

FEULING® REAPER® SERIES CAMSHAFTS FOR MILWAUKEE EIGHT GRINDS: 405, 465, 508, 521, 592

- FEULING® REAPER® camshafts have wide lobe separations producing very wide power bands
- Smooth camshaft lobe ramps are easier on valve-train components eliminating excessive valve-train noise and wear.
- Better Throttle Response - Increased MPG - Easy Starting - Unique Idle Sound
- Made in U.S.A.



405 CAM - A workhorse, producing a wide powerband increasing torque and HP throughout the entire RPM range when compared to stock. Direct bolt in replacement for Milwaukee Eight engines, can be used with stock valve springs, pushrods, lifters and exhaust. Will respond well with slip-on mufflers and or complete exhaust system and a high flow air cleaner. Note Feuling recommends using mufflers with smaller cores for best lower RPM power and pull.

Part # 1340	Valve Lift	Open	Close	Duration @ 50"	lift @ TDC	Lobe Centerline
Intake	.395	4 ATDC	24 ABDC	200	.068	103
Exhaust	.405	36 BBDC	11 BTDC	205	.049	108

RPM range: 1,700 - 5,700 Grind: 405 Overlap: 7

465 CAM - The 465 Reaper is an accelerator, producing solid bottom end performance with substantial gains above 2,800 RPM when compared to stock. This direct bolt in replacement for Milwaukee Eight engines can be used with stock valve springs, pushrods, lifters and exhaust. Will respond well with slip-on mufflers and or performance exhaust system and air cleaner. Use of performance valve-springs is not required but may result in a quieter, smoother running valve-train See Feuling #1107. This cam will also respond well with increased bore and or compression

Part #1343	Valve Lift	Open	Close	Duration @ 50"	lift @ TDC	Lobe Centerline
Intake	.445	4 BTDC	23 ABDC	207	.100	99.5
Exhaust	.465	50 BBDC	6 ATDC	236	.100	112

RPM range: 1,850 - 5,950 Grind: 465 Overlap: 10

521 CAM - Aggressive pulling power with a "nasty" sound, the REAPER 521 grind will shine in 114" and larger cubic inch engines with added compression ratio. Ported cylinder heads are not required but will complement the cam and add even more pulling power throughout the range. The stock throttle body produces an excellent powerband, use of a high flow throttle body may increase peak power numbers. A high flow exhaust system and air cleaner is highly recommended for optimal performance. FEULING recommends matching this cam with our RACE SERIES oiling system #7097. **High lift valve springs are required on stock cylinder heads**, see FEULING BEEHIVE valve spring kit #1107 or #1108 Note SE cylinder heads have high lift valvesprings and do accept the 521 grind cam. Heavy duty one piece pushrods are also highly recommended see #4087.

Part # 1346	Valve Lift	Open	Close	Duration @ 50"	lift @ TDC	Lobe Centerline
Intake	.518	17 BTDC	34 ABDC	231	.162	98.5
Exhaust	.521	51.5 BBDC	11.5 ATDC	243	.125	110

RPM range: 2,250 - 6,250 Grind: 521 Overlap: 28.5

**Cam specs measured on the lifter @ 0.050" lift with 1.61 rocker arm ratio*

DISCLAIMER: NOT LEGAL FOR SALE OR USE IN CALIFORNIA ON ANY POLLUTION CONTROLLED MOTOR VEHICLES

FEULING® DOES NOT RECOMMEND TUNING BEYOND STOCK EMISSIONS STANDARDS.



508 CAM - 'The Grim Reaper' Aggressive pulling power with a "nasty" sound. This camshaft revs up faster than the 521 grind, sounds nastier and pulls harder but is more difficult to tune. The REAPER 508 grind will shine in 114" and larger cubic inch engines with added compression ratio. Ported cylinder heads are not required but will complement the cam and add even more pulling power throughout the range. The stock throttle body produces an excellent powerband and use of a high flow throttle body will increase peak power numbers. A high flow exhaust system and air cleaner is highly recommended for optimal performance. FEULING recommends matching this cam with our RACE SERIES oiling system #7097. High lift valve springs are required, see FEULING BEEHIVE valve spring kit #1107 and #1108. Heavy duty pushrods are highly recommended see #4087.

