Manchester XPAG Tests

Part 10 - Solutions - Fitting a vacuum advance to an XPAG

Introduction

After the spark plug fires a fireball of burning mixture about the size of a pin head is created. At first this fireball grows slowly, increasing in speed until the whole of the air / fuel mixture is burned. Because this process takes a relatively long time, it is necessary to fire the spark plug in advance of the piston reaching Top Dead Centre (TDC) to give time for the mixture to burn in time for the start of the power stroke. This is called ignition advance.

There are many factors that affect the speed at which the flame front grows, one significant factor is the cylinder pressure at the end of the compression stroke. The lower the pressure of the mixture the longer it takes for the flame front to grow.

This cylinder pressure is related to throttle setting and to a lesser extent compression ratio. With a partially opened throttle, less mixture enters the cylinder so the lower the cylinder pressure when the piston reaches TDC. As a result more ignition advance is needed at low throttle settings than for full throttle at the same engine revs. This is where a vacuum advance plays its part.

The centrifugal advance is separate from the vacuum advance. It controls how far in advance of TDC the spark plug fires, increasing as engine revs increase. To avoid the engine being too advanced and pinking, the centrifugal advance should be set at full throttle when the mixture burns the fastest. The vacuum advance is “added onto” the centrifugal advance to further advance the ignition timing at low throttle settings.

The tests at Manchester showed that advancing ignition timing significantly reduces exhaust temperature. As normal road driving mostly uses a partially open throttle, a vacuum advance is especially important for road driving to help keep the exhaust and engine cooler.

Vacuum Advance

To prove an additional advance at low throttle settings, the Z Magnette, MGA and the majority of later MGs were fitted with a vacuum advance as standard. This consists of a vacuum pod on the distributor connected by a fine tube to the inlet manifold or carburettor(s). At low throttle settings, the pressure in the inlet manifold is below atmospheric causing the vacuum pod to advance the timing by rotating the plate on which the points are mounted.

Usually, the vacuum advance pods are marked with three digits, e.g. 5-13-10. This indicates that vacuum advance starts at 5 inches of mercury (inHg), ends at 13 inHg, and produces 10^{o} of distributor advance. The distributor rotates at half the speed of the engine, so this corresponds to a maximum of 20^{o} engine advance at 0.43 Bar. The different degrees of advance for given pressures is called the Vacuum Advance Curve. This is typically a straight line going from 0^{o} at atmospheric (full throttle) to the maximum around 15 inHg (closed throttle).

The cylinder pressure, when the plug fires, depends to a degree on compression ratio as well as throttle setting. For this reason engines with different compression ratios are fitted with different advance pods. The optimum maximum vacuum advance for the XPAG with a 7.25:1 compression ratio, as measured at Manchester, was found to be 15^{o} (crank) at 15 inHg.

With a mechanical distributor it is possible to vary the vacuum advance by changing the pod. On programmable electronic distributors this is a lot easier and is done on a computer.

If your car is fitted with a vacuum advance, it is important to check that it is working properly. To ensure it actually works, remove the distributor cap and pipe connected to the inlet manifold and suck on the pipe ideally using a vacuum pump. You should see the plate with the points rotate. A more effective check is to re-measure the advance curve, as described in previous articles, this time with the vacuum advance connected. You should get a curve that runs 5^{o} – 15^{o} in advance of the centrifugal one.

Superchargers

A warning for those cars fitted with superchargers.

Superchargers **INCREASE** the pressure of the gases in the inlet manifold above atmospheric. This causes the flame front to grow more quickly requiring **LESS** advance. Setting the vacuum advance on these engines is more difficult as the pod on a mechanical distributor may not cope with positive manifold pressures.

Fitting a vacuum advance to an XPAG

The distributor on the XPAG was not fitted with a vacuum advance. Tests using a 123TUNE distributor in my TC and feedback from others who have fitted a vacuum advance to their T Types is very promising. The engine temperatures are noticeably lower in slow moving and stop-start traffic, where the *Weak Running* problem is at its worse, in addition, the engine runs cooler when cruising on the flat up to around 35-40 mph. Overall response is better.

If your car is not fitted with a vacuum advance, fitting one is something worth considering.

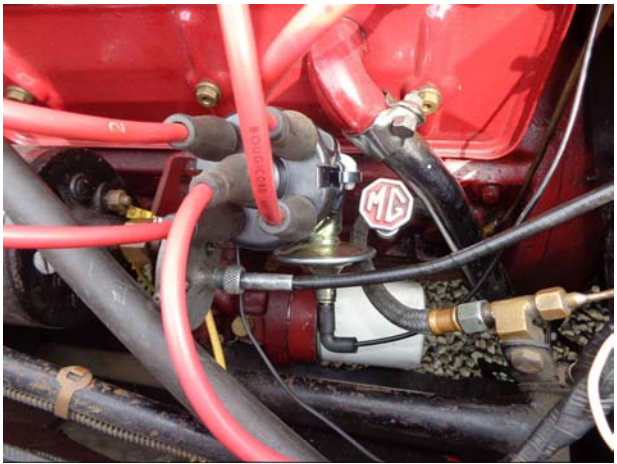
Options

There are three suggested ways to fit a vacuum advance, either a mechanical distributor with a vacuum advance pod, an electronic distributor with a vacuum sensor, or an external electronic box that has a vacuum advance facility.

