State of California
AIR RESOURCES BOARD

EXECUTIVE ORDER D-279-1
Relating to Exemptions Under Section 27156
of the Vehicle Code

COMPETITION CAMS, INC.
PURE ENERGY CAMSHAFT
(P/N 12-305-4)

Pursuant to the authority vested in the Air Resources Board by Section 27156 of the Vehicle Code; and

Pursuant to the authority vested in the undersigned by Sections 39515 and 39516 of the Health and Safety Code and Executive Order G-45-5;

IT IS ORDERED AND RESOLVED: That the installation of the Pure Energy Camshaft, P/N 12-305-4, manufactured by Competition Cams, Inc. of 3406 Democrat Road, Memphis, Tennessee 38118 has been found not to reduce the effectiveness of the applicable vehicle pollution control system and, therefore, is exempt from the prohibitions of Section 27156 of the Vehicle Code for 1987 and older General Motors vehicles powered with a 267 CID (4.4L) to 350 CID (5.7L) carbureted V-8 gasoline engines.

This Executive Order is valid provided that installation instructions for this Pure Energy Camshaft, P/N 12-305-4, will not recommend tuning the vehicle to specifications different from those submitted by Competition Cams, Inc.

Changes made to the design or operating conditions of the camshafts, as exempt by the Air Resources Board, which adversely affect the performance of a vehicle's pollution control system shall invalidate this Executive Order.

Marketing of this camshaft using any identification other than that shown in this Executive Order or marketing of this camshaft for an application other than those listed in this Executive Order shall be prohibited unless prior approval is obtained from the Air Resources Board. Exemption of the camshaft shall not be construed as exemption to sell, offer for sale, or advertise any component of the kit as an individual device.

This Executive Order does not constitute any opinion as to the effect the use of this camshaft may have on any warranty either expressed or implied by the vehicle manufacturer.

THIS EXECUTIVE ORDER DOES NOT CONSTITUTE A CERTIFICATION, ACCREDITATION, APPROVAL, OR ANY OTHER TYPE OF ENDORSEMENT BY THE AIR RESOURCES BOARD OF CLAIMS OF THE APPLICANT CONCERNING ANTI-POLLUTION BENEFITS OR ANY ALLEGED BENEFITS OF COMPETITION CAMS INC.'S PURE ENERGY CAMSHAFT, P/N 12-305-4.

No claim of any kind, such as "Approved by the Air Resources Board" may be made with respect to the action taken herein in any advertising or other oral or written communication.

Violation of any of the above conditions shall be grounds for revocation of this order. The order may be revoked only after ten day written notice of intention to revoke the order, in which period the holder of the order may request in writing a hearing to contest the proposed revocation. If a hearing is requested, it shall be held within ten days of receipt of the request and the order may not be revoked until a determination after hearing that grounds for revocation exist.

Executed at El Monte, California, this 1st day of October, 1992.

R. B. Summerfield
Assistant Division Chief
Mobile Source Division

State of California
AIR RESOURCES BOARD

EVALUATION OF COMPETITION CAMS, INC.'S PURE ENERGY CAMSHAFT, P/N 12-305-4, FOR EXEMPTION FROM THE PROHIBITIONS OF VEHICLE CODE SECTION 27156 IN ACCORDANCE WITH SECTION 2222, TITLE 13, OF THE CALIFORNIA CODE OF REGULATIONS

October 1992

State of California
AIR RESOURCES BOARD

EVALUATION OF COMPETITION CAMS, INC.'S PURE ENERGY CAMSHAFT, P/N 12-305-4, FOR EXEMPTION FROM THE PROHIBITIONS OF VEHICLE CODE SECTION 27156 IN ACCORDANCE WITH SECTION 2222, TITLE 13, OF THE CALIFORNIA CODE OF REGULATIONS

by

Mobile Source Division
State of California
Air Resources Board
9528 Telstar Avenue
El Monte, CA 91731

SUMMARY

Competition Cams, Inc. has applied for an exemption from the prohibitions of the Vehicle Code Section 27156 for their Pure Energy Camshaft, P/N 12-305-4, for installation on 1987 and older General Motors vehicles equipped with 267 CID (4.4L) to 350 CID (5.7L) V-8 gasoline engines utilizing feedback or conventional carburetors. Competition Cams has submitted a completed application and all the required information, as well as exhaust emissions test data performed at E. C. S. Laboratories, Inc. which demonstrated that the Pure Energy Camshaft does not have any adverse effect on the exhaust emissions of the affected vehicles. Testing performed at the Air Resources Board (ARB) confirmed the test results.

Based on the submitted information and the results of the emissions tests performed at E. C. S. Laboratories, Inc. and the ARB, the staff concludes that the installation of Competition Cams, Inc.'s Pure Energy Camshaft, P/N 12-305-4, will not adversely affect exhaust emissions on the specified vehicles.

