TWIN CAM OILING SYSTEM BASICS

Avoid oiling problems while building a bulletproof oiling system

WORDS: D. William Denish
PHOTOS: By the manufacturer

In the May issue of *Baggers*, we looked at several weak spots in the Twin Cam's bottom end, mainly excessive crankshaft runout and drive issues relating to the chain-driven cams. One area we did not discuss was the Twin Cam's oiling system and associated problems found on stock and high-performance Twin Cam engines. Oil is the lifeblood of any engine, and the Twin Cam is no exception. But having too much oil in certain areas of the engine or too low of oil pressure can lead to oil puking out the cylinder head breathers and a noisy valvetrain. Since Feuling Parts has optimized their Twin Cam hydraulic lifters, cam support plate and pushrods to work with their oil pump as a "balanced system," *Baggers* decided to check out what they have to offer.

The Twin Cam 88 engine uses a dry-sump system for lubrication. A dry-sump system only circulates a minimal amount of oil in the engine at any one time, while the majority is stored in a remote oil tank. To perform properly, a dry-sump system must be properly sized to the engine's requirements and "balanced" on the feed and scavenge sides so all residual oil is removed from the crankcase at all engine speeds and conditions. Failure of the oil pump's scavenge side to satisfy such requirements typically results in "wet-sumping." Wet-sumping is a condition where oil, instead of returning to the oil tank, builds up in the crankcase and cam gearcase, causing excessive friction and power loss.

01

Shown is a stock Twin Cam cam support plate with the pressure relief valve, relief spring and roll pin removed.

02

Compare this photo of Feuling's billet cam support plate, pressure relief valve, relief spring and roll pin to the stock plate. Feuling recommends a pop-off pressure of 50–60 psi for the Twin Cam's pressure relief valve. The Feuling spring provides the proper spring rate for the optimum pop-off pressure and oil flow through the bypass port.

03

Shown is the Feuling pressure-testing tool mounted on a cam support plate. The arrow indicates the cam plate hole that will leak air if the pressure relief valve in the cam plate is leaking (valve not seating).

04

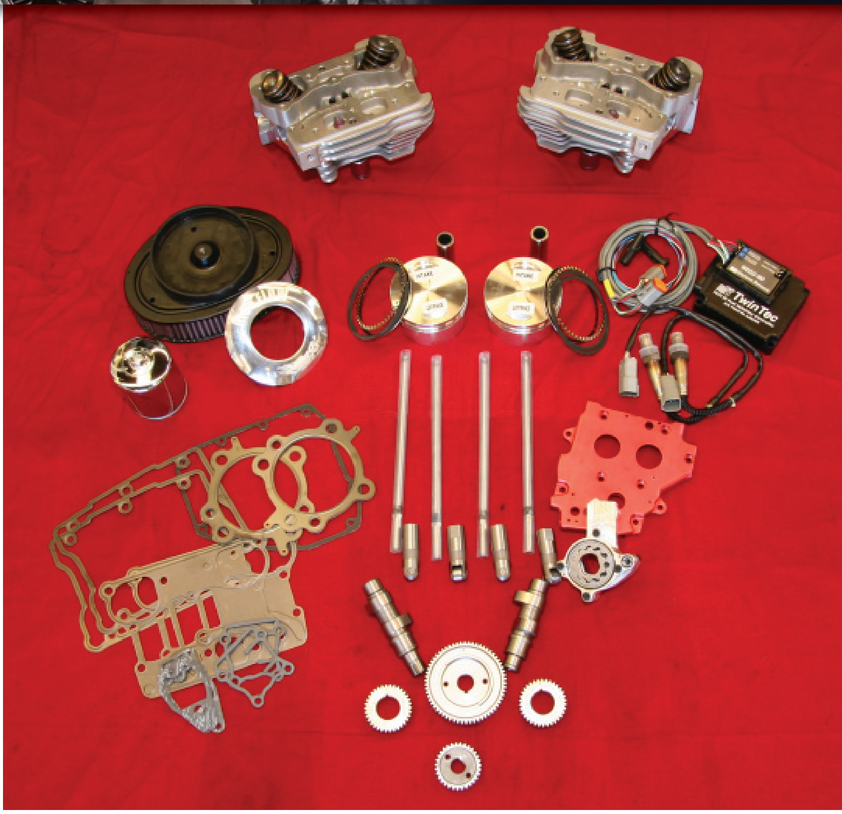
Feuling's pressure test tool makes it easy to bench-test the cam support plate and pressure relief valve before installation. The tool allows the engine builder to test relief valve pop-off pressure and cycle the pressure relief valve to ensure it moves freely and seats and seals properly. Leakage at the relief valve will reduce oil pressure. The tool fits all Twin Cam engine cam plates and includes a regulator, 0–100 pressure gauge, gasket and assembly hardware.

05

In the event testing shows the pressure relief valve is leaking in the cam plate, you can remove and clean all components to remove any debris and/or burrs. Then reinstall the plunger valve, use a brass punch centered in the back of the valve and give it a good whack with a hammer. This will reseat the hardened steel plunger valve against the aluminum cam plate. Next retest with the pressure spring installed using the pressure test tool. When testing the cam plate, you can use a 1/8-inch pin punch to hold the spring in place, eliminating the need to reinstall the roll pin each time.

06

Feuling's performance hydraulic roller lifters are CNC-machined, precision-ground and a drop-in replacement for stock lifters. The lifters are available in standard and .001-inch and .0015-inch oversize to maintain proper lifter-to-bore clearance for optimized engine oiling.



