

Camshaft Installation (08/2007)

If you do not follow these instructions, you will be sorry!! The most important time in the life of your new camshaft and lifters are the first few minutes of start-up.

➤ **Cleaning and lubrication:**

Lightly wash the camshaft in clean solvent and blow it dry with compressed air. **DO NOT BRUSH OR SCRUB THE CAM WITH ANYTHING!!** For flat tappet camshafts, apply the supplied camshaft break-in lube to the cam lobes including fuel pump lobe, and the lifter bottoms only. *NOTE:* Magnum hydraulic roller cams do not require break in lube on the cam. Use light engine oil on the sides of the lifters. Use engine oil or assembly lube on the bearing journals, distributor gear, and pushrod ends. With roller tappet camshafts use a good quality heavy-duty engine oil to lubricate the camshaft and lifters. Double check that the number stamped into the end of the cam matches what you ordered. Check our website for latest oil updates. We recommend our Extreme Pressure Oil Additive, P/N 3690 for all performance camshafts.

➤ **Valve springs:**

Our camshafts are designed differently and have more lift than other cams; therefore it is mandatory that you use a spring with the correct amount of opened and closed (seat) pressure and also check the valve spring installed height. The enclosed camshaft card will tell you our part number for the springs and the pressures/installed height to use. A minimum of .060" spring travel beyond the maximum lift is required. If you have a problem, we have many different retainers to adjust the installed height --- **CALL US**. When checking true double springs, be sure to use a retainer or other spacer to simulate the step on the head and/or retainer for the inner spring. If you are using a double spring assembly, we require you break in the camshaft with the outer springs only. In this case assemble the heads with the outer springs only and follow the regular break-in instructions. After that add the inner spring assembly and go racing. Be sure and check the retainer-to-seal clearance. There should be a minimum of .060" of clearance at maximum valve lift.

➤ **Piston-to-valve clearance:**

Chryslers do not have the piston-to-valve clearance problems that most other engines experience. However, after the valve lifts exceeds .500" and above you must check to be sure. The critical area is not at TDC (top dead center). The critical areas are approximately 10° to 15° before TDC on the exhaust lobe and 10° to 15° after TDC on the intake lobe. We suggest a minimum piston-to-valve clearance of .060" intake and .110" exhaust. In the event you need additional clearance, we have a piston-notching fixture that we rent to our customers. It can be used on a short block in a car. Call for details.

➤ **Check lifter bores: (Also see page 3 for detailed lifter rotation check instructions)**

The lifters should slide up and down and turn freely in the bore when lubricated only with WD-40 or similar light oil as a lubricant. You should be able to lift the lifter off of the cam, release it and hear it "thunk" against the cam. If it doesn't do this using only it's own weight, it is too tight. If the old lifters had to be forced through the bore to remove them, it is quite likely that the lifter bore is damaged and will not allow the lifter to rotate. It doesn't take much. Fix it or expect problems. Use our Lifter Broaching Tool, P/N 8319, to correct tight or damaged lifter bores.

➤ **Lifters (Tappets):**

All flat tappet camshafts (both hydraulic and solid) must be installed with new lifters. **NO EXCEPTIONS!!!** Only roller camshafts can be installed with good used roller lifters. **DO NOT** fill, pump-up, or soak any hydraulic lifters before installation. Mechanical camshafts should be given slightly less valve lash for break-in only, approximately .004"/.005" less. This causes the lifter to spin more easily. Hydraulic lifters should have approximately .020" to .060" lifter pre-load, (1/4 to 1 turns on the rocker arm adjusting screw). Use a wire gauge to measure the gap between the pushrod seat and the retaining clip in the lifter. Check this if adjustable rockers are not used. Be sure and check this pre-load when the lifter is on the heel of the camshaft. If you do not have adjustable rocker arms or pushrods and you find the preload is incorrect, you will need either rocker shaft shims or longer pushrods. Hughes Engines Inc. can supply all these parts if needed, call us.

