3 The ignition system

This chapter describes the ignition systems used on Wedges. It is quite an involved story, which is why it is a chapter in its own right. The ignition system is not easy and straightforward as you would expect.

Ignition systems

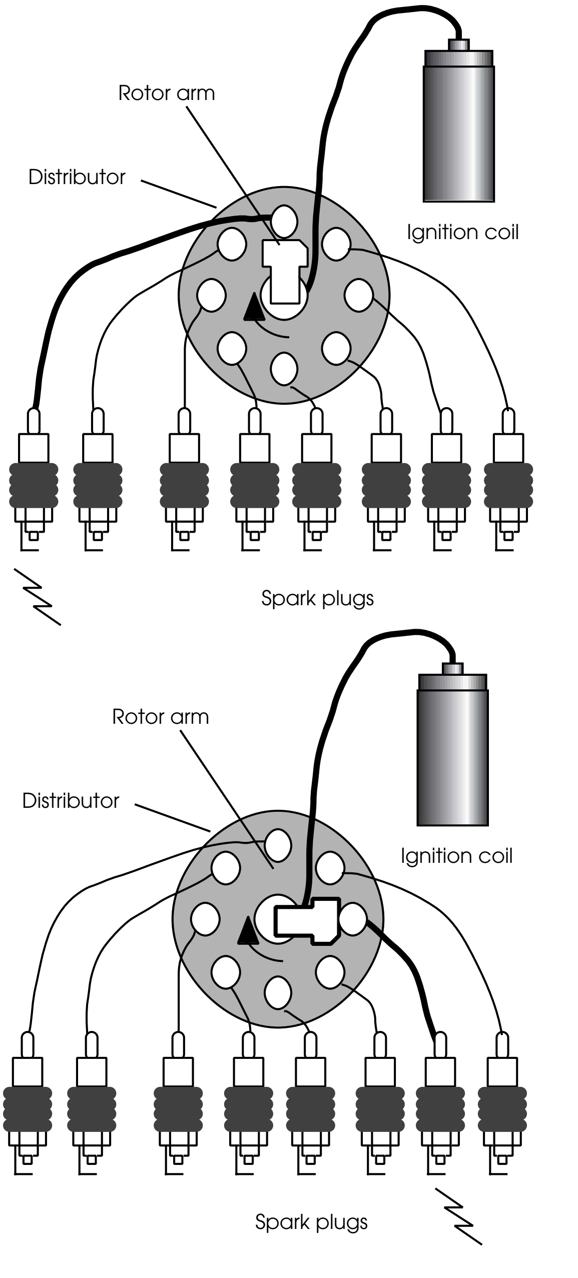
Having described how the fuel is injected into the engine, it is now time to explain how the spark that ignites the fuel is generated. This system is electronic and controlled by the engine control unit (ECU) in all three engines: the 2.8 V6, the 2.0 4 cylinder and the V8 cars.

General principles

The ignition system is based around the distributor, which is mechanically linked to the engine crankshaft. As it revolves, the rotor arm and cam inside the distributor also revolve. The cam is used to make and break a low voltage (12 volt) circuit to the ignition coil. When this contact is broken by the circuit breaker switch, the coil generates a very high voltage (typically 30-40 kV) which is used to generate a spark.

The high voltage is fed back into the distributor so that it can be directed to the correct spark plug by the rotor arm. The high voltage lead from the coil goes into the top of the distributor cap, where it makes contact with the rotor arm inside the distributor, normally through the use of a spring-loaded contact. As it rotates, the rotor arm gets very close to the studs that are connected to the spark plug leads and hence to each spark plug.

The rotor arm is connected to the central distributor shaft which is also where the cams that drive the contact breaker. As a result, the contact breaker opens when the rotor arm is opposite a stud.



The rotor arm has moved round and the spark is distributed to another spark plug.

The 12 volt circuit to the coil is broken and the coil generates a high voltage which is conducted through the rotor arm to the stud. This high voltage is transferred via the spark plug lead to the spark plug, which uses the voltage to generate a spark that ignites the fuel.

