Pico Technology Case Study

Vehicle details

Jaguar E-type 3.8 Series 1 two-seater

Year

1961

Symptom

Unstable idle speed, reluctance to rev, backfiring and wide open throttle (WOT) hesitation.

Source

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Investigation

Among all the hi-tech, ultra-fast, multi-computing vehicles of modern times comes a real gem from yesteryear that still requires a solid basic understanding of ignition systems and a PicoScope to confirm the ignition cycle in real time.

The vehicle in question is a 3.8-litre E-type straight six-cylinder that is a stunning example of this model and privilege to work with. Our customer's concern was that it had an unstable idle speed, reluctance to rev and horrendous backfiring with hesitation at wide open throttle.

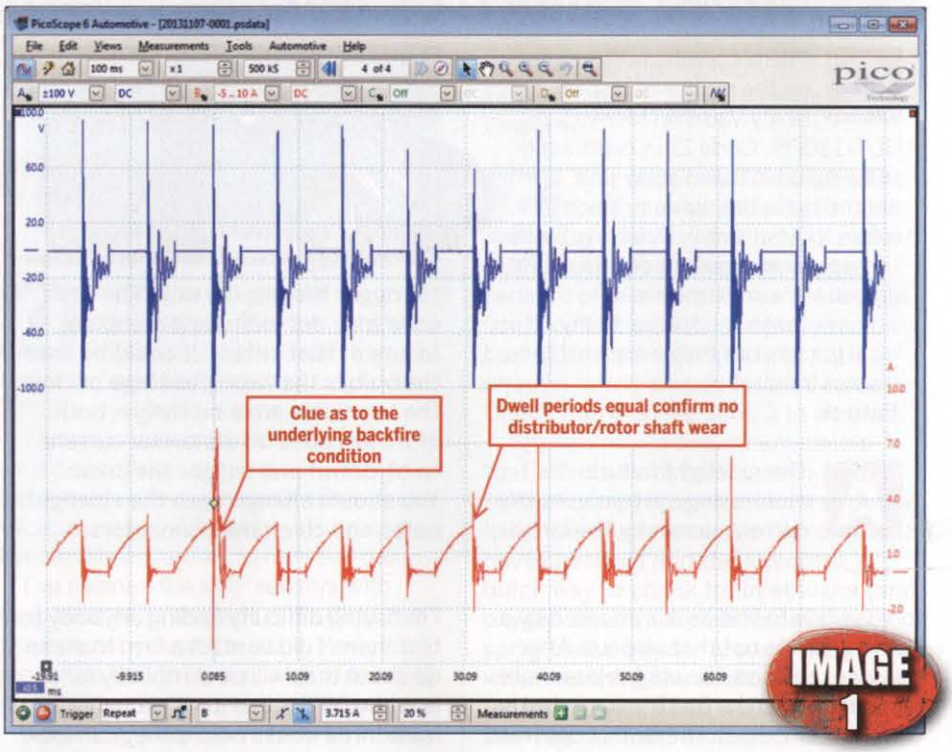
The vehicle had been fully restored to factory condition a number of years ago and only ever came out for fun driving during the summer months. For almost nine months of the year, the vehicle remained in hibernation and this turned out to be a clue to the underlying cause of the symptoms.

