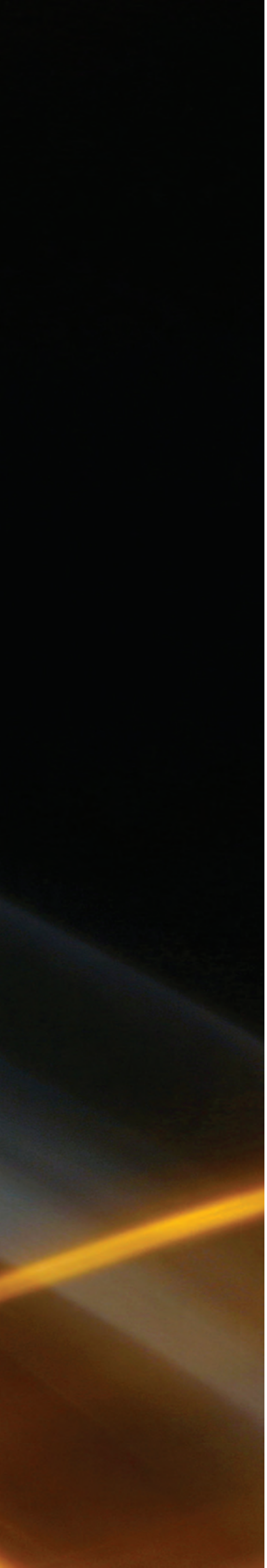
FEATURE

FLAT TAPPET CAMSHAFTS & OILS



Gasoline engine oils with reduced anti-scuffing additive packages are found to be the main cause of flat tappet camshaft failures

BY **DAVE HAGEN**, **MIKE CARUSO**, and **STEVE FOX**

AERA is providing you with this information just in case you have not heard about problems with flat tappet camshaft failures caused by gasoline engine oils.

The problem started years ago when oil companies reduced the anti-scuffing additive packages in gasoline engine oils. When reduced, we all started to have flat tappet camshaft and lifter failures. Everyone was quick to blame camshaft or lifter hardness, however that was not the case at all.

Flat tappet camshaft and lifter failures have increased over the last ten years and it has been really bad for the last three years. As AERA members reported flat tappet camshaft and lifter failures, we kept track of them and discovered two issues to be common denominators:

- 75% of the failures were, in part, due to a reduction of anti-scuffing additive packages in the gasoline engine oils;
- The other 25% of failures were caused by improper break-in procedures such as not pre-oiling the engine before start-up and letting the engine idle.

Although 75% failed when using late model engine oil for break-in, looking back, these failures coincided with EPA mandated for reduction of Zinc additive over the past ten years in gasoline engine oils for cleaner air and longer life of the catalytic converters. Remember, we all have to breathe the same air. This is no problem in late model engines using roller lifters and camshafts because they do not need the anti-scuffing additive packages to protect the sliding action of flat tappet camshaft and lifter surfaces.

Special Note — During engine disassembly, check camshaft side of lifter bore hole for wear (egg-shaping) of the lifter bore hole in the block. If it has worn egg-shaped, fix it by bushing the lifter bore or replace block. This egg-shaping will allow the lifter foot or bottom which contacts the camshaft lobe to move off center line, changing the lifter to lobe contact angle. Now, the lifter acts as a scraper removing the oil film between it and the cam lobe causing metal to metal contact and cam and lifter failure.

American Petroleum Institute (API) Announces New Service Category for Diesel Engines: CJ-4

On October 15, 2006, the American Petroleum Institute (API) began certifying diesel oils against a new Service Category, API CJ-4. API CJ-4 describes oils for use in high-speed four-stroke cycle diesel engines designed to meet 2007 model year on-highway exhaust emission standards as well as for previous model years. These oils are especially

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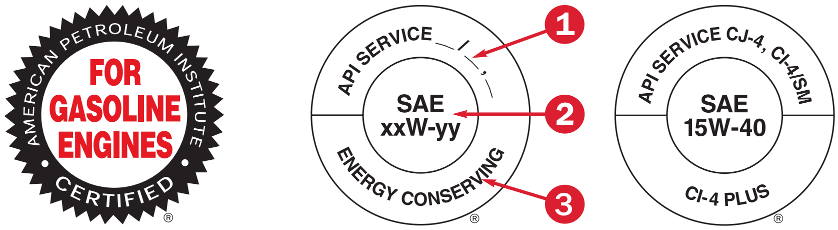
Look for the API Certification Marks (pictured right) every time you buy engine oil. Ask for API-licensed oil whenever you have your oil changed. (API graphics used with permission.)