Engine timing can be adjusted by turning the distributor body around the shaft so that the circuit breaker opens earlier or later. This timing point can be changed by using a set of weights inside the distributor to make further adjustments as the engine speed changes. This is achieved by using the centrifugal force that the weights experience to physically move the circuit breaker. The weights used in the V8 engine distributors are TVR specials, which give a different ignition advance/retard profile. This essentially mechanical system means that the timing and the circuit breaker gaps need to be periodically adjusted to prevent the engine becoming detuned.

Distributors

The description above is valid for distributors used on older cars. However, the distributors used on all three engines fitted to the Wedges are different. They generally use electronic modules to work out the position of the distributor shaft and hence the engine crankshaft. The cam is replaced with a sensor (either optical or magnetic) that detects the movement of the distributor shaft. This signal is supplied to the ECU which derives the appropriate timing to generate the spark. All this happens electronically under the control of the ECU. The result is that there is little, if anything, that can be done with these distributors except to ensure that the rotor arm and the stud contacts inside the distributor cap are clean.

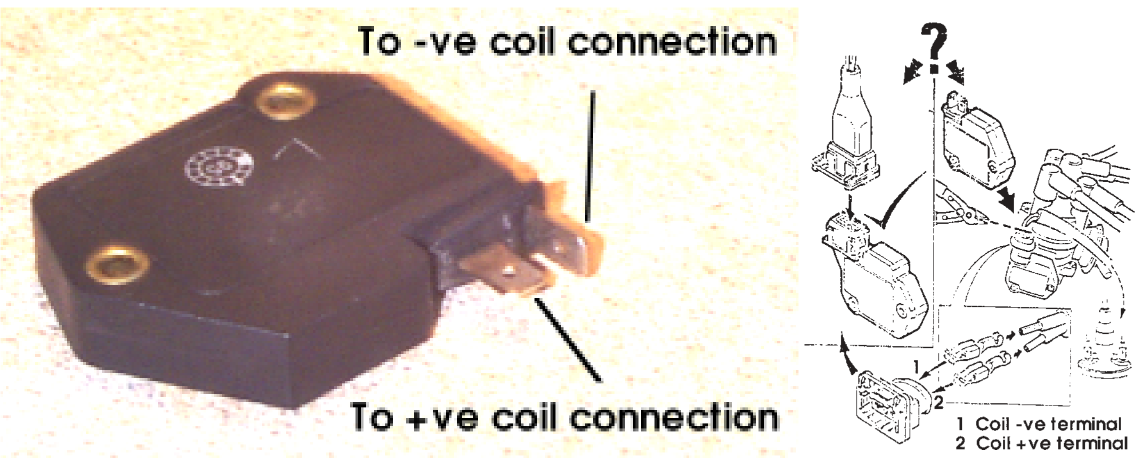
Ford engines

Two types of distributor have been used with the V6 engines: both are fully electronic and the only serviceable parts are the rotor arm and cap. The Motorcraft model (Ford part number 82TF-12100-AAA) should have a blue cap and the electronics lead is on the same side as the vacuum advance diaphragm. The Bosch unit (Ford part no 82TF-12100-ABA) has a brick red cap and the lead is on the opposite side to the vacuum advance diaphragm. Beware that the cap colours may have changed when replaced and therefore it is not uncommon for red caps to be on Motorcraft distributors and so on. The Dwell angle, and so on, is all governed by the electronics and the only thing that can be changed is the static ignition timing. The electronic module is located at the front of the car.

Rover V8 engine

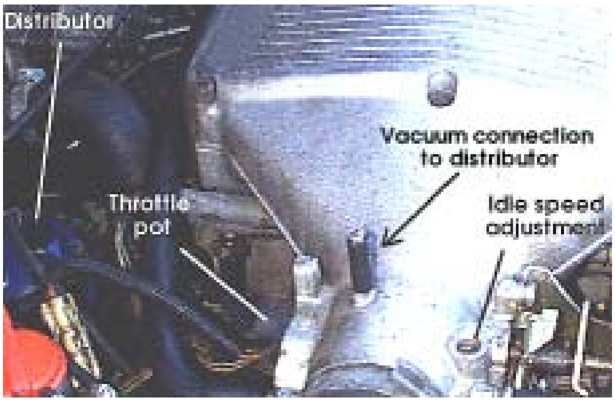
The Rover V8 engines essentially use a Lucas 41935A distributor which has a special ignition module (Lucas part DAB135) bolted to the outside of the distributor body. Again, there is little that can be done with these units except replace the rotor arm, cap and set up the timing. Other distributors do appear to have been fitted, including units that do not use vacuum advance. This may require different timing values to those normally given for the standard distributors and may even require a slightly different set up.