The staff recommends Competition Cams, Inc. be granted an exemption as requested and that Executive Order D-279-1 be issued.

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EVALUATION OF COMPETITION CAMS, INC.'S PURE ENERGY CAMSHAFT, P/N 12-305-4, FOR EXEMPTION FROM THE PROHIBITIONS OF VEHICLE CODE SECTION 27156 IN ACCORDANCE WITH SECTION 2222, TITLE 13, OF THE CALIFORNIA CODE OF REGULATIONS

I. INTRODUCTION

Competition Cams, Inc. of 3406 Democrat Road, Memphis, TN 38118, has applied for an exemption from the prohibitions of Vehicle Code Section 27156 for their Pure Energy Camshaft, P/N 12-305-4, for installation on 1987 and older General Motors vehicles equipped with 267 CID (4.4L) to 350 CID (5.7L) engines utilizing feedback or conventional carburetors.

Competition Cams has submitted a completed application and all the required information, as well as exhaust emissions test data performed at E. C. S. Laboratories, Inc. which demonstrated that the Pure Energy Camshaft does not have any adverse effect on the exhaust emissions of the affected vehicles. Testing performed at the Air Resources Board (ARB) confirmed the test results of E. C. S. Laboratories, Inc.

The staff recommends Competition Cams, Inc. be granted an exemption as requested and that Executive Order D-279-1 be issued.

II. CONCLUSIONS

Based on the submitted information and the results of the emissions tests performed at E. C. S. Laboratories, Inc. and confirmatory testing conducted at the ARB, the staff concludes that the Competition Cams, Inc. Pure Energy Camshaft will not adversely affect exhaust emissions from vehicles for which the exemption is requested.

III. RECOMMENDATION

The staff recommends that Competition Cams, Inc. be granted an exemption as requested and that Executive Order D-279-1 be issued.

IV. PURE ENERGY CAMSHAFT DESCRIPTION

The Pure Energy Camshaft, P/N 12-305-4, is specifically designed for installation on 1987 and older General Motors vehicles powered by 267 CID (4.4L) to 350 CID (5.7L) V-8 carbureted gasoline engines. The camshaft operate in conjunction with the original equipment manufacturer (OEM) computer controlled feedback or conventional carburetors along with the emission control systems already certified with the stock engines. The purpose of using the Pure Energy Camshaft is to increase the overall engine performance which is a direct result of modifying the valve characteristics. An example would be the increase in valve lift and duration.

The Pure Energy Camshaft, P/N 12-304-4, increases the intake lobe lift by 21.5 percent and increases the exhaust lobe by 14.0 percent when compared to the OEM camshaft. The installation instructions for the Pure Energy Camshaft is located in Appendix A.

V. DISCUSSION OF THE PURE ENERGY CAMSHAFT

A 1987 Chevrolet Camaro powered by a 305 CID engine was used for the evaluation of the Pure Energy Camshaft. Documentation given to Competition Cams by General Motors indicated that a prom change would calibrate their Camaro to California specifications. This information was verified by

the ARB during the application process and confirmatory testing. The dynamometer inertia weight and loading used during the testing were 3625 lbs. and 7.6 hp, respectively.

Emission tests conducted by E. C. S. Laboratories, Inc. consisted of cold-start CVS-75 emission tests with the Pure Energy Camshaft, P/N 12-305-4, installed on the test vehicle. This test was used to compare vehicle exhaust emissions in the modified configuration with the applicable emission standards. The test results are shown in Table 1.

Table 1

CVS-75 TEST RESULTS

(E. C. S. Laboratories, Inc.)

	NMHC	CO	NOx
Emission standards	0.39	7.0	0.7
Pure Energy Cam	0.253	2.983	0.428

Confirmatory testing was performed at the ARB. The results are shown in Table 2.

Table 2

CVS-75 TEST RESULTS

(Haagen-Smit Laboratory)

	NMHC	CO	NOx
Emission standards	0.39	7.0	0.7
Pure Energy Cam test 2	0.104	1.286	0.272

The CVS-75 emissions test results at E. C. S. Laboratories, Inc. and confirmatory testing at the ARB indicate that HC, CO and NOx emissions of the Pure Energy camshaft are well below the emission standards. This demonstrates that the installation of the Pure Energy Camshaft, P/N 12-305-4, for 1987 and older 267 CID (4.4L) to 350 CID (5.7) V-8 carbureted gasoline engines will not adversely affect the exhaust emissions.

Competition Cams has submitted all the required information and fulfilled the requirements for an exemption. The test results confirmed that Competition Cams' Pure Energy Camshaft meets the requirements for the exemption.