The API Certification Mark, also known as the "Starburst"

An oil displaying this mark meets the current engine protection standard and fuel economy requirements of the International Lubricant Standardization and Approval Committee (ILSAC), a joint effort of U.S. and Japanese automobile manufacturers. Most automobile manufacturers recommend oils that carry the API Certification Mark.

API's Service Symbol and Certification Mark identify quality engine oils for gasoline- and diesel-powered vehicles. Oils displaying these marks meet performance requirements set by U.S. and international vehicle and engine manufacturers and the lubricant industry. More than 500 companies worldwide participate in this voluntary program, which is backed by a marketplace sampling and testing program.

The API Service Symbol, also known as the "Donut"

1. Performance Level: **Gasoline engine oil categories** (for cars, vans, and light trucks with gasoline engines): Oils designed for gasoline-engine service fall under API's "S" (**S**ervice) categories. See inside for descriptions of current and obsolete API service categories. **Diesel engine oil categories** (for heavy-duty trucks and vehicles with diesel engines): Oils designed for diesel-engine service fall under API's "C" (**C**ommercial) categories. See inside for descriptions of current and obsolete API service categories.

2. Viscosity Grade: The measure of an oil's thickness and ability to flow at certain temperatures. Vehicle requirements may vary. Follow your vehicle manufacturer's recommendations on SAE oil viscosity grade.

3. Energy Conserving: The "Energy Conserving" designation applies to oils intended for gasoline-engine cars, vans, and light trucks. Widespread use of "Energy Conserving" oils may result in an overall savings of fuel in the vehicle fleet as a whole.

The API Service Symbol "Donut" with CI-4 PLUS

Used in conjunction with API CI-4 and CJ-4, the "CI-4 PLUS" designation identifies oils formulated to provide a higher level of protection against soot-related viscosity increase and viscosity loss due to shear in diesel engines. Like Energy Conserving, CI-4 PLUS appears in the lower portion of the API Service Symbol "Donut."

For more information about API's Engine Oil Program, visit www.api.org/eolcs.

effective at sustaining emission control system durability where particulate filters and other advanced after-treatment systems are used. More information on API CJ-4, including frequently asked questions, can be found at www.apicj-4.org.

Engine Oil Licensing and Certification System (EOLCS)

API's Engine Oil Licensing and Certification System (EOLCS) is a voluntary licensing and certification program that authorizes engine oil marketers who meet specified requirements to use the API Engine Oil Quality Marks — the API Service Symbol "Donut" and Certification Mark "Starburst." This program is a cooperative effort between the oil industry and vehicle and engine manufacturers Ford, General Motors, and DaimlerChrysler; the Japan Automobile Manufacturers Association; and the Engine Manufacturers Association. Performance requirements, test methods, and limits are cooperatively established by vehicle and engine manufacturers, technical societies like the Society of Automotive Engineers (SAE) and the American Society for Testing and Materials (ASTM) and industry associations like the American Chemistry Council and API. Oils meeting these requirements are recommended by vehicle manufacturers.

Aftermarket Audit Program

API's Engine Oil program is backed by an ongoing monitoring and enforcement program to ensure licensees adhere to industry technical specifications. Additionally, the program ensures that the API-registered symbols are properly displayed and convey accurate information to consumers. Currently, more than 500 marketers in more than 50 countries are using the symbols on more than 8,000 products. You can view a complete list of our licensees and their products by visiting our Licensee Directory.

API-licensed marketers may display two types of marks: the API service symbol "donut" and the API certification mark "starburst." Each mark conveys information that can be used by the consumer.

The API Service Symbol

The API service symbol "donut" is divided into three parts. The top half describes the oil's performance level. The center identifies the oil's viscosity. The bottom half tells whether the oil has demonstrated energy-conserving properties in a standard test in comparison to a reference oil.

