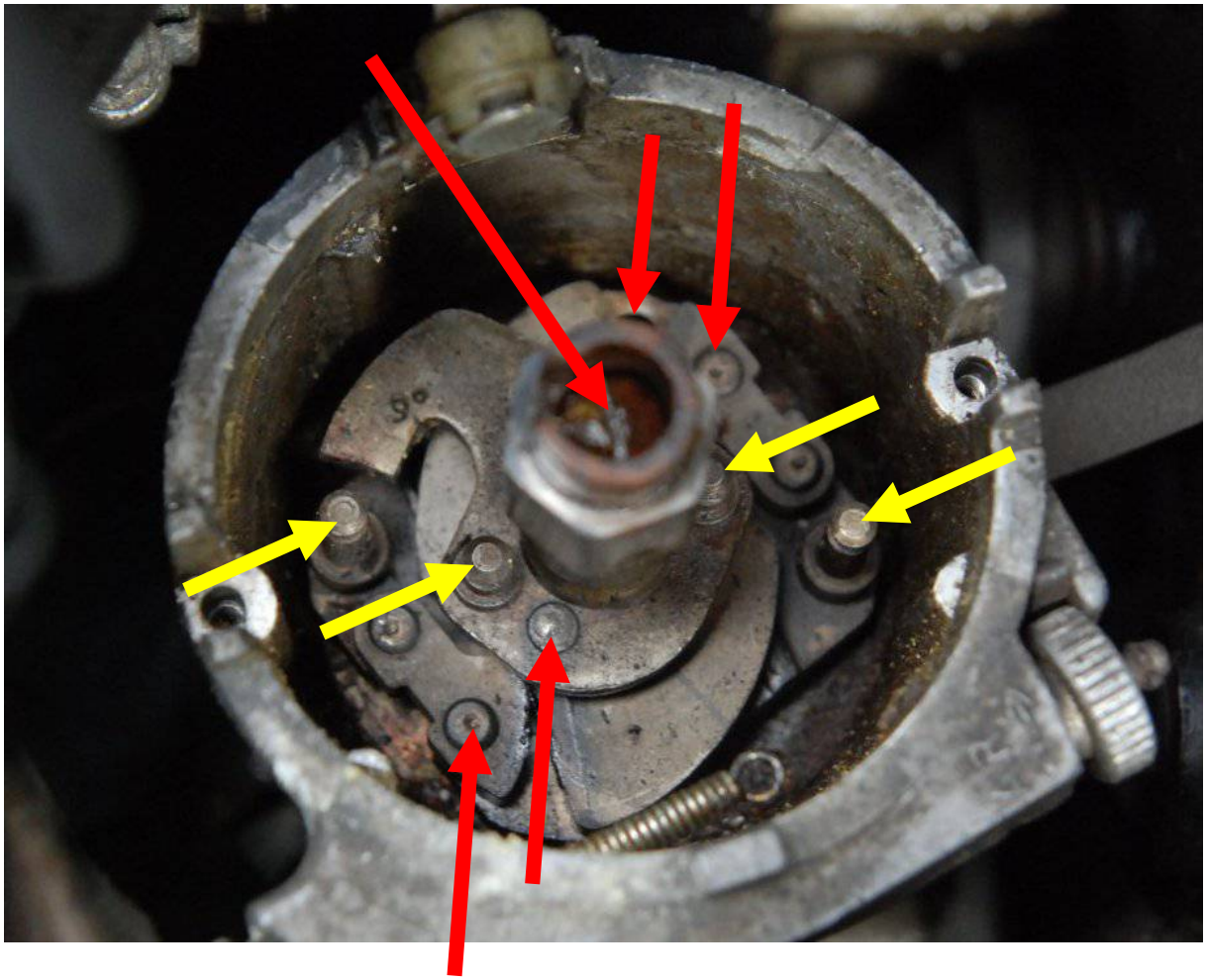
“Amethyst”

