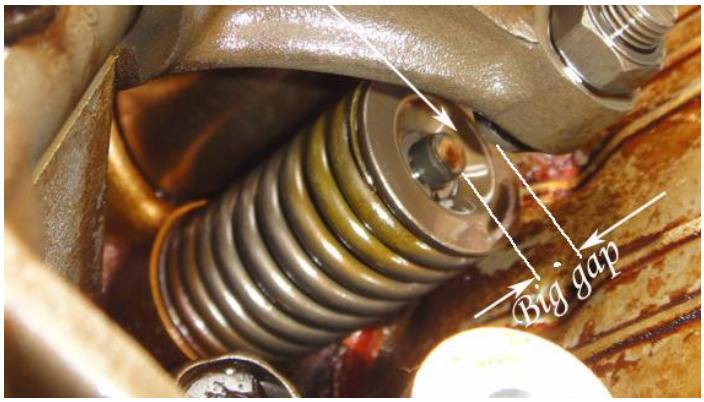
2006 Acura TL repair challenge (four day run for a hopeless ball)

Background: 2006 TL with unknown mileage, used US engine was installed 2 year ago
I changed ATF on this car 6 months ago which took care of shifting issue.

Day one, Saturday, September 15
I went to check a car which did not start after short term parking. According to the owner, the car cranks but does not fire. An OBD code P0340 (cam sensor) has been displayed
I asked owner about the mileage on the timing belt (unknown), and emphasized that this engine is an interference type.
I hooked up the scanner and read the freeze frame which indicated that the code was set at 250 rpm (cranking speed). The live data indicated -10% LTFT for cylinders 1-2-3 (near firewall) and + 10% for the cylinders 4-5-6 (near the radiator) which is often result of incorrect valve timing.
I pulled the rubber inspection cap in the front upper timing cover to expose a part of the cam sprocket and asked owner to briefly crank the engine.

During the cranking the cam sprocket remained stationary confirming my suspicion of broken timing belt and possible interference valve damage.
Incompetent expert's analyses: Later this day I've found an article [1] about using visual valve train inspection to confirm a valve damage (that will be indicated by excessive valve lash); more accurate inspection calls for measuring of each spring with precision rule and comparing it to specks (after rocker arm assembly removal).



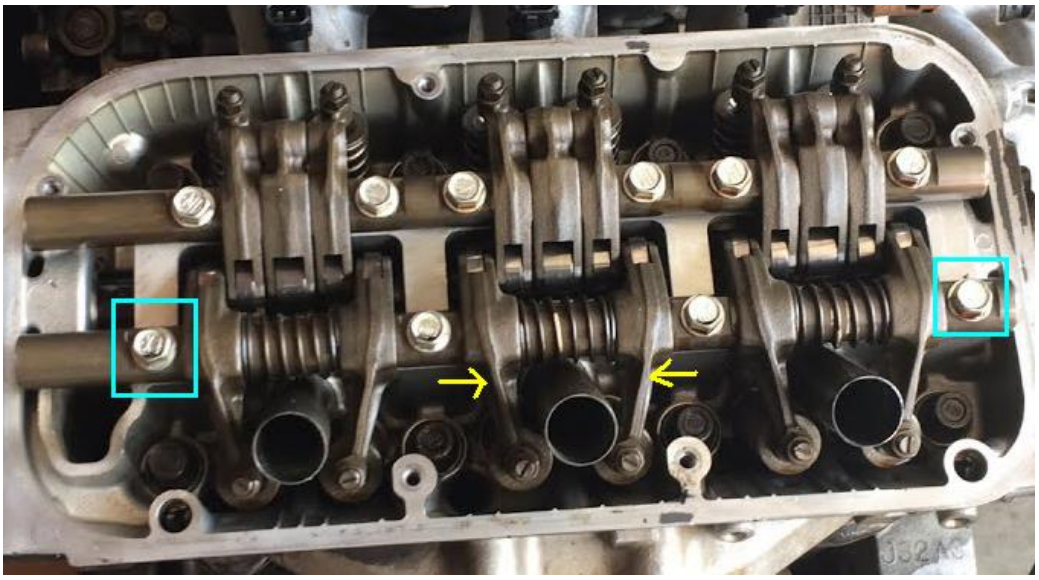
I planned to use both methods for my inspection

Day two, Sunday September 23

I began the inspection with removal of the plenum, followed by removal of the front valve cover. I've found no excessive valve lash and prepared to remove rocker arm assemblies. Although some mechanics suggested checking only exhaust valves I've pulled booth intake and exhaust rocker arms. Checking the valves heights with no pressure from the rocker arms indicated uniform height of approx. 47 mm for all, which is well within the specks. I inspected the valves in the rear head with same results. No obvious evidence of damaged valves gave me (and the owners) some optimism, but later that day I've read a horror story about frozen cam in the head, and planned to check it during tear down of the timing belt components.