Pre-Load settings for flat tappet camshafts

<u>Application type</u>	<u>Turns</u>	<u>Preload</u>	<u>Sound</u>
RV/Cruiser, 4 x 4	2 to 3	.085"/.148"	Quiet
Street/Strip	2 to 3	.085"/.148"	Quiet
Bracket racers/Oval track	1/2 to 1	.022"/.042"	Some tick
Record attempts	0 to loose	.000"/+.003"	Tick all the time

(One turn = .040")

When using aluminum heads the cold lash setting for mechanical cams should be about .007/.008" tighter than when using iron heads for initial start-up and break-in.

Magnum (Roller Hydraulic Cams "Ram Cams")

Before removing the distributor, mark the base and the intake with "witness" marks so that the distributor can be reinstalled correctly. The distributors in these applications *DO NOT* control the spark timing and cannot be "timed" with a timing light. All Roller lifters need 2 to 3 turns (.080" - 0.120") pre-load. This applies to all engines. Roller cams do not require a break-in or spring changes like flat tappet cams.

➤ **Diagnosis:**

Hydraulic lifters that lose their prime (collapse) quickly after start up, have dirt in them. The lifters with dirt in them can be disassembled and cleaned or replaced. Many problems are created during disassembly of an engine prior to a rebuild by pulling damaged lifters up through the lifter bore causing grooves and burrs in the bore. These burrs will make lifter spin difficult, if not impossible. If you flatten a lobe, checking the sides of the lifter with a 10X magnifying glass will show the grooves about 1/8" to 1/2" off of the bottom of the lifter on the sides. Sometimes they will be deep enough to feel with your fingernail. These grooves act as a keyway and prevent lifter rotation causing cam and lifter damage.

A dry or improperly lubricated camshaft will suffer damage as soon as the engine is fired up. The lobe and lifter can be totally destroyed in a few minutes. The engine should run for 16-20 hours before the lobe wear pattern is completely across the tip and the swirl grind marks on the bottom of the lifter are gone. Quicker developing wear patterns indicate problems such as spring stack up, lubrication breakdown, or too much pressure. Flooding the crankcase with fuel is the second leading cause of cam/lifter failure. Excessive fuel pressure, sticking float, etc. causes the oil to lose its' lubrication ability. Say goodbye camshaft. With Holley carbs, we suggest a 3.5 power valve for break-in. Coolant leaks can also destroy the oil's ability to do its job.

➤ **Start-Up:**

It is very important that the engine not turn over more than 3 or 4 times to fire up. While you are cranking over the engine, the break-in lube is being wiped off --- **BAD NEWS!!!** Do not crank the engine with a new cam to:

1. Bring up the oil pressure. ---- Use an oil pump primer shaft
2. Fill the carburetor with fuel. ---- Use your electric pump or take the line off and fill it by hand
3. Check the spark. ---- Take the distributor out and spin it by hand with the ignition key off (non -Magnum)

Don't listen to anyone who says to do this differently, you don't want a flat cam and we don't want to hear about a flat cam. People who tell you differently are not your friends. Triple check the ignition timing (approximately 6° to 8° BTDC is good) and spark plug wire order before touching the key. Most start-up problems occur here. Pump the carburetor (2 or 3 times) to squirt fuel into the manifold. Make sure your battery is up to full charge and that you have sufficient fuel to run 30 minutes. The carburetor idle screw should be turned in approximately 1/2 to 3/4 turn to make sure the engine idles properly. DO NOT SLOW IDLE the engine for the first 30 minutes.

➤ **Now you are ready:**

Fire it up! The engine should idle at a minimum of 1500rpm for the first 30 minutes. Rev the engine in short bursts of speed up to 3000RPM max. After the break in period, reset the idle and timing. Check for air leaks (vacuum), fuel leaks, oil leaks, and coolant leaks. Correct as needed. Install the inner valve springs if they were removed and check the valve lash.