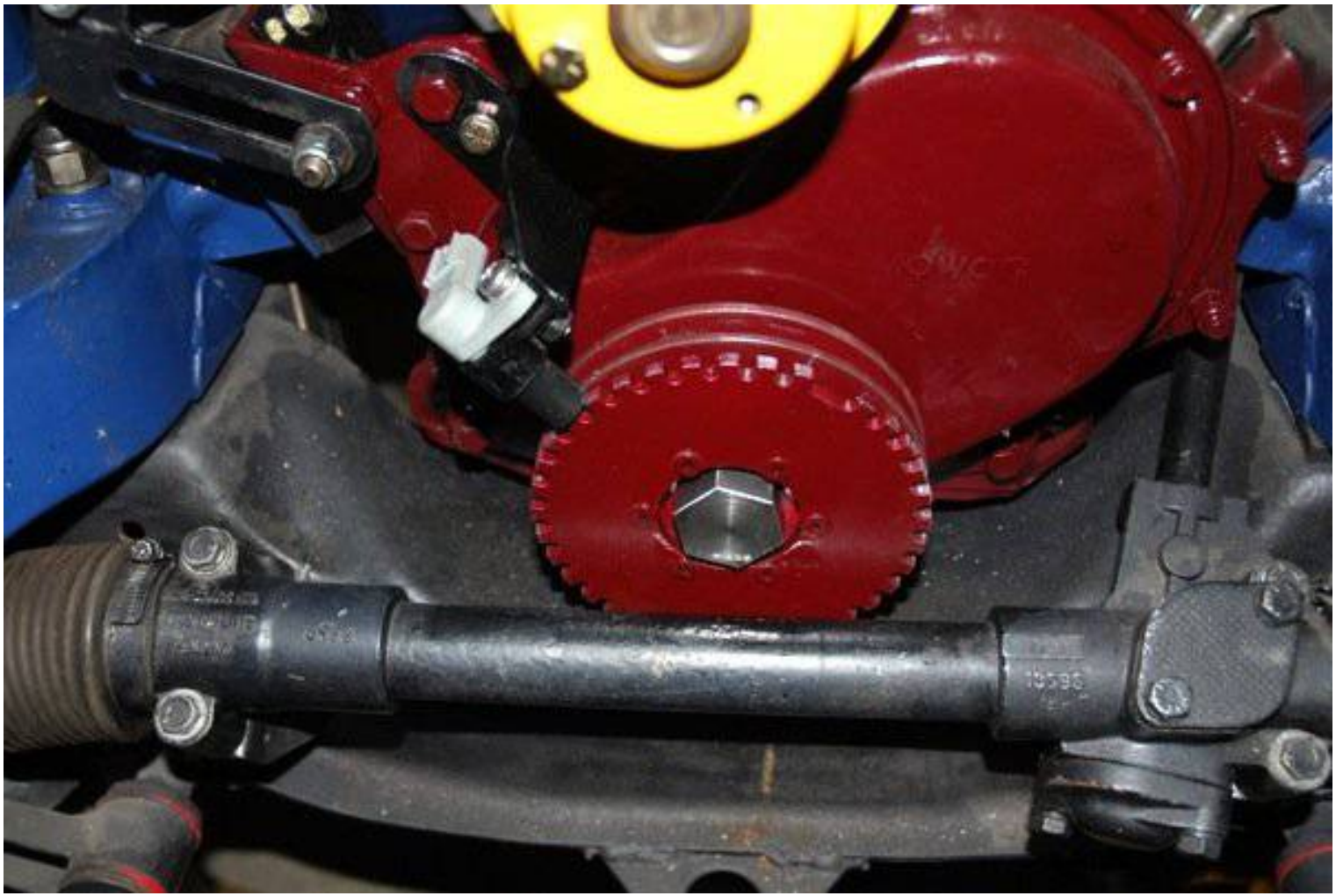
Mappable Ignition System

Where the project began...

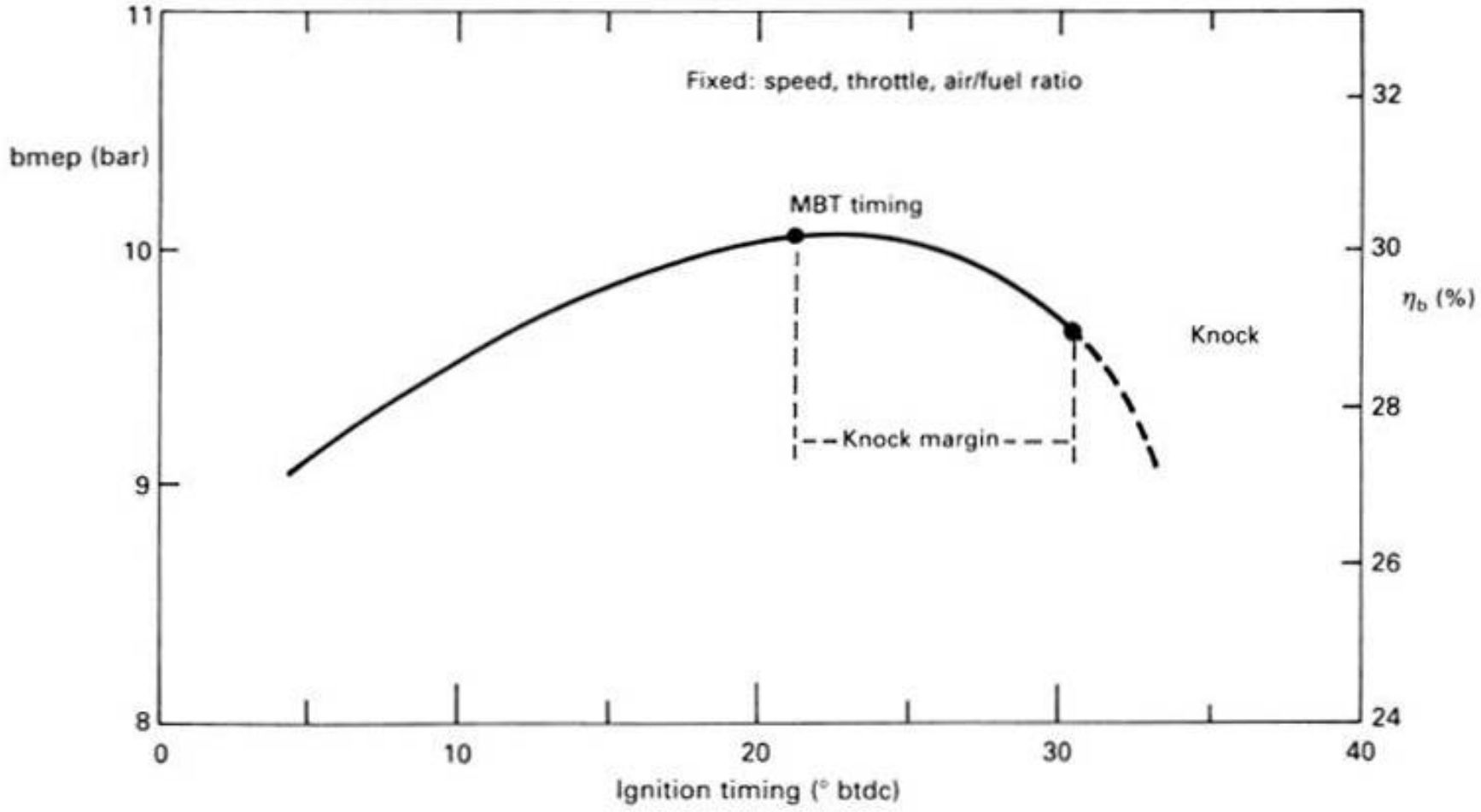
Centrifugal advance mechanism



Use a crank sensor?