Performance Levels

The top of the donut shows the oil's performance level for gasoline and/or diesel engines. The letter "S" followed by another letter (for example, SM) refers to oil suitable for gasoline engines. The letter "C" followed by another letter and/or number (for example, CI-4) refers to oil suitable for diesel engines. These letters officially stand for "Service" and "Commercial." The current API performance categories that can appear in the top part of the Donut are listed in the API Motor Oil Guide.

SAE Viscosity Grade

The center of the Donut shows the oil's SAE viscosity grade. Viscosity is a measure of oil's flow characteristics, or thickness, at certain temperatures.

The low-temperature viscosity (the first number, 5W in 5W-30 oil) indicates how quickly an engine will crank in winter and how well the oil will flow to lubricate critical engine parts at low temperatures. The lower the number the more easily the engine will start in cold weather.

The high-temperature viscosity (the second number, 30 in a 5W-30 oil) provides thickness, or body, for good lubrication at operating temperatures.

Multi-grade oil (for example, SAE 5W-30) provides good flow capability for cold weather but still retains thickness for high-temperature lubrication.

Single grade oil (a single number in the center of the donut) is recommended for

API energy | Engine Oil Guide

Which oil is right for you?

Note: API intentionally omitted "SI" and "SK" from the sequence of categories.

GUIDE TO SAE VISCOSITY GRADES OF ENGINE OIL FOR PASSENGER CARS	
Multigrade oils such as SAE 5W-30 and 10W-30 are widely used because, under all but extremely hot or cold conditions, they are thin enough to flow at low temperatures and thick enough to perform satisfactorily at high temperatures. Note that vehicle requirements may vary. **Follow your vehicle manufacturer's recommendations on SAE oil viscosity grade.**	
If lowest expected outdoor temperature is	**Typical SAE Viscosity Grades for Passenger Cars**
0°C (32°F)	5W-20, 5W-30, 10W-30, 10W-40, 20W-50
−18°C (0°F)	5W-20, 5W-30, 10W-30, 10W-40
Below −18°C (0°F)	5W-20, 5W-30

The current and previous API Service Categories are listed below. Vehicle owners should refer to their owner's manuals before consulting these charts. Oils may have more than one performance level.

For automotive gasoline engines, the latest engine oil service category includes the performance properties of each earlier category. If an automotive owner's manual calls for an API SJ or SL oil, an API SM oil will provide full protection. For diesel engines, the latest category usually – but not always – includes the performance properties of an earlier category.

GASOLINE ENGINES

Category	Status	Service
SM	Current	For all automotive engines currently in use. Introduced in 2004, SM oils are designed to provide improved oxidation resistance, improved deposit protection, better wear protection, and better low-temperature performance over the life of the oil. Some SM oils may also meet the latest ILSAC specification and/or qualify as Energy Conserving.
SL	Current	For 2004 and older automotive engines.
SJ	Current	For 2001 and older automotive engines.
SH	Obsolete	For 1996 and older engines.
SG	Obsolete	For 1993 and older engines.
SF	Obsolete	For 1988 and older engines.
SE	Obsolete	**CAUTION:** Not suitable for use in gasoline-powered automotive engines built after 1979.
SD	Obsolete	**CAUTION:** Not suitable for use in gasoline-powered automotive engines built after 1971. Use in more modern engines may cause unsatisfactory performance or equipment harm.
SC	Obsolete	**CAUTION:** Not suitable for use in gasoline-powered automotive engines built after 1967. Use in more modern engines may cause unsatisfactory performance or equipment harm.
SB	Obsolete	**CAUTION:** Not suitable for use in gasoline-powered automotive engines built after 1951. Use in more modern engines may cause unsatisfactory performance or equipment harm.
SA	Obsolete	**CAUTION:** Contains no additives. Not suitable for use in gasoline-powered automotive engines built after 1930. Use in more modern engines may cause unsatisfactory performance or equipment harm.