Part # 1349 \$299.95

	<u>Valve Lift</u>	<u>Open</u>	<u>Close</u>	<u>Duration @ 50"</u>	<u>lift @ TDC</u>	<u>Lobe Centerline</u>
Intake	.508	21.5 BTDC	36 ABDC	231	.180	97.5
Exhaust	.511	45 BBDC	9 ATDC	243	.146	104.25

RPM range 2,250 - 6,250. Grind: 508 Overlap: 30.5

592 CAM - 'The big nasty' Put your big boy pants on get serious with bore size, ported cylinder heads, compression and throttle body. Aggressive camshaft requiring high lift and higher load valvesprings, performance pushrods and lifters. High flow air cleaner and triple stepped exhaust pipe highly recommended. FEULING also recommends matching this cam with our RACE SERIES oiling system #7097 or #7099. High lift valve springs are required, see FEULING BEEHIVE valve spring kit #1207. Heavy duty pushrods are highly recommended see #4087.

Part # 1348 \$299.95

	<u>Valve Lift</u>	<u>Open</u>	<u>Close</u>	<u>Duration @ 50"</u>	<u>Lobe Centerline</u>
Intake	.578	20	34	234	97
Exhaust	.592	68	16	264	116

RPM range 2,850 - 6,250. Grind: 592 Overlap: 36

**Cam specs measured on the lifter @ 0.050" lift with 1.61 rocker arm ratio*

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IMPORTANT NOTICE

This installation should be done by an experienced mechanic who has access to a factory service manual and all required tools. Measure flywheel pinion shaft run out & end play. Excessive pinion shaft runout and or end play will cause damage and or failure and voids manufacturer's warranty. Feuling recommends ideal end play at 0.003"-0.004", crankshaft runout at or below 0.003" but our warranty covers up to 0.0045" combination of runout and bearing play, measure crank bearing play by lifting up on the tip of the pinion shaft.

*The FEULING REAPER 405 & 465 grind camshafts are direct bolt-in. The FEULING REAPER 508, 521 and 592 camshaft grinds require high lift valvesprings when used with factory cylinder heads. The SE cylinder heads do have high lift valvesprings and can use the 508 or 521 cam as a bolt-in. The 592 grind will require checking valve to piston clearance.

CAUTION

Incorrect installation can cause engine damage not covered under warranty. Failure to install components correctly can cause engine seizure. Engine seizure may result in serious injury to motorcycle, operator, passenger, and/or others. Removal of the rocker arms and or pushrods with the valve train loaded can damage rocker arms, push rods, bushings and or camplate. Rotate engine to TDC of compression stroke on the servicing cylinder.

WARRANTY NOTE

Feuling offers an additional 12 month warranty for a total of 2 years if product is installed by a professional V-Twin installer, oil tank is dropped and cleaned at time of install and the WARRANTY REGISTRATION form is filled out - form can be found on www.Feulingparts.com



FEULING® CAMCHEST INSTALLATION FOR MILWAUKEE EIGHT ENGINES



FEULING OE + CAMPLATE #8037 IS ONLY FOR USE WITH THE FACTORY HD® OIL PUMP AND IS DESIGNED TO USE THE FACTORY OIL PUMP BOLTS OR THE OPTIONAL FEULING X ARP BOLT KIT WITH WASHERS SEE #8023

FEULING HIGHFLOW CAMPLATE #8017 REQUIRES A FEULING HP+ #7018/7019 OIL PUMP OR RACE SERIES #7020/7021 OIL PUMP, USE THE PROVIDED ALLEN HEAD OIL PUMP BOLTS OR SEE OPTIONAL FEULING X ARP BOLT KIT SEE #8022

FEULING RECOMMENDS THE FOLLOWING INSTALLATION PROCEDURES FOR ALL OILING SYSTEM COMBINATIONS ON M-EIGHT ENGINES.