It is not unknown for the ignition module to fail and need replacing. It basically switches the 12 volt supply to the coil to create the high tension voltage for the spark. The unit has two versions: the original, which used two Lucar spade connections, and the current version which replaced these connections with a special plug. The electrical connec-

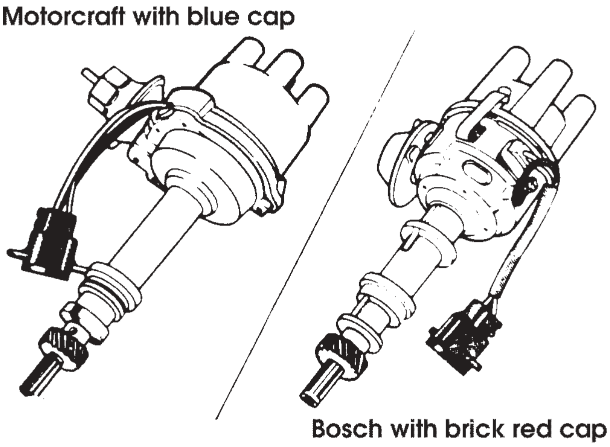


The Lucas ignition module. This is the early version with the Lucar connectors. The drawing on the right shows the connector conversion kit.

tions are thus different and therefore you will need a plug converter kit (Lucas part XXB445) if replacing the original style unit with the new version. The module can be tested by measuring the output voltage from the negative terminal. This will switch as the engine is turned over. Providing the supply voltages are correct, the unit should work and interrupt the coil supply to provide the spark. If not, this normally indicates a fault.



The vacuum connection between the distributor and the plenum chamber. In this case, the distributor is not standard and does not use the vacuum connection. The connection has been sealed with a piece of tubing and a small bolt. Normally a tube connects the distributor and the plenum chamber.



The Ford V6 distributors. (TVR Engineering)

Ignition timing and unleaded fuel

This is not an exact science with TVRs in general for several reasons. The octane rating of petrol has generally gone down over the years and this has led to readjustment of the ignition timing to compensate. Add to that the differences in the distributors that have been used, the engine specifications and tolerances in the engine build and it has become very difficult to simply state that this engine should be set to this ignition setting and that is it. In practice the timings are really a starting point for setting up the ignition and should therefore be treated as a guide only. This is very true with the Rover V8 engines and especially those with highly tuned versions.

With the imminent withdrawal of leaded petrol, one of the major concerns with the Wedges is their suitability for running on regular unleaded fuel. The broad answer is that all V8 engines can and most of the V6 engines will as well. The remaining engines may require valve seat conversion as well as changes to the ignition timing. The main problems with using unleaded fuel were highlighted by TVR in an engineering bulletin as follows:

"The following bulletin describes the situation regarding the compatibility of TVR Sports Cars produced since 1975, and the standard RON 95 (95 ULG) unleaded petrol now being sold by most of the major oil refining companies. The two most important criteria relating to running any engine on 95 ULG are as follows:-

1) The material from which the valve seats are constructed.