DIESEL ENGINES

Category	Status	Service
CJ-4	Current	Introduced in 2006. For high-speed, four-stroke engines designed to meet 2007 model year on-highway exhaust emission standards. CJ-4 oils are compounded for use in all applications with diesel fuels ranging in sulfur content up to 500 ppm (0.05% by weight). However, use of these oils with greater than 15 ppm (0.0015% by weight) sulfur fuel may impact exhaust aftertreatment system durability and/or oil drain interval. CJ-4 oils are effective at sustaining emission control system durability where particulate filters and other advanced aftertreatment systems are used. Optimum protection is provided for control of catalyst poisoning, particulate filter blocking, engine wear, piston deposits, low- and high-temperature stability, soot handling properties, oxidative thickening, foaming, and viscosity loss due to shear. API CJ-4 oils exceed the performance criteria of API CI-4 with CI-4 PLUS, CI-4, CH-4, CG-4 and CF-4 and can effectively lubricate engines calling for those API Service Categories. When using CJ-4 oil with higher than 15 ppm sulfur fuel, consult the engine manufacturer for service interval.
CI-4	Current	Introduced in 2002. For high-speed, four-stroke engines designed to meet 2004 exhaust emission standards implemented in 2002. CI-4 oils are formulated to sustain engine durability where exhaust gas recirculation (EGR) is used and are intended for use with diesel fuels ranging in sulfur content up to 0.5% weight. Can be used in place of CD, CE, CF-4, CG-4, and CH-4 oils. Some CI-4 oils may also qualify for the CI-4 PLUS designation.
CH-4	Current	Introduced in 1998. For high-speed, four-stroke engines designed to meet 1998 exhaust emission standards. CH-4 oils are specifically compounded for use with diesel fuels ranging in sulfur content up to 0.5% weight. Can be used in place of CD, CE, CF-4, and CG-4 oils.
CG-4	Current	Introduced in 1995. For severe duty, high-speed, four-stroke engines using fuel with less than 0.5% weight sulfur. CG-4 oils are required for engines meeting 1994 emission standards. Can be used in place of CD, CE, and CF-4 oils.
CF-4	Current	Introduced in 1990. For high-speed, four-stroke, naturally aspirated and turbocharged engines. Can be used in place of CD and CE oils.
CF-2	Current	Introduced in 1994. For severe duty, two-stroke-cycle engines. Can be used in place of CD-II oils.
CF	Current	Introduced in 1994. For off-road, indirect-injected and other diesel engines including those using fuel with over 0.5% weight sulfur. Can be used in place of CD oils.
CE	Obsolete	Introduced in 1985. For high-speed, four-stroke, naturally aspirated and turbocharged engines. Can be used in place of CC and CD oils.
CD-II	Obsolete	Introduced in 1985. For two-stroke cycle engines.
CD	Obsolete	Introduced in 1955. For certain naturally aspirated and turbocharged engines.
CC	Obsolete	**CAUTION:** Not suitable for use in diesel-powered engines built after 1990.
CB	Obsolete	**CAUTION:** Not suitable for use in diesel-powered engines built after 1961.
CA	Obsolete	**CAUTION:** Not suitable for use in diesel-powered engines built after 1959.

use under a much narrower set of temperature conditions than multi-grade oils.

Operators should refer to their owner's manuals to select the proper viscosity oil for the ambient temperature and operating conditions at which the equipment will be used.

Diesel Energy Conserving and CI-4 PLUS Designations

The bottom of the donut tells whether the oil has energy conserving properties when compared with a reference oil in an engine test or if an oil meets CI-4 PLUS requirements.

Oils labeled as "Energy Conserving" have passed the test that measures oil's ability to conserve energy. Widespread use of engine oils with this designation should result in an overall saving of fuel in the vehicle fleet as a whole, but a particular vehicle operator may not experience a fuel savings as a result of using these oils.

Used in conjunction with the CI-4 category, the "CI-4 PLUS" designation identifies oils formulated to provide a higher level of protection against soot-related viscosity increase and viscosity loss due to shear in diesel engines.

The API Certification Mark

The API Certification Mark "Starburst" is designed to identify engine oils recommended for a specific application (such as gasoline service). Oil may be licensed to display the Starburst only if the oil satisfies the most current requirements of the International Lubricant Standardization and Approval Committee (ILSAC) minimum performance standard for this application (currently GF-4 for passenger cars). Many automobile manufacturers recommend oils that carry the API Certification Mark.