IMPORTANT NOTICE

This installation should be done by an experienced mechanic who has access to a factory service manual and all required tools. Measure flywheel pinion shaft run out & end play. Excessive pinion shaft runout and or end play will cause damage and or failure and voids manufacturer's warranty. **Feuling recommends ideal end play at 0.003"-0.004", crankshaft runout at or below 0.003" but our warranty covers up to 0.0045"** combination of runout and bearing play, measure crank bearing play by lifting up on the tip of the pinion shaft.

*The FEULING REAPER 405 & 465 grind camshafts are direct bolt-in. **The FEULING REAPER 508, 521 and 592 camshaft grinds require high lift valvesprings** when used with factory cylinder heads. The SE cylinder heads do have high lift valvesprings and can use the 508 or 521 cam as a bolt-in. The 592 grind will require checking valve to piston clearance.

CAUTION

Incorrect installation can cause engine damage not covered under warranty. Failure to install components correctly can cause engine seizure. Engine seizure may result in serious injury to motorcycle, operator, passenger, and/or others. Removal of the rocker arms and or pushrods with the valve train loaded can damage rocker arms, push rods, bushings and or camplate. Rotate engine to TDC of compression stroke on the servicing cylinder.

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FEULING® DOES NOT RECOMMEND TUNING BEYOND STOCK EMISSIONS STANDARDS.

1. Refer to the proper factory service manual for your model and year of engine, for removal of camchest. Note the FEULING 508, 521, 592 grind camshafts require highlift valvesprings (See #1107, #1108, #1207). The 405 & 465 cam grinds are direct bolt-ins.
2. If using 1 piece pushrods which is highly recommend by FEULING - see FEULING #4087. Remove fuel tank, front head mount, exhaust, oil/water lines and engine rocker box top covers and rocker arms to access the pushrods. SEE TECH TIP PAGE 4
3. Remove lifters, cam cover, sprockets, cam chain, camplate and cam. Inspect pinion shaft for burrs, use scotch brite or fine grit sand paper to clean and assure smoothness of shaft. Pinion shaft OD to camplate bore has a recommended clearance of 0.0005" – 0.003". Feuling recommends a maximum of 0.004" crankshaft end play.

Feuling recommends inspecting crankshaft runout, ideal runout is at or below 0.003" but our warranty will cover up to 0.0045" combination of runout and bearing play, measure bearing play by lifting up on the tip of the pinion shaft.

FEULING CRANKSHAFT
RUNOUT MEASURING
TOOL #9014



FEULING INNER
CAM BEARING
#2080



4. Feuling highly recommends dropping the oil tank and performing a deep clean & flush on the oiling system to remove any & all debris. Required for our 2 year warranty policy – See warranty registration form on www.FeulingParts.com
5. Feuling recommends replacing the inner cam bearing with a full complement style see FEULING part #2080.

6. Wash, clean and inspect the new FEULING components.



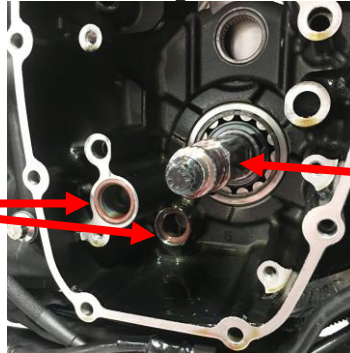
Camplates #8017 & 8037 have 8 black Allen head plugs installed around the profile



Oil pumps: 7018, 7019, 7020, 7021 Have 1 Allen head plug installed as well as the pressure relief valve/spring held in with a roll pin.