If you have any questions, **CALL US BEFORE YOU DO IT!** There are no dumb questions. After you make the mistake, they are dumb questions because you already know the answer. The odds are in your favor, only about 1 in 250 people screw-up and flatten their cam. If you have any questions about the components recommended for your camshaft refer to the supplied cam spec card or call us.

If you have any questions, call us!
Phone (309) 745-9558
Fax (309) 296-9990
www.hughesengines.com



Flat tappet hydraulic & solid lifter clearance & rotation check

It is mandatory that all flat tappet lifters be free in their bores and spin as the cam rotates in the block. We suggest the following procedure to test for both of these conditions, before final installation of the cam.

- 1) Install the camshaft clean and dry in the block, with oil only on the bearing journals.
- 2) Install the lifters dry with only a light coat of WD- 40® or similar light oil on the sides.
- 3) Mark all the lifter tops, in similar manner, with a felt tip pen so you can see how far they rotate.
- 4) Install the camshaft timing chain sprocket, only.
- 5) Using a speed handle and the proper socket, rotate the cam while applying a small pressure on the socket, to keep it properly located against the block.
- 6) Observe the lifters; they must rise and fall by their own weight. If not, they are too tight. We have a special tool to properly size and clearance the lifter bores, P/N 8319.
- 7) Rotate the camshaft at the speed of approximately 2 turns per second, for a total of 16 revolutions.
- 8) Check the mark on top of the lifter. It must indicate that the lifters were trying to rotate. You would like to see about 90° rotation indicated, though some may turn as much as 1 full turn. All lifters will not rotate the same amount. If a lifter does not rotate at all - try again – the cam and lifter must be dry where they contact for this test to work properly. It may be necessary to move lifter(s) to other bores in order to see rotation.
- 9) If you encounter a lifter that absolutely will not rotate after following these steps contact us.

If you have any questions, contact us!

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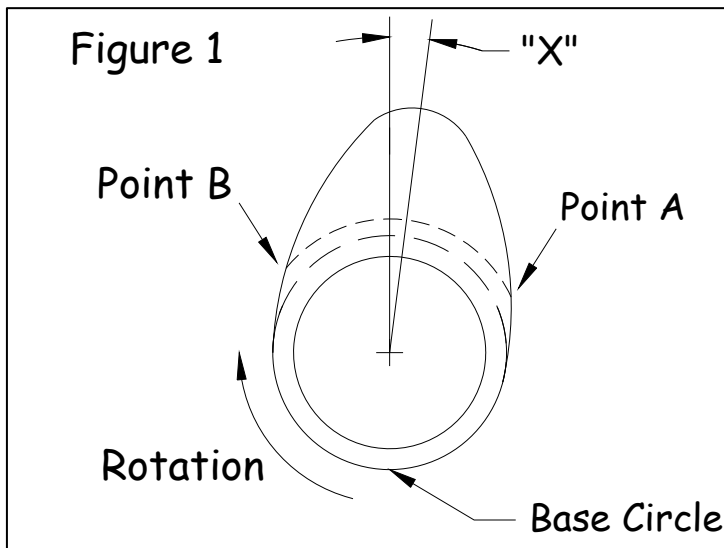
Degreeing the camshaft

Why degree the camshaft?

Degreeing the camshaft correctly with a dial indicator and degree wheel tells you that all the components that control the position of the camshaft are accurate. Just because the parts are new, does not guarantee they are accurate. The only way to know is to check. Checking the center-line position of the camshaft can be confusing due to the similarity of the terms lobe separation angle and center-line. We will try to make it as easy as possible to center-line the camshaft the correct way.

Note: All Hughes Engines camshafts are ground with a 3° advance. This means if the camshaft is center-lined or degreeed-in to the specs on the cam card it will be advanced 3° . However, this does not mean if you install the camshaft "dot-to-dot" it will be 3° advanced. It should be, but you don't know for sure unless you check it.