Off-Road Oils

Straight weight racing oils these applications contain higher concentrations of anti-wear agents such as in the Castrol GP series or the Pennzoil with Z-7. If you're not sure whether your oil has the proper anti-wear agents all you have to do is smell it. If it has an aroma that faintly resembles gear oil then it probably has a higher concentration of wear inhibitors.

Shell Diesel Oil

The API CI-4 licensed formula of ROTELLA T Synthetic SAE 5W-40 has been manufactured for some time now. Shell stands behind the performance of ROTELLA T Synthetic SAE 5W-40 in all applications where the API CI-4 service rating oil is recommended and even with the bottles reflecting the older CH-4 rating. Diesel engine oil is commercial-rated and service-rated oils fall under different standards, oils approved for diesel pre-2007 and commercial use typically contain more of the desirable high-pressure, anti-wear additives. Since many commercial-grade oils have older API CI-1 or API CI-4 category ratings, oil companies claim it is safe for use in gasoline-fueled engines, unless catalytic converter failure is a concern. Commercial-grade diesel oil is also available in synthetic, conventional, or a blend, and may fit a wide range of non-catalytic converters.

Racing Engine Oils

Many higher-viscosity oils are restricted to off-road-use only which generally means the oil is for use without catalytic converters. This indicates a higher level of Zinc with-in each product which could have an effect on the exhaust catalytic converters. (Zinc plates itself to the inside of the catalytic converter not causing blockage or back pressure but rendering the Cat useless) now we have an EPA Emissions problem. Check the oil manufacturer's web site for the latest Material Safety Data Sheet (MSDS) from your preferred oil's manufacturer. Most MSDS information is available on the oil manufacturer's website. Or you can call them on the phone asking about the specific product and its category ratings. We find that many machinists and engine builders with old hot rod cars, trucks and boats will use racing engine oil to protect the flat tappet camshafts. Often, that oil is not in the engine very long, as those engines are disassembled frequently.

Vintage Cars, Trucks, Boats and Tractors

Using a flat-tappet camshaft in your engine protection may be only as good as the oils you use. Flat tappet camshafts will need the correct oil formulation for protection, but oils have been changing in the last few years as some of you are just finding out. The best suggestion we can offer is to follow your camshaft manufacturer or engine builder's recommendations for break-in for a long useful live. We suggest paying close attention to several factors with regard to oils.

It is important to choose a viscosity range that will work with your older, high compression engine and its bigger clearances. Forget the 0W-30 and 5W-20 used in today's engines, today's engines run tight clearances...they are specifically designed to work with these new, thinner oils. Older engines used heavier weight oils designed for the time you used straight 10 or 20 for winter, 30, 40 weights for summer. Then the 10W-30, 10W-40, 20W-40 and 20W-50 came along and worked fine. If you're running a flat tappet mechanical camshaft today in 2008, you have a big problem because you are limited on which oils to use. Most of oils do not have the shear strength or the anti-scuffing additive packages necessary to keep these camshaft and lifters properly lubricated. If you use late type motor oil in your engine with a mechanical flat tappet camshaft you possibly could experience premature camshaft failure! Mechanical camshaft engines require oils containing higher concentrations of anti-wear additives phosphorous and zinc (1200-1300ppm VS less than l000 for conventional oils). See AERA TB 2333R.

Why oil pressure is low at a hot idle after rebuilding

This is a good time to mention measuring engine oil clearance when rebuilding a late model engines. AERA receives calls asking why the oil pressure is too low after a late model or any engine is rebuilt.

AERA Tech Support will first ask, "What is the measured oil clearance on the engine bearings mains, rods, camshaft and balance shaft?"

The answer will be, "Well it's a .010-.010 crank and bearings."

In other words, they never measured it. So, it's no wonder they have problems with having low oil pressure at a hot idle!

Engine oil systems are a leak system by design. Knowing this fact, an engine with hot oil of 167-195°F has (within specifications) idle oil pressure because of tight clearances.

But as an engine falls below the specification the idle oil pressure is lowered.

