0 kΩ for the secondary coil on a fully electronic system.

Hella Gutmann Solutions told *CM* that some coils are equipped with a high-voltage diode that suppresses sparks, making it difficult to measure the secondary coil's resistance. In this case, connect your multimeter between the coil's secondary winding and the battery. Should zero voltage be observed, reverse the polarity and a reading should result; should no voltage be noted in either case, it is likely that the secondary coil is suspect; should a voltage be noted in both directions, the diode is faulty.

Live data diagnostics, taken when the engine is running, involve checking the triggering signal from the ignition distributor, or ECU, or else measuring the high-voltage curve with an oscilloscope. However, be wary that a mechanical fault with the engine, such as low compression, can give low voltage readings, which might lead you to blame a coil.

Choosing replacements

As with spark plugs, choosing low-grade replacement coils can have serious ramifications, resulting in poor starting, misfiring and, ultimately, poor reliability. NGK told us that makers of sub-standard coils tend to make cost savings in the general construction, internal windings and potting materials used, which can be difficult to check. Aside from the issues resulting from misfiring, ECUs can be damaged by defective, or non-OE quality, ignition coils, because of excessive fly-back voltages that are fed into the unit, which can promote failure of the internal ignition drivers. Always buy parts from reputable companies, or proven suppliers, that are prepared to offer generous warranties.

An adjustable spark tester is a useful and safe way to test the strength of the coil. This model (part no 5655) costs £25.78 from The Tool Connection.

Continued on page 14

ROB'S TOP TIP

Do not replace a single failed glow plug – renew all of them together.

IGNITION SYSTEMS & TIMING

Aside from supplying sufficient voltage to the spark plugs, the contact-breaker type of distributor provides a means of adjusting the ignition timing according to load. Driven by the camshaft, internal bob weights within the distributor are thrown outwards as engine speed rises, moving an internal cam and adjusting the timing. Load is compensated by inlet manifold vacuum (which decreases under load), which rotates the plate on which the contact breaker is mounted.

This system is fairly inaccurate by modern standards but remained prevalent until the late 1970s, when solid-state transistorised ignition increased in popularity. Modern engine management systems are far more precise, but adjusting ignition timing manually tends not to be possible. Even so, you can verify the timing diagnostically, by looking at live data and comparing it with your vehicle's specifications.

Diesel ignition systems

Early automotive indirect-injection compression ignition engines were extremely simple electrically, mainly incorporating a solenoid for the injection pump, a set of glow plugs and an associated relay/control gear. Glow plugs were necessary, especially on older engines, to pre-warm the cylinder to facilitate cold starting and, in some cases, remained switched on to speed engine warm-up times.

While the latest crop of common-rail direct-injection diesel engines run at much higher pressures, they can start from cold virtually instantly (unless they are in extremely low ambient temperatures), although part of this is due to improved glow plug technology. While modern glow plugs play an essential part in ensuring stable combustion, they are also critical to successful regeneration of the diesel particulate filter. Should one be faulty, regeneration might not take place, which will lead to premature blockage.

Unlike spark plugs, glow plugs do not need to be replaced until they fail, which explains the lack of data in the public domain. For this reason, NGK's Tim Howes recommends: "Because the glow plug is now a vital part of the engine management system, it has never been more important to ensure that the correct specification item is installed. You cannot go for a budget alternative nowadays, because the engine management system can pick up very quickly if it is not to the correct specification and the performance of the vehicle will suffer. My advice is to always to fit a glow plug that has been manufactured to OE specification."

Removal and replacement advice

Practical difficulties, including inaccessibility and an elderly plug seizing in the cylinderhead, conspire to make glow plug removal tricky.

