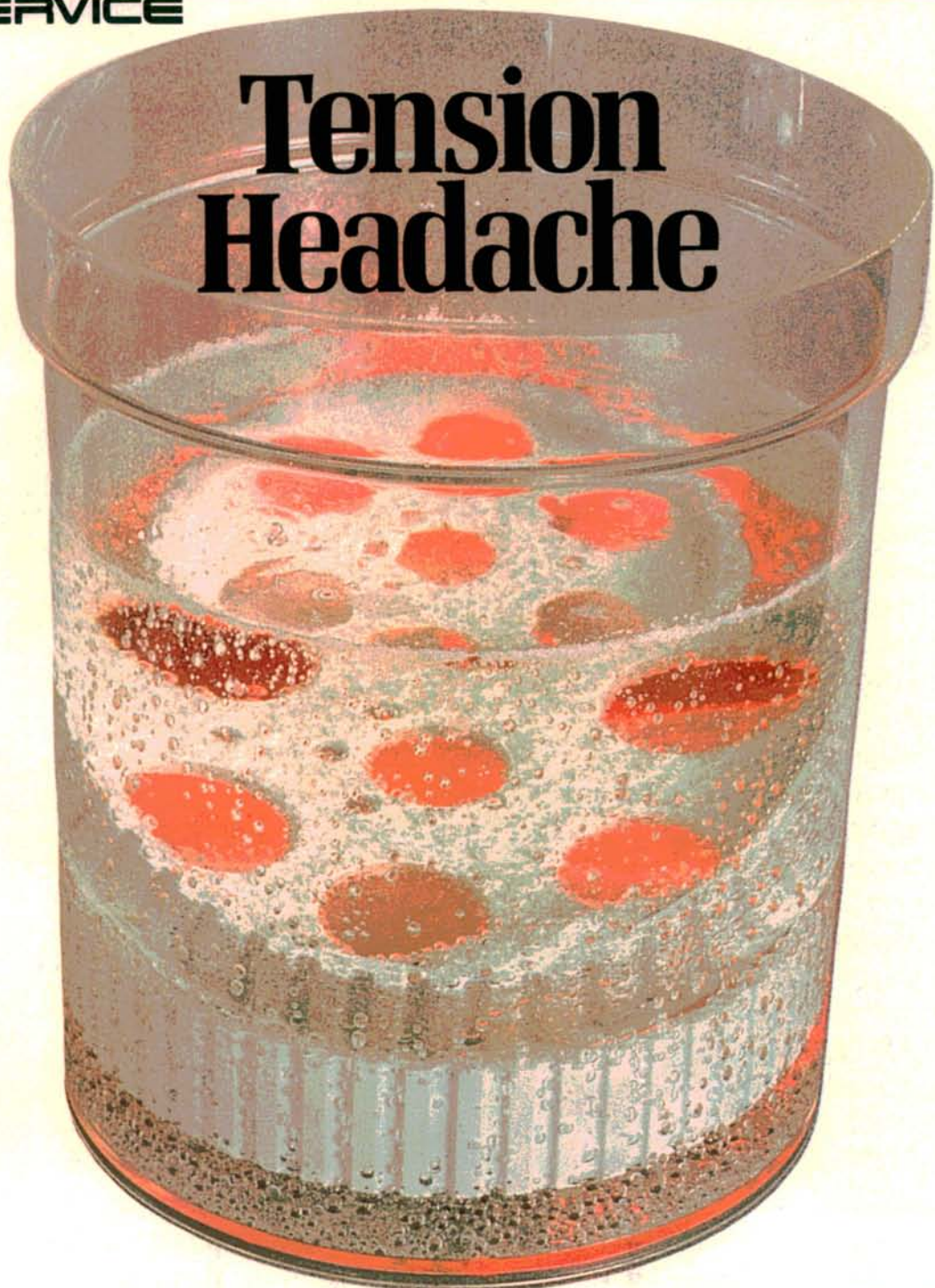


Tension Headache



Replacing the timing belt on most engines isn't all that difficult. Just take it apart, line up the timing marks, install the new belt, put it all back together, and away you go. But when you add an extra camshaft and some other interesting mechanical details, the same job can quickly become a tension headache.

For the past two months, we've given you a detailed description of our overhaul of a Toyota 5M-GE twin cam six engine. We've got most of the engine back together now. About the only thing that's left before dropping the engine back into the car is to install the new timing belt. As we've found with other parts of this engine overhaul, the 5M-GE

is different from your average run of the mill engine.