Don't be fooled by measuring the crankshaft and then trying to use the listed size in the catalog bearing shell thickness. Measure, measure, measure!

Engine bearing catalogs list the maximum wall thickness of the shell. But it does not mean that all shells will measure the listed size in the catalog. Most of the time they are thinner.

Samples of Break-in Lubes

Use liberal amounts of any brand when installing new camshaft and lifters.

- COMP Cams® Camshaft Break-In Oil Additive, Part #159
- Crane Moly Paste, Part #99002-1
- Crane Super Lube, Part #99003-1 oil additive
- GM E.O.S. Assembly Lubricant oil additive
- Hughes Extreme Pressure Oil Additive Moly, Part #3690 (ok for cats)
- Lunati Assembly Lube, Part #99010
- Melling and Melling Select Performance
- Mell-Lube Camshaft Lube Melling Oil Additive, Part #M-10012

Break-in Procedures

Since proper camshaft break-in is such a critical step in ensuring its longevity, most camshaft manufacturers are suggesting physical steps or specific products for break-in. But some have recently begun advocating certain oils approved for commercial-fleet vehicles and/or separate oil additives that are currently available from mail-order retailers, local parts stores, or GM dealers.

Each aftermarket camshaft company will have a slightly different break-in procedure but they all want you to have long life of their flat tappet camshaft and lifters. Below is a sampling of camshafts break-in procedures.

Tech Bulletin: Flat Tappet Camshafts

Recent changes in oil are likely the cause of premature camshaft failure; here's what you can do to protect your engine! Pre-mature flat tappet camshaft failure increased over the last few years and not with just one brand or type of camshaft. In almost every case, the hardness or the taper of the cam lobe is suspected, yet most of the time that is not the problem. This growing trend is due to factors that are unrelated to camshaft manufacture or quality. Changes in today's oil products because of catalytic converters and "advanced" internal engine design (roller lifters and cams) have contributed to a harsher environment for the flat tappet camshaft and more potential for failure during break-in. See AERA TB 2333R

Adequate Lubrication

Another major factor in the increase of flat tappet camshaft failure is your favorite brand of engine oil. Simply put, today's engine oil is just not the same as it used to be, thanks to ever tightening environmental regulations. The EPA has done a great job in reducing emissions and the effects of some of the ingredients found in traditional oils; however these changes to the oil have only made life tougher on your camshaft. The lubricity of the oil and specifically the reduction of important additives such as zinc and manganese, which help break-in and overall camshaft life, have been drastically reduced. In terms of oil selection, we recommend Shell Rotella T oil for the break-in procedure. Most often used in diesel engine applications, this higher lubricity oil works in gasoline engines as well. Today's engines are great at providing oil to every engine component except one — your camshaft. Windage trays, limiting oil's ability to reach the top of the engine, modification of connecting rod side clearances for less splash oil and special oil pans further complicate both the break-in process and camshaft operation in general. But there are several things you can do to correct these problems. COMP Cams® offers flat tappet lifters with oiling holes in the cam face surface, which will increase oil flow to the lifter-camshaft lobe contact point. Furthermore, using a lifter bore grooving tool will enhance oiling throughout the camshaft and valve train. As we all know by now, better oil flow means better initial break-in and increased camshaft durability.

Flat Tappet Lifter Selection – Choose Carefully!

In addition to these engine modifications, make certain you purchase the highest quality lifters. Most lifters look alike on the outside, but you don't really know where they were produced. "Imported" flat tappets often times use inferior lifter castings and DO NOT deliver the durability of high-quality, US-built lifters. Lifters that are built to the strictest diameter and radius tolerances are designed to fit precisely within their lifter bores must be used. This ensures the lifter rotates properly and decreases the potential for failure. Additionally, make sure the lifters you're using have the correct oil band depth and location to properly regulate the internal oiling of your engine.

How to Increase Flat Tappet Camshaft Durability

1. Double check your camshaft and lifter set-up prior to the break-in process, and use an ample amount of the supplied assembly lube on all lobes, distributor gear and the face of bottom of each lifter.