Here's the parts for our installation: Edelbrock's 95-inch kit (Suggested List Price $2,599.00), which includes CNC-ported EFI cylinder heads with a 72cc combustion chamber, chain or gear driven camshafts (in our case gear), Edelbrock/JE pistons (with rings, wrist pins, and pin locks); not shown is adjustable pushrods, EFI intake manifold for stock throttle body, gasket set, air cleaner, and CD-ROM with application-specific fuel calibrations for aftermarket pipes (note: Gear drive is sold separately from Edelbrock kit). Some of the parts from the Edelbrock kit were not used because the bike owner opted to purchase the following parts instead or in addition to the kit: Feuling's oil pump (Retail $425.00), cam plate (Retail $389.00), adjustable pushrods (Retail $219.00), and hydraulic lifters (center, Retail $279.00); S&S Cam Gear Drive Kit (bottom, Retail $432.95); SuperTrapp SuperMeg 2-into-1 exhaust system (not shown here, MSRP $775.00); Daytona Twin Tec fuel injection kit (right, $875); K&N Twin Cam RK Series air cleaner (retail $168)and oil filter (left, retail $14.44); Cometic Twin Cam Top End Gasket kit (left, retail $100).

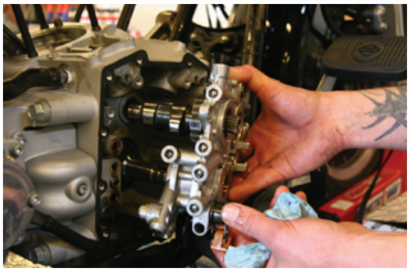
NEED FOR SPEED

Edelbrock's Twin Cam Hop-Up Kit

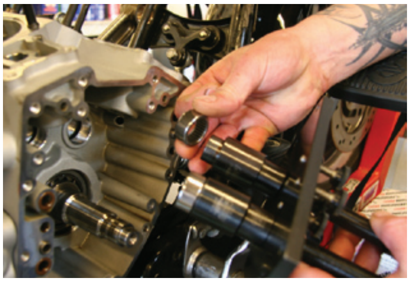
WORDS AND PHOTOS: TARYN FUNCHEON

As motorcyclists, it seems like it's hard to resist the need for speed. No matter how fast and powerful our bikes are, we just can't help but want more. When size does matter to us—at least with our engines—increasing the displacement of the motor can not only fill that need for speed, but also does wonders for the ego—it's like Enzyte for your motor.

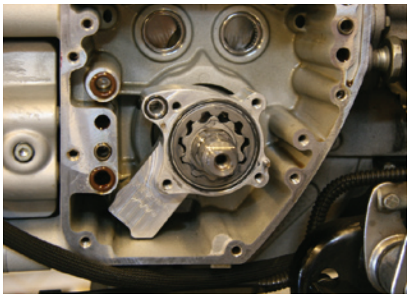
1. Getting started on the disassembly Eric removed the seat, disconnected the battery, loosened and lifted up the gas tank for clearance, drained the oil, removed the rocker box assembly and motor mount, and disconnected all the throttle body wires and sensors. Then the throttle body, air cleaner, exhaust pipes, heads, and cylinders were removed.



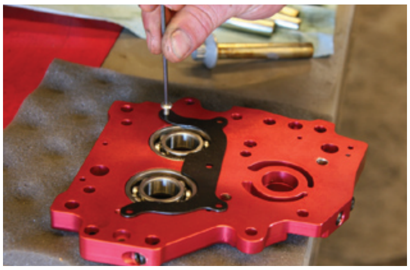
2. Next, the cam cover was taken off to get to the cam plate. Then the stock cam plate assembly was removed, which included the cams, cam drive chains, and stock oil pump housing.



3. Before any new components were installed Eric replaced the stock H-D inner cam bearings with new Torrington bearings, which will provide more support and durability for the new cams.



4. Then Eric got started assembling the Fueling oil pump. First the pump housing/body was placed into the case with new O-rings, followed by the scavenger rotor, gasket, and the oil feed rotor.



5. For the cam plate assembly, Eric pressed the outer bearings into the cam plate, then installed the retaining plate to hold them in place.

builder to know at what psi the relief valve opens. Spring tension can be adjusted as necessary through either shimming or stretching to achieve the desired pop-off psi.

Hydraulic Lifters

Proper lifter-to-lifter-bore clearance is imperative for maintaining adequate engine oil pressure and correct lifter operation. Since the hydraulic lifters control the flow of oil to the engine's top end, the top end will be starved for oil when the lifters are insufficiently pressurized. Insufficient pressurization not only increases lifter noise but also reduces performance, because valve lift and timing are lost. Feuling recommends a lifter-to-bore clearance of 0.001 inch to 0.0015 inch for optimum lifter performance. An out-of-tolerance lifter-to-bore clearance further escalates the problem of noisy lifters and valvetrain. Maintaining optimum clearance should keep the lifters "happy," even under extreme oil temperatures when the engine oil is thin. Additionally, sustaining adequate oil pressure to the lifters ensures proper oiling of the rocker arms, shafts and valvesprings for quiet operation. Since the rocker arms operate in plain bearings, Feuling recommends a minimum of 7 to 10 psi of oil pressure per 1000 engine rpm to lubricate the rocker arms and provide proper cooling for the valvesprings.

Feuling manufactures high-performance, CNC-machined, precision-ground hydraulic roller lifters that are a drop-in replacement for stock lifters. The Feuling lifters are available in standard and .001-inch and .0015-inch oversize (.842 inch is standard lifter O.D.) to maintain proper lifter-to-bore clearance.

Crankshaft Runout

A serious problem with the Twin Cam engine is excessive crankshaft runout, which is a result of the flywheels shifting on the crankpin. Under harsh acceleration, deceleration or burnouts, the Twin Cam's pressed-together crankshaft can shift out of true by as much as .030 inch or even more. For comparison, a well-built Twin Cam crank will exhibit .001 inch or less of runout, although factory tolerances are often .004 inch and sometimes more. When a crank drastically shifts out of true, the pinion shaft (right side) wobbles severely, usually causing catastrophic damage to the oil pump, cam support plate and other related parts. Additionally, oil pressure and scavenging decrease, allowing excess oil to fill the crankcase and gearcase areas. Once the excess oil builds up to a certain level, it is usually blown out the cylinder head breathers and into the air cleaner assembly. Warning signs of a shifted crank include loud noises from the gearcase area, noisy lifters and significant amounts of oil being tossed out the breather hoses. Typically, the crankshaft, oil pump, camshafts, cam support plate and cam drive mechanism require replacement when a crank shifts significantly out of true. Refer to our May installment for additional information about shifted cranks.