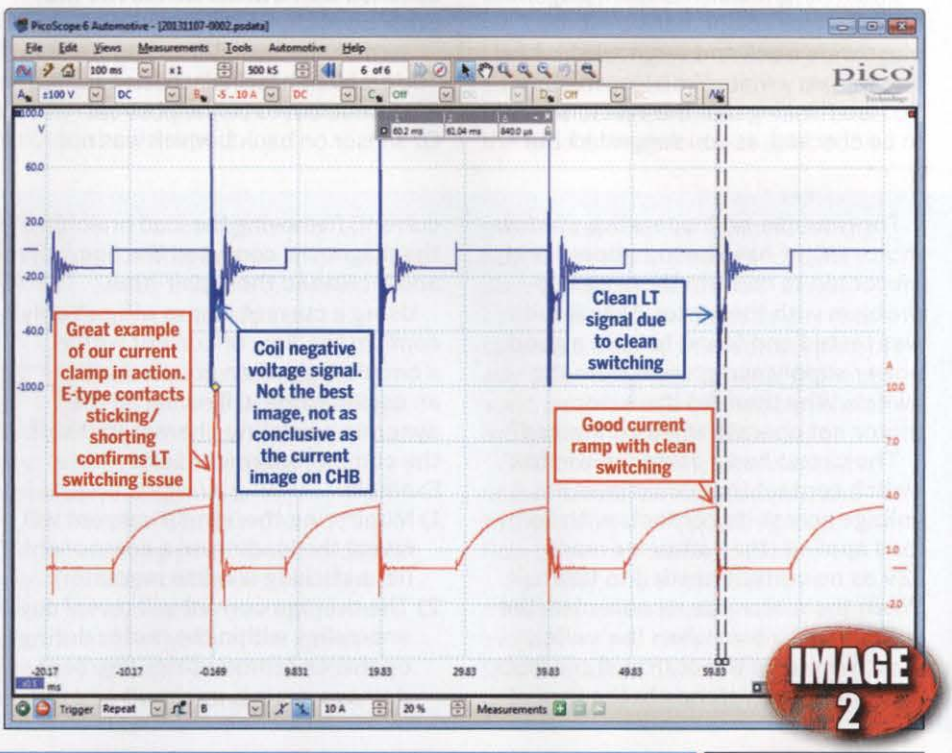
Like all vehicles, regardless of age, a basic inspection was carried out to confirm connections, harness routing, fuel quality and fuel supply were all in place. Given the technology at the time of manufacture, this extended to checking the triple SU carburettors for sticking, along with the ignition points contact breaker gap and condition (how often do we say that now?).

All of the above proved to be fine and so we moved on to checking the tuning condition of the engine, bearing in mind the symptom of backfiring via the intake and the exhaust.

The ignition timing and dwell angle all proved to be correct and all triple carburettors were drawing an equal amount of air with very similar main jet seat positions. On the surface, everything looked well, until we loaded the ignition system by applying WOT.

Using the timing light to view the timing marks under initial WOT application, the engine became so violently unstable that the results of the ignition advance test were rendered virtually useless. As a result of this, the only logical step was to view the behaviour of the ignition system using the PicoScope.





Identifying the problem

Taking a look at the ignition primary voltage and current at idle, all appeared fine, with adequate ignition coil saturation, equal dwell periods and even burn times. Then, as the ignition was loaded during WOT, the truth was revealed when the ignition primary current increased dramatically at the point of 'contacts open'.

At this stage, the current should have been cut instantly to collapse the magnetic field within the ignition coil and so produce adequate firing voltage within the secondary ignition circuit.