Mechanical options are to use an MGB 25D4 or 45D4 distributor or a Metro 59D4 distributor. All of which are relatively easy to source. For XPAG engines, it is necessary to replace the drive dog with a gear (available from NTG http://www.mgbits.com/contents/en-uk/p5341_Gear-Distributor.html).

These will fit directly into later TDs and TFs (i.e. those fitted with the D2A4 distributor). However, they will require additional machining modifications in order to fit the earlier XPAG engines using a DKY4A unit. With this distributor distance between the base of the distributor and the drive gear must be increased by approximately 5mm, to accommodate the thickness of the Vernier, and a groove must be machined into the shaft to take the locating bolt.

The advantage of a mechanical distributor is that it is simple, efficient and relatively easy to fix should it go wrong. Unfortunately on the XPAG, there is very little space to accommodate the vacuum advance pod because of the dynamo and tachometer gearbox, making a mechanical replacement distributor less than the ideal choice.



Barrie Jones has fitted a 45D4 distributor to his 1500TF. This has a relatively small vacuum pod which means it fits reasonably well in the confined space. He has used the holes in the carburettor, described below, for the vacuum take off.

On its own it is probably not worth fitting an electronic distributor in the XPAG. Many classic MGs cover only a few thousand miles every year. At this rate of usage, a rebuilt mechanical distributor fitted with a good quality condenser will run for a number of years without the need for maintenance. The tests at Manchester showed that, over a very large range, spark energy had no effect on power output or the efficiency of the engine. Cyclic Variability appears to add around 5^{o} to 10^{o} error to the timing, greater than the $1^{o} – 2^{o}$ timing error of a mechanical distributor.

As a result, the benefits claimed for electronic distributors; lower maintenance, stronger spark and more accurate timing, give little practical improvements compared to the potential problems of a more complex system that cannot be easily fixed at the side of the road should it fail.

However, some electronic ignition systems offer two real advantages, a vacuum advance and the ability to program the centrifugal and vacuum advance curves.

One possible solution is the 123TUNE which can be supplied as a replacement for the MGB distributor. For earlier XPAG engines, it will need to be modified as described above (conversions are available from www.123ignition-conversions.com). This distributor is slightly smaller in size than the original and with no vacuum pod, just a small brass vacuum tube (seen on the left hand side of the picture), it fits very well in the confined space. This distributor allowed me to reprogram the standard centrifugal advance curve to exactly match that measured at Manchester.

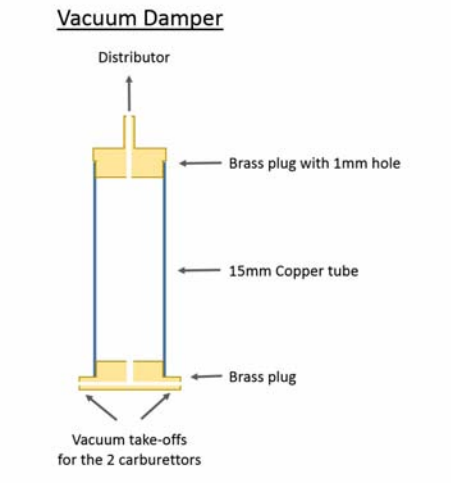
CSI also produce electronic distributor for the XPAG, however, the version with the vacuum advance has a pod similar to a mechanical distributor making fitting difficult.

An alternative is to use an external box that connects to the existing distributor, such as the Aldon "Amethyst" Mappable Ignition System, Interceptor™ Ignition or CB Performance Black Box Programmable Timing Control Module. These use the original points with the centrifugal advance locked. The benefits are they are easy to fit and should they fail, relatively easy to revert to using the mechanical distributor. However, currently they are only supplied to fit negative earth cars. While it is possible to make an inverter for the points to allow it to run on a positive earth car. No tests have been done with this unit with or without an inverter fitted.

Vacuum Take off

The vacuum advance on a distributor or external box needs to be connected to some point on the engine side of the carburettor butterfly to give a measure of the pressure of the gases entering the cylinder. There are three possible options; use a take-off on the carburettor, adapter plates fitted between the inlet manifold and carburettor or from the inlet manifold itself.