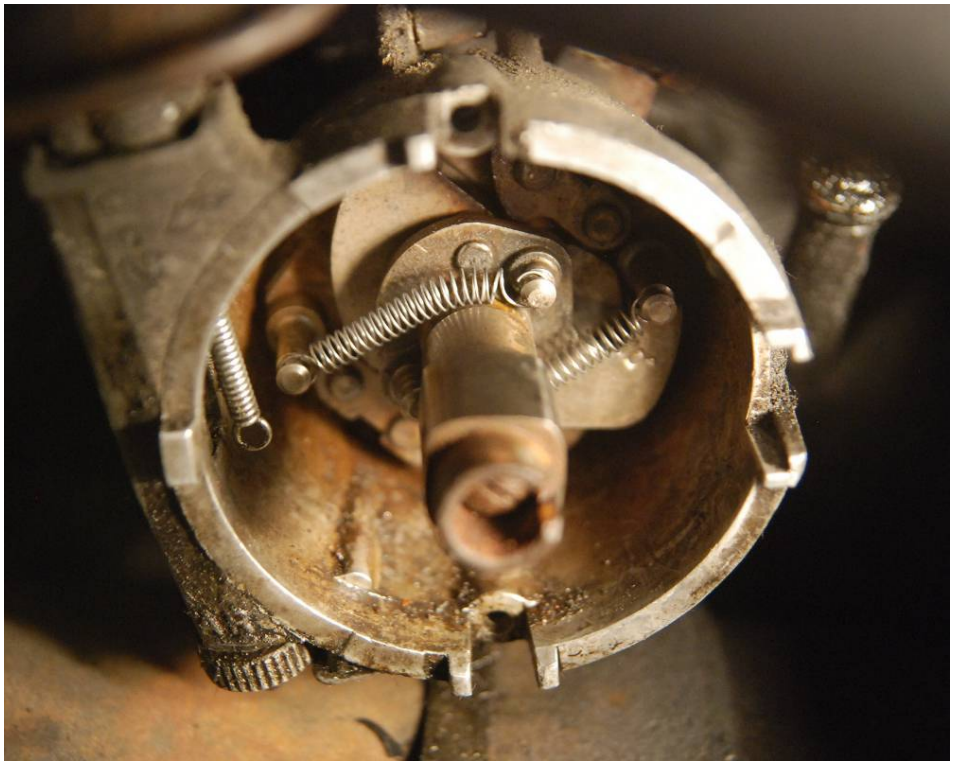
Torque versus ignition advance



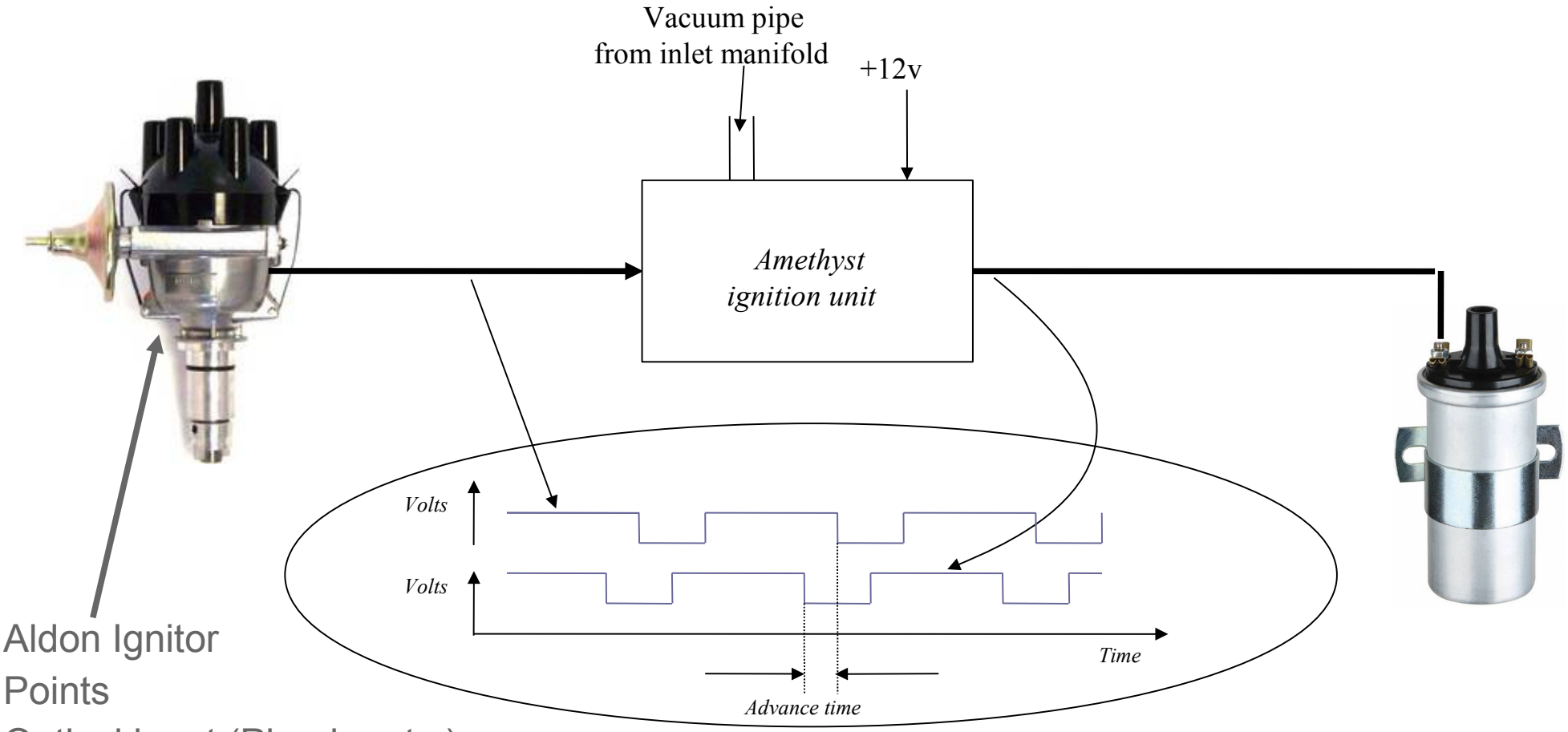
C. R. Stone, "Introduction to Internal Combustion Engines", 4th edition. Reproduced by permission.