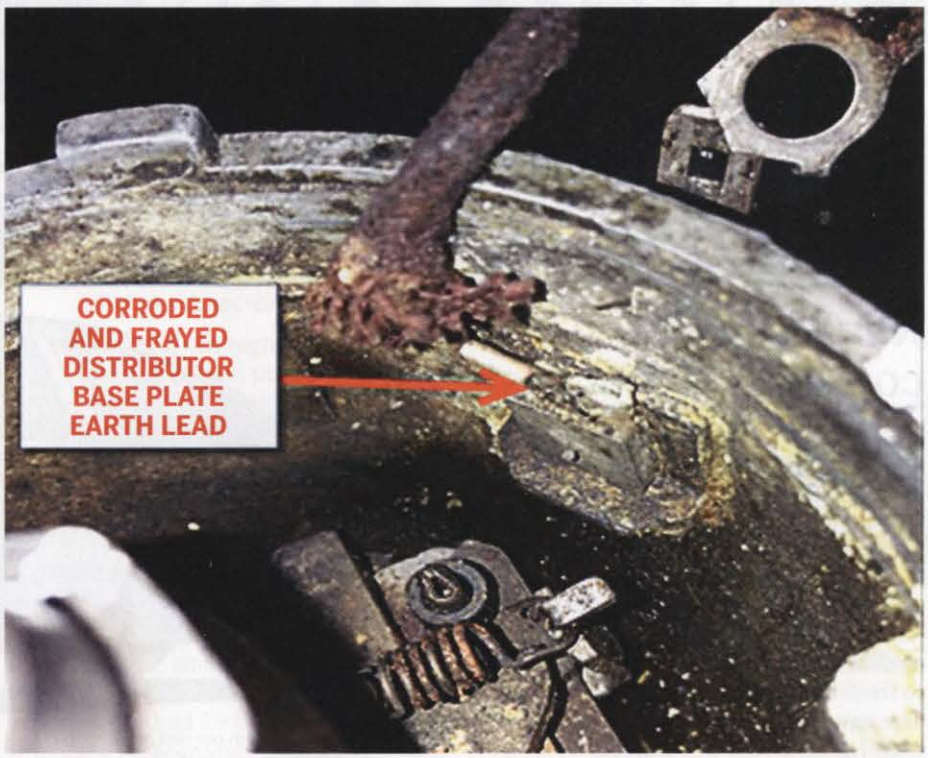
Reviewing the ignition captures using the replay feature of PicoScope Automotive software, it was easy to confirm that 'distributor and rotor shaft wear' were NOT at fault, because even though the misfire was clearly evident in our captured trace, the dwell periods remained equal. Often at high rpm, wear in the distributor becomes noticeable due to centrifugal force being applied to the shaft, which, in turn, alters the dwell angle, resulting in a misfire developing (see Image 1).

Closer inspection

Armed with the knowledge that all of the previous checks had thrown up no anomalies and that the dwell angle remained stable, closer inspection of the switching of the primary current revealed excessive, intermittent arcing at the contact breaker points under WOT during the switching stage of 'coil on to coil off'. This, in turn, had an adverse effect on the HT firing voltage and, of course, the HT timing (see Image 2).

The scope trace proved the flow of current after the contact breaker points had opened, confirming the presence of either a short circuit or arcing across the contact points face. Removal of the distributor assembly confirmed the installation of new contact points and a condenser, with no evidence of burning or arcing at the contact breaker point faces. Given these components were new, they could not be relied upon for any relevant witness markings.

Closer inspection of the distributor base plate revealed there was excessive corrosion between the floating base plate, contact breaker points and base plate earth lead. The contact breaker points ultimately earth the coil primary windings through the distributor base plate, via a very fine earth lead to the oxidised distributor body and then to earth via the engine block.



The corrosion within this circuit resulted in arcing across the contact breaker points that could not be absorbed by the traditional condenser as the path to earth under WOT increased in resistance with movement of the base plate under centrifugal advance.

After weighing up the pros and cons of simply repairing the earth lead, and given the usage pattern of the vehicle it was recommended we install an electronic ignition kit that removed the earthing issues of the distributor from the equation.

Finding a fix

The contact breaker points were replaced with an optical switch whose infrared beam is interrupted by a 'chopper plate' fitted just below the rotor arm, removing any earthing issues relevant to the distributor. The interruption of this infrared beam provided the switch signal required to control the ignition coil via an external power module. The vehicle was then reassembled, the ignition timing reset to the original manufacturer specification and the first WOT test revealed that the engine had been restored to its original free-revving manner.

Conclusion

A high resistance at the distributor base plate resulted in a poor earth path for the primary ignition circuit, which could manage current with no load, but failed under load applied by WOT.

An interesting point to mention was the value of the current clamp when reviewing the ignition primary circuit. At first glance, the ignition primary voltage looked the correct shape and form, but the current pattern revealed the truth about the huge increase in primary current during the coil 'switch off' stage.