2. Use high-lubricity engine oil, such as Shell Rotella T oil, to help during the break-in process, and use a Camshaft Break-In Oil such as COMP Cams® Additive (Part #159).

3. Flat tappet lifters cam face oiling provisions also supplement a fresh oiling path.

4. Use of a lifter bore grooving tool provides another path to increase oiling to the cam lobe.

5. Use high-quality lifters (no brown-bagging it here) to make certain you are receiving the best quality lifter you can buy.

Comments from Crane Cams

Camshaft failure is rarely caused by the camshaft itself. The details controlled during manufacture pertaining to camshaft lobe wear are lobe taper, lobe hardness and surface finish. Of all the damaged cams we have checked over the years, more than 99.99 percent have been manufactured correctly. Some people have the misconception that it is common for a cast iron flat tappet cam to occasionally have a soft lobe or lobes. We have yet to see a cast iron flat tappet cam that had a soft lobe. When the cast core is made at the casting foundry, all the lobes are flame hardened. That process hardens all the lobes to a depth below the barrel of the core. That depth of hardness allows the finish cam grinder to finish grind the cam lobes with Rockwell hardness above 50Rc. The generally accepted hardness on a finished cast cam should be between 48Rc to 58Rc. All of our finished cams that we have checked are always above 50Rc hardness on the lobes. Many outside factors, or a combination of factors, can cause cam failures. We will list some of the factors we have determined that may cause camshaft failure.

Do not use synthetic oil during the break-in period. It is not recommended to use any type of oil restrictors to the lifter galley, or use windage trays, baffles, or plug any oil return holes in the valley. Oil has a two-fold purpose, not only to lubricate, but to draw the heat away from whatever it comes in contact with. The cam needs oil splash from the crankcase, and oil run-back from the top of the engine to help draw the heat away. Without this oil flow, all the heat generated at the cam is transferred to the lifter, which can contribute to its early demise.

Correct Break-in Procedures

After the correct break-in lubricant is applied to the cam and lifters fill the crankcase with fresh non-synthetic oil. Prime the oil system with a priming tool and an electric drill so that all oil passages and the oil filter are full of oil. Pre-set the ignition timing and prime the fuel system. Fill the cooling system. Start the engine. The engine should start quickly and run between 1500 and 3000 rpm.

If the engine will not start, don't continue to crank for long periods, as that is very detrimental to the life of the cam. Check for the cause and correct. The engine should quickly start and be run between 1500 to 3000 rpm. Vary the rpm up and down in this rpm range during the first 15 to 20 minutes, (do not run the engine at a steady rpm). During this break-in time, verify that the pushrods are rotating, as this will show that the lifters are also rotating. If the lifters don't rotate, the cam lobe and lifter will fail. Sometimes you may need to help spin the pushrod to start the rotation process during this break-in procedure. See AERA TB1935.

It is important to remember that lifter rotation is created by a taper ground on the cam lobe and the convex shape of the face of the flat tappet lifter. Also in some cases, the lobe is slightly offset from the center of the lifter bore in the block. If the linear spacing of the lifter bores in the block is not to the correct factory specifications, or the angle of the lifter bore is not 90 degrees to the centerline of the cam, the lifter may not rotate. Even if the engine you're rebuilding had 100,000 miles on it and the cam you removed had no badly worn lobes, this still doesn't mean that your block is made correctly. It just means that the break in procedure caused everything to work correctly. Be careful to watch the pushrods during break in to verify lifter rotation. Don't assume everything will work correctly the second time.

Always use new lifters on a new flat tappet cam. If you are removing a good used flat tappet cam and lifters and are planning to use them again in the same (or another) engine, you must keep the lifters in order as to what lobe of the cam they were on. The lifter breaks-in to the specific lobe it is mated with and it can't be changed. If the used lifters get mixed up, you should discard them and install a new set of lifters and break the cam in again as you would on a new cam and lifters. You can use new lifters on a good used cam, but never try to use used lifters on a new cam. Roller tappet cams don't require any break-in. You can use roller lifters over again on a new cam if they are in good condition. There will be, of course, no lifter or pushrod rotation with the use of a roller tappet cam.