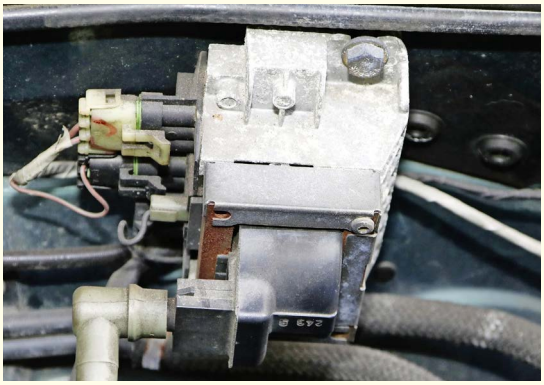
Using penetrating oil might help, as will attempting to unscrew them when the engine is warm. If possible, prior to removal, activate the plugs so that they glow hot. Obviously, do not disconnect the plugs while they are operating and be wary of the high current. Should you be in no particular rush, apply a synthetic oil to the exposed plug

TYPES OF IGNITION COIL

Ignition coil designs vary considerably. These are the main types that you will encounter.

Oil-filled 'can'

Common on classic cars with contact breaker distributor systems, these coils are filled with oil, which acts as an insulator and coolant. More powerful coils than those fitted originally can be bought through classic car ignition system specialists.



Distributor (coil and module/ignition modules)

In most cases, these systems have the contact breaker points replaced by a transistor. You may find that the coil and ignition ECU are combined. The high-voltage is directed to the spark plugs via a separate mechanically-driven distributor and HT leads.

threads and drive the car for a week, prior to performing the work.

Your main concern should be the plug snapping. If access permits it, a torque wrench could be useful when removing the old parts. Do not exceed the following shear torques, according to the thread diameter used:

Thread	Shear torque
M8	20Nm
M9	22Nm
M10	35Nm
M12	45Nm

When fitting new plugs, take care not to drop them. The higher temperature glow plugs with a ceramic structure are especially vulnerable to impact, so treat them with care. As with spark plugs, screw the glow plugs into the cylinderhead by hand, ensuring that the threads are neither damaged, nor obstructed by carbon. Glow plugs are also very sensitive to tightening torques, the values of which should be printed on the box.

If fitted, the terminal nut should be torqued to 0.8-1.5Nm for 4mm sizes, or 3.0-4.0Nm for 5mm fixings.

While Tim Howes told *CM* that, unlike spark plugs, you cannot fit an upgraded glow plug, he emphasised that many manufacturers are choosing to fit New High Temperature Ceramic (NHTC) and Advanced Quick Glow System (AQGS) plugs. These types reach their optimum temperatures very quickly – attaining 1000°C in one second is not uncommon. They can remain active for longer periods without failing after engine start-up, including during particulate filter regenerations. While they are available as replacements, he advises that you should not be tempted to fit lower specification parts, because they can affect starting, drive quality, emission levels, and have severely restricted durability.

SAFETY

Given that the HT system operates at many thousands of volts, safety must be your priority when working on them.

- Do not touch, or remove, the ignition cables, the distributor cap, or the spark plug connectors while the engine is running. Only 40-50 volts is sufficient to overcome the resistance of your skin, with 0.08 amps being enough to cause cardiac arrest.
- Only connect, or disconnect ECUs, HT and LT plugs and wiring when the ignition is switched off.
- During all tests on the ignition system that require you to crank the engine on the starter motor, disconnect the fuel injection power supply to protect the catalytic converter and reduce the risk of a fire.

THANKS TO

NGK Spark Plugs
ngkntk.com/uk/
ngkpartfinder.co.uk/

Behr Hella Service
behrhellaservice.com

Bosch Automotive Aftermarket
tw.bosch-automotive.com

Standard Motor Products Europe
smpe.co.uk

Dual-spark systems

▶ Using a distributorless layout, two spark plugs are supplied with high-voltage by a single ignition coil. High-tension (HT) leads are employed to connect the outlets of the block coil to the individual spark plugs. The ignition coils are triggered by the ECU, which receives an appropriate signal via the crankshaft sensor. The one shown employs a coil that mounts to the plug, with an HT lead connecting the other one. Both plugs are fired simultaneously, so one is triggered on the exhaust stroke, thus employing the wasted-spark principle.

Rail (coil packs)

◀ A rail coil is a row of pencil coils joined into one component. The rail sits directly on top of a bank of spark plugs. The main advantage is for packaging reasons but, should one coil develop a fault, you will have to replace the entire block.

Pencil (coil on plug coils)

▶ Pencil coils are mounted directly to the spark plug. These minimise resistance and increase efficiency, by negating the need for HT leads.