APPENDIX A

COMPETITION CAMS® Valve Trains Engineered for the Way You Drive!

Camshaft Installation Instructions

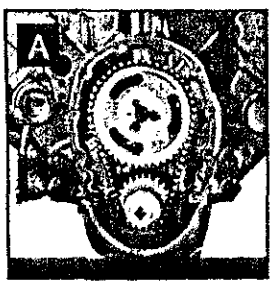
Congratulations on your purchase of a new Competition Cams camshaft. It is a highly sophisticated high performance part, and requires a little bit of "Tender Loving Care" during installation and break in. If you will take the time to read and follow these instructions you can look forward to many rewarding miles of driving with your Competition Cams equipped engine.

This instruction sheet has been broken down into several categories so that it will be easier for you to use. Some of the topics may not apply, but in general all of the information will be very beneficial to you during your camshaft installation. For step by step visual detail, we recommend that you refer to our new 35 minute instructional video, "The Proper Procedure to Install and Degree a Camshaft" (part #190-1). If you have any questions or problems at any time during your installation please don't hesitate to contact the toll free Cam Help tech line at 1-800-999-0853 from 8a.m. to 8p.m. CST Monday through Friday. We are there to help you do it right the first time!

Important: In order for your new Competition Cam's camshaft to be covered under any warranty, you must use the recommended Competition Cams lifters and the recommended Competition Cams valve springs. Failure to install new Competition Cams lifters and valve springs with your new cam will cause the cam lobes to wear excessively and will cause engine failure. If you have any questions about this application, please contact our technical department immediately!

Installation:

STEP 1. Prepare a clean work area, and assemble the tools needed for the camshaft installation. We suggest you acquire an automotive manual to help you determine which items must be removed from the motor in order to expose the timing chain, lifters and camshaft. A good, complete automotive manual will save you time and quite possibly some frustration during the installation process.



STEP 2. Once the camshaft, lifters and timing chain are exposed, line up the timing marks on the timing gears by rotating the crankshaft (fig. A). This will position the #1 piston at Top Dead Center. Next remove the camshaft timing chain sprocket, the timing chain, and the camshaft retaining plate if equipped. Remove all lifters, and re-install the cam sprocket to serve as a handle. Slowly and carefully "roll" the camshaft from the motor. Excessive force is not required.

If the camshaft does not come out easily, stop! Look for obstructions such as fuel pump rods, distributor gears, etc. Do not force the camshaft. Something is holding it in the block.

STEP 3. Once the camshaft is out, pull the bottom timing chain gear off the snout of the crankshaft. In many cases you will need a gear puller to remove the crankshaft sprocket. The bottom gear is usually an interference fit, which may make it difficult to remove without the proper tool. Be careful not to damage the threads in the end of the crankshaft.

STEP 4. Now is the time to inspect the old cam, lifters, timing components and distributor for any abnormal wear indications. An example would be an excessively worn distributor gear. If this gear is placed on a new camshaft it will destroy both the distributor and cam gear. Replace all suspect parts!

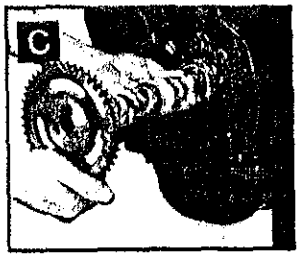
STEP 5. Remove your new Competition Cams camshaft from its packaging. Inspect all lobes and the gear, making sure the camshaft was not damaged in shipment. Next compare the stamped numbers on the end of the cam with the spec card, making sure this is the correct cam. It is a good idea at this point to lightly wire brush the distributor gear to remove any possible slivers or sharp edges which may remain after the gear has been machined. Clean the cam with mineral spirits or an equivalent solvent. Remember, during the installation process, the cleaner you keep your new components, the better chance you have of avoiding any type of failure during the break-in period.

Using the Competition Cams Assembly Lube supplied with your cam, coat all lobes and distributor gear. It is important to coat the lobes completely, yet not excessively. This same rule applies to the distributor gear and the fuel pump lobe (fig. B).

Coat the cam bearing journals with an SAE 30 or 40 wt. oil. Remember, we do not recommend the use of synthetic oils with our cam and lifter packages during break in.

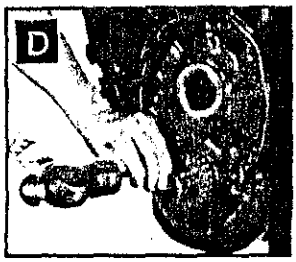
STEP 6. We recommend you install a new Competition Cams timing chain and gear set for two reasons. First, the old chain is likely to be stretched beyond its service limits. Second, your old timing set, as well as many new ones on the market, may be machined to retard the cam timing. Either of these conditions will detract from the performance your camshaft was designed to deliver.