First prototype, February 2009

Locking the distributor

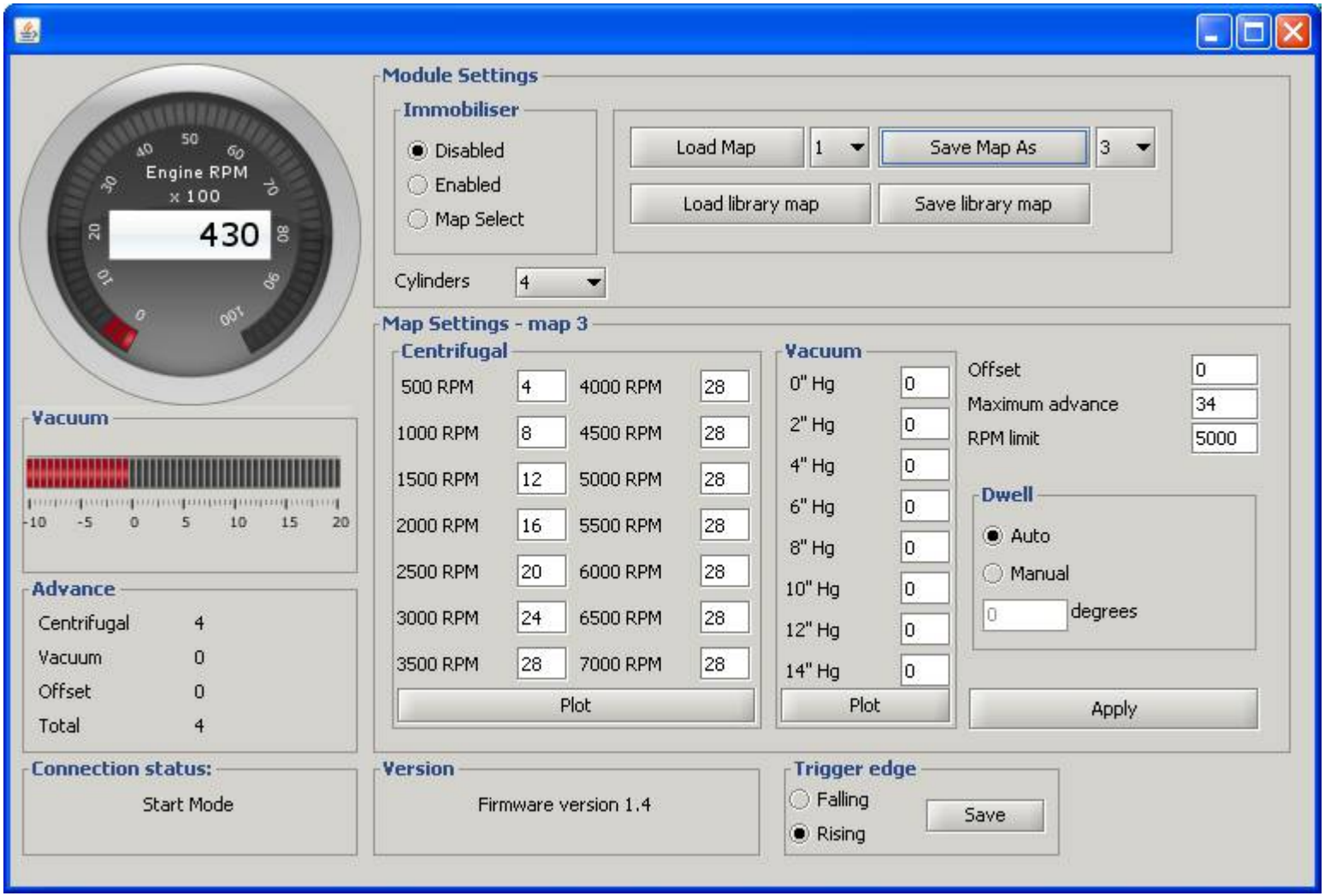


Amethyst timing calculation

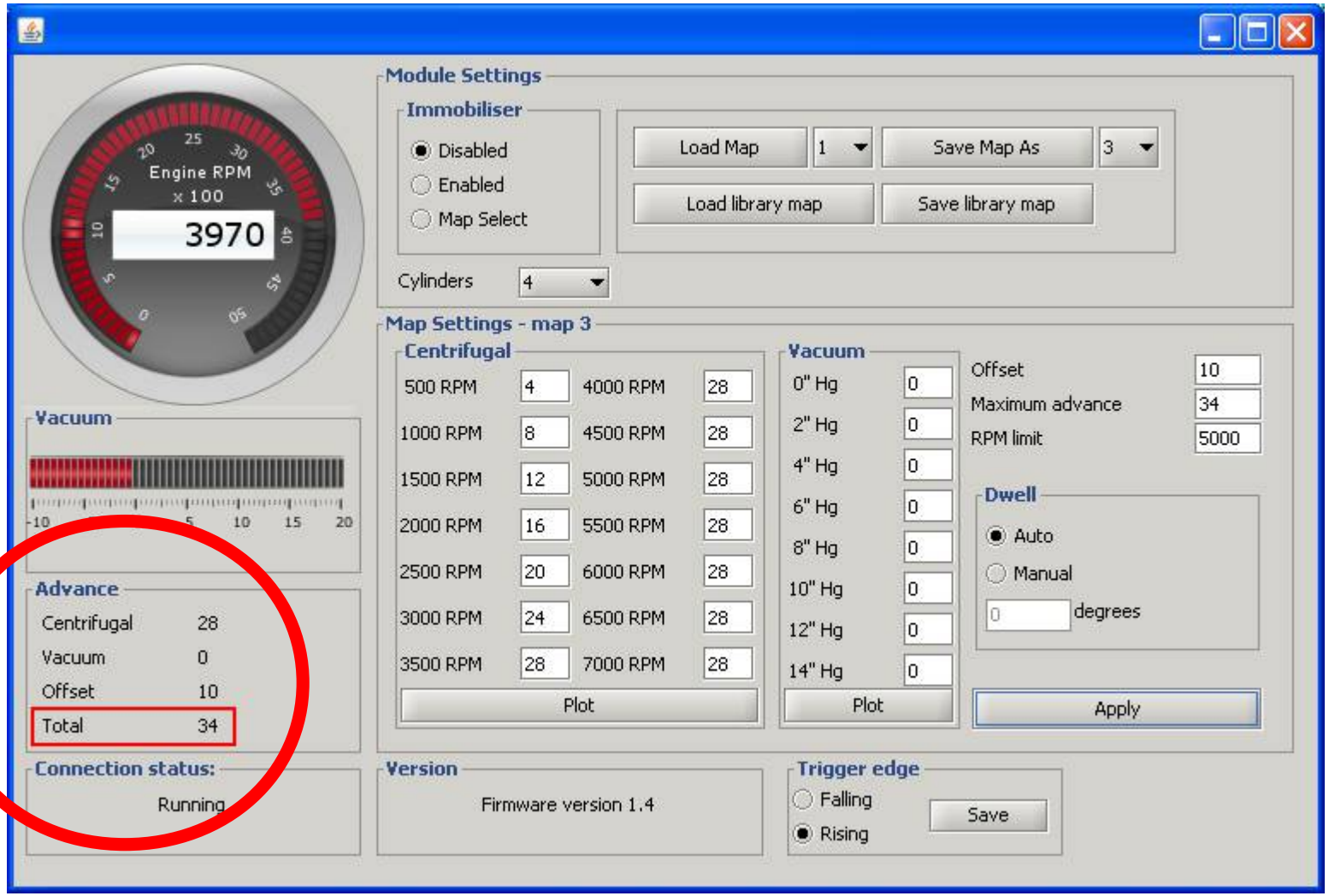


Aldon Ignitor
Points
Optical input (Piranha etc.)
Reluctor

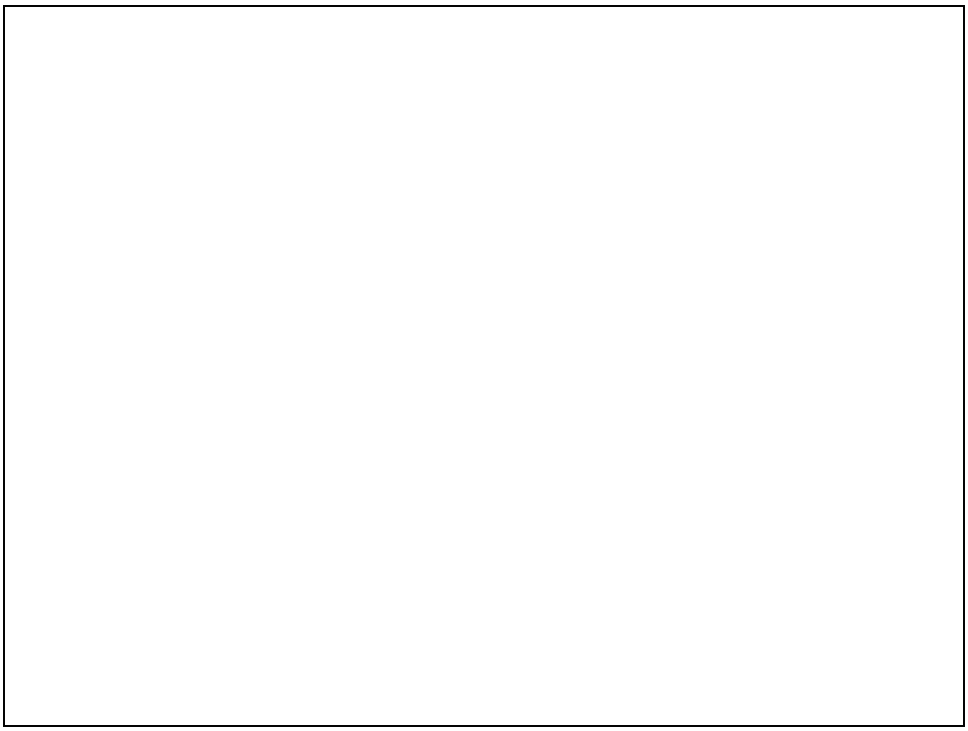
Configuration screen

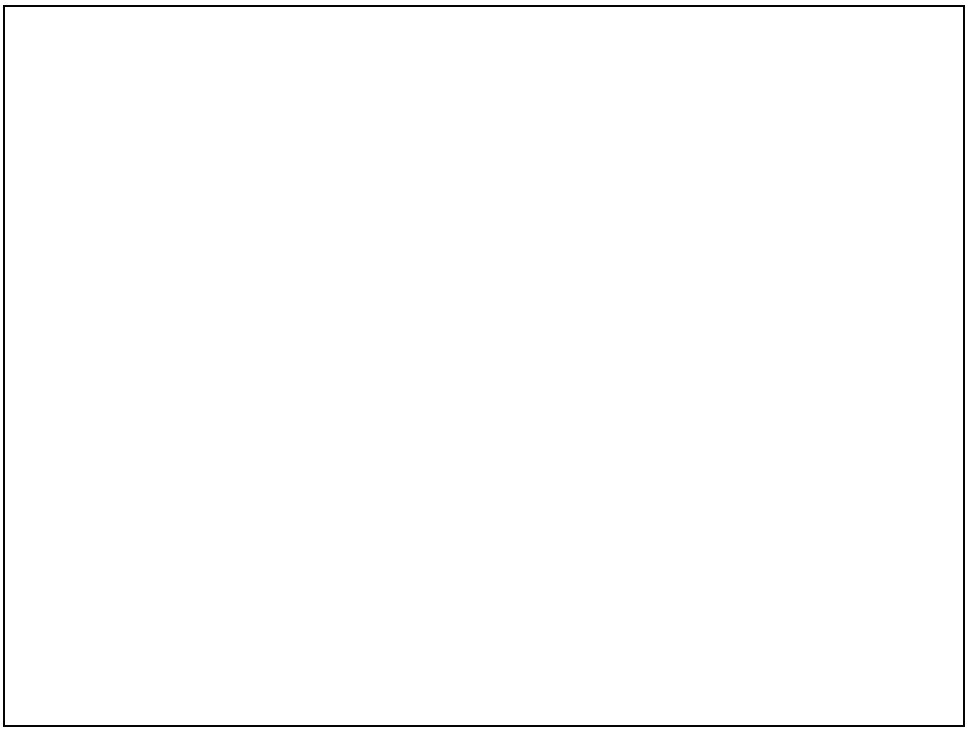


Maximum advance

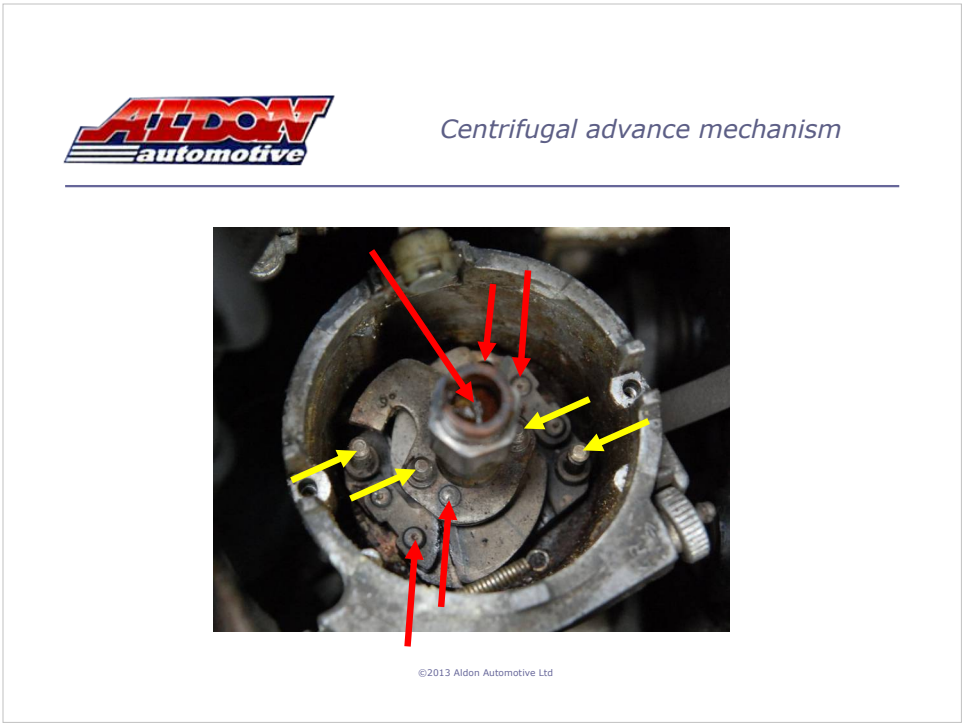


For best results...





This is where the Amethyst project started. Bought five years ago, covered 30,000 miles since. However, at first, we could not get this car to run properly. Either it would pink under load, or there would be flat spots, or both. The