Camshaft Degreeing Instructions

The purpose of degreeing a camshaft is to ensure that it is phased correctly with the crankshaft. Some factors that may cause improper positioning are:

1. Cam or crank gear marked incorrectly
2. Incorrectly machined cam or crank gear keyways
3. Misindexed cam keyway or dowel pin
4. Improper machining of camshaft or crankshaft
5. Accumulation of machine tolerances – Remember that camshaft position or phasing to the engine is extremely important for the engine to operate at maximum efficiency.

Equipment needed to properly “degree” a camshaft is available from COMP Cams®. You will need:

1. Degree wheel
2. A rigid pointer that can be attached to the block
3. A dial indicator to accurately measure cam lift

Note: Refer to your spec card for maximum lift and check your dial indicator to be sure it has sufficient range to measure the full cam lift.

4. Either a magnetic or attachable base to affix the dial indicator
5. A Top Dead Center piston stop
6. A solid lifter to fit your engine. Engines that have non-adjustable rocker arms will also require an adjustable pushrod length checker to accommodate that engine
7. A means to attach the degree wheel to the crankshaft

A Cam Degree Kit is available from COMP Cams® (Part #4796) (Fig. A)

The Intake Centerline Method

There are several accepted ways to degree a camshaft. At COMP Cams®, we feel the Intake Centerline Method is the easiest and most accurate. This method of cam degreeing is very practical and indifferent to design characteristics. It simply involves positioning the center, or point of maximum lift, of the #1 intake lobe with Top Dead Center (TDC) of the #1 piston. The Intake Centerline Method still requires accuracy to be correct, but it is somewhat more forgiving. Once you have degreed a camshaft using this method, you will be surprised at its ease. We also recommend positioning the dial indicator on the #1 intake retainer because lift measurements will include any deflection that may occur in the pushrod and rocker arm. This makes the degreeing process as accurate as possible in relation to what actually goes on inside the engine.

Time to Go to Work

Step 1: The camshaft and timing set have been installed. Make sure that the timing marks on both the cam gear and crank gear are aligned properly per the cam installation instructions. Use chalk or a similar marker to better define the marks.

Step 2: For example, we have our cam card, and it suggests we install the cam on 106° intake centerline. Install all the rocker arms and pushrods in the engine as normal. On the #1 intake lobe, install the solid lifter in place of the hydraulic lifter. If a solid lifter or roller cam is being checked, use that respective lifter. Adjust the #1 intake lash to exactly zero. Do not pre-load the lifter. Next, adjust the #1 exhaust lash to zero. You should be able to turn both pushrods with your fingers easily.

Step 3: Attach your COMP Cams® pointer (Part #4794) to the block. Many people will make a pointer out of some sort of rigid, yet manageable wire (Fig. B).

Step 4: Attach the degree wheel to the balancer and install the assembly on the crankshaft. There are several ways to attach the degree wheel to the crankshaft. In our example, the degree wheel is mounted to the balancer. The crank may be rotated from either the front or from the flywheel end. Obviously, if the engine is in the car, you must rotate from the front. Remember, the greater the leverage, the smoother the crank rotation, thus more accuracy. NEVER use the starter to turn the engine while degreeing the cam.

Step 5: Before installing the piston stop, rotate the crankshaft to get the #1 piston in approximate TDC position with both the intake and exhaust valves closed. This can be a rough guess, but it can save you from making a mistake later. Adjust your pointer to zero or TDC on the degree wheel.

Step 6: Turn the crankshaft opposite the engine rotation approximately 15-20°. This will lower the position enough to allow the TDC stop to be installed in the spark plug hole. Screw in the piston stop until it touches the piston. (Fig. C). Continue to turn the engine in the same direction until the piston comes back up and touches the piston stop. Mark the degree wheel with a pen or pencil on the number the pointer is on (Fig. D). Turn the engine in the other direction, same as engine rotation, until the piston comes back up and touches the piston stop. Make a mark on the number the pointer is on (Fig. E).

Step 7: Remove the piston stop after marking the two points on your degree wheel. Rotate the crankshaft to the midpoint of the two marks. This point is TDC for cylinder #1. Without rotating the crankshaft, adjust the degree wheel to read 0° at the pointer (Fig. F). You are now ready to locate the intake lobe centerline relative to TDC. If you are not absolutely sure that your 0° mark is set at TDC, repeat this procedure. This step is critical to proper cam alignment.

Step 8: Attach the dial indicator to the dial indicator mount. Position the dial indicator mount so that the tip will contact the retainer of the #1 intake valve (Fig. G). It is important that the indicator plunger be parallel to the valve stem. Any variance in the angle of the indicator will introduce geometric errors into the lift readings.