Cam Support Plate

The stock cam support plate does a decent job of supporting the camshafts and directing oil, but it can flex and warp under prolonged severe operation and high valvespring pressures. A wobbling pinion shaft will score or even break the oil pump housing and gerotor gears, since the pump is mounted over the shaft. Additionally, as a pump wobbles, it scores the cam support plate at the pump mounting surface, decreasing oil pressure while allowing the feed and scavenge sides of the engine's oiling system to intermingle, causing more havoc in the engine.

Feuling makes a hard-anodized, 7075 billet aluminum cam support plate that works great when hopping up an engine or replacing a damaged cam plate. Since the cam support plate has a dual function of supporting the camshafts and acting as an oil distribution point, Feuling not only made their plate extremely robust to handle high valvetrain pressures but also included several additional improvements for better oil distribution to the camshafts and engine.

For example, Feuling machines their cam plates with larger, kidney-shaped channels and internal oil galleys for greater

13

Feuling's high-volume bolt-in replacement oil pumps are made from 6061-T6 billet aluminum (Race Series from 7075 billet) and aerospace materials that result in a high-efficiency pump without the need for a high-friction spring washer between the gerotors. The pump is designed to increase oil pressure, oil volume, engine oil flow and return oil scavenging, thereby eliminating wet-sumping while reducing engine heat.

14

Shown are the size differences (diameter and thickness) of the feed gears used in three different Twin Cam oil pumps. From left: stock factory '99–'06 gear, factory gear in "new style" 2006 Dynas and all 2007-and-later models and Feuling feed gear. The Feuling pump gears are 40 percent larger on the feed side and 60 percent larger on the return side when compared to '99 –'06 factory pump gears and 20 percent larger on the feed size and 30 percent larger on the scavenge side when compared to 2006 Dyna and all 2007-and-later oil pumps.

15

This photo demonstrates the size differences (diameter and thickness) of the scavenge gears used in three different Twin Cam oil pumps. From left: stock factory '99–'06 gear, factory gear in "new style" 2006 Dynas and all 2007-and-later models and Feuling scavenge gear. The Feuling pump gears are 40 percent larger on the feed side and 60 percent larger on the return side when compared to '99–'06 factory pump gears and 20 percent larger on the feed size and 30 percent larger on the scavenge side when compared to 2006 Dyna and all 2007-and-later oil pumps.

oil flow throughout the engine. Also included are additional oil passages for the 2007-and-newer (2006-and-newer Dyna) engines with large camshaft journals. These modifications not only improve lubrication but also can reduce engine operating temperatures up to 20–25 degrees at the cylinder head. Feuling cam support plates are available for all years and models of Twin Cam engines; however, take note that the plates must be used in conjunction with Feuling's high-volume oil pump.

Gerotor Oil Pump

Twin Cam 88 and 88B engines use a small, die-cast, gerotor-style oil pump turning at crankshaft rpm that utilizes a spring washer to preload the pump gears against the cam support plate and pump housing. Over the years, the Factory made several improvements to the Twin Cam's gerotor oil pump, with the late-model 2007-and-newer (2006-and-newer Dyna) pumps being the best of the lot. Nevertheless, what you want in an oil pump is a pump that can supply the pressure and volume of oil required at both low- and high-rpm conditions in addition to sufficient scavenging capability to eliminate wet-sumping (sometimes called oil carryover).

Feuling was the first company to offer a performance oil pump that addresses the needs of the Twin Cam engine. Feuling's high-volume bolt-in replacement pumps are made of 6061-T6 billet aluminum and aerospace materials that result in a high-efficiency pump without the need for a high-friction spring washer between the gerotors. The pump features 40 percent larger gerotors on the pressure side and 60 percent larger units on the return side when compared to the '99–'06 factory oil pumps. Compared to the '06 Dynas and all '07-and-later oil pumps, the Feuling pumps show a 20 percent increase on the pressure side and 30 percent on the scavenge side. The Feuling pump was specifically designed to increase oil pressure and volume while maintaining sufficient oil scavenging to eliminate wet-sumping.

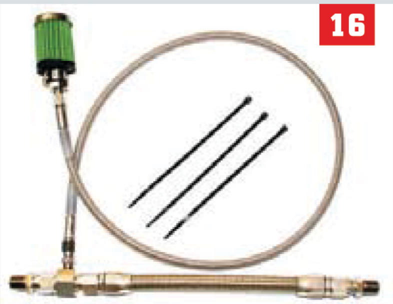
When setting up a Twin Cam's oiling system, you ideally want the engine to have just enough oil pressure and volume to keep vital engine parts lubricated, hydraulic lifters operating properly without collapsing or pumping up (even in hot stop-and-go traffic) and sufficient oil volume to keep the engine cool while having excess scavenging capacity so that oil is quickly removed from the flywheel cavity and gearcase under all conditions. Be aware that running excessive oil pressure—or even volume—is akin to running too much valvespring pressure: Both waste horsepower.

Odds and Ends

Building a bulletproof Twin Cam oiling system starts with a properly modified crankshaft, quality parts, proper prepping of components and a basic understanding of how the oiling system works. However, several other details should be addressed.

For starters, oil passages between the cam support plate and engine case are sealed with O-rings. Oil leaks can easily develop if the O-rings are pinched or hardened, overloading the gearcase with excessive oil. Always check that the O-rings are soft and supple, not hardened, and the correct size when assembling a Twin Cam engine. Make sure all oil and breather lines are free-flowing and not pinched. It is best to use two separate vent lines (instead of one line) from the cylinder heads. For maximum performance, vent the breather lines to the atmosphere. To remain EPA-compliant, you'll have to route the lines to the air cleaner. Be sure to align the oil pump using the procedure described in the factory's service manual. Make sure the umbrella valves in the rocker boxes are in good condition and not brittle, warped or torn. Also, make sure that engine oil passages are not accidentally blocked due to an incorrectly stamped gasket.

