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TECH TIPS FROM THE CHIEF

DEGREEING THE CAMSHAFT



What does “Degreeing the Camshaft” mean, and why is it necessary?

The term “Degreeing In Your Camshaft” means you are making sure the camshaft's position in the engine coincides with that of the crankshaft, so that their rotation is synchronized. This is the only way you will know if the rise and fall of the pistons properly matches the opening and closing of the valves, so the engine will run properly. A few degrees of misalignment can affect the engine's operation dramatically. If the circumstances were perfect, one would only need to line up the marks on the timing chain sprockets and the cam would be degreeed.

In reality, you are dealing with a group of components (the camshaft, crankshaft, timing chain, and sprockets), all with their own standards and tolerances. If these tolerances stack up against you, it could throw you out of alignment. Without degreeing the cam, you can never be sure that the parts are in correct position. If you have the tools and expertise, we always recommend that the camshaft's position in the engine be degreeed in.

Is there more than one way to degree a cam, and which is better?

Currently there are two popular methods for degreeing a cam; the **centerline method**, and the **duration at .050" lift** method. We believe it is far better to degree the camshaft with either method than not to degree the cam at all; but of the two methods, **the duration at .050" lift is much more accurate.**

The main problem with the centerline method is it has you finding the theoretical centerline of the intake and/or exhaust lobe and line up on it. It makes the basic assumption that the lobe you are checking is symmetrical, with its opening side being the exact same shape and size as the closing side of the lobe. The truth is that most modern lobes are asymmetrical, with the opening side of the lobe being much more aggressive and the closing side being gentler. Therefore, when you attempt to locate the middle (or centerline) of the asymmetrical lobe there is an automatic error factor. It could be as little as 2 degrees off or as much as 6 degrees, depending on the exact lobe shape and the procedure used during the degreeing operation. Neither does it verify that the camshaft has been properly ground with the correct duration lobes, which can drastically affect performance. Since the duration at .050" lift method is not affected by the asymmetrical lobe design, we believe it is the more accurate way to degree.

What tools will I need to degree the cam?

The basic tools required are:

- A degree wheel, such as Crane Cams part no. CRA-99162-1. (You can also use a professional fully degreeed damper or hub or install degree tape to your stock damper. Be sure to get the tape that matches the diameter of the damper. Use whatever will give you accurate markings for 360 degrees.)
- A stable pointer that can be conveniently mounted to the engine.
- A dial indicator with at least a half inch of travel in .001" increments. A rigid stand that mounts to the engine or with a magnetic base to hold the dial indicator will also be required.
- A positive stop device to locate T.D.C. will be necessary. (You can make your own by using an old spark plug. Remove the porcelain insides, then drill and tap the interior of the spark plug housing and thread a long bolt through it.)



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How do you find Top Dead Center (T.D.C.)?

Determining exactly where Top Dead Center is can be tricky. The problem in finding the true T.D.C. of the piston's travel is that the piston dwells at T.D.C. for several degrees of crankshaft rotation. You must use a device to stop the piston in the same position on either side of T.D.C. and take readings from the degree wheel. You will then split the difference in these readings and move the pointer this amount, making it the true T.D.C. point.

Begin the procedure by first mounting the degree wheel on the end of the crankshaft securely, and rotating the engine to approximately T.D.C. Mount the pointer and line it up at zero on the degree wheel. Now rotate the engine to move the piston down into the cylinder. Install your positive stop device into the spark plug hole and extend the bolt. Now hand turn the engine (do not use the starter motor or you will put a hole through the piston), rotating until the piston comes up and stops against the bolt. Look at the degree wheel and write down the number of degrees shown by the pointer. Hand turn the engine in the opposite direction until the piston comes up and stops on the bolt again. Go back to the degree wheel and write down the degrees it now reads. Add these two readings together and divide the answer by two. Now either move your pointer by this many degrees, or carefully loosen the degree wheel (without disturbing the position of the crankshaft) and move the wheel this required amount. Retighten the bolts, and rotate the engine again making sure that the readings on each side of T.D.C. are equal degrees away from zero. If they are, the zero on the degree wheel will now be the true T.D.C. point. Remove the stop device from the spark plug hole, as this procedure is complete.