Toyota squeezed a lot of power out of the 5M-GE's 2.8 liters because this engine saw action in the upscale Supra and Cressida models. To achieve the very accurate valve timing the engine needs, Toyota uses a system of eccentric camshaft and cam sprocket alignment holes. Small dowel pins (Toyota calls them match pins) index the cams and sprockets.

This system allows you to accurately "degree" the camshafts during timing belt replacement, so the engine can develop its full output. Instead of one choice for camshaft to cam sprocket installation, you've got a possibility of three for each cam.

It may sound complicated, but don't let the 5M-GE's cam timing system scare you off. One source told us he leaves the match pins in their original cam and sprocket locations during a timing belt replacement. He checks the valve timing as a final step after the new timing belt is installed, and changes the location of the match pins only if necessary. He claims that most of the time the pins don't need to be moved, because the valve timing ends up right on the money.

We were starting from scratch with two new cams, new sprockets, new cam housings, and an engine that had been completely disassembled. We couldn't assume that the previous match pin locations were going to be right, or even close. You might find yourself in a similar situation, so we'll describe the camshaft alignment procedure in greater detail as we go along.

Preliminary Precautions

If you've been following the continuing saga of our 5M-GE engine overhaul, you already know why the engine was on an engine stand when we replaced the timing belt. The job is a lot easier on an engine stand, and the pictures come out much better to boot.

If you're replacing the timing belt with the engine in the car, there are several preliminary steps and precautions that we won't be discussing in our photo captions. They are:

- Let the engine cool before replacing the belt. A hot engine will affect both belt tension and cam timing adjustments.
- Disconnect the negative battery cable.
- Drain the coolant.
- Remove the air inlet plumbing that passes over both valve covers.
- Remove the upper radiator hose.
- Loosen and remove all three drive belts.
- Remove the fan clutch, fan, and radiator shroud.
- Remove the power steering pressure and return line brackets from the upper timing belt cover.

The crankshaft pulley bolt is torqued at the factory to 197-235 Nm (146-174 ft-lb), with thread locker added. Removing and reinstalling this bolt didn't pose much of a problem for us with the engine on an engine stand. All we had to do was grab the flywheel with a flywheel turner to keep the crankshaft from turning while we removed and reinstalled the pulley bolt.

It's not quite so easy when the engine is in the car. The shape of the transmission's bell housing doesn't leave enough room for a flywheel turner. Carefully grip the crankshaft pulley with a locking chain wrench. The factory chain wrench originally designed for the 20R engine also works well on the 5M-GE.

Position the tool to avoid damaging the pulley's belt grooves. The crank pulley is cast iron and tends to be on the brittle side. Don't overtighten the chain wrench or the pulley may crack.

Toyota specialists recommend a 60,000 mile change interval for 5M-GE timing belts. Large piston cutouts ensure that the valves can't contact the piston tops even if an overdue timing belt does break. Knowing the valves haven't been bent should make it easier to quote the price of the job when one of these cars gets towed off the interstate after the timing belt breaks.

Always give the tensioner pulley and bearing a careful inspection during a belt replacement. The tensioner pulley should be clean and free of rubber debris. The tensioner bearing should turn smoothly and quietly.

Tensioner bearings seem to give up the ghost close to the 100,000 mile mark. So if you're doing a timing belt replacement at 70,000 miles or more, it's good insurance to recommend a tensioner replacement as well. Then you can be sure that the new tensioner bearing will last at least as long as the replacement timing belt.

Tool Requirements

These days, most repair jobs seem to require at least one special tool. We got off light with the 5M-GE's timing belt replacement, and only needed one. You might need two.

The crankshaft timing belt sprocket is keyed to the crankshaft and seldom comes off the crank without a fight. You may need to remove the sprocket to replace a leaking front crankshaft seal. Grabbing the front lip of the crank sprocket with a puller or prying on the sprocket from behind may damage the sprocket and/or the engine's front cover. A puller available from Assenmacher Tools screws into the sprocket's inner threads to safely remove the sprocket without damage.

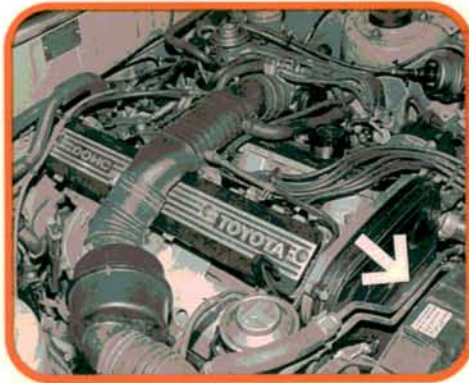
The last step in the replacement procedure is to check the belt tension. The tensioner spring should set the belt tension correctly, but it's worth checking the tension manually just for insurance. To do the job, you'll need a calibrated push/pull scale. Ours came to us from the Kent-Moore Division of SPX Corporation. It looks like a glorified fish scale, if that gives you any ideas.