culprit was the centrifugal advance mechanism, which had become partially seized after years of neglect.



The centrifugal advance mechanism was introduced in the 1920s and survived more or less unchanged until the arrival of digital engine management systems in the late 1970s.

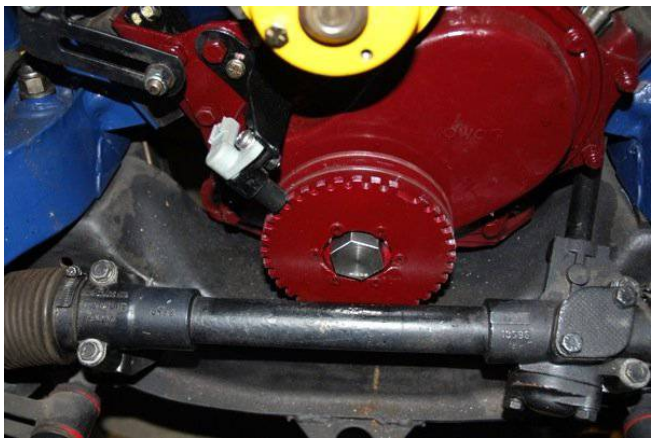
The arrows show friction points: at least four on the weights, one concentric one on the shaft, and (to a small extent) the spring posts themselves. Maintenance consists of allowing a few drops of oil to fall through the contact breaker plate and hoping that they hit their target. Whether they actually do so is debatable, especially if (as on the MGB) the distributor is not mounted vertically!