Step 9: Rotate the engine in the normal direction of crankshaft rotation until you reach maximum lift. The dial indicator will change direction at the point of maximum lift. At this point, set the dial to zero (Fig. H).
Step 10: Back the engine up (usually counter-clockwise) until the indicator reads .100". Turn the engine back in the normal direction of rotation until (usually clockwise) the dial indicator reads .050" before maximum lift. Record the degree wheel reading.

Step 11: Continue to rotate the engine over in its normal direction of rotation until the indicator goes past zero to .050" on the closing side of maximum lift. Again, record the degree wheel reading.

Step 12: Add the two numbers together and divide by two. That number will be the location of maximum lift of the intake lobe in relation to the crank and piston. This is the intake centerline. For example: The first degree wheel reading was 96°. The second reading was 116°. These two numbers (96 + 116) added together will be 212. 212 divided by 2 will equal 106. Your actual intake centerline is 106°. Reference back to your cam spec card, and see that the recommended intake centerline for your camshaft is 106°. Everything is where it should be.

In the event that your camshaft did not degree in per manufacturer’s specs, it will be necessary to either advance (move ahead) or retard (move back) the cam to meet the suggested intake centerline. Depending on the engine application, there are several different suggested methods for advancing or retarding the camshaft.

One common method is by use of a crank gear with multiple keyways—each one being at a slightly different relationship to the gear teeth. A second method is used to offset bushings that fit on the cam pin and in the cam gear. The offset will advance or retard the cam depending on how the bushing is placed on the cam pin. Another method is by offset keys that fit into the crank gear keyway. A more elaborate system uses an adjustable timing gear. Contact COMP Cams® or your local COMP Cams® dealer for the method best suited to your application.

Note: When degreeing a cam, remember to look at the degree wheel as a full 360°, no matter how the degree wheel you’re using is marked. Many degree wheels are marked in 90° or 180° increments. On wheels that are marked in 90° increments, keep in mind that you must continue to count the number of degrees past 90°. Be sure all readings are taken from TDC.

Keep in mind that to advance the cam, you must lower the intake centerline. For example, if our cam has a lobe separation of 110°, the cam is “straight up” when the intake centerline is 110°. Moving the centerline to 106° advances the cam 4°. If we change the centerline to 112°, this would be 2° retarded.

Checking Piston to Valve Clearance

Step 1: With the camshaft installed, remove the cylinder head from the block. Clean the combustion chamber and the top of the piston and valve reliefs. The cleaner the piston, the better the clay will stick to it.

Step 2: Apply a strip of model clay 3/8" to 1/2" wide and approximately 1/4" thick to the pistons. The clay strips should be placed perpendicular (across) to the intake and exhaust valve reliefs (Fig. I). Applying a small amount of oil to the clay will prevent it from sticking to the valves as they press into the clay.

Step 3: Reinstall the cylinder head with the gasket that is going to be used. It will not be necessary to re-torque the head yet. All head gasket manufacturers can tell you what the compressed thickness of their gasket will be. Measure the gasket before you install it permanently and add the difference of the gasket thickness to your piston to valve clearance. This will be within .001" or .002" of the exact clearance. Install a sufficient number of head bolts to secure the head in place while you are rotating the engine. Install the pushrods, lifters and rocker arms on the cylinder you have prepared for the clearance check.

Step 4: Adjust the rocker arms to their suggested clearance. If the camshaft you are checking uses the hydraulic lifters, you must temporarily use solid lifters in their place. Hydraulic lifters bleed down and would provide a false measurement. Once the hydraulic lifters are replaced with solid lifters, adjust the lash to zero. Be sure not to pre-load the valve spring (Fig. J). (Be sure to reinstall the hydraulic lifters before starting the engine).

Step 5: Turn the engine over by hand in the normal direction of rotation. Be sure to rotate the engine over two times. This will be one complete revolution of the cam and assure you of an accurate reading on both the intake and exhaust. Remove the cylinder head from the block. Be sure to do this gently, so the clay is not disturbed. It may be stuck to the valves or combustion chamber, so be careful.

Step 6: With a razor or a sharp knife, slice the clay cleanly, lengthwise through the depression and peel half of it off the piston (Fig. K). The clay’s thickness in the thinnest area will represent the minimum piston to valve clearance.

Step 7: To accurately check the thickness, use a set of dial calipers (Fig. L). The clay can also be measured close enough with a thin steel rule. Note: Be sure to check piston to valve clearance after the cam has been degreed in. The positioning of the cam in the engine will greatly affect the piston to valve clearance.

COMP Cams® carries a video entitled “The Proper Procedure to Install and Degree a Camshaft” (Part #190DVD). This video covers all of the points discussed here and illustrates many other helpful tips to achieve the maximum performance from your engine. If you wish to order this video, or if you have any other questions concerning your cam change, please call our toll free CAM HELP® line at 1-800-999-0853.