Temporarily install the new cam sprocket on the camshaft. The sprocket will again serve as a handle to help "roll" the cam in to its bearings. Carefully slide the camshaft into the motor, oiling the bearing journals as it slides into the block (fig. C). Excessive force is not necessary to install the cam. Take your time. You do not want to scar the camshaft or the cam bearings. Be sure you do not wipe away any of the assembly lube as you install the cam into the block.



STEP 7. Install the new crankshaft sprocket on the snout of the crankshaft (fig. D). Be sure that the sprocket has "bottomed out" on the crankshaft. If the bottom gear has not been properly installed, chain misalignment will occur. This could cause severe damage!

If your engine was equipped with a camshaft retaining plate, it should be installed at this time. Some engines have a spacer between the camshaft and the upper timing gear, and some of the replacement gears are made with this spacer incorporated into the gear. To insure that you have the correct combination of parts, simply check the end play of the cam. It should be within .004" to .008" when a retaining plate is used. When a retaining plate is not incorporated in the engine, the taper on the hydraulic or solid lifter lobes will hold the camshaft in position. When a roller cam is used, either a retaining plate or a camshaft thrust button must be used.

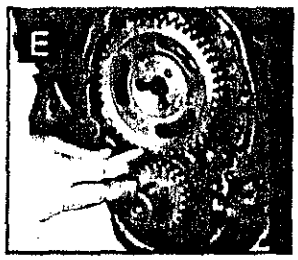


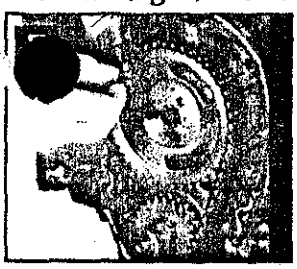
DEGREEING:

It isn't absolutely necessary to degree the cam for the motor to run efficiently. We grind all of our High Energy and Magnum cams 4° advanced to make up for all machining tolerances. This will position the cam for the best street performance. However, to assure maximum performance we recommend you degree your new Competition Cams camshaft. The purpose of degreeing a cam is to correct the errors and tolerances in the machining processes of the engine that effect camshaft timing. If you do decide to degree your new cam, we suggest the intake centerline method. It's simple, quick and efficient!

For instructions, see "How To Degree Your Cam" on pages 7-8 of this brochure.

STEP 8 Check the timing mark alignment in your engine manual. Rotate the crankshaft and camshaft to its proper position. Our small block Chevy has a "dot over dot" alignment as shown (fig. E). Remove the camshaft sprocket and install the new Competition Cams chain.



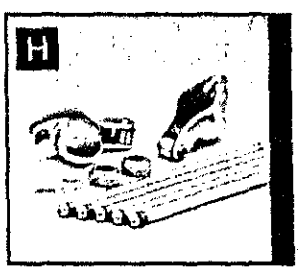


Bolt the cam sprocket to the cam making sure the sprocket is pulled up flush onto the cam (fig. F). Once again make sure the timing marks are positioned properly and according to your manual.

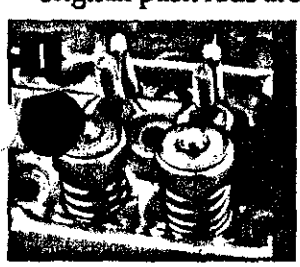
Refer to your manual for the proper torque specification before tightening the camshaft bolt or bolts. We also suggest that loctite be applied to the threads of the camshaft bolts to assure the bolts remain torqued to the proper specification. This process is very important! Improperly torqued camshaft bolts can loosen up and cause severe engine damage. A camshaft bolt locking plate is recommended for Chevrolet 262-400cu. in. and 396-454cu. in. engines. Ask for Competition Cams part #4605.

STEP 9. Remove your new Competition Cams lifters from the packaging and clean the lifters thoroughly in mineral spirits or equivalent solvent. Remember, in order to protect your camshaft warranty, new lifters must be installed. We recommend new Competition Cams lifters be used to assure maximum performance and reliablility. Coat the bottom of all lifters with the Competition Cams lube supplied with your cam and use SAE 30 wt. oil on the sides (fig. G). Install the lifters, making sure they fit well and rotate freely. Any excess clearance or tight lifters will cause damage to the camshaft and lead to engine failure.

STEP 10. Next, we recommend you install Competition Cams Magnum Rocker Arms and Push Rods. They will insure compatible mating surfaces and long life. Additionally, because of the increased stiffness, accuracy of ratios and roller tip, the Magnum Roller Rockers can give you up to an extra 15 to 30 HP over stock rocker arms. Both the Magnum Rockers and Competition Cams Push Rods are conveniently packaged for you in the RP-KIT (fig. H).