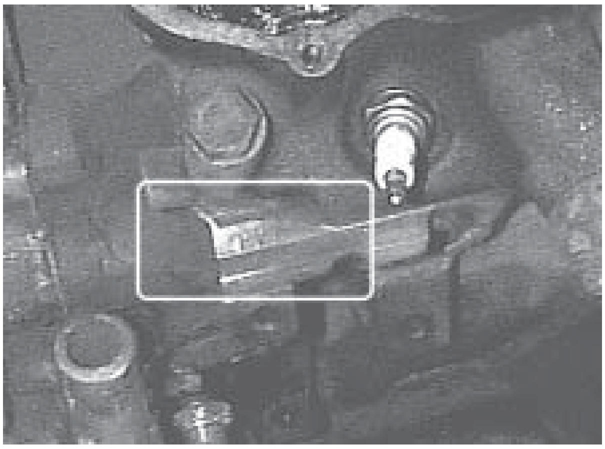
2) Modification (if any) to the static (idle) ignition timing necessary to compensate for the octane drop from 97 leaded to 95 unleaded thus avoiding detonation or the more dangerous pre-ignition. Any engine fitted to a TVR vehicle, which does not have valve seats manufactured from hardened material, may still use 95 ULG, provided that every fourth fuel tank fill is made with 97 leaded fuel, and that the following ignition timing modifications are adhered to. After performing any ignition timing alteration necessary the exhaust gas CO content should be checked and adjusted if required. TVR strongly recommend that after each retune the vehicle be road tested to check for detonation and pre-ignition.

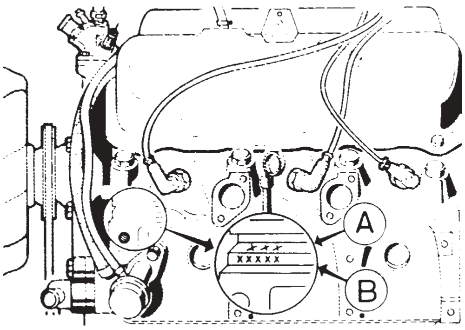
Detonation is the light metallic ping normally termed pinking. This noise can be provoked on most engines by deliberately labouring the engine in a high gear, (i.e. 1500 rpm in 4th or 5th gear). 1 or 2 seconds of pinking under the above conditions is not harmful. If this condition exists for a longer period of time - throughout an acceleration run, then the ignition timing should be further retarded. Pre-ignition is harmful to the engine and sounds like the noise that would be produced by hitting the engine block smartly with a 2 lb hammer. This condition normally occurs under high engine speed full throttle operation and if present during road test, the ignition timing should be further retarded until pre-ignition is eliminated. Neither of the above conditions should be confused with 'running on' — the engine appears to fire once or twice after the ignition has been switched off. This phenomenon has different causes."

A vehicle tuned to run on unleaded fuel can always be run on leaded fuel, providing it is not fitted with a catalytic converter.

2.8 V6 engines

The question of whether these engines can run on unleaded fuel depends on when they were made. For Tasmin FHC Series 1 and 2 cars with the 4 speed or automatic gearbox and made up to 1983, the valve seats are not hardened, so these cars cannot be run continuously on unleaded fuel. TVR recommend that every fourth tank of fuel is leaded. When leaded fuel disappears from the market, these engines will require the heads to be converted or the use of a suitable additive to ensure that valve head recession does not occur.





A = Engine code
B = Engine number

The location of the engine code and number on a V6 2.8 engine. (TVR Engineering)

For Tasmin cars made from 1983 onwards and the 280i models, the situation is different. These may be run continuously on unleaded fuel, providing they have been fitted with the later version cylinder heads with hardened valve seats. These can be identified by looking for the letters D or E that are stamped on the cylinder head exhaust flange upper face, near the middle spark plug.This mark can be very light and covered with grime. Cleaning with some solvent will often help reveal it. Check both sides to ensure that both heads are unleaded unfriendly. Note: it is easy to confuse this mark with the TVR engine number and code which are located on one of the 4 upper flange faces and may also contain a letter D. The engine number is typically below the engine code, which also causes some confusion. The TVR engine number should contain the letters WPP and, from 1985, also has the letter D added. The engine code should start with PR (standing for 2.8 litre fuel injection). If there is no letter, assume that the cylinder head does not have hardened valve seats and will need a tank of leaded fuel or an additive as per the earlier cars.

It is worth checking this very carefully: it is not unknown for engines or just the cylinder heads to have been replaced and so a car that should be fine on unleaded may not be.

To cope with the lower octane, the ignition timing should be adjusted in all cases to 9° BTDC from the normal 12° BTDC. For super unleaded, no timing modification is necessary. US cars should have the ignition already set to 9°.