Incompetent expert's analyses:

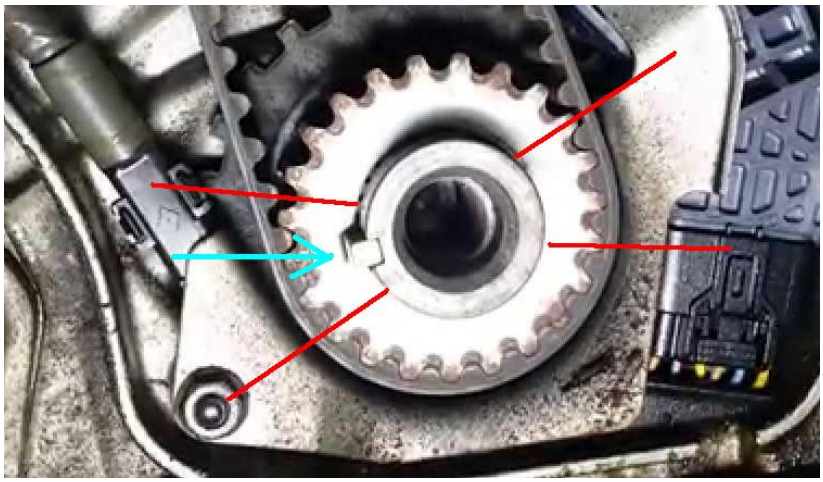
1) Installation of exhaust rocker arm assembly is challenging due to the expanding spring s between the rocker arms. In order to facilitate installation tightening arms to each other with a soft wire will compress the spring (yellow arrows) and make aninstallation easier. (Remember to install the exhaust arms first!) Also, temporary use of two longer M8 bolts (from the plenum) can help guiding the rocker arm shaft to its position (install them in place of the outside bolts)



Tightening torque is 16 foot pounds.

2) It was not necessary to loosen the valve lash adjusters prior to rocker arm removal
3) I removed the plenum after separating it from the throttle body, leaving TB in the car, connected to the cooling lines and electrical wires. The TB to plenum green paper gasket had no damage and remained on TB.

Day three, Saturday September 29
After obtaining Lisle heavy socket coupled to the Porter–Cable 120V impact gun, I began the tear down of the timing belt drive. As a good habit, I've match marked one rib of the crank bolt relative to the harmonic balancer. The bolt came right out (perhaps because the past service technician had under tightened the crank bolt using ordinary impact). I've also noted that the key for the crank timing gear had been installed upside down in the slot. The crank has stopped at 9 o'clock position (safe zone) for cam adjustment.