Clean all push rods thoroughly because most engines oil through the center of them. If the original push rods are being used, be especially sure they are clean inside and out. Apply a small amount of Competition Cams lube or equivalent lube on each end of the push rod and install into the motor (fig. I).



Clean all rocker arms thoroughly. If the original rocker arms are used, examine each one for excessive wear and replace any that are questionable. Apply a small amount of Competition Cams lube on all contact areas of the rocker arm. With a clean rag or towel wipe the tips of the valves clean and apply Competition Cams lube on the tip of each valve where the rocker arm will come in contact with it. Also be sure to check the valve tips for excessive wear.

STEP 11. Install rocker arms onto motor (fig. J). Do not tighten the adjusting nut down before you go through the proper sequence. On engines with shaft mounted adjustable rocker arms, back off all adjusters completely before installing the assembly. Make sure the push rod is in the lifter and the rocker arm seat when making valve adjustments.

For hydraulic lifter camshaft adjustment, turn the engine in the normal direction of rotation. When the exhaust valve moves to maximum lift, adjust the intake valve to zero lash with no preload. Turn the adjusting nut an additional 1/2 turn more. Rotate the motor over again until the intake valve reaches maximum lift and is almost all the way back down. Set the exhaust valve to zero lash plus a 1/2 turn. Adjust the valves on each cylinder in this manner until all valves are adjusted (fig. K).

If your engine has non-adjustable rocker arms, a lifter preload of .020 to .040 must be maintained.

See "Lifter Preload Made Easy" for proper preload instructions.

For mechanical lifter camshafts, follow the same adjustment procedure. Instead of lifter preload, use the prescribed valve lash clearance found on the cam specification card.

STEP 12. It is very important to "fire" the engine as quickly as possible. The only lubrication that the camshaft receives is from oil slung off the crankshaft. First, change the oil and filter using an SE, SF grade or racing oil for initial break-in. Fill the new oil filter with oil before installing. This allows the motor to achieve oil pressure immediately.

Timing the motor properly the first time will be necessary for the motor to start quickly. The following procedure is simple and effective.

Rotate the crankshaft in normal crankshaft rotation until the number one cylinder is coming up on the compression stroke. Align the timing mark on the balancer/dampner to the recommended factory initial timing setting, being sure that both valves on the #1 cylinder are closed. Install the distributor with the rotor pointing to the #1 plug wire on the cap. The motor should fire up as soon as it receives fuel.

STEP 13. Important! As soon as the motor fires, bring the engine RPM to 1500 to 2000 RPM during the first 30 minutes of operation. Slower engine speeds may not supply the camshaft with an adequate amount of oil for the break-in period.

Change RPM periodically to direct oil splash to different areas of the camshaft. After the 30 minute break-in time, change the oil and filter again to be sure all contaminants and break-in lube are removed from the motor.

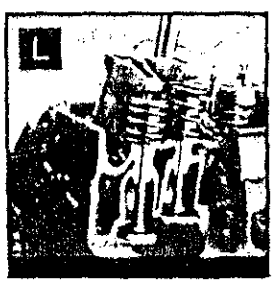
If you do not understand any part or all of these instructions, please contact one of our technical consultants at 1-[illegible]-999-0853. We will be glad to help you with any problem you may have.

Lifter Pre-load Made Easy

When installing a hydraulic cam, new hydraulic lifters, or replacing rocker arms, it is necessary to establish the proper lifter pre-load. Insufficient lifter pre-load will cause excessive valve train noise. Excessive lifter pre-load will cause the motor to idle rough or have low manifold vacuum and can lead to severe engine damage. It is critical to engine efficiency and to the service life of the valve train (camshaft, lifters, push rods, valve springs etc.) for the lifters to have the proper amount of lifter pre-load.

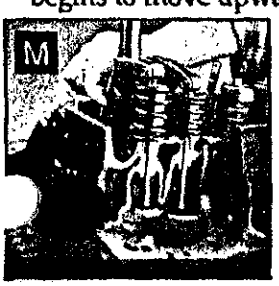
On any hydraulic lifter camshaft the ideal lifter pre-load should be .030". A variance of + or - .010" is acceptable. Two methods are used in setting lifter preload. One is for adjustable rocker systems such as a small block Chevy, and the other is for non-adjustable systems such as the small block Chrysler.

Adjustable Rocker Arms



Install the push rods into the motor. Install the rocker arms, balls and nuts on the rocker studs. Be sure the push rods are seated properly into the lifter and the rocker arm seats.

Turn the engine over by hand in the direction of rotation until the exhaust push rod just begins to move upward to open the valve. You are now ready to adjust the *intake* rocker of the same cylinder (fig. L).