2.0 litre Pinto engine

These engines cannot be run continuously on unleaded fuel and will require conversion or a lead replacement additive. For premium unleaded, the timing should be adjusted to 4° BTDC from the normal 8° BTDC. For super unleaded, no timing modification is necessary.

Rover V8 engines

All the V8 Wedges can run continuously on unleaded fuel. They have the hardened valve seats and the only modification they need to run on regular unleaded fuel is to have the timing adjusted from 8° to 4° BTDC.

TVR issued a bulletin on the use of Super Unleaded in the Rover based V8 engines several years ago which I have reproduced here:

"Since the above service bulletin was mailed out, a further grade of unleaded petrol has been introduced by several of the major petrol companies.

This new grade, having a minimum octane rating of 98 RON is being marketed as S plus, Premium Unleaded etc. Although not fully tested by TVR, initial trials have suggested that, due to the octane increase from 97 (standard leaded 4 star) to 98 (high octane unleaded), there may be an advantage to be gained from using this fuel with certain TVR models able to cope with lead free petrol.

With the gradual reduction of lead content in petrol, and consequently octane rating, it has become increasingly necessary to reduce the degree of ignition advance during vehicle service. This has been particularly evident with TVR Vee 8 models, where in practice, very few will actually run detonation free with the standard idle advance setting of 8° BTDC. The octane 'factor of safety' that once catered for production tolerances in compression ratio, distributor backlash and combustion chamber deposits etc. now no longer exists. Hence the variation found between the amount of idle advance individual cars will stand before the onset of detonation.

Due to the fact that all TVR Vee 8 engines can be used safely on unleaded petrol (350, 390, 400, 420, 450) there may be a performance and economy advantage to be gained from using the new high octane lead free petrol.

As the new grade becomes more widely available, customers with vehicles exhibiting specific detonation problems should be asked to try the new grade.

In theory, any TVR, with the capability of running on unleaded petrol (subject to the guidelines contained in Electrical Bulletin 002) should be capable of using high octane lead free without any alteration to the idle advance settings. TVR ENGINEERING LTD."

While the usual cause of pinking is using the wrong grade of petrol, there are many other causes: the timing being too far in advance, the mixture being set wrong, poor fuel (cheap brands), the engine running too hot or sometimes by the air entering the air intake being too hot.

In practice, the Ford V6 engines seem less susceptible to pinking than the V8 engines. If a V8 engined Wedge pinks with 4 star petrol, TVR suggest running the car on super unleaded petrol, which has a higher octane rating (98 RON vs. 97 RON). This does work but with the current price premium on super unleaded in the UK, it does increase the running costs.

There are two solutions: get the car tuned dynamically on a rolling road or get it detuned to run on lower grade fuel.

Adjusting for unleaded fuel

One of the biggest reasons for altering the ignition is to retune the engine to run on premium unleaded fuel. In practice this means retarding the ignition by a few degrees. When adjusting the engine, the general practice is to advance the ignition as far as possible without pinking. In practice, this means retarding the ignition to the point where pinking just occurs and then adding an extra degree of retardation. The problem is that the actual value can vary dramatically and some further adjustment may be necessary to ensure that the car meets emission legislation.

However, care must be taken to limit the amount of retardation. You cannot and should not continue to retard the engine if it continues to pink. Pinking can be caused by other factors and, in these cases, adjusting the ignition is insufficient to solve the problem and more drastic solutions are called for, such as lowering the compression slightly or even reducing the temperature of the incoming air. In summary, it is task that can be very simple to do but can have complications. If you are going to do it yourself, please bear these points in mind.