7. If installing a high lift cam, inspect camshaft for rotating clearance on engine case etc. Also verify correct valvespring to camshaft combination and clearance from coil bind. Feuling highly recommends Beehive valvespring kit #1107 or 1108 for cams up to .565" lift.
8. Install new O-rings into engine case using assemble lube on O-rings to aid in installation. Rotate crankshaft so flats are vertical

Install new O-rings and apply engine assembly lube



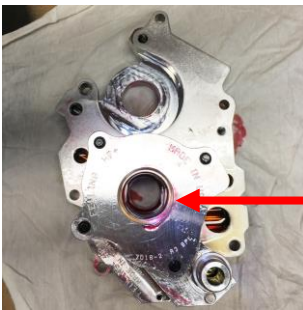
Install crank bolt then rotate crankshaft so flats are vertical

9. Use proper engine assemble lube on camplate, camshaft, crankshaft, inner cam bearing, oil pump, scavenge port hole/oil pump o-ring and lifters.



DO NOT USE LOCTITE ON OIL PUMP OR CAMPLATE BOLTS, use moly lube paste or assembly lube on bolt threads & underhead flange. Loctite will interfere with the stack up clearance of the oil pump & can cause sealing issues with camplate to engine case.

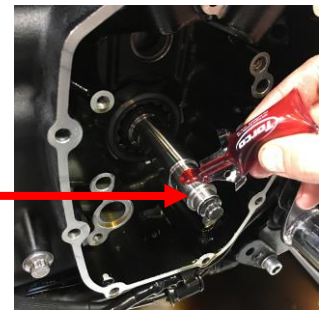
10. Rotate oil pump gears so gear flats are vertical to match the crankshaft per step 6. We found having the crank and gear flats vertical make for the easiest install of the oil pump and camplate assembly.



Rotate pump gears so flats are vertical to match crankshaft



Use assemble lube on camplate bore, thrusting surfaces, camshaft & pinionshaft



11. Feuling recommends installing the oil pump and camshaft into the camplate on the bench, fasten oil pump finger tight, align the oil pump gear flats with the crankshaft flats and slide complete assembly onto the crankshaft. Once the camplate assembly is in position we recommend pressing firmly on the oil pump with your left thumb or a finger to press back of oil pump into the scavenge port O-ring. **Feuling recommends this procedure so the components are always going in towards the crankshaft, this procedure produces the best seal on the oil pump scavenge port hole.**

NOTE: FEULING X ARP OPTIONAL BOLT KITS: OE+ CAMPLATES USE #8023 WHICH INCLUDE WASHERS FOR THE OIL PUMP BOLTS. HIGHFLOW CAMPLATES USE OPTIONAL ARP KIT #8022 WHICH DOES NOT USE OIL PUMP BOLT WASHERS.



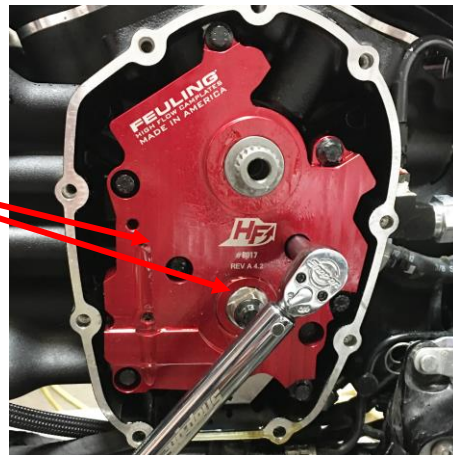
NOTE: DO NOT USE LOCTITE ON OIL PUMP OR CAMPLATE BOLTS, use moly lube paste or assembly lube on bolt threads & underhead flange

12. With the oil pump and camplate bolts finger tight rotate the engine over by hand, tighten and torque the camplate bolts first. Alternately tighten camplate bolts in a crisscross pattern and step torque from 40 in-lb, 80 in-lb then to a final 120 in-lb.
13. With the camplate torqued to 120 in-lbs now tighten and torque the oil pump bolts. Alternately tighten oil pump bolts in a crisscross pattern and step torque from 40 in-lb, 80 in-lb then to a final 120 in-lb.