The lobes on Hughes Engines Inc. are non-symmetrical. A non-symmetrical lobe will have a different center-line when checked at 0.050" above the base circle than it does when checked at the top of the lobe. Hughes Engines Inc. camshafts must be checked at the bottom of the lobe, which is 0.050" tappet lift off the base circle.



Point A is 0.050" off the base circle and is the opening point.

Point B is 0.050" off the base circle and is the closing point.

A camshaft that is advanced 3° will have a center-line that is 3° less than the lobe separation angle. For example, if the lobe separation angle is 110° , a 3° advance would be 107° centerline ($110^\circ - 3^\circ$)

"X" is the difference of the center-line at the top of the lobe vs. at 0.050" off the base circle.

Tools Required

1. Dial indicator with at least .500" travel
2. Degree wheel (12" or more in diameter). The best ones are marked 0° to 180° and start at 0° again.
3. Pointer for the degree wheel

Locating Top Dead Center

(Note: Finding true top dead center is the area where many mistakes are made. Follow these instructions carefully.) In this example we will work with the intake lobe on cylinder #1.

1. Install the camshaft, timing chain and gears. For checking purposes, set the sprockets "dot-to-dot".
2. Start by rotating the crankshaft 360° to position the piston in cylinder #1 back at the top of the cylinder. Then mount the degree wheel to the front of the crankshaft with the 0 (zero) or TDC mark at the 12 o'clock position. Mount the pointer to the block and position it to point to the TDC (zero) mark on the degree wheel.

3. Next, mount the dial indicator on the top of the block with the plunger contacting the center of the piston and about .100" preload.

4. Rotate the crankshaft clockwise and counter-clockwise past TDC. Then zero the dial indicator at the highest point of the piston travel. **This is not true TDC**, yet! Again, rotate the crankshaft clockwise until the piston has descended exactly .060" below TDC as shown on the dial indicator. Mark this position on the degree wheel (masking tape and a pen works well). Precision is important at this point. Your mark should be approximately 3° to 10° from TDC. We will call this point "A".

5. Back up the crankshaft, (turning it counter-clockwise) moving the piston up to the top position and then down in the bore. Allow the piston to go about 1/8" down and then stop. Now rotate the crankshaft clockwise until the dial indicator shows exactly .060" before the piston has reached TDC. At this position, mark the point on the degree wheel "B". Exactly ½ way between points "A" and "B" is true TDC.

6. Rotate the crankshaft clockwise until the pointer is at the exact ½ way point between "A" and "B". This point may or may not be on the zero mark of the degree wheel, but very close if you have followed these instructions properly. Now the crank and piston position are at true Top Dead Center. Reposition your pointer to the zero mark on the degree wheel.

Checking the Open and Closing Points of the Intake Lobe

1. Install a lifter on the intake lobe corresponding to the piston you just checked TDC (#1). Lubricate the lifter with very light oil, such as WD-40 (**do not use cam lube at this time**) and check to make sure it moves freely in its bore. The weight of the lifter and the dial indicator spring are the only things pushing the lifter down against the camshaft. If the lifter hangs or binds in the lifter bore during checking, you will get very confusing results and the job will be difficult.

2. Turn the crankshaft until the lifter is on the heel (base circle) of the camshaft (See Figure 1). At this point zero the dial indicator with about .100" preload on the plunger on the lifter. The indicator plunger **must be inline** with the lifter's line of travel.

3. Rotate the crankshaft clockwise until the lifter has lifted .050" according to the dial indicator, this will be Point A in Figure 1. Note the position of pointer on the degree wheel.

4. Continue to rotate the crankshaft and the lifter will rise to over .300" lift and then begin to descend. When the lifter descends, equal to what it rose, to a point .050" before reaching the base circle, stop. Make a note of the location of the pointer on your degree wheel; this is the intake closing point. Always turn the crankshaft clockwise while checking the camshaft timing, NEVER back up!

5. Half way between Point A and Point B is the camshaft centerline and should correspond to the centerline printed on the camshaft card.