Note that very small movements are amplified to produce big results. The weights in this example move through much less than 9° to produce 9° camshaft advance, and 18° crankshaft advance.

Small variations in spring strength will result in large changes to the advance characteristic. The springs need to be manufactured very accurately if all the distributors from a production line are to give the same advance characteristic.

Lastly, the distributor is often inaccessible, and maintenance is often neglected altogether.

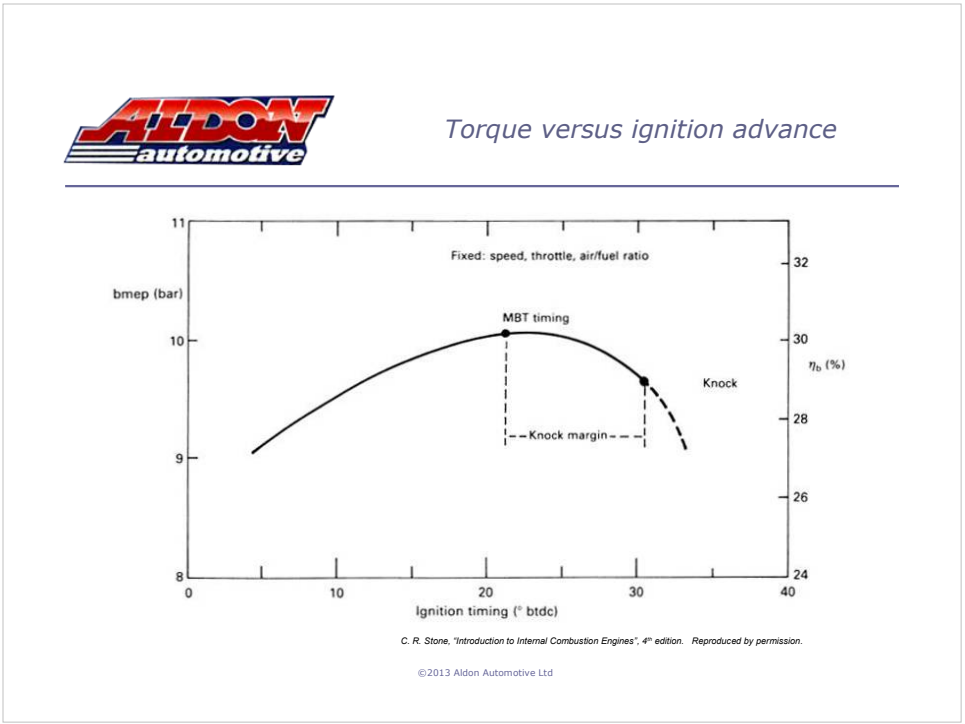
Use a crank sensor?



