ntelligent Engine Analyzer

Training

Impossible Dodge

by Bernie Thompson - ATS

The white Dodge Stratus pulled into the parking lot not under its own power, but behind the tow truck. An elderly gentleman walked into the office with the tow driver. He explained that the Dodge dealer had diagnosed his 2003 2.4 liter DOHC Stratus for a no start condition and that the valves had been damaged due to a timing belt problem. A close friend of his had recommended our shop for a second opinion. We exchanged information and I told him that I would call him later that day.

We pushed the vehicle in and cranked it over. At first it sounded like they were right but cranking over the engine will only indicate the RPM is high, not the cause of the problem. If there is a compression problem the engine will increase its cranking speed. In turn one could associate this rapid RPM with a timing belt problem or bent valves. However; additional testing will need to be preformed to determine the cause of the problem.

Until recently there was no testing sequence that could determine the exact cause of such a problem. With advancements in technology have come new diagnostic techniques that will astound you. These techniques use pressure transducers to make the impossible into the possible. With this new technology the technician can look inside the engine to determine the mechanical operating condition through the spark plug hole. How is this done? By removing the spark plug form the cylinder head and threading a compression test hose into spark plug hole a waveform can be generated by a pressure transducer attached to this compression hose. Figure 1 shows this compression waveform as the red trace. The yellow trace is produced from a pressure transducer connected to the intake manifold and represents the vacuum in the intake manifold. The green trace is used as a reference of 0 PSI. By analyzing these waveforms the engine condition can be determined

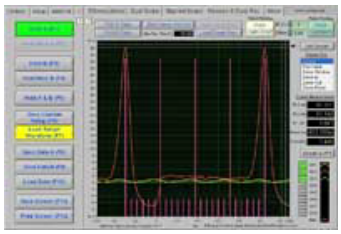

Fig. 1

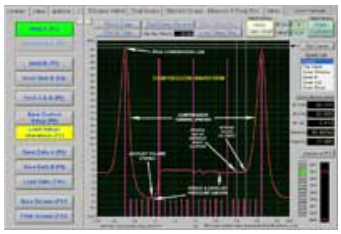

Fig. 2

Now let us analyze the compression waveform in figure 2. Starting at the left side of the chart the red trace starts to rise. This pressure rise is due to the piston moving toward the cylinder head. The closer the piston comes to the cylinder head the higher the pressure within the cylinder becomes. At the point the piston comes as close to the cylinder head as possible; this is where the peak pressure will occur and represents top dead center (TDC). This peak pressure during cranking should be greater than 95 PSI and is usually about 140PSI in a good engine. The peak pressure in this Dodge 2.4 liter engine is very low at 40PSI. If a conventional compression test were done using a gauge this peak pressure would be all the data that would be given. It indicates that the cylinder's ability to produce pressure is compromised but does not indicate why. Perhaps the Dodge dealer used this test to determine their conclusion. The problem with a traditional compression test is that there is not enough data to make a diagnostic conclusion.

As the crankshaft continues to rotate, after TDC the red trace starts to drop indicating a decrease in pressure. This is caused by the piston moving away from the cylinder head and increasing the volume within the cylinder. As the pressure continues to drop it is important to look at the pressure half way down the compression tower. At this point the two compression tower halves should be even (right and left of the pink TDC mark). The Dodge 2.4 liter compression towers are uneven, indicating a leak within the cylinder. This usually indicates a mechanical problem in the engine such as valves that do not seat or valves that do not open. However, incorrect intake camshaft timing can also cause the compression towers to become uneven.

As the piston continues its downward travel it starts to pull a negative pressure at about 50 degrees after TDC (0 deg). The negative pressure has a steady increase until the exhaust valve opens at about 30 degrees before BDC (180 deg). The exhaust valve should open at approximately 40 deg +/-10 deg before BDC (180 deg). This shows the exhaust camshaft is properly timed to the crankshaft. The pressure then starts to rise as the higher exhaust pressure flows into the lower cylinder pressure. At the BDC (180 deg) mark the pressure has equalized to the exhaust pressure. The piston now starts its upward travel creating a high pressure area in the cylinder. This high pressure moves to the low pressure area in the exhaust system. At the TDC (360 deg) mark the intake valve should open causing a drop in pressure as the piston moves down. The Dodge 2.4 liter has a slight pressure drop at the TDC (360 deg) mark as the piston moves down. There is a larger pressure drop at the 60 deg ATDC (360 deg) mark which could indicate that the intake valve opened late.

With the intake pressure not changing it is hard to determine exactly when the intake valve opened. A much better place to check for the intake cam timing is at the point the intake valve closed. The intake valve closing will start the cylinder pressure to rise. This usually occurs at 50 deg +/-10 deg after BDC (540 deg mark). The Dodge 2.4 liter intake valve closes at 93 deg after BDC (540 deg mark). This indicates that the intake camshaft is over 40 degrees retarded. The Dodge dealer was correct that the camshaft timing was off; but are the valves bent?

To determine this we will need to analyze the intake vacuum waveform in figure 3. The yellow trace shows the pressure changes in the intake manifold. As the yellow trace increases (goes up) the piston is moving down. This creates a negative pressure (vacuum) in the intake manifold. Normally the vacuum is 1 to 3 inches of mercury. The Dodge 2.4 liter is low at 0.8 inches of mercury. It is important to notice that all of the cylinders have equal vacuum pulls and that they all can pull vacuum. This would indicate the valves are not damaged. It is also important to notice that on each stroke of the intake the pressure goes positive. This usually indicates that the intake valve is not seating. If the intake valve is not seating and the piston is rising on the compression stroke; the high pressure created under compression is forced into the intake manifold. This creates the positive pressure in the intake manifold.

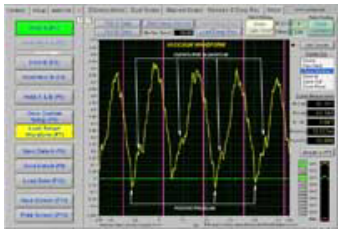

Fig. 3

Now let us put the data that we have collected together so we can diagnose the Dodge 2.4 liter engine. We now know that the exhaust camshaft is in time but the intake camshaft is out of time by an amount of 40 degrees in the retarded position. This would mean that the piston is moving up to compress the air within the cylinder; although the intake valve does not close due to the retarded intake camshaft timing. As the piston continues to move upward the air is forced into the intake manifold. This creates the positive pressure on the intake waveform that we see. This pressure is not caused by a bent valve but solely by the intake camshaft timing error.

The timing belt was replaced and the Dodge 2.4 liter engine once again roared to life. This entire diagnosis took just under 15 minutes. Just a few years ago this would have seemed impossible, but with today's technology the impossible has become the possible!