*This process will center the camplate and oil pump as best as possible to the engine and crankshaft runout. We recommend re-checking the torque after 10-15 Min.

14. It is advisable to have clean fresh oil in the oil tank, and while rotating the engine over to center the oil pump and camplate, the system will start to prime and you should see oil coming out the tensioner feed hole and around the pinion shaft. This aids in initial start up oil psi.

With clean, fresh oil in the tank and a full oil filter, while rotating the engine to center oil pump & camplate the system will prime and you will see oil coming out tensioner feed hole and pinion bore



15. Install sprockets, lining up timing marks. Check sprocket alignment with a straight edge, use correct thrust washer thickness to achieve proper sprocket alignment. See Feuling #8041 for spacer thickness selection/options. Sprocket alignment is critical for wear and longevity of tensioner pad.
16. Install chain tensioner/housing by installing bottom bolt first then rotate top of tensioner to line up the top bolt, FEULING recommends doing this before installing pushrods and loading the cam to ensure slack in chain on the tensioner side.



17. Install lifters, pushrods and rocker arms, Feuling recommends using an oil squirt can to manually pump up the lifters, pushrods and rocker arms during assembly. This will aid in lubrication for initial start up and will provide a quiet engine with immediate oil psi.
18. It is recommended that you rotate the engine over with the lifter 'cuffs' finger tight to center the holders on the lifters before final torque



19. With engine on TDC of adjusting cylinder tighten the rocker arm shaft bolts evenly until they are seated with estimated 10 Ft. Lbs, then loosen the bolts or nuts to allow the shafts to settle in, then re-tighten evenly and step to final torque. If using Feuling stud/nut kit final torque is 24-26 Ft. Lbs. Wait estimated 15-20 minutes for the lifters to bleed down before rotating the engine to tighten the other cylinder rocker arms, when the lifters are bleed down the pushrods will spin/rotate by hand. Following this procedure will eliminate any chance of valve/piston interference during installation. Feuling recommends the installation of #3047 rocker arm studs and nuts to prevent cylinder head cracking. **For FEULING ROCKER STUDS/NUTS TECH TIP SEE NEXT PAGE.**

*FEULING Rocker Stud/Nut kit #3037 or complete lower rocker kit #3047 will reduce stress on the rocker arm head stand offs. The rocker arm 'stand offs' are a weak link and prone to cracking

20. New lifters are recommended by Feuling® but not required. See Feuling HP+® series lifters #4000 or RACE SERIES lifters #4017, RACE SERIES lifters have a slower bleed down and will operate quieter than factory HD® or HP+® lifters.

TECH TIP FOR USING 1 PIECE PUSHRODS WITH CAMSHAFT/OILING SYSTEM INSTALL:

- 1.) Remove gas tank, spark plug wires from plugs, left side spark plugs, fuel injector plug ins, compression release plug ins etc.
- 2.) Remove voltage regulator bracket bolts qty. 2
- 3.) Remove front top engine mount, from frame first then cylinder heads
- 4.) Remove exhaust
- 5.) Remove oil/water lines, use a small catch tray on top of trans cover, wad of rags in the front to catch oil/water
- 6.) Remove cam cover, rotate engine to timing marks
- 7.) Remove top rocker covers, rocker arms, pushrods, pushrod tubes, lifter covers



*FEULING Rocker Stud/Nut kit #3037 or complete lower rocker kit #3047 will reduce stress on the rocker arm head stand offs. The rocker arm 'stand offs' are a weak link and prone to cracking



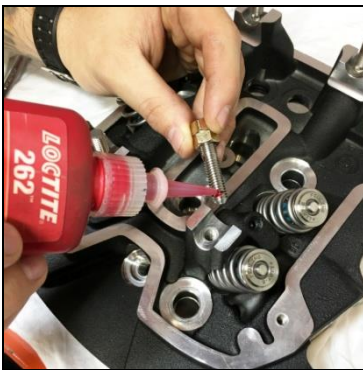
HELP PREVENT MILWAUKEE EIGHT CYLINDER HEAD CRACKING!