—By Karl Seyfert

Assenmacher Tools
Circle No. 202

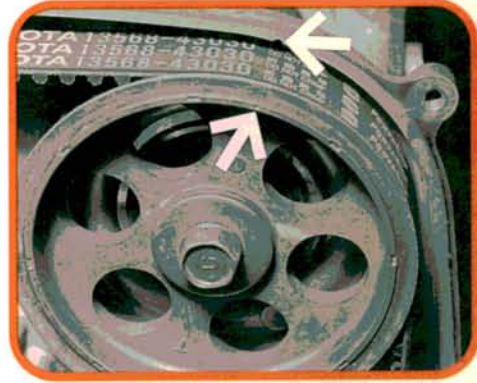
Kent-Moore Tools
Circle No. 203

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This is an overall view of the Cressida's engine compartment. If you're doing the job on a Supra, you'll find things are a bit more cramped. Once the parts we've already mentioned have been removed, the only things you'll have to work around are the power steering lines (arrow).



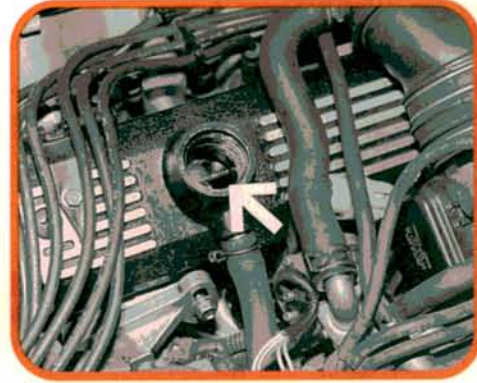
2

Remove the upper timing cover. Turn the crankshaft clockwise to line up the crank pulley timing notch with the TDC notch on the lower belt cover. Check the camshaft sprocket timing marks to make sure you're at TDC/compression for number 1. The sprocket marks should line up with the inner timing cover notches.



3

Remove the idler pulley and A/C compressor bracket. The bracket wraps around the front of the lower timing cover. Remove the crankshaft pulley bolt, then the crankshaft pulley. Our pulley wiggled off by hand, you may need to use a puller. Remove the lower timing cover bolts and cover.



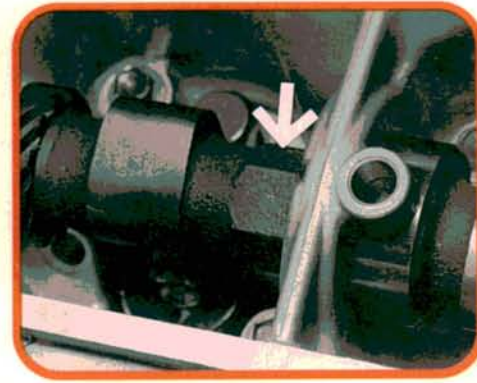
4

Remove both valve covers. The camshafts and cam carriers use alignment holes at their number 2 journals to set valve timing. You can see the intake cam alignment holes through the valve cover's oil filler opening (arrow), but it's still worth removing the cover to check for valve train wear.



5

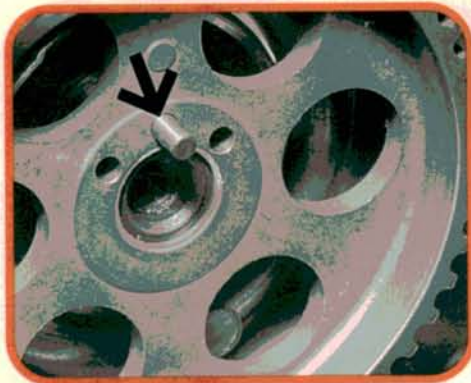
Make sure the crankshaft is still at TDC. Relieve the timing belt tension by loosening the belt tensioner pulley set bolt. Prop a screwdriver against the long bolt in the inner cover, then push the pulley toward the alternator. Retighten the pulley set bolt. Slip the belt off the cam sprockets.



6

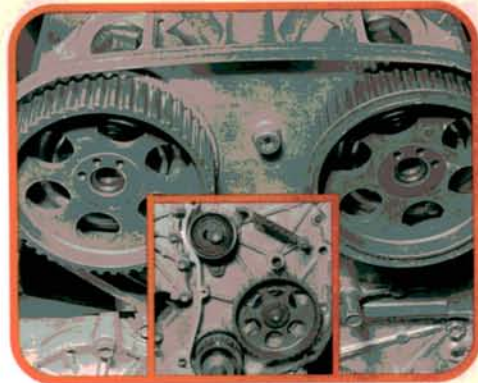
Here's another reason for removing both valve covers. The factory recommends a special spanner to hold the sprockets while removing the sprocket bolts. An open end wrench can also be used to hold the large cast hex next to the second cam journal (arrow). Both sprocket bolts have right hand threads.