We wanted to replace the centrifugal and vacuum advance mechanisms with a system more similar to the ones used on modern cars. Retrofit mapped ignition systems have been available for several years, but generally use a crank sensor. This is the most accurate way of measuring crank position, but fitting involves a great deal of work (engine out?) and does not look at all original.

Every installation is different: once you have developed a procedure for fitting a crank sensor to an MG, somebody will arrive with a Triumph, Jaguar, Ford...

Because of this, we were keen to trigger from the distributor, provided that this did not compromise the effectiveness of the system.



To decide whether triggering from the distributor is an acceptable compromise, two questions need to be considered.

1. How much play between crank and distributor is acceptable?

This diagram helps to answer this question. MBT stands for Minimum Advance for Best Torque, i.e. the optimum timing point. Note:

(i) MBT is not the same as the knock limit. It is usually at least a couple of degrees after (i.e. retarded from) the knock limit, although this varies with RPM and load.

(ii) The response around MBT is fairly flat. This is because increasing advance gives more torque pushing the crankshaft forwards after TDC, but also gives more torque pushing the crankshaft backwards before TDC. The two counteract. This implies that the last degree or so of accuracy is not critical, provided that the advance characteristic is repeatable, and can be matched to the engine's requirements right through the range, rather than only at certain points.

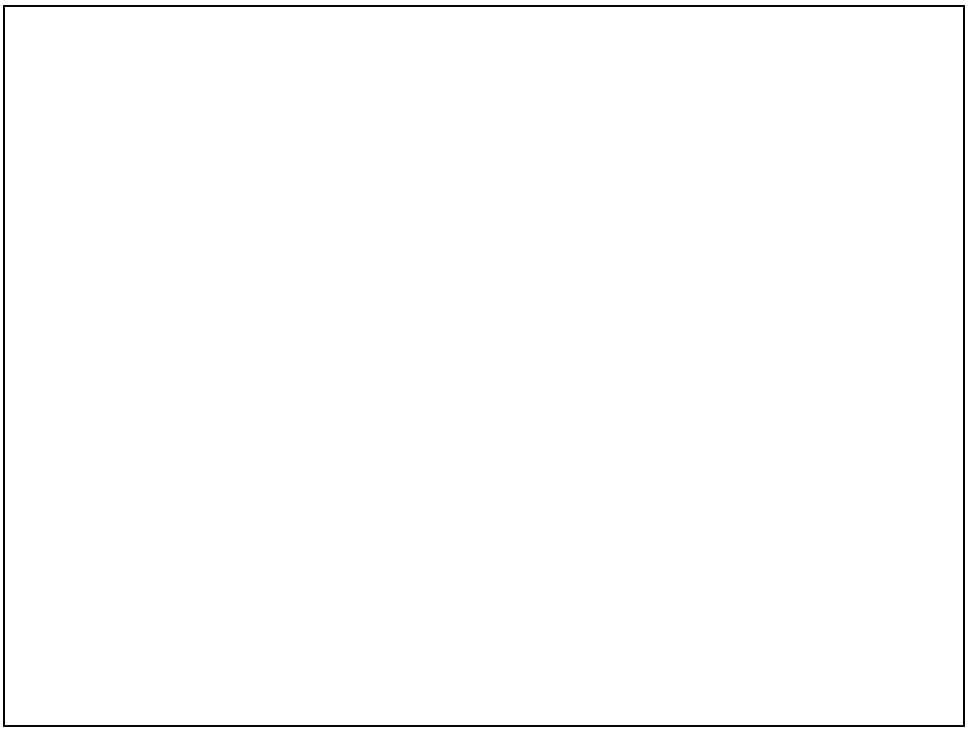
2. How much play is there?

This varies from engine to engine! Anybody who has set up static timing knows that, when the crankshaft is turned, there is some play before the distributor shaft starts to move. Our tests with fixed advance and a strobe light suggest that play is generally very small once the slack has been taken up, usually less than a degree.

We concluded that this would not represent a major compromise, and that it was worth building a programmed ignition system triggered from the distributor...