Example 1: When using a small cam where the intake opens after TDC with a 112° lobe separation angle.

If for example the intake should open at 2° ATC (After Top Center) and close at 36° ABC (After Bottom Center). Add up the total number of degrees from 2° to BDC (178°) and the number of degrees from BDC to 36° ABC (36°), $178^\circ + 36^\circ = 214^\circ$. Divide 214° by 2, this is 107°. The 107° is added to the opening point of the 2° ATC equaling 109°, which is the proper intake centerline, and 3° advanced for the sample cam.

Example 2: Using a larger camshaft where the intake opens before TDC with a 107° lobe separation angle.

If for example the intake should open at 21° BTC (Before Top Center) and close at 49° ABC. Add the 21° BTC and the 180° (from TDC to BDC) and the 49° ABC, which totals 250°. Divide the 250° by 2, this is 125°.

Starting at 21° BTC (the intake opening point) the centerline of the lobe is 125° after the intake opens which puts the intake centerline at 104° ATC, just as the camshaft card suggests and is also 3° advanced.

6. The following are general guidelines for comparing your measured points vs. the numbers on your cam card. If the centerline is within:
 - a. 1° of the camshaft spec card, then put then engine together
 - b. 2° of the camshaft spec card, correct it.

Corrections and Final assembly

1. Correct the timing as necessary and Recheck. Low-Priced crankshaft sprockets with 3 keyways, offset keys and offset bushings are notoriously inaccurate. We have found the Pro Gear® timing chain assembly to be very accurate and long-lived, which is why we use and sell them.
2. When it's correct, Loc-Tite® the bolts, torque to spec and put it together.

This method is for Hughes Engines' "real Chrysler Cams" and may not work with other brands of cams.

Tips:

If the engine is on an engine stand, rotate it so the lifter is vertical which helps it follow the lobe more accurately. In our shop we use an "extra-long" lifter (7") to add weight to help follow the cam lobe and to allow us to position the dial indicator in a more readable position. The extra-long lifter is 3 old lifters tack welded together.

A common problem encountered when installing a timing chain and sprockets is to install the ignition distributor 180° out of time. This happens because the piston is on the overlap stroke, not the compression stroke. This is how. When the sprockets are in the classic installation position, with the cam sprocket's dot down at 6:00 position and the crank sprocket's dot up at the 12:00 and the number 1 piston at top dead center, it is not on the compression stroke. Rotate the crank 1 more turn, putting both sprockets' dots at 12:00 and the #1 piston at top dead center. Now you are on the compression stroke, and you can install the distributor. (No, I don't know why it is this way. It has been this way forever, on all American engines since timing chains have been used).

DANGER!!!

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Oil Warning

Do not use oils that have an A.P.I. rating of SL, SJ, or SM.

These are the latest oil ratings and these oils, both petroleum and synthetics, have reduced the zinc/phosphorous additive about 40% to reduce catalytic converter contamination. This is the additive that reduces wear in high-pressure areas of your engine, most notably on the cam and lifters. You need to have at least 1200 parts per million of zinc phosphate in your oil. The SL and SJ oils are under 900 ppm and the SM oil is even worse. Engine oils classified as "Heavy Duty" in a 10W40 or 20W50 weight are best. Diesel oils that have a CI-4 or CI-4+ are also good oils. DO NOT use oils classified as "EC" (energy conserving). They will not provide the wear protection you need; can you say, "flattened cam", sure, I knew you could!

We do not recommend the use of most synthetic oils with flat tappet type camshafts. Synthetic oils are in some cases okay with roller tappet camshafts.

We offer an Extreme Pressure Lubricant oil additive (#3690) that we **highly recommend** using during break-in and at each oil change. We also offer our own Synthetic Blend Racing Oil. The oil that the "fast guys" on TV claim to use is not the same as what you and I can buy at "Wally world". You cannot buy what they use, regardless of what the bottle has printed on it, unless you are buying Joe Gibbs' oil!

If you have any questions, call us!
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