Excessive piston ring blow-by (combustion chamber gases entering the flywheel cavity) will pressurize the crankcase cavities beyond normal levels, potentially leading to wet-sumping. The sealing ability of the piston rings can be checked by using a leak-down tester. Feuling makes an oil tank breather kit that releases power-robbing pressures from the oil tank and crankcase, reduces blow-by, helps prevent dipstick blowout and promotes proper oil flow to and from the remote oil tank.



16

Shown is the Feuling oil tank breather kit designed to help release power-robbing pressures from the oil tank and crankcase, reduce blow-by, prevent dipstick blowout and promote proper oil flow to and from the remote oil tank.

Final Thoughts

Keep in mind that a properly functioning oiling system is a system of interrelated subsystems requiring quality parts, proper prepping of components and correct installation procedures. Under some conditions, even a stock engine can tax the Twin Cam's oiling system. And a large-displacement motor—roughly 100ci and larger—makes the situation worse yet. To achieve an efficient oiling system, the entire system must be balanced for oil pressure, oil volume and oil scavenging capability.

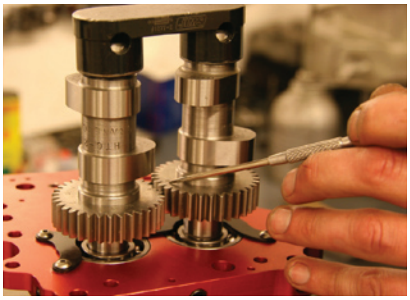
Don't forget that excessively high oil pressures or volume is a power robber and can lead to wet-sumping and oil leaks. Conversely, very low oil pressure is most conducive to high-rpm racing engines or street engines using solid lifters. For street engines, you need sufficient oil pressure to maintain proper hydraulic lifter operation during low-rpm stop-and-go riding in the hot summer months when the engine oil is thin. Installing an oil cooler and thermostat will not only improve the longevity of engine parts but also reduce the potential for power-limiting detonation. Feuling's system approach to the Twin Cam's oiling system is a major step in the right direction for eliminating the Twin Cam's "oiling system blues." B

SOURCE

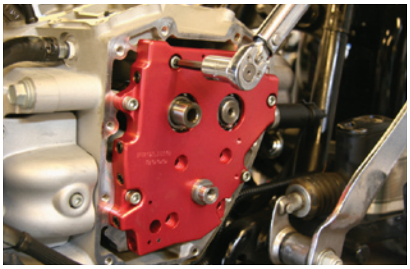
FEULING PARTS
17215 Roper St.
Mojave, California 93501
(619) 917-6222
www.feulingparts.com

Combining the increase in cubic inches with a more aggressive cam design, a set of good pipes, and an air cleaner, you can have a more powerful bike. In our case, we were starting with a stock '06 Electra Glide Standard that we wanted to bump up in size. We headed to Bennett's Performance in Signal Hill, California, and asked for a helping hand from motor gurus Bob and Eric Bennett.

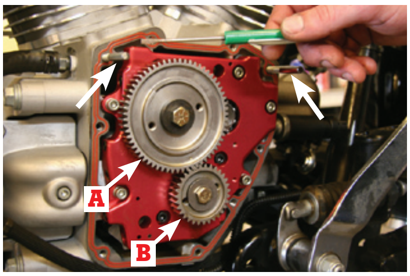
As far as the parts for our installation, the Edelbrock 95-inch Performer RPM Package was going on the bike, which includes all of the necessary components to upgrade your '06 88-inch Twin Cam motor to 95ci. In preparation of increasing displacement, we handed off the stock cylinders to Bob to bore them out to accept the new larger pistons, while Eric was installing the rest of the goodies. We snapped photos of the motor hop-up to show you how we achieved increased power levels from putting all these components together. **HB**



6. **Once the S&S inner cam drive gears were aligned with the timing marks in the right place, Eric pressed the Edelbrock cams into the cam plate, then rotated them to make sure the timing marks were lined up.**

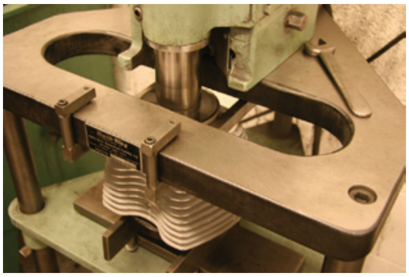


7. **Before completely bolting on the cam plate, Eric first turned the motor over by hand. This allowed him to check for proper cam clearance. Once everything moved freely, he torqued the cam plate to 120 lb-in.**



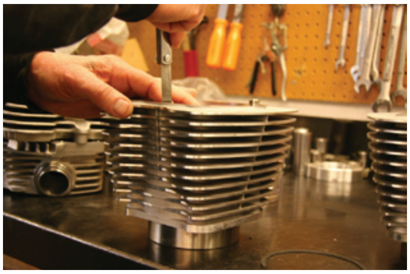
8. **Then the S&S outer cam drive gears (A) and pinion gear (B) were installed. Eric screwed in two bolts (*arrows*) with the tops cut off so they would help keep the gasket in place until he put the RSD cover back on and torqued to 120 lb-in.**

9. **The new cylinders and pistons were handed over to Bob to go through their boring and honing procedure, while Eric continued with the install. First, a dial caliper was used to measure both pistons. Then the value obtained with the dial caliper was transferred to a bore gauge instrument. This allows him to know when the cylinder bore matches the fitment of the piston.**

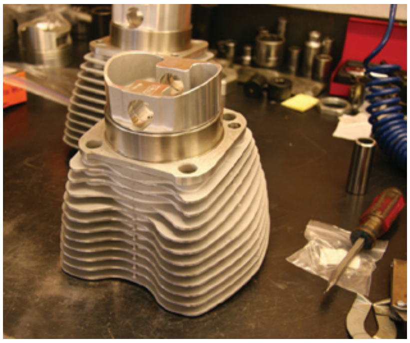


10. **After placing each cylinder in a Kwik-Way vertical boring/honing machine, they were brought to within .002 thousandths of an inch to a finished bore of 3.875 inches.**