Use Feuling/ARP rocker arm shaft studs and nuts to help relieve stress on the Milwaukee Eight cylinder heads. The factory and SE cylinder heads have an extremely weak link with the rocker arm shaft standoffs. By using a stud some of the stress is transferred from the standoff casting into the stud. The use of higher lift camshafts and heavier valvesprings puts additional stress on the cylinder head making the use of our stud kit a must.

FEULING ROCKER STUD/NUT INSTALLATION:

1. Double nut the stud with qty. 2, 5/16-24 nuts, loctite the stud course threads and install into the cylinder head
2. Torque studs to 48-60 in-lbs (4-5 Ft. Lbs)
3. FEULING recommends filling the rockers with oil using an oil squirt can, fill from the pushrod seat until oil squirts out the exit oil holes.
4. Install rocker arms/shafts, Loctite the fine threads

NOTE: It is important to seat the rocker arm shafts by evenly tightening the nuts to estimated 10 Ft. Lbs. then loosening to allow the shafts to settle in, then re-tighten evenly and step the torque 5/10/15/20 Ft. Lbs. then to a final 24 – 26 Ft. Lbs



Loctite course threads



Install stud



Torque stud to 4-5 Ft. Lbs



Fill rocker arm with oil



Loctite fine threads



Evenly seat rocker arm to 10 Ft. Lbs
loosen to allow shaft to settle then evenly
step torque to final spec of 24-26 Ft. Lbs



OIL LEVEL - DO NOT OVERFILL OIL TANK

It is important to get the correct hot oil level in your bike. Feuling recommends running the oil level 90%-99% full when hot.

Note: The oil pick up port is on the right side of the engine. Letting the bike idle or warm up on the kickstand will naturally fill the engine case and skew the oil level in the tank.

We recommend the following steps to achieve proper oil level:

1. Check cold oil level.
2. Ride the bike until operating temperature is reached.
3. Shut the bike off while still in the upright position. (This insures an accurate reading)
4. Once the bike is on the kickstand check oil level.
5. Add or remove oil as needed

SUMPING:

- Oil level too high – see above
- Detonation, check tune, fuel, exhaust/intake leaks
- Blow by through rings and cylinders, perform a leakdown test
- 1/4 NPT sump plug screwed in too deep on bottom of engine case blocking pick up port
- Leaky piston cooling jet valves and or leaky cooling jet gaskets
- Oil type: If running synthetic try running conventional, we highly recommend the use of conventional oil in the M-Eight engine
- Oil pump sub seal O-ring damaged and or incorrect installation, install oil pump/camplate per our instructions
- Loctite was used on oil pump and camplate bolts, interfering with oil pump side clearances and camplate sealing to case
- Oil pump housing, cover or camplate face scored from debris running through it and or dry start up etc., excessive crank end play/runout
- Breather valves in rocker boxes not working correctly and or issue with O-ring seal inside head. **Note** the valves do not sit squarely on cylinder head thus cocking the valve and compromising the seal. The O-ring groove on the valve is too large for the O-ring, we recommend running an additional smaller O-ring on the top of the OE O-ring which can help hold the OE O-ring in position and assist in sealing. Use HD drain plug O-ring #11105 or a -012 to -013 O-ring.