Carefully tighten the nut on the intake rocker arm while spinning the push rod with your fingertips. You will feel a slight resistance in the push rod when you have taken up all of the clearance. This is refered to as "zero lash". Now turn the adjusting nut 1/2 turn more. Generally 1/2 turn on the adjusting nut will provide the suggested .030" pre-load.

Once again, turn the engine in its direction of running rotation until the intake push rod comes all the way up and almost all the way back down. Now set the *exhaust* rocker to "zero lash" and add 1/2 turn (fig. M). You now have set the pre-load on one cylinder. Repeat these same steps to set the pre-load on each cylinder.

Non-adjustable Rocker Arms

In situations where you are dealing with non-adjustable rocker arms, a different procedure must be followed. After applying lube, install the pushrods and torque all rocker arm bolts down in the proper sequence and torque specification. Rotate the motor by hand in the normal direction of motor rotation until both the exhaust and intake valves have opened and closed completely. Allow a couple of minutes for the lifter to bleed down.

Using the valve cover gasket surface on the head as a reference point, place a mark on the pushrod. It is advisable to use a pencil or scribe to mark the push rod. The smaller and more defined the mark, the more accurate the measurement. Be sure the reference point you choose for the first mark is easily accessible and easy to duplicate. You will be marking the push rod twice. It must be from the same reference point and angle for the measurement to be accurate.

Loosen the rocker or rocker shaft bolts. Leave the rockers on the head so that they will support the push rods. Be sure the push rods are standing free in the lifters, and do not have any pre-load. Using the same reference point, place a second mark on the push rod. Make sure the angle and reference point are the same as the first mark.

You now have two marks on the push rod; one with the assembly bolted into place as the motor will run, and the second mark with the lifter unloaded. The distance between these two points will represent the amount of lifter pre-load your motor has.

If you find that the pre-load is not within .020" to .040" range, adjustment will be necessary. The simplest way to accomplish this is by using different length push rods. These push rods are available for most motors with non-adjustable rockers. When measuring to find the correct length needed, be sure to include the .030" pre-load that the lifter requires.

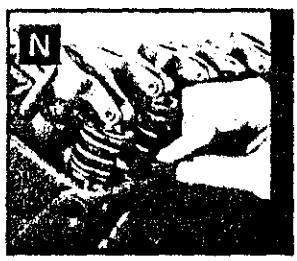
If your engine has pedestal style (bolt mounted) rockers, you can use shims under the pedestal to lessen the pre-load. This method also works with shaft mounted rocker systems. Longer pushrods will be needed for insufficient pre-load.

In most cases you will only need to check one intake and one exhaust push rod. However, if your valve stem heights are not equal you will need to check pre-load on each valve. If this procedure is not followed, it will almost certainly result in a poor running engine and ultimately engine failure.

Valve Springs

The number one factor in premature failure of a new camshaft is the valve spring. Either incorrect pressure or incorrect spring application will lead to a worn out cam. For this reason it is highly recommended that the corresponding part number Competition Cams spring be used in any cam change.

Most aftermarket cams have much higher than stock lift. Therefore the stock valve springs will "coil bind" or "stack" before the cam reaches its full lift. This condition will cause the cam to fail immediately. You should always use the recommended part number spring with a new cam, and check to be sure there is no coil bind. With the valve at full lift, check the clearance between the coils. You need to maintain a minimum of .060" between the coils at this point (fig. N).

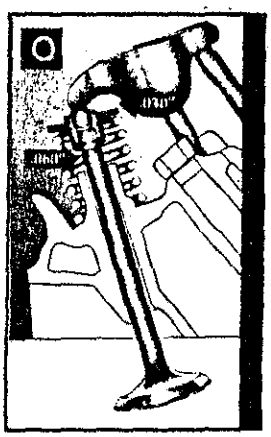


Excessive spring pressures will also lead to early failure. These pressures can be the result of incorrect springs, short valves, improper retainers, or many other factors unrelated to the cam or the valve spring. The only way to ensure the correct pressure is to actually check the installed height and pressure. Refer to the instructions in the valve spring box or contact a local machine shop for help.

Coil bind will not usually be a problem when High Energy Camshafts are used. However, the big block Chevy is an exception to this rule. When installing any non stock cam it's recommended to check for coil bind, but it is imperative that coil bind be checked on the higher lift and Magnum Series of Camshafts. With the 292H or 305H Magnum Cams the valve springs must be replaced. Stock valve springs will not have sufficient travel for cams that incorporate that much lift.

Rocker Arm Clearance

Rocker arm clearance must be checked at several places. It is very common with higher lift cams to have the rocker arm contact the rocker stud when the valve is at full open position. Be certain to check this, as lack of proper clearance will cause broken studs, broken pushrods, or a worn out camshaft.