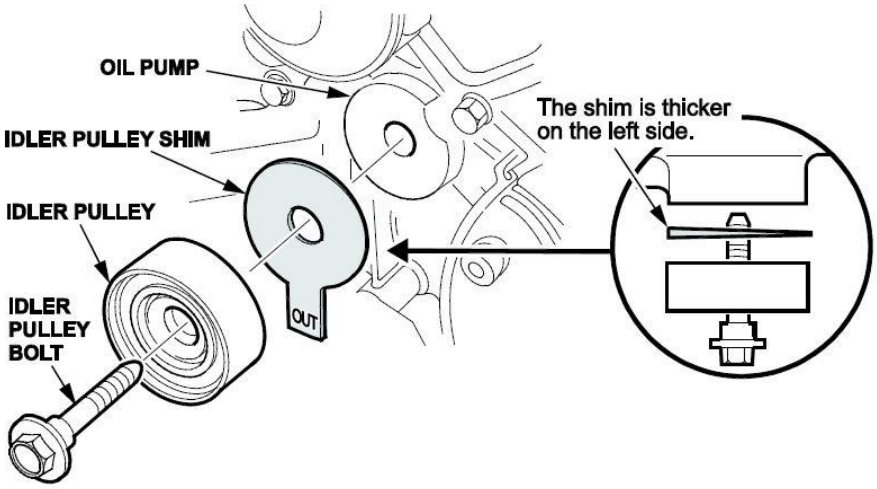


After removal of timing covers I found out that the belt walked off the pulleys, got shredded on one side (facing the timing covers) and then broke (like on Russian front wheel drive Lada!). Both cam shafts were moving freely (no frozen heads!) and had a quite strong spring back action. (As the belt began to break, this spring back action pushed the cam lobes to certain position and saved the valves from damage; this could happen on very low engine RPMs, though such as during cranking). The timing rollers and water pump were GMB and the rollers had leaking grease and significant play; the hydraulic tensioned was in the good condition. First I lined up both cams (they must be rotated really slowly with 17 mm socket placed on the sprocket bolts; the cams are stable within a tooth from the timing marks, more movement causes cams to jump 30 degrees away), second I moved up the crank leaving it half tooth retarded with respect to the mark (for easiness of the new belt installation)

Incompetent expert's analyses:
There were two problems to solve before proceeding:

1) Find out what caused belt to fail in such manner and
2) How to install the replacement belt correctly to keep the engine in time (unlike Toyota, Honda does not put installation reference marks on the new belts)

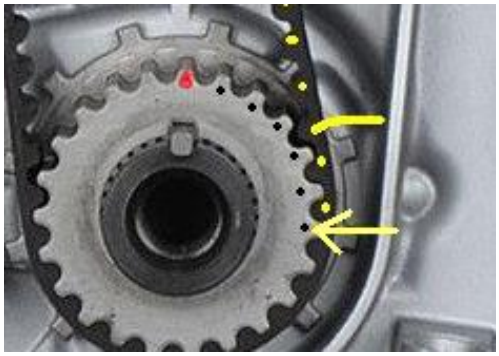
The issue number one has been covered by TSB 08-031; the owner confirmed the presence of the noise. Inspection of motor mounting bracket revealed relief made to accommodate a shim which probably had been discarded by previous service technician.

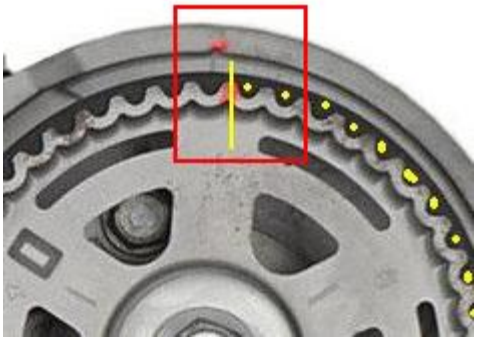


The very narrow belt width (20 mm compared to 36 mm on Avalon) made it prone to walk on the pulleys as well.

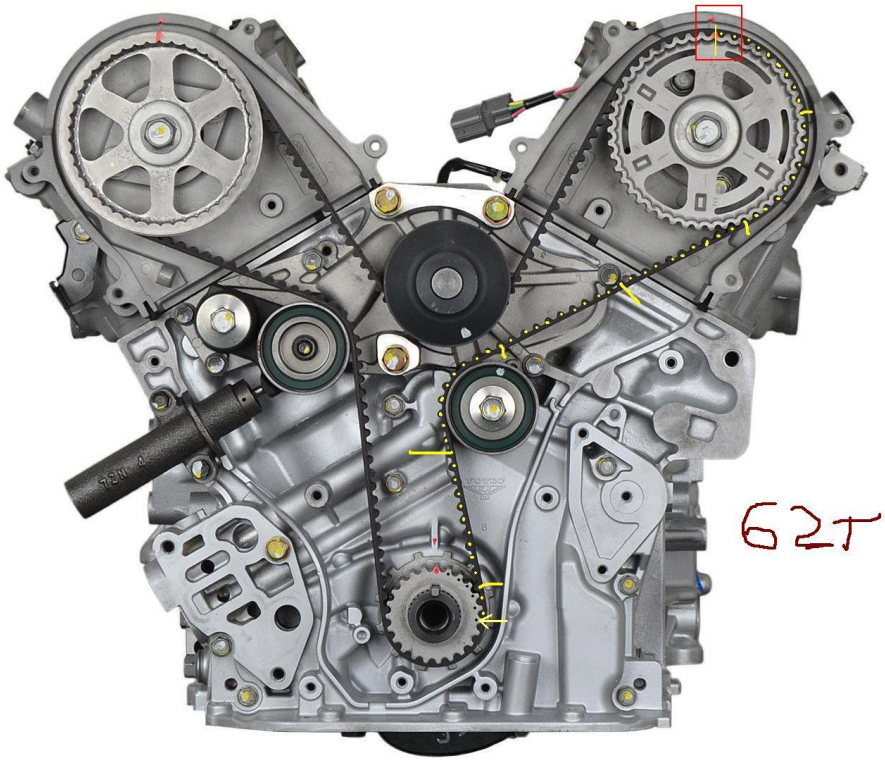
I resolved an issue number two by analyzing high resolution images of J series engines with timing belt exposed downloaded from the rebuild engine retailers' websites [3].