PRESSURE ISSUE:

- Pressure relief valve in oil pump not seating and sealing
- Scoring in oil pump housing and or camplate face surface, possible dry start up, debris in oil and or excessive crankshaft end play and or crankshaft runout
- Low oil level
- Leaky piston cooling jet valves and or leaky cooling jet gaskets
- Loose camplate pinionshaft bore ID to crank pinionshaft OD clearance, we recommend 0.0005” – 0.003”
- Loose lifter to lifter bore clearance, we recommend 0.001” -0.0015” lifter to lifter bore clearance – See Feuling tool #9004
- Loose rockershaft to bushing clearance and or excessive side end play
- Out of spec pressure side of oil pump due to scoring
- Loctite was used on oil pump and camplate bolts interfering with oil pump side clearance stack up and or camplate sealing to case
- Broken oil pump gears, inspect for debris in oil, excessive end play and or crankshaft runout
- Stripped or loose camplate bolts causing camplate to leak

EXCESSIVE NOISE

- Low oil pressure
- Thrusting wear on rocker arm stand offs in cylinder heads
- Quick install pushrods flexing and creating valvetrain harmonics, possible pushrods contacting tubes
- Under performing lifters: Scored lifter internals, valvetrain harmonics, loose lifter to lifter bore clearance, we recommend 0.001” -0.0015” lifter to lifter bore clearance – See Feuling tool #9004
- Excessive crankshaft runout and or excessive crankshaft end play
- Valvetrain harmonics, bad valvespring to camshaft combination
- Flexing crankshaft
- Compensating assembly worn, compensating bolt not installed all the way

WARRANTY:

All parts are guaranteed to the original purchaser to be free of manufacturing defects in materials and workmanship for a period of twelve (12) months from the date of purchase. Merchandise that fails to conform to these conditions will be repaired or replaced at FOP's option if the parts are returned to FOP by the purchaser within the (12) month warranty period. In the event warranty service is required, the original purchaser must notify FOP of the problem immediately. Some problems may be rectified by a telephone call and need no further action. A part that is suspect of being defective must not be replaced without prior authorization from FOP. If it is deemed necessary for FOP to make an evaluation to determine whether the part was defective, it must be packaged properly to avoid further damage, and be returned prepaid to FOP with a copy of the original invoice of purchase and a detailed letter outlining the nature of the problem, how the part was used and the circumstances at the time of failure. After an evaluation has been made by FOP and the part was found to be defective, repair, replacement or refund will be granted. Excessive flywheel pinion shaft run out will damage camplate and oil pump and or cause engine damage and or failure. Damage to Feuling oil pump corporation products from excessive pinion shaft run out will void manufacturer's warranty.

ADDITIONAL WARRANTY NOTE

Feuling offers an additional 12 month warranty for a total of 2 years if product is installed by a professional V-Twin installer, oil tank is dropped and cleaned at time of install and the WARRANTY REGISTRATION form is filled out - form can be found on www.Feulingparts.com

ADDITIONAL WARRANTY PROVISIONS:

FOP shall have no obligation in the event an FOP part is modified by any other person or organization, or if another manufacturer's part is substituted for one provided by FOP. FOP shall have no obligation if an FOP part becomes defective in whole or in part as a result of improper installation, improper break-in or maintenance, improper use, abnormal operation, or any other misuse or mistreatment. FOP shall not be liable for any consequential or incidental damages resulting from the failure of an FOP part, the breach of any warranties, the failure to deliver, delay in delivery, delivery in non-conforming condition, or any other breach of contract or duty between FOP and the customer. The installation of parts may void or otherwise adversely affect your factory warranty. In addition, such installation and use may violate certain federal, state and local laws, rules and ordinances as well as other laws when used on motor vehicles operated on public highways, especially in states where pollution laws may apply. Always check with federal, state, and local laws before modifying your motorcycle. It is the sole and exclusive responsibility of the user to determine the suitability of the product for his/her use, and the user shall assume all legal, personal injury risk and liability and all other obligations, duties and risks associated therewith. Our high performance parts, engines and motorcycles are intended for experienced riders only. Feuling Oil Pump Corporation reserves the right to change prices and/or discounts without notice and to bill at the prevailing prices at the time of shipments. The words Harley®, Harley-Davidson® and H-D® and all H-D® part numbers and model designations are used in reference only. Feuling Oil Pump Corporation is in no way associated with, or authorized by Harley-Davidson Motor Co®. To manufacture and sell any of the engine parts described in this instruction sheet.