The clearance between the rocker arm and the retainer must also be checked. This problem will be more pronounced when the valve is closed. The retainer is likely to contact the underside of the rocker arm right in the center. Be sure to maintain at least .030" clearance at this point (fig. O).

When assembling the head, check the retainer to valve seal clearance. Sometimes when you install a high lift cam and a different seal, this distance becomes too small. This will bind the valve train and result in camshaft failure. If the clearance does not measure the total valve lift plus .060" the heads should go to a machine shop and the guides shortened.

Pushrod clearance must also be checked, especially when using a higher ratio rocker arm. The pushrod seat in the rocker is moved toward the stud in this case, so it must be checked at several different lift points.

Piston To Valve Clearance

Anytime a higher than stock lift camshaft is installed it is important to check piston to valve clearance. The High Energy Series and smaller Magnum Cams, such as the 270H, 280H, 270S or 268AR camshafts, should not have this problem. However, the 292H, 294S, 280AR and larger camshafts may have an interference problem.

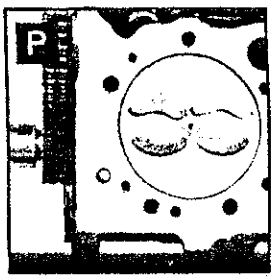
Competition Cams strongly urges you to check the piston to valve clearance on the larger street cams, and on all race cams. We recommend at least .100" clearance on the intake valve and at least .125" for exhaust valves. If aluminum rods are used, add a minimum of .030" to the suggested clearance figures. Aluminum rods will stretch and expand more than a steel rod.

The easiest and possibly most accurate way to check piston to valve clearance is to place strips of modeling clay on top of one of the pistons, then rotate the engine over by hand with the head bolted in place and all of the valve train with valves adjusted. The clay will be compressed to the exact clearance. You can remove the head and measure the thickness of the clay. If the engine meets resistance in turning, stop! You probably have no clearance.

A decision must be made either to flycut the pistons, which will involve completely disassembling the motor, or to exchange the cam for a profile that will fit into your motor. Do not try to operate the motor with less than .100" clearance on the intake and .125" on the exhaust. Severe damage will occur!

"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.



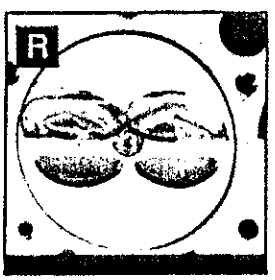
STEP 2. Apply a strip of modeling clay 3/8" to 1/2" wide and approximately 1/4" thick to the pistons. The clay strips should be placed perpendicular (across) the intake and exhaust valve reliefs (fig. P). Applying a small amount of oil to the clay will prevent it from sticking to the valves as they press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

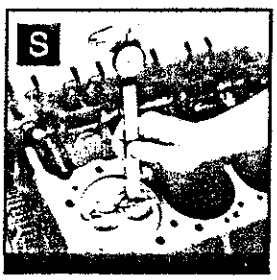
Install a sufficient number of head bolts to secure head in place while you are rotating the motor. Install the push rods, lifters and rocker arms on the cylinder you have prepared for the clearance check.

STEP 4. Adjust the rocker arms to their suggested clearance. If the camshaft you are checking uses hydraulic lifters, you must 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 preload the valve spring (fig. Q).

STEP 5. Now turn the motor over by hand in the normal direction of rotation. Be sure to rotate the motor over 2 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 sharp knife, slice the clay cleanly, lengthwise through the depression and peel half of it off the piston (fig. R). 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. S). 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.

COMPETITION CAMS® Valve Trains Engineered for the Way You Drive!

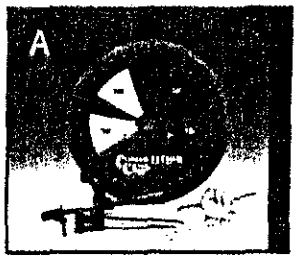
Camshaft Degreeing Instructions

The purpose of degreeing a camshaft is to insure 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 machining tolerances

The important thing to remember is that camshaft position or phasing to the engine is extremely important for the engine to operate at maximum efficiency.

There are several pieces of equipment needed to properly "degree" in a camshaft. They are sold at Comp Cams and are as follows:
1. A 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 with which to affix the dial indicator
5. A Top Dead Center stop
6. A solid lifter to fit your motor. Motors that have non-adjustable rocker arms will also require an adjustable push rod that accomodates that motor.
7. A means to attach the degree wheel to the crankshaft

A "Cam Degreeing Kit" is available, Comp Cams Part #4796 (fig A).