11. **Then Bob grabbed a finer multiple pedal honing stone and attached it to a handheld drill. This is what brought the cylinders to the finished bore for size that matched each piston. Constant measurements were taken throughout and various size honing stones were used for a precise bore/hone job. (See *HOT BIKE* Vol. 40, No. 3 for more information on boring and honing procedures.)**



12. **Before installing the rings on the pistons, each ring was inserted into the cylinder and the end-gap of each ring was measured with a feeler gauge. We were looking for .018 thousandths of an inch gap on the top and lower ring, and .020-.025 thousandths of an inch gap on the middle ring.**



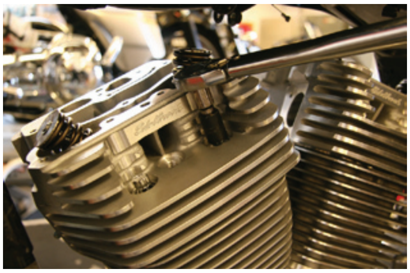
13. **Placing the rings set on each piston, Bob then slid the piston into the cylinder and applied assembly lubricant to its surface. Now the cylinders were ready for the install.**

14. **Eric installed a new cylinder base O-ring, then the wrist pin through the rod, followed by the pin clips onto each piston.**

15. **Then the Feuling Race Series lifters were installed along with new gaskets and the lifter block.**

16. Before putting on the heads, a Cometic MLS (Multi-Layer Steel) head gasket was placed on top of each cylinder…

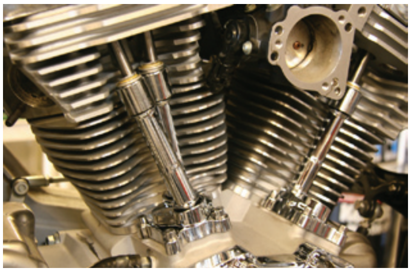
17. …then the Edelbrock heads were installed.



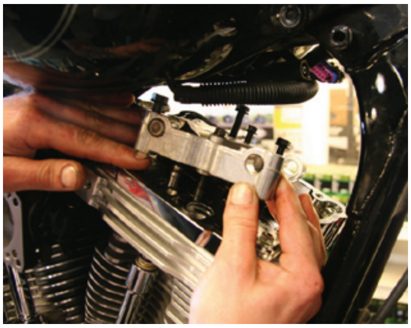
18. After applying anti-seize and installing the head bolts, Eric began a four-step process of torquing the head bolts, starting in a crisscross pattern at 20 lb-ft, then 28, 36, and finally to 42 lb-ft, ending in a perfectly seated head.

19. To insure a proper seal, all new gaskets were installed onto the intake. The flange was installed onto the throttle body, followed by installing the throttle body and reconnecting all the wires and sensors.

20. Before Eric installed the rocker box base and gasket, he had to grind some of the lower corner of the base because it was hitting the valve spring, then he torqued it to 20 lb-ft.

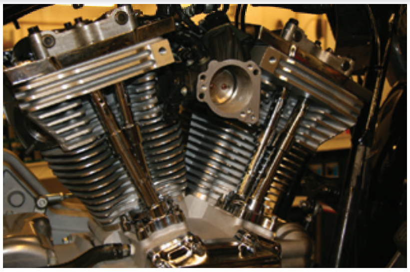


21. Next, Eric prepared the Feuling adjustable pushrods and tubes for installation. Made of chrome-moly steel tubing and utilizing a minimal adjustable parameter, the pushrods were slid down through the rocker housing to rest on the lifters.



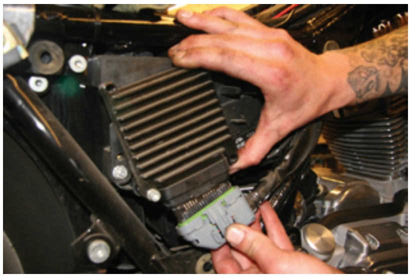
22. With the pushrods in place, however, not adjusted, the rocker arm support plate and the rockers were installed and torqued to 20 lb-ft, and the breather assembly was installed as well.

23. After successively getting each pushrod to the desired adjustment, Eric tightened the locknut on each of the pushrods.



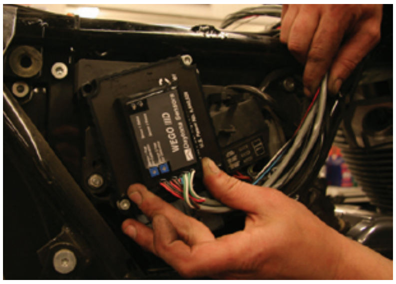
24. According to Feuling, their pushrods have 32 threads per inch and one full turn equals 0.031 inches of adjustment. When adjusting Feuling pushrods on Feuling lifters from zero lash, 3 to 3-1/4 turns will put 0.093 to 0.100 inches of crush on the lifter. Here, we're almost finished with the top-end/cam change part of the installation. Once each pushrod was adjusted, the pushrod tubes were extended and held with the spring cap retainers.

25. Eric installed the RSD rocker box cover lids and re-installed the coil to finish up the top end of the build.



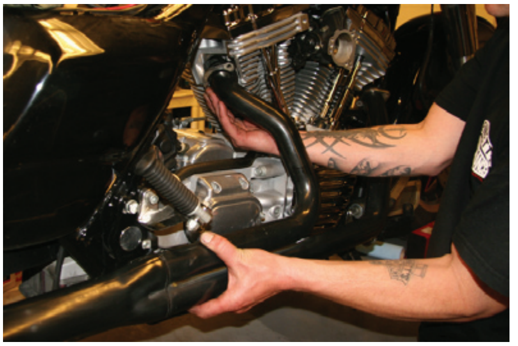
26. Moving on to the Daytona Twin Tec kit, Eric removed the side frame covers and the OEM O2 sensors. Next, he removed the stock ECM module…

27. …then replaced it with the Daytona Twin Tec ECM controller. This is a direct plug-in replacement.