- TVR published information a few years ago on how to adjust the cars for unleaded fuel and this provided the information earlier in this chapter. However they also said that these details are for 'guidance only' and that the tuning should be checked using emission equipment. It may require further adjustment.
- The ignition timings that have been published by TVR for their engines can vary considerably. When I queried this, the comment came back that they were effectively only a starting point and, guess what, check the tune and emissions using the diagnostic equipment. Most cars will be fine but some may not be.
- Talking to many of the TVR specialists who set up these cars, they told me some of the discrepancies that they have come across. Some cars needed 5 degrees of retardation, one that needed over 8 and one needed 20 degrees... but the theory in this last case was that Rover had marked the crankshaft pulley incorrectly. I have heard that this may be quite common. The problem is these values are way beyond the expected range and if they were implemented could lead to damage.
- Many of the older cars have been retrofitted with different distributors with different vacuum rates and different vacuum advance... Again it is difficult to say what the appropriate value actually is. Some distributors have no vacuum advance at all and in this case the ignition timing figures are done by touch and feel!
- The onset of pinking and pre-detonation can occur for reasons other than ignition timing so again a retardation figure may not be applicable for all engines. The air temperature and actual compression ratio can cause pinking when everything else is correct. A lot of the Wedges were prone to this.

In summary, playing with the ignition timing may not be as simple as it looks and getting it done and checked by someone who knows these engines is worth considering. There is a risk of damaging the enging if this is not carried out correctly which is not worth taking.

Ignition coil

The ignition coil is usually mounted on the plenum chamber or bolted to the inner wing or bulkhead. It can get extremely warm and, over time, the insulation can start to break down. As a result, the coil can start to fail when it and the engine get hot. If it does fail, the spark is greatly reduced and the engine will not start or it will misfire due to a lack of sparks. Placing an ice pack on the coil to cool it down will often confirm that the coil is the problem. The only real solution is to replace it.

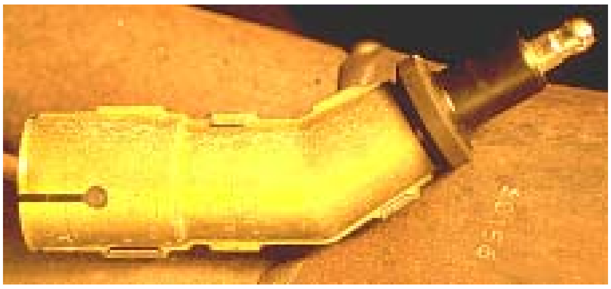
The Ford V6 ignition coil uses a ballast resistor which is bypassed during starting to provide additional electrical current to provide a bigger and better spark. On the Ford V6 powered cars, this is a blue wire loop.

Spark plugs

Spark plugs are a very important part of the ignition system and can cause many problems. They are designed to operate at temperatures between 300 and 700°C. Below 300°C, the plugs cannot burn off the carbon deposits and start to oil up. Above about 700°C, the electrodes start to burn away and at 900°C or higher, the electrodes incandesce and pre-ignite the fuel, causing damage to the engine.

A spark plug's length (or reach, as it is sometimes known) is all important. Too long and the electrodes can overheat. Too short and they can be shielded from the petrol vapour, causing misfiring problems.

Assuming the length is correct, the operating temperature is dependent on the spark plug's ability to conduct heat away and the compression ratio of the engine. The compression ratio defines how hot the engine runs internally in the cylinders and this has led to the concept of hot and cold plugs.



The spark plug shroud. This should pull off but it can be quite stubborn. In the background is the exhaust manifold.

Hot and cold plugs

A cold (or hard plug) is built with good thermal conductivity so heat from the engine is dissipated through the screw thread body and the correct operating temperature of a normally hot engine is maintained. A hot (or soft) plug is not as good as a cold plug at dissipating this heat energy. Therefore if a plug is overheating in an engine, a potential cure could be to fit colder plugs that can better dissipate the heat away and thus bring the operating temperature down to within the correct range.

High compression engines, like the ones fitted to S series cars, run hotter — so cold plugs are normally used. For cold running engines, hotter plugs would be used. It is important that the correct plug is used. It is also likely that different plugs — hot or cold — may have been used to ensure that the spark plugs operate at the correct temperature. So be careful: if your car is running well using a particular brand and type, take note and always use those plugs.

Spark plug condition

Looking at the plugs can tell a lot about an engine. Here are the descriptions of various conditions and their causes.

Normal

The plug tip should be covered in grey-brown deposits with no sign of black carbon or oil.

Carbon fouling

The plug tip is covered in carbon black soot which can be rubbed off. This problem results in a weak spark and misfiring. The normal cause is too rich a mixture, which can be the result of blocked air filters, defective temperature and air flow sensors or just too many miles crawling in traffic jams.

