

Harley/S&S Engine Build

Part I: Assembling the kidney-shaped gearcase

THE MAJORITY OF TODAY'S MILWAUKEE-EIGHT AND Twin Cam mechanics have only worked on these two engine designs, though some have also spun wrenches on the Evolution (Evo). The Evo (1984-99), with its cone-shaped cam cover and single camshaft, has a very different single cam arrangement than a Milwaukee-Eight. In fact, the Evo's gearcase setup is the same as a 1970 and later cone cam cover Shovelhead, the engine before the Evo and

one even fewer present-day H-D mechanics have worked on. However, the engine design we're going to be working with in this engine build goes back even further into Harley-Davidson's past. We're dealing with an engine style only a few Milwaukee-Eight and Twin Cam wrenches have worked on. The main mechanics for these early engines are vintage bike builders, greybeards, and the current group of vintage chopper and bobber builders. This family of H-D engines is identified by its kidney shaped cam cover, which is found on 1966-69 (Flatside) Shovelheads, all Panheads and Knuckleheads, and flathead Big Twins. This distinctive cam cover and the similarly-shaped right crankcase enclose a series of gears that drive

the valvetrain, as well as the charging and ignition systems, as you'll see in the accompanying photos. These engines have a generator mounted on the right case, right in front of and

below the front cylinder. The 1970 cone Shovelheads and all later engines have an alternator mounted on the left crankcase inside the primary covers instead of a generator, which eliminated the need for an elongated gearcase compartment and its signature cover. As for the ignition system, we'll talk about that in Part II.

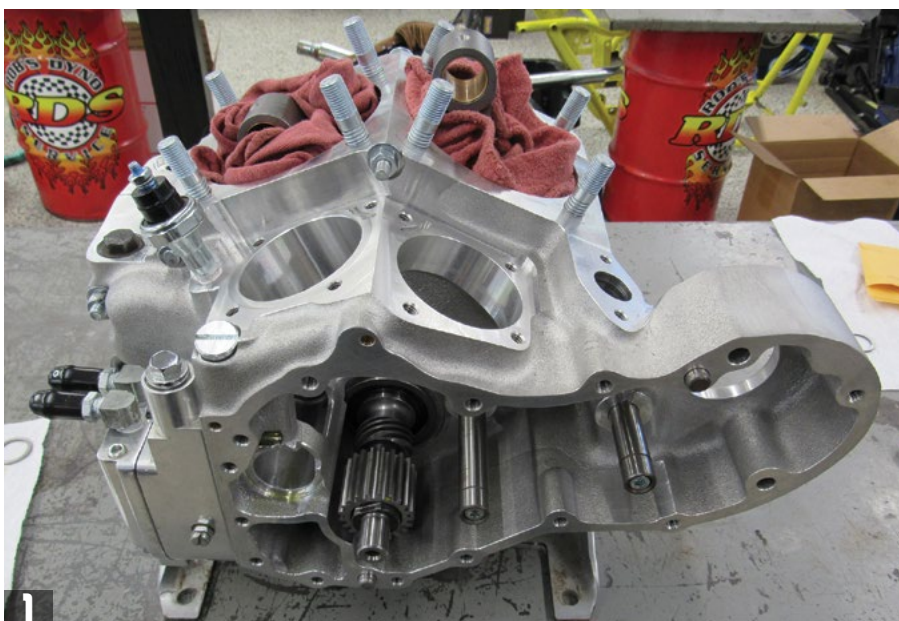
Though we're assembling an S&S P-Series motor, and not a Harley-Davidson early Shovel, Pan, etc., the process is basically the same for the gearcase section except for the clearance specifications. If you're rebuilding a H-D engine, having the correct year H-D service manual and parts catalog on hand will keep you from making expensive mistakes. To that same end, we've consulted the S&S service manual for this engine during our build.

As you'll see in the opening photo, an S&S billet oil pump and the pinion shaft gears are already installed on our lower end. We're starting this rebuild article at this point because, as stated earlier, reassembly for this style of S&S and Harley engine is basically the same when it comes to the gearcase section. If you want to see how we installed the pump and pinion gears, that article is in American Iron issue 376. And though a S&S pump is what our engine would come with from S&S, I recommend upgrading to the correct S&S pump when you rebuild your Harley engine. Unless, of course, you're installing the engine on a correct, stock machine, in which case the S&S pump would look out of place. In fact, if you want us to do an article on checking and installing an early Harley pump, let us know.

When it was time to pick a shop to do this reassembly and oil pump install, we went to see our buddies at Rob's Dyno Service. As longtime readers know, Rob and Dan have done the wrenching on many of our tech articles. These guys are great to work with and are excellent at what they do, be it spinning wrenches or dyno tuning bikes.

TOOLS NEEDED

- Clean rags
- Assembly lube
- Blue Loctite
- Black marker
- Magnets (2)
- 1/4" wrench
- 12-point 1/4" socket
- 3/16" Allen
- 3/8" Allen
- Flat feeler gauge
- Steel straight edge
- Torque wrench (in-lbs.)



1 Our opening shot shows our assembled crankcase with the balanced flywheel assembly, oil pump, and pinion shaft gears installed. Clean rags are in the cylinder spigots to keep out dirt and other debris.



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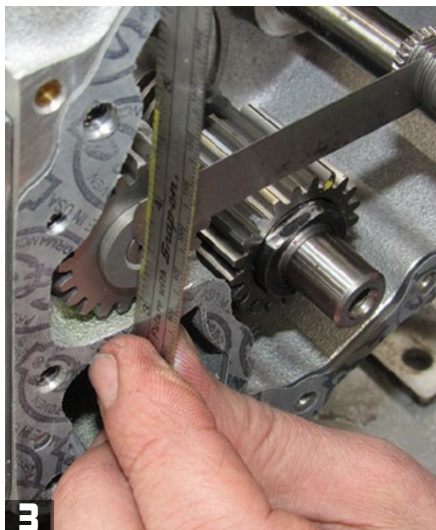
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2

After coating it with assembly lube, slip the S&S steel breather gear into its well in the right crankcase. Then position a new cam cover gasket on the case and a breather gear shim onto the breather gear.



3

Use a steel straightedge and flat feeler gauge to measure the gap between the shim and straight edge. Once you subtract the 0.006" that the gasket will compress, you need to have 0.005"-0.015" of clearance.



4

After lubing the circuit breaker drive gear and its shaft, slip the gear onto its shaft with its timing mark aligned with the one on the pinion gear. Two versions of this gear are available.



5

After lubing the idler (generator) gear (if you're running a generator) and its shaft, slip the gear, which doesn't have a timing mark, onto its shaft. Then position a shim onto both the idler and circuit breaker drive gear shafts.