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Setting the cam timing is a little different on the 5M-GE. Each camshaft sprocket has three alignment holes, and three mating holes in each camshaft. The hole spacing is offset, so only one camshaft and one sprocket hole will line up at a time. A match pin fits between them to hold the adjustment.



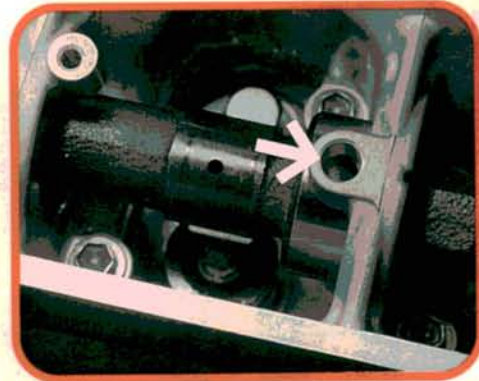
8

Check all four timing belt sprockets for wear or debris in the teeth. Remove the tensioner pulley and check the bearing for smooth operation. The tension spring's free length must be 69 mm (2.72 in) or less. During reassembly, the intake sprocket belt guide must face outward. The exhaust belt guide faces inward.



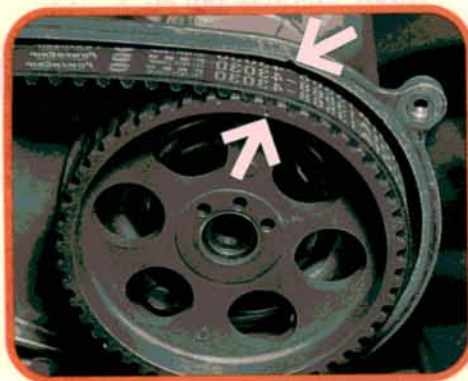
9

Slip the new timing belt over the crankshaft sprocket. Reinstall the lower timing belt cover and drive belt pulley. Apply thread locker, then torque the crank pulley bolt to 197-235 Nm (146-174 ft-lb). Reinstall the A/C compressor bracket. Align the crankshaft pulley notch with the zero degree timing mark.



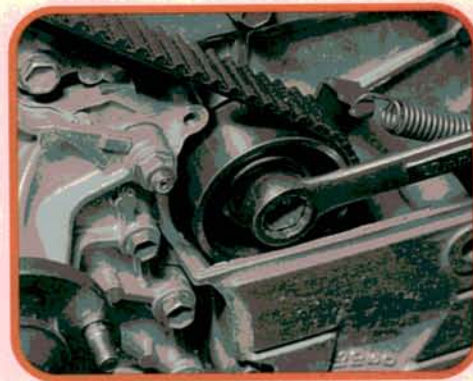
10

The intake and exhaust camshaft match holes must be aligned with the match holes in the number 2 cam housing journals. The cam and cam housing match holes are exactly the same size (arrow). Use the camshaft hex in front of the cam housing journal to rotate the cam into proper alignment.



11

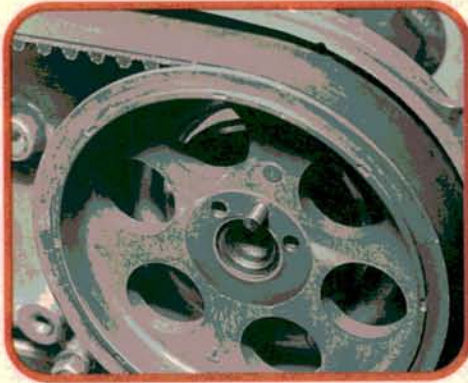
Reinstall both camshaft sprockets. Don't install the match pins or sprocket bolts just yet. Align the sprocket timing marks with the notches on the inner timing cover (arrows), then slip the timing belt over the sprockets. Keep all timing belt slack on the tensioner pulley side of the engine.