Oil fouling

The plug tip is covered in a wet black deposit. This causes a weak spark and misfiring. The normal cause is worn bores and/or piston rings or worn valve guides. A hotter plug can sometimes help if there is no sign of wear.

Overheating

The plug tip is glazed with no deposits and the ceramic core nose is very white. This is symptomatic of an ignition timing problem, weak fuel mixture, octane rating too low or the plug being too hot.

Electrode damage

Here the electrode is actually starting to burn away. This is symptomatic of an ignition timing problem, weak fuel mixture, octane rating too low or the plug being too hot.

Changing spark plugs

This should be easy to do, except that the plugs are quite difficult to get at and I needed a couple of different size plug sockets to do the job. A 1/2 inch drive socket will do most but a 3/8 inch drive socket is useful for the end plugs near the bulkhead. Before removing the plugs, clean out the hollow in which each plug is located so that dirt does not get introduced into the cylinder when the plugs are removed.

When replacing the plugs, make sure that they are not cross-threaded. A good way of doing this is to put them back by hand so you can feel how well they are going back in. I also found that an old gardening glove was very useful to protect my hand and knuckles from inadvertently touching the exhaust manifold. I now keep such a glove in the boot for

Accessing the spark plugs can be very tight. Without the metal shroud, the rubber cap and lead would touch the exhaust manifold and melt the insulation. Eventually this would lead to a short circuit.

It can get worse! The rear plugs are extremely difficult to access! It is also very easy to inadvertently get dirt into the threaded holes and cylinders.

this purpose. The spark plugs are usually but not always fitted with a metal shroud. It is important that this is always replaced as it prevents the spark plug leads from falling onto the exhaust manifold, melting the insulation and causing the lead to fail. These shrouds can be difficult to remove. I have found unscrewing them will often help but they should pull off!