28. Next, the WEGO III module was attached to the TCFI controller, using hook and loop strips and a few zip-ties, then carefully following all recommended wiring instructions...

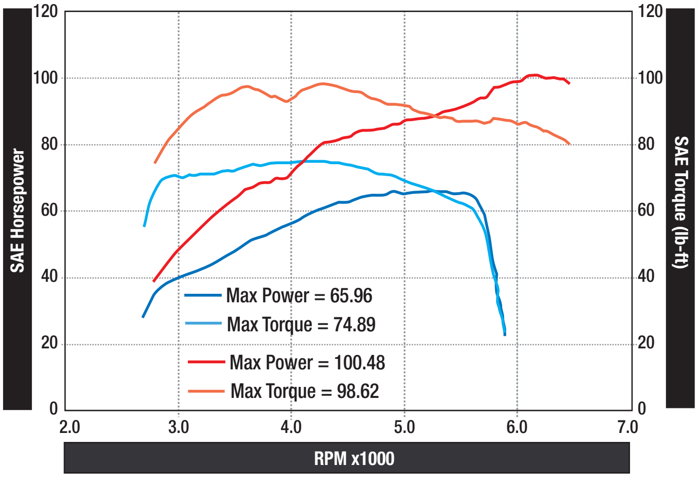
29. ...Eric hooked up the 02 sensors to the SuperTrapp SuperMeg 2-into-1 black ceramic pipe, which includes 4-inch external tunable discs. Eric will later hook up the PC and perform the initial TCFI setup, make any adjustments, and perform some initial tuning. (See *HOT BIKE* Vol. 40, No. 5 for the complete Daytona Twin Tec install and tuning.)



30. After installing the SuperTrapp header pipe and muffler, Eric installed a starting point amount of discs and the end cap on the outlet of the muffler, followed by installing the heat shields.

31. A K&N high-flow, washable air cleaner and oil filter was installed. Afterwards, the outer cover was placed over the air cleaner.

32. Here's the '06 Electra Glide all finished and after 200 or so break-in miles before the final dyno run.



33. The bike baselined at 65.96 hp and 74.89 lb-ft of torque. After the install, break-in miles, and one more run on the dyno, the bike pulled 100.48 hp and 98.62 lb-ft of torque. This was an increase of 34.5 hp and 23.6 lb-ft of torque. These are good numbers, considering the gain in torque alone is strong in the lower rpm band with an overall steady increase. There was also a nice gain in horsepower—especially in the higher rpm band—and the gains steadily increase over the power band. As with any performance upgrade results may vary, though in our case we pretty much achieved Edelbrock's advertised power levels. So, what does the bike owner, who happens to work in the motorcycle industry, have to say about the hop-up? "This performance package has dramatically improved the throttle response, low, mid, and top-end torque and horsepower. Now my bagger really gets up and goes. It climbs hills with ease. It is able to achieve higher speeds at lower rpms. My fuel economy has not been affected at all. It's truly a great and affordable 'out of the box' package."

SOURCES

BENNETT'S PERFORMANCE INC.
(562) 498-1819
www.bennettsperformanceinc.com

EDELBROCK
(310) 781-2222
www.edelbrock.com

FEULING
(619) 917-6222
www.feulingparts.com

S&S CYCLE
(608) 627-1497
www.sscycle.com

SUPERTRAPP INDUSTRIES
(216) 265-8400
www.supertrapp.com

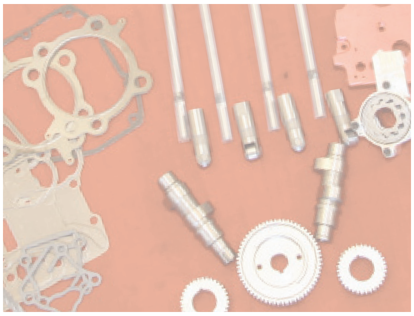
DAYTONA TWIN TEC
(386) 304-0700
www.daytona-twintec.com

K&N
(800) 858-3333
www.knfilters.com

COMETIC GASKET
(800) 752-9850
www.cometic.com

FEEDBACK

hot.bike@sourceinterlink.com



Moreover, excess crankcase oil is often whipped into a froth of air and oil by the machined paddles of the left flywheel. This condition is called oil aeration. Aerated oil makes scavenging much more difficult and can hinder the return of oil from the rocker box area. The combination of these conditions often results in oil being forced out the head breathers, air cleaner contamination, oil leaks, loss of oil supply, lifter clatter, premature component wear and potential engine failure.

The Twin Cam's oiling system requires a fine balancing act to maintain the correct amount of oil pressure, oil volume and scavenging to eliminate wet-sumping while maintaining quiet operation and optimized power production without generating excessive heat. In many cases, the genesis of the Twin Cam's oiling problems lies in significant parts wear, hardened oil seals, poor part alignment, inaccurate machining tolerances and catastrophic damage to key components.

Oil Pressure

To maintain proper oil pressure, the Twin Cam engine uses a spring-loaded pressure relief valve, which is located in the cam support plate. The purpose of the relief valve is to protect the engine from excessive oil pressure. However, a sticking valve will cause low oil pressure. For example, when starting a cold engine in 20-degree weather and using 20/50 oil, the relief valve will open and protect the engine from extreme pressures that can damage engine seals. In contrast, if the valve stops working properly and sticks open due to debris from worn chain tensioners or poor machining tolerances, oil pressure can drop below minimum requirements. Unfortunately, low oil pressure causes a domino effect. First, the hydraulic lifters start clattering due to a lack of oil. Additionally, the oil supply to the top end is reduced, further amplifying engine noise and clatter. To compound the problems, the piston cooling jets, when opened, usurp oil from the lifters.

The pressure relief valve consists of a plunger and spring. The plunger must move freely and seat properly to maintain proper oil pressure. In addition to being held open due to debris circulating in the oil, the plunger has been known to catch and hang up on a machining burr in the bypass port, thereby reducing oil pressure. Whenever you rebuild a Twin Cam engine or install new cams, it's important to make sure the pressure relief plunger moves freely and seats properly in the cam plate bypass port. Feuling makes a high-quality pressure relief spring for the Twin Cam with the correct spring rate to control and maintain proper oil pressure.