Each of these take-off points have different characteristics that need to be considered namely; speed of response and pickup from tick over. For cars with twin carburettors, it is better, though not necessary, to T together connections to both of the carburettors as this will give a balanced measurement and be less prone to being affected by pressure pulses.



The articles on the Manchester tests have already discussed how *Slow Combustion* can result in pressure pulses in the inlet manifold. A vacuum take-off point which gives a good response to the changes in pressure, will potentially also pick up these pressure pulses and produce the wrong vacuum advance.

A suggestion is to buy cheap vacuum gauge (e.g. https://www.ebay.co.uk/b/Car-Vacuum-Gauges/33680/bn_876975) and fit it to the distributor end of the vacuum tube. If the needle

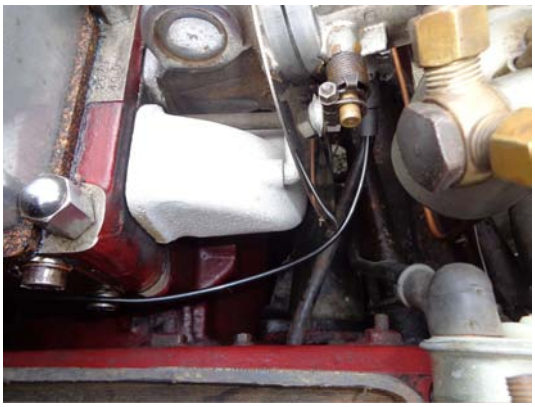
vibrates when the engine is running, it is advisable to fit a damper between the take-off point and distributor.

I have made a damper from a piece of 15mm copper pipe with two connectors on one end to take the two feeds from the carburettors. The other end has a single connector to the distributor with a very fine 1mm diameter hole.

The second potential issue is engine pickup from tick over. When ticking over, there will be a high vacuum in the inlet manifold potentially resulting in a large advance. As the throttle is pressed, more air fuel mixture will enter the cylinder and this will require less advanced ignition. Unless the distributor can respond sufficiently quickly, or there is a mechanism to prevent advancing the engine at low revs, the engine may initially run too advanced, running unevenly or possibly even stalling. In practice, this may not cause a problem but it is something to be aware of.

On some electronic programmable units it is possible to set an rpm below which there will be no vacuum advance, avoiding this problem completely. Unfortunately, there is nothing that can be done with a mechanical distributor.

Carburettor body take off



Some carburettor bodies already have a hole drilled into them at the bottom, particularly the ones fitted to later vehicles. These are normally blanked off but Burlen Fuel Systems sell an adapter that will screw into this hole. The advantage of using this is that it provides a rapid response to changes in inlet manifold pressure, hence it is advisable to consider a damper. At tick over, the hole is blocked by the butterfly which helps prevent over advancing the engine on initial pickup. If it is available, this is probably the best take off point to use with a mechanical distributor.

Adapter Plates take off

Specially made adapter plates were used at Manchester to measure the inlet manifold pressure during the tests. These were fitted between the carburettors and inlet manifold and I now use them on my TC. The advantage is they provide a rapid response to changes in pressure and require no permanent alterations to the car. The picture shows a plate fitted with a vacuum take-off. Spacers are also available for most carburettors and by drilling a fine hole and fitting a pipe they could be used in the same way.

Using a damper should be considered and, unlike the carburettor take-off, there is no mechanism to prevent over advancing the engine from tick over. This is probably the easiest solution to use with an electronic distributor or external electronic box.

Inlet Manifold take off

Rather than drill and tap the inlet manifold itself, it is possible to fit the vacuum take off using a modified core plug that fits into the end of the balance tube (core plugs are available from NTG Motor Services Ltd). This will provide a slower response, removing the need for the damper, but consideration will need to be

given to prevent over advancing the engine from tick over if this shows itself to be a problem.

Conclusion

A vacuum advance reduces exhaust and under bonnet temperatures especially when driving at slow speeds or in stop start traffic. Where cars are fitted with a vacuum advance, it is important to ensure this works properly. Unfortunately, the XPAG and other early cars are not fitted with one.

Early indications from people who have fitted a vacuum advance to their XPAG and MPJG engines are that it is one of the most practical solutions helping to mitigate the problems of modern fuel. Specifically the high under bonnet temperatures that make the volatility problems of modern petrol worse. At low throttle setting, advancing the ignition timing, reduces exhaust temperatures without the risk of pinking.

It is also important the correct centrifugal advance curve is used. The Manchester data showed the standard XPAG centrifugal advance curve for a rebuilt distributor were around 5^{o} too retarded below 3,000 rpm due to the *Slow Combustion* problem. It is suggested that other registers in the club arrange for a typical car to be taken to a rolling road to measure the ideal centrifugal and, if possible, vacuum advance curves. These would provide a good baseline for other owners.