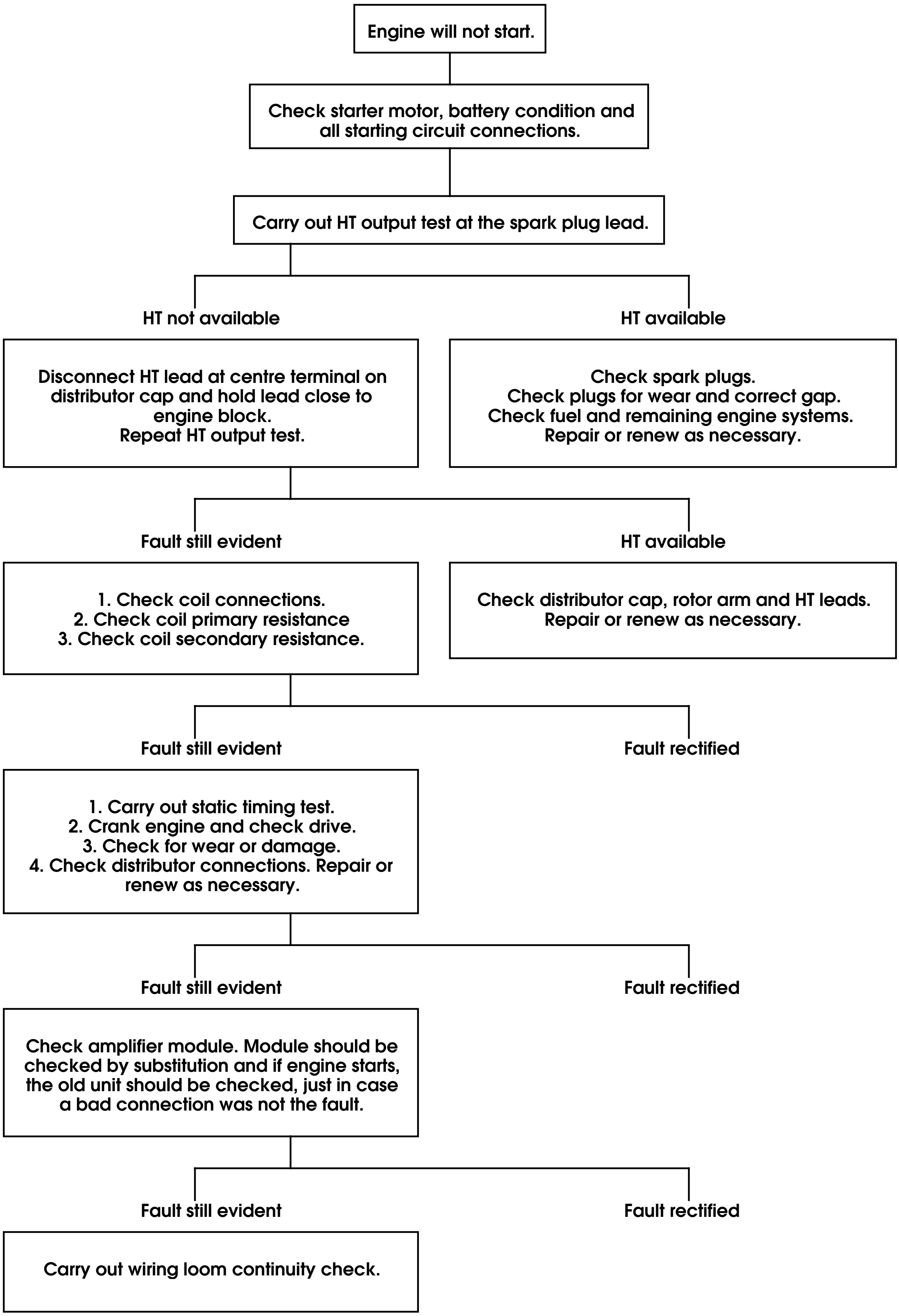
Fault finding

Fault finding is relatively easy, providing you have a multimeter to check that the appropriate voltages are present, that connections are made correctly and the components have the right resistances. TVR produced a fault finding chart that describes the process and order in which to carry out the checks. The HT checks can be done by holding the HT cable a few mm from the engine block or alternatively a spark tester can be used. The spark tester has the other benefit of being to give some idea of the strength of the spark.

The module amplifiers cannot really be completely tested. It is possible that despite having the correct voltages they are partially failing and causing the problem. I have experienced this with the Lucas ignition module which would work sometimes but then fail under load. In these cases, the only real method of testing is to substitute a known working module. Such substitution can be an expensive method of diagnosing a problem and, in these cases, it may be cheaper and quicker to call in the professionals.

Ignition details

The ignition settings and other information for the V6 2.8 litre, the 2 litre Tasmin 200 and the V8 powered cars are shown overleaf after the fault finding flow chart.



The fault finding chart for the ignition system. (TVR Engineering)

Parameters	V6 2.8 litre	2 litre	V8 powered
Spark plugs	Motorcraft AGR22C* Motorcraft AGR12C	Motorcraft BRF32	Unipart GSP151 NGK B7ECS**
Spark plugs (US only)	Bosch WR8DC		
Plug gap setting	0.6 mm (0.025in)	0.6 mm (0.025in)	0.9 mm (0.035in)
Plug gap setting (US only)	1.0 mm (0.045in)		
Ignition timing (std)	12°±2 BTDC at 850 ± 50 rpm Vacuum advance disconnected & plugged	8° BTDC	8° BTDC
Ignition timing (U/L)	Retard to 9° BTDC	Retard to 4° BTDC	Retard to 4° BTDC
Dwell angle	Not applicable	48-52°	Not applicable
Firing order	1 4 2 5 3 6	1 3 4 2	1 8 4 3 6 5 7 2
Ignition coil	Bosch/Motorcraft	Bosch/Motorcraft	Lucas 35C5
Primary resistance	Typically 1.1 to 1.3Ω	Typically 1.1 to 1.3Ω	Typically 1.2 to 1.4Ω
Secondary resistance	Typically 7500 to 9500 Ω	Typically 7500 to 9500 Ω	Typically 7500 to 9500 Ω

* The handbook states the AGR22C plug while the AGR12C plug is specified in other TVR documentation.

** This plug is better at preventing pinking and the first choice to use.