12

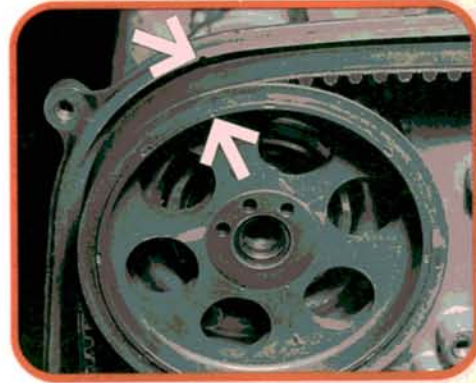
Loosen the tensioner pulley set bolt and allow the tensioner spring to remove the timing belt slack. Belt tension between the exhaust camshaft sprocket and the tensioner pulley should be equal to the tension between the intake camshaft sprocket and oil pump drive sprocket.

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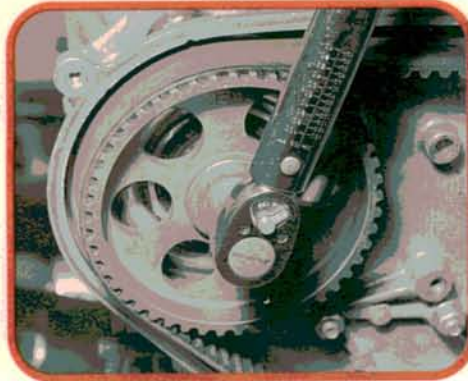
13

Recheck the camshaft match holes, cam sprocket timing marks, and crank pulley TDC mark for proper alignment. Look through the three holes at the front of the cam sprockets. Select one hole in each sprocket that aligns with a matching hole in the camshaft, then install the match pin.



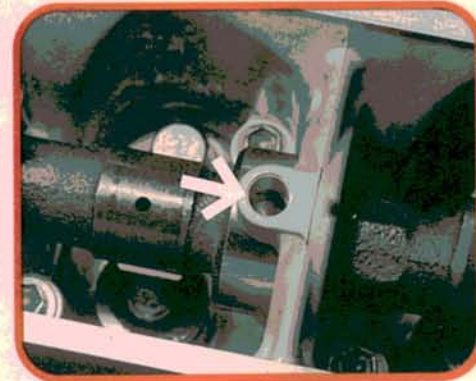
14

In some cases, the sprocket holes won't line up. Rotate the crankshaft (not the camshaft) until the closest pair of match holes line up. Less than one tooth of timing mark misalignment is allowed (arrows). Three degrees of crankshaft pulley rotation moves the cam sprocket from one pair of match holes to the next.



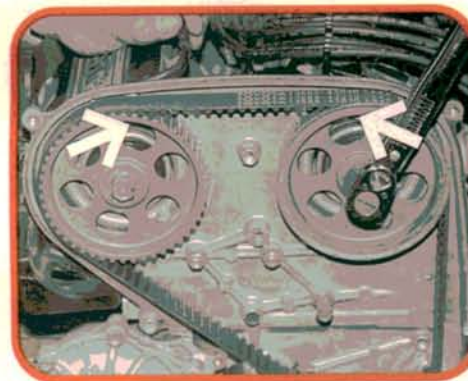
15

After installing the sprocket match pins, torque the camshaft sprocket bolts to 64-74 Nm (47-55 ft-lb). Hold the camshaft or use a sprocket spanner while tightening to prevent timing belt stretch. Loosen the tensioner set bolt, rotate the crankshaft twice, then retighten the tensioner set bolt to 49 Nm (36 ft-lb).



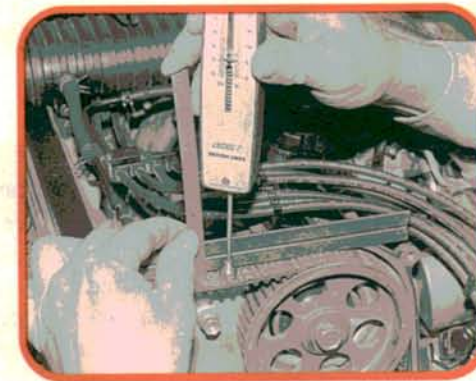
16

Turn the crankshaft until the intake camshaft and cam housing match holes are aligned. Check the position of the crank pulley pointer. Now align the exhaust cam match holes. The crank pulley pointer must be within 5 degrees of TDC when each pair of cam match holes is aligned.



17

Use two torque wrenches to rotate the cam sprockets toward each other at the same time. Set both torque wrenches to 20 Nm (14 ft-lb), then torque the exhaust sprocket clockwise and the intake sprocket counterclockwise. This puts any remaining belt slack between the cam sprockets.



18

Remove the torque wrenches, then place a straight edge across the top of the timing belt. Push down on the calibrated scale at the center of the belt with a force of 2-3 kg (4.4-6.6 lb). The belt should deflect 4-6 mm (0.16-0.24 in). Readjust the belt tensioner if necessary, then reinstall all previously removed parts.