Spring Pressures

Normal recommended spring seat pressure for most mild street-type flat tappet cams is between 85 to 105 lbs. More radical street and race applications may use valve spring seat pressure between 105 to 130 lbs. For street hydraulic roller cams, seat pressure should range from 105 to 140 lb. Spring seat pressure for mechanical street roller cams should not exceed 150 lbs.

Racing roller cams with high lift and high valve spring pressure are not recommended for street use. Oil splash used to cool the camshaft at low RPM and lubrication for the roller lifters is not sufficient. High spring pressure causes the heat created at the cam to be transferred to the roller wheel, resulting in its early failure. Any springs that may be used must be assembled to the manufacturer's recommended height. Never install springs without verifying the correct assembled height and pressures for the camshaft being installed.

Increased spring pressure from a spring change and/or increased valve lift can hinder lifter rotation during cam break-in. We have found that decreasing spring pressure during the break-in period will be a great help. This can be accomplished by using a shorter ratio rocker arm to lower the valve lift; and/ or removing the inner spring, during the cam break-in time, if dual springs are being used.

Mechanical Interference

There are many factors that can cause mechanical interference.

Spring Coil Bind

This is when all of the coils of the spring (outside, inside or flat damper) contact each other before the full lift of the valve. We recommend that the spring you are using be capable of traveling at least .060" more than the valve lift of the cam from its assembled height.

Retainer to Seal Valve or Guide Boss Interference

You need at least .060" clearance between the bottom of the retainer and the seal or the top of the valve guide when the valve is at full lift.

Valve to Piston Interference:

Increased valve lift, valve thickness and diameter, (check valve to valve relief diameter in pistons), re-surfacing the block and/or cylinder head(s) will reduce P/V clearance. Minimum P/V clearance +.080" intake and +.100" exhaust.

Rocker Arm Slot to Rocker Stud Interference

As you increase valve lift, the stud mounted rocker arm swings farther on its axis. Therefore the slot in the bottom of the rocker arm may run out of travel, and the end of the slot will contact the stud and stop the movement of the rocker arm. The slot in the rocker arm must be able to travel at least .060” more than the full lift of the valve. Some engine families, like small block Chevrolet, have stamped steel rocker arms available in long and extra long slot versions for this purpose.

Distributor Gear Wear

The main cause for distributor gear wear is the use of high volume or high-pressure oil pumps. We don’t recommend the use of these types of oil pumps. If you do run these types of oil pumps, you can expect short life of the cam and distributor gears, especially for low speed running, in street type applications. If you must run these types of oil pumps, you can increase the life of the gears by adding more oil flow over the gear area to help cool off the point of contact.

Note: Distributors that have end play adjustment (up and down movement of distributor shaft and gear), Maintain a maximum of .010” end play, to help prevent premature wear.

Camshaft End Play

Some engines have a thrust plate to control the forward and backward movement of the cam. The recommended end play on these types of engines is between .003” to .008”. Many factors may cause this end play to be changed. When installing a new cam, timing gears, or thrust plates verify end play after the cam bolts are torqued to factory specs. If the end play is excessive, it will cause the cam to move back in the block, causing the side of the lobe to contact an adjacent lifter.

Note: When removing a used cam that may be worn, you may have difficulty turning or removing it. This may not mean that the cam is cracked or fractured. The heat generated at the cam during the failure of the cam lobe, and/or lifter, will distort the cam and cause it not to be straight any more. ■

We’re interested in your thoughts

If you found this information useful or if you have other topics of interest for the magazine, please let us know by calling the AERA tech team directly, toll-free 888-324-2372.

The AERA tech team, from left to right: **Steve Fox** has over 16 years experience in the engine building industry with eight of those years spent working in the machine shop. Steve is an ASE-certified Master Machinist, as well as a longtime member of the drag racing circuit. **Dave Hagen**, our Senior Technician, has over 32 years of experience in our industry. An ASE-certified Master Machinist, Dave specialized in cylinder head work and complete engine assembly for the first 17 years of his career. **Mike Caruso** brings over 35 years of rebuilding and high-performance experience to AERA. An ASE-certified Master Machinist, Mike came to us from FEL-PRO’s high-performance R&D and tech line, where he worked for 11 years.