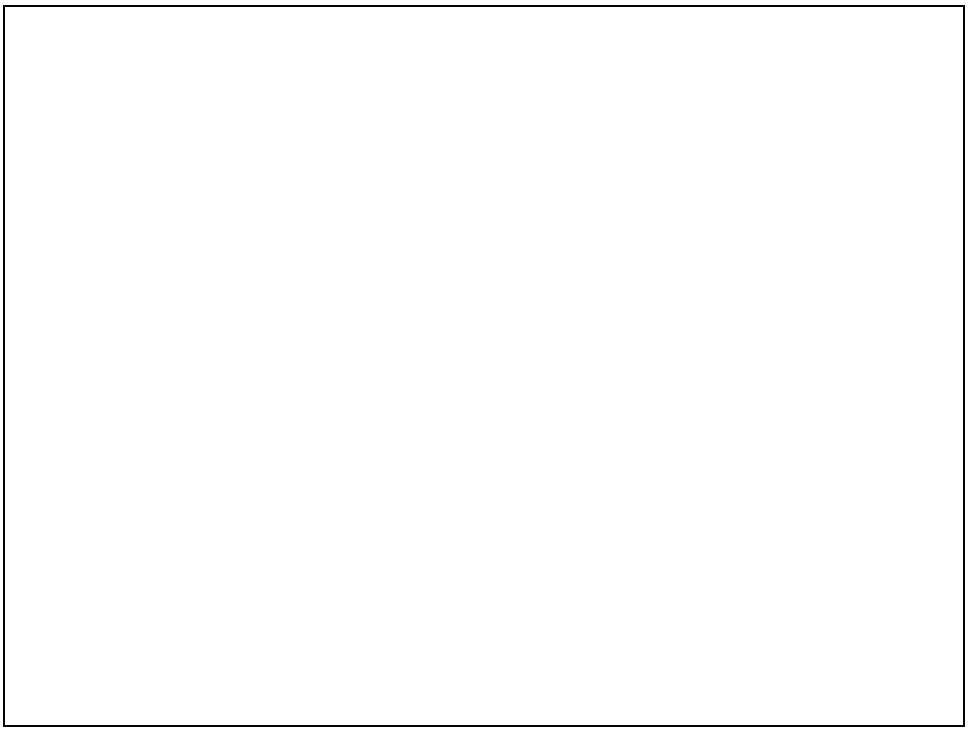
... so we did! This is the first Amethyst prototype, installed in our MGB. This served for approximately two years, and covered some 15,000 miles. It used the Newtronic (aka Piranha) pickup that came with the car, and the Newtronic amplifier, and intercepted and adjusted the signal between the two. Note the vacuum pipe coming from the inlet manifold.

The core of the firmware, which repeatedly turns the coil on and off and thus runs the engine, has undergone only one significant change since the beginning, in order to enable ignition retard as well as advance.



Two examples of locked distributors, one using extension springs and the other with rubber O-rings. We recommend locking the distributor in the fully advanced position, since this is the natural position for the weights. Simply connect post 1 of spring 1 to post 1 of spring 2.

Although a wide range of timing points can be used, we find setting up most convenient if the trigger point is set to the official factory static timing point, with the official dynamic advance characteristic being entered into the Amethyst unit as a starting point.



Amethyst summarised. The unit examines the waveform from the distributor, and feeds another waveform, advanced or retarded by the correct amount, to the coil. Most types of input can be used to trigger the unit. We have customers running successfully with Aldon Ignitors, points, optical inputs and reluctors.

Although this example shows a vacuum pipe as the load sensor, we also offer versions for boost (up to 1.5 bar) and throttle position sensors.

Amethyst configuration screen

The left hand panel show data from the engine (RPM and load), the advance currently applied, and how this advance is calculated.

The modes at bottom left can be *disconnected*, *immobilised*, *start mode*, *running* or *rev limit*.

Immobiliser: Either off, on or map select mode.

The *number of cylinders* enables the unit to calculate RPM correctly.

Maps: The unit can store eight maps, any of which can be selected at any time, even when on the move. Library maps are stored as files on the PC.

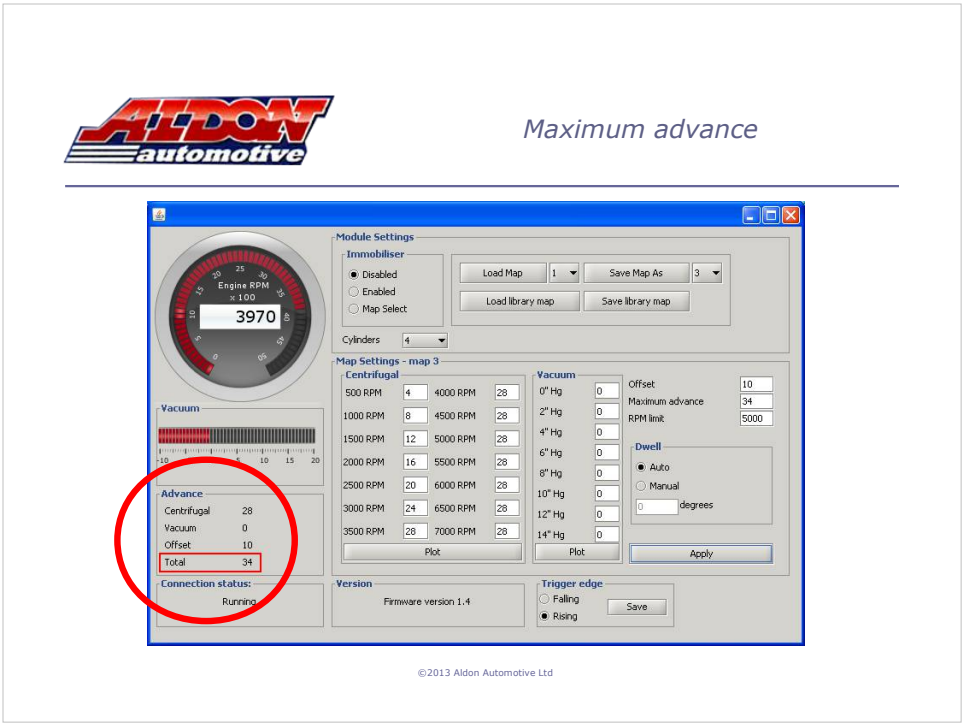
Advance is set at 500RPM intervals, and at 2" Hg intervals. If the boost version or TPS version is used, the scale changes automatically.

The *advance offset* is applied to the entire map, and is an easy way to advance or retard the map without altering its shape.

The *maximum advance* is applied for safety if the sum of (offset + centrifugal + load) advance exceeds this figure.

The *rev limit* is a "soft" limit, which progressively cuts out sparks the more the limit is exceeded.

Dwell is automatically calculated to provide a strong spark at high RPM, whilst minimising stress on the coil at lower RPM. A dwell figure can be entered manually if required.



Here we see the maximum advance of 34 degrees being applied, even though the sum of centrifugal advance (28) plus offset (10) exceeds this figure.

For best results...

A rolling road session allows best results to be obtained under controlled conditions. Normally, we start with the factory timing characteristic, and advance or retard it to optimise power output. Then, we adjust the timing at various RPM points to optimise mid-range power and efficiency.