THE INTAKE CENTERLINE METHOD

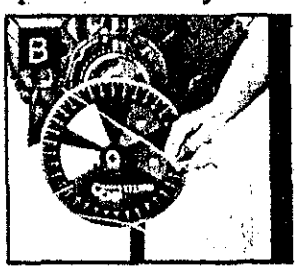
There are several accepted ways to degree a camshaft. At Competition Cams we feel the Intake Centerline Method is the easiest and most accurate. This method of cam degreeing is very practical and indifferent to design characteristics. It simply involves positioning the center, or point of maximum lift, of the #1 intake lobe with top Dead Center 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 push rod 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 similar marker to better define the marks.

STEP 2. We have our cam card, and it suggests we install the cam on a 106° intake centerline. Install all the rocker arms and push rods in the motor as normal. On #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 preload the lifter. Next, adjust the #1 exhaust lash to zero. You should be able to turn both push rods with your fingers easily.

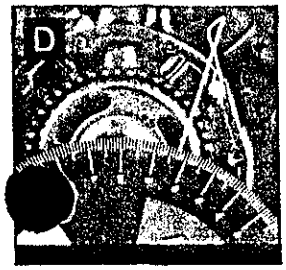
STEP 3. Attach the pointer to the block. Many people will make a pointer out of some sort of rigid, yet manageable wire. Stiff coat hanger wire works well (fig. B).



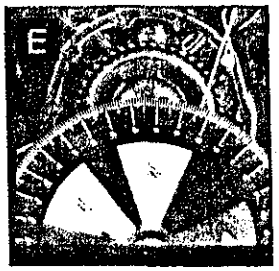
STEP 4. Attach the degree wheel to the balancer and install the assembly on the crankshaft. There are several ways to attach the degree wheel to the crankshaft. In our example, the degree wheel is mounted to the balancer. The crank may be rotated from either the front or from the flywheel end. Obviously, 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.

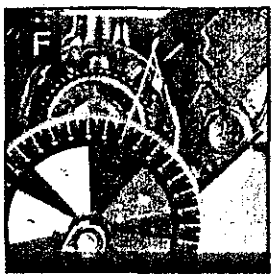
STEP 5. Before installing the piston stop, rotate the crankshaft to get the #1 piston in approximate T.D.C. position with both the intake and exhaust valves closed. This can be a rough guess, but it can save you from making a mistake later. Adjust your pointer to zero or T.D.C. on the degree wheel.

STEP 6. Turn the crankshaft opposite the motor rotation approximately 15-20 degrees. This will lower the piston enough to allow the T.D.C. 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.

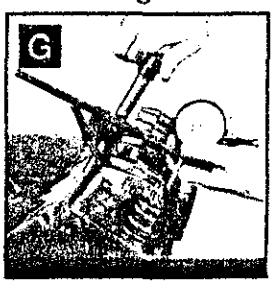


Mark the degree wheel with a pen or pencil on the degree the pointer is on(fig. D). Turn the engine in the other direction, same as motor rotation, until the piston comes back up and touches the piston stop. Make a mark on the degree the pointer is on (fig. E).

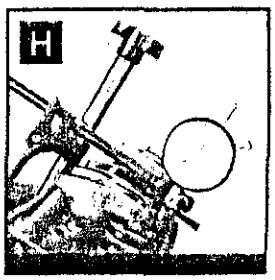




STEP 7. Count the number of degrees between the two marks and divide them in half. For example, lets say your marks are 40° apart from each other. Forty divided by 2 is 20, so 20° from either mark is T.D.C. Move the pointer to align it 20° from either mark, without moving the engine or degree wheel (fig. F). Now you have found Top Dead Center. Remove your piston stop, and you are ready to properly degree your cam.



STEP 8. Attach the dial indicator to the dial indicator mount. Position the dial indicator mount so the tip of the dial indicator 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 (opposite normal rotation) until the indicator reads .100". Turn the engine back in the normal direction of rotation until the dial indicator reads .050" before maximum lift. Record the degree wheel reading.

STEP 11. Continue to rotate the motor 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. That number (212) divided by 2 will equal 106. Your actual intake centerline is 106°. Refering back to your cam spec card, we 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 as per manufacturers specs, it will be necessary to either advance (move the cam ahead) or retard (move the cam back) the cam to meet the suggested intake centerline. Depending on the motor 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 to use 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 and expensive system is with an adjustable timing gear. Contact Competition Cams or your local Competition Cams dealer for the method best suited to your application.

Note: When degreeing in 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 on past 90°. Be sure all readings are taken from Top Dead Center.

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.

We at Competition Cams hope that these instructions have been helpful in making your camshaft installation a successful and pleasant experience. Competition Cams has also produced a video tape entitled "The Proper Procedure to Install and Degree a Camshaft". 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 contact our Cam Help technical line at 1-800-999-0853. They are there to help you, and are available from 8:00a.m. to 8:00p.m. CST Monday through Friday.

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