The front view on engine is clear enough to visualize the timing belt teeth and timing marks; using the MS Paint allows easy tooth count. When both cam sprockets are in time, there should be **64** belt teeth between timing marks on the sprockets.





When the crank sprocket is aligned with the mark on the oil pump (tooth number zero, red mark), there should be **62** belt teeth (yellow dots) between crank sprocket tooth #6 (indicated by an arrow) and the mark on the front cam sprocket (red box). Important: use marks on the **sprockets**, not on the housing as a reference points for the tooth counting!



Other method is to use 1/4 inch wide gift wrapping ribbon paced square on the pulleys. Since most Japanese T belts are having tooth pitch of 8 mm, I fabricated the 20 teeth (16 cm long) rule which speeds up the tooth count. I should add that if old belt is intact and in time, it can be match marked to the sprockets before removal followed by transferring marks from old to new belt (it's also important to mark direction of the belt rotation to prevent mirror" installation). Installing the new or used belt without making reference marks may allow too much slack between the sprockets causing one pulley to be retarded relatively to the other ("I've done everything right and my marks did not line up!")

Day four, Sunday September 29

After reassembly the car started right up and the engine run like nothing had been happening.
There were, however two significant hurdles and few mishaps during assembly process as outlined below:

1) While knocking off an old pump off the block I placed small nick near the edge of the gasket sealing surface (fixed it with small file before installing new pump)
2) I used blue *Loctite* on idler mounting bolt
3) The T-belt installation outlined in manual is useable with engine out of the car; the sequence should be as follows: rear cam pulley, water pump, front cam pulley, idler followed with crank pulley. Two clips should secure belt to the cam pulleys to prevent belt from jumping teeth before tensioner is released
4) The replacement tensioner had soft grenade pin that jammed during removal; I applied more force and broke the replacement tensioner. I ended up reusing original NTN tensioner which I compressed with a large C-clamp and locked with 2mm Allen wrench prior to installation.
5) Remove crank position sensor (swing aside) and crank sprocket before knocking down the water pump
6) The vintage power steering hose between the reservoir and pump broke spilling the fluid; I recommend replacing this hose during the job if it feels hard or looks brittle. Overall, items number 3 and 4 added more than an hour to the job!

7) I used impact wrench to tighten harmonic balancer bolt; the bolt stopped right at the mark I made prior to disassembly.
8) It is not necessary to rotate the crank six times; when using belt marking method two full turns are enough to check the valve timing!
9) Two gear wrenches, 10 and 14 mm are useful for the job. I used 10 mm to tighten two closest to the firewall bolts on the rear timing belt cover and used 14 mm on the motor mount bracket mounting bolts
10) Intake plenum gaskets can be reused if they are not bend provided the mounting screws are tightened in proper sequence in several steps
11) Genuine parts will save installation frustration and assure long service (minimum 65,000 miles)

Incompetent expert analyses:
This work is example of doing full diagnostic workup using elements of engineering analyses and research to find and correct a root cause of the problem as well as eliminating costly unneeded repairs.

References and photo credits:

1. 2003 Acura 3.2TL bent valves | Takaki Automotive
takakiauto.com/blogs/kunio/2003-acura-32tl-bent-valves
2. YouTube various videos (screen shots)
3. Autozone.com