A simple explanation of cam degreeing

In simple terms, the degreeing process can be thought of as using a dial indicator and degree wheel as tools to map out one revolution of the cam lobe. You will start on the base circle of the lobe where there is no lift. Then, by rotating the engine, you will move up the opening side, go over the top of the lobe, and then move down the closing side, finishing back on the base circle. The dial indicator will move from zero, up to maximum lobe lift, then back to zero during this revolution. You will watch the dial indicator, and stop at two key points to take readings from the degree wheel. Both points will be when the dial indicator shows .050" of lifter rise. This .050" reading will occur on the opening side and again on the closing side of the lobe. These readings will then be compared to the specification card to see how close they are. If necessary, corrections can be made to put the camshaft in the exact position.

Important tips to remember when degreeing a camshaft

1. You must always **use the same type and size lifter that your camshaft was designed for**. For example, you cannot use a .842" diameter lifter on a camshaft designed for a .875 diameter lifter. You cannot use a standard (flat) lifter to degree a roller camshaft.
2. **Clean off any excessive lubricant** from the lobes and lifters that you are checking. Thick oil, especially assembly lube (paste) can cause false readings to occur. Wipe the parts clean before checking, and remember to re-lubricate them when you are finished.
3. If you make a mistake and rotate the engine past the point you wished to take a reading, **do not back up the rotation**. If you do, any slack in the timing chain or lash in the gears will affect the readings, causing an error. If you miss your stopping point, just continue rotating the engine in the normal direction until you return to the desired point.

The procedure to degree the camshaft

1. The dial indicator and stand must be attached securely to the engine. Any deflection could cause an error in your readings. Using the number one cylinder as a starting point, hand rotate the engine in a normal direction (clockwise, when standing in front of the engine) until the intake



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valve is closed, (the lifter is down on the base circle of the cam lobe). If the intake manifold is off the engine, mount the plunger of the indicator directly on top of the intake lifter itself. If the intake manifold is on the engine, you can use the pushrod as an extension to the dial indicator and mount the plunger tip directly on top of the pushrod. In either case, it is important to make sure the angle of the dial indicator plunger is the same angle as the lifter or pushrod travel. We want to read "straight line" (linear) movement of these parts, so the plunger must be aligned properly. With the indicator in position, set the dial indicator to zero.

2. Hand rotate the engine in its normal direction while watching the dial indicator. As the lifter starts to move up the opening side of the lobe, the reading on the dial indicator will start to increase. Continue rotating the engine until the dial indicator shows .050" of rise. Stop and take a reading on the degree wheel and write it down.

3. As you continue to rotate the engine, the reading on the dial indicator will rise up to the maximum lobe lift. The lifter is now on the top of the lobe. (The maximum lobe lift is shown on the spec card and can be verified at this point if you wish.) Continue the rotation and the lifter will start down the closing side of the lobe. Carefully watch the dial indicator as the numbers descend. When the indicator descends back to the .050" reading, stop, take a reading from the degree wheel and write it down. Rotate the engine and return to the base circle of the lobe. The dial indicator must read zero again to be sure the process was correctly done.

4. You now have the two important readings from the degree wheel, both taken when the dial indicator read .050". One reading as the indicator was ascending on the opening side, the other when it was descending on the closing side. Compare these numbers to those on your camshaft inspection card to verify the position of the intake lobe. The camshaft specification card provides much more information, but the numbers you are most interested in for the degreeing of the cam are at the bottom of the card. In the box identified as "Cam timing at .050" Tappet Lift". (Just a reminder, the word tappet and lifter mean the same thing. This can also be expressed as .050" lifter rise.) Inside this box are the degree readings that the degree wheel would show for the intake "opening" side of the lobe and the intake "closing" side of the lobe when the dial indicator is at .050" of lift. (Below those figures are the opening and closing figures for the exhaust.) Compare your readings for the intake to those on the card. If you are within a degree, your camshaft is installed in the correct position.

5. You can follow exactly the same procedure on the exhaust lobe to determine its opening and closing degree points at .050" of tappet (or lifter) rise, and compare these readings to those on the specification card. If you also check the exhaust lobe, you will have four points of reference (intake opening and closing, and the exhaust opening and closing) to go by. Remember, if you are plus or minus one degree of these readings, your cam is in the correct location and will be synchronized to the crankshaft's rotation.

What can you do if your camshaft is off location and needs correction?

There are several methods of adjusting the location of the camshaft to correct for misalignment. Most high performance timing chain sets have the lower crank sprocket machined with three or more keyways, allowing you to advance or retard the camshaft. There are also offset keys made for the crankshaft. Another popular method is offset eccentric timing bushings that can be installed in the upper camshaft sprocket to change the camshaft's position in relation to the sprocket on those camshafts that use a dowel pin for indexing. Use any of these methods, and then degree the camshaft once again to be sure it is correct.