Feuling also manufactures a neat pressure test tool that allows the engine builder to test the pressure relief valve operation before installation of the cam support plate to ensure the oil relief plunger moves freely, seats completely and seals properly. The tester includes a pressure gauge, 0–100 psi regulator, mounting plate, gaskets and related hardware. The tool allows the engine

Shown is one method for checking pinion shaft runout using a dial gauge. Always measure runout without the cam plate installed.

Here's an example of a mildly scored, stock '99–'06 cam support plate. The scoring was due to excessive crankshaft runout, which resulted in pinion shaft wobble. Arrows indicate scoring around the circumference of the plate's pinion shaft bushing and between the kidney-shaped feed- and scavenge-side oil channels. Scoring around the circumference allows oil to leak into the gearcase cavity. Scoring between the kidney-shaped channels allows oil to commingle between the feed and scavenge sides of the pump, creating havoc in the oiling system. If you can feel score marks with your fingernail, the cam plate must be replaced.

All Feuling billet cam support plates include enlarged, kidney-shaped feed- and scavenge-side oil channels for increased flow through the engine. Shown is a stock Twin Cam cam support plate. Notice that the machinist rule shows the kidney-shaped channels measure about 1.469 inches in diameter. Compare this stock diameter against a Factory SE support plate and a Feuling plate.

The kidney-shaped oil channels machined into this Factory SE cam support plate measure about 1.594 inches in diameter, which is larger than the stock plate channels but smaller than the Feuling cam support plate.

The large, kidney-shaped feed- and scavenge-side oil channels in this hard-anodized, billet aluminum Feuling cam support plate measure about 1.812 inches in diameter. The increased size improves oil flow through the engine.

Feuling's cam support plates are machined from 7075 billet aluminum and then hard-anodized. The plates are machined with larger-than-stock, kidney-shaped feed- and scavenge-side oil channels and internal oil galleys for greater oil flow throughout the engine. Also included are additional oil passages for the 2007-and-newer (2006-and-newer Dyna) engines with large camshaft journals. Shown is the Feuling plate for '99–'06 engines except '06 Dynas, PN 8000.

builder to know at what psi the relief valve opens. Spring tension can be adjusted as necessary through either shimming or stretching to achieve the desired pop-off psi.

Hydraulic Lifters

Proper lifter-to-lifter-bore clearance is imperative for maintaining adequate engine oil pressure and correct lifter operation. Since the hydraulic lifters control the flow of oil to the engine's top end, the top end will be starved for oil when the lifters are insufficiently pressurized. Insufficient pressurization not only increases lifter noise but also reduces performance, because valve lift and timing are lost. Feuling recommends a lifter-to-bore clearance of 0.001 inch to 0.0015 inch for optimum lifter performance. An out-of-tolerance lifter-to-bore clearance further escalates the problem of noisy lifters and valvetrain. Maintaining optimum clearance should keep the lifters "happy," even under extreme oil temperatures when the engine oil is thin. Additionally, sustaining adequate oil pressure to the lifters ensures proper oiling of the rocker arms, shafts and valvesprings for quiet operation. Since the rocker arms operate in plain bearings, Feuling recommends a minimum of 7 to 10 psi of oil pressure per 1000 engine rpm to lubricate the rocker arms and provide proper cooling for the valvesprings.

Feuling manufactures high-performance, CNC-machined, precision-ground hydraulic roller lifters that are a drop-in replacement for stock lifters. The Feuling lifters are available in standard and .001-inch and .0015-inch oversize (.842 inch is standard lifter O.D.) to maintain proper lifter-to-bore clearance.

Crankshaft Runout

A serious problem with the Twin Cam engine is excessive crankshaft runout, which is a result of the flywheels shifting on the crankpin. Under harsh acceleration, deceleration or burnouts, the Twin Cam's pressed-together crankshaft can shift out of true by as much as .030 inch or even more. For comparison, a well-built Twin Cam crank will exhibit .001 inch or less of runout, although factory tolerances are often .004 inch and sometimes more. When a crank drastically shifts out of true, the pinion shaft (right side) wobbles severely, usually causing catastrophic damage to the oil pump, cam support plate and other related parts. Additionally, oil pressure and scavenging decrease, allowing excess oil to fill the crankcase and gearcase areas. Once the excess oil builds up to a certain level, it is usually blown out the cylinder head breathers and into the air cleaner assembly. Warning signs of a shifted crank include loud noises from the gearcase area, noisy lifters and significant amounts of oil being tossed out the breather hoses. Typically, the crankshaft, oil pump, camshafts, cam support plate and cam drive mechanism require replacement when a crank shifts significantly out of true. Refer to our May installment for additional information about shifted cranks.

Cam Support Plate

The stock cam support plate does a decent job of supporting the camshafts and directing oil, but it can flex and warp under prolonged severe operation and high valvespring pressures. A wobbling pinion shaft will score or even break the oil pump housing and gerotor gears, since the pump is mounted over the shaft. Additionally, as a pump wobbles, it scores the cam support plate at the pump mounting surface, decreasing oil pressure while allowing the feed and scavenge sides of the engine's oiling system to intermingle, causing more havoc in the engine.

Feuling makes a hard-anodized, 7075 billet aluminum cam support plate that works great when hopping up an engine or replacing a damaged cam plate. Since the cam support plate has a dual function of supporting the camshafts and acting as an oil distribution point, Feuling not only made their plate extremely robust to handle high valvetrain pressures but also included several additional improvements for better oil distribution to the camshafts and engine.

For example, Feuling machines their cam plates with larger, kidney-shaped channels and internal oil galleys for greater

Feuling's high-volume bolt-in replacement oil pumps are made from 6061-T6 billet aluminum (Race Series from 7075 billet) and aerospace materials that result in a high-efficiency pump without the need for a high-friction spring washer between the gerotors. The pump is designed to increase oil pressure, oil volume, engine oil flow and return oil scavenging, thereby eliminating wet-sumping while reducing engine heat.

Shown are the size differences (diameter and thickness) of the feed gears used in three different Twin Cam oil pumps. From left: stock factory '99–'06 gear, factory gear in "new style" 2006 Dynas and all 2007-and-later models and Feuling feed gear. The Feuling pump gears are 40 percent larger on the feed side and 60 percent larger on the return side when compared to '99 –'06 factory pump gears and 20 percent larger on the feed size and 30 percent larger on the scavenge side when compared to 2006 Dyna and all 2007-and-later oil pumps.

This photo demonstrates the size differences (diameter and thickness) of the scavenge gears used in three different Twin Cam oil pumps. From left: stock factory '99–'06 gear, factory gear in "new style" 2006 Dynas and all 2007-and-later models and Feuling scavenge gear. The Feuling pump gears are 40 percent larger on the feed side and 60 percent larger on the return side when compared to '99–'06 factory pump gears and 20 percent larger on the feed size and 30 percent larger on the scavenge side when compared to 2006 Dyna and all 2007-and-later oil pumps.

oil flow throughout the engine. Also included are additional oil passages for the 2007-and-newer (2006-and-newer Dyna) engines with large camshaft journals. These modifications not only improve lubrication but also can reduce engine operating temperatures up to 20–25 degrees at the cylinder head. Feuling cam support plates are available for all years and models of Twin Cam engines; however, take note that the plates must be used in conjunction with Feuling's high-volume oil pump.

Gerotor Oil Pump

Twin Cam 88 and 88B engines use a small, die-cast, gerotor-style oil pump turning at crankshaft rpm that utilizes a spring washer to preload the pump gears against the cam support plate and pump housing. Over the years, the Factory made several improvements to the Twin Cam's gerotor oil pump, with the late-model 2007-and-newer (2006-and-newer Dyna) pumps being the best of the lot. Nevertheless, what you want in an oil pump is a pump that can supply the pressure and volume of oil required at both low- and high-rpm conditions in addition to sufficient scavenging capability to eliminate wet-sumping (sometimes called oil carryover).

Feuling was the first company to offer a performance oil pump that addresses the needs of the Twin Cam engine. Feuling's high-volume bolt-in replacement pumps are made of 6061-T6 billet aluminum and aerospace materials that result in a high-efficiency pump without the need for a high-friction spring washer between the gerotors. The pump features 40 percent larger gerotors on the pressure side and 60 percent larger units on the return side when compared to the '99–'06 factory oil pumps. Compared to the '06 Dynas and all '07-and-later oil pumps, the Feuling pumps show a 20 percent increase on the pressure side and 30 percent on the scavenge side. The Feuling pump was specifically designed to increase oil pressure and volume while maintaining sufficient oil scavenging to eliminate wet-sumping.

When setting up a Twin Cam's oiling system, you ideally want the engine to have just enough oil pressure and volume to keep vital engine parts lubricated, hydraulic lifters operating properly without collapsing or pumping up (even in hot stop-and-go traffic) and sufficient oil volume to keep the engine cool while having excess scavenging capacity so that oil is quickly removed from the flywheel cavity and gearcase under all conditions. Be aware that running excessive oil pressure—or even volume—is akin to running too much valvespring pressure: Both waste horsepower.

Odds and Ends

Building a bulletproof Twin Cam oiling system starts with a properly modified crankshaft, quality parts, proper prepping of components and a basic understanding of how the oiling system works. However, several other details should be addressed.

For starters, oil passages between the cam support plate and engine case are sealed with O-rings. Oil leaks can easily develop if the O-rings are pinched or hardened, overloading the gearcase with excessive oil. Always check that the O-rings are soft and supple, not hardened, and the correct size when assembling a Twin Cam engine. Make sure all oil and breather lines are free-flowing and not pinched. It is best to use two separate vent lines (instead of one line) from the cylinder heads. For maximum performance, vent the breather lines to the atmosphere. To remain EPA-compliant, you'll have to route the lines to the air cleaner. Be sure to align the oil pump using the procedure described in the factory's service manual. Make sure the umbrella valves in the rocker boxes are in good condition and not brittle, warped or torn. Also, make sure that engine oil passages are not accidentally blocked due to an incorrectly stamped gasket.

Excessive piston ring blow-by (combustion chamber gases entering the flywheel cavity) will pressurize the crankcase cavities beyond normal levels, potentially leading to wet-sumping. The sealing ability of the piston rings can be checked by using a leak-down tester. Feuling makes an oil tank breather kit that releases power-robbing pressures from the oil tank and crankcase, reduces blow-by, helps prevent dipstick blowout and promotes proper oil flow to and from the remote oil tank.

Final Thoughts

Keep in mind that a properly functioning oiling system is a system of interrelated subsystems requiring quality parts, proper prepping of components and correct installation procedures. Under some conditions, even a stock engine can tax the Twin Cam's oiling system. And a large-displacement motor—roughly 100ci and larger—makes the situation worse yet. To achieve an efficient oiling system, the entire system must be balanced for oil pressure, oil volume and oil scavenging capability.

Don't forget that excessively high oil pressures or volume is a power robber and can lead to wet-sumping and oil leaks. Conversely, very low oil pressure is most conducive to high-rpm racing engines or street engines using solid lifters. For street engines, you need sufficient oil pressure to maintain proper hydraulic lifter operation during low-rpm stop-and-go riding in the hot summer months when the engine oil is thin. Installing an oil cooler and thermostat will not only improve the longevity of engine parts but also reduce the potential for power-limiting detonation. Feuling's system approach to the Twin Cam's oiling system is a major step in the right direction for eliminating the Twin Cam's "oiling system blues." *B*

16

Shown is the Feuling oil tank breather kit designed to help release power-robbing pressures from the oil tank and crankcase, reduce blow-by, prevent dipstick blowout and promote proper oil flow to and from the remote oil tank.

SOURCE

FEULING PARTS
17215 Roper St.
Mojave, California 93501
(619) 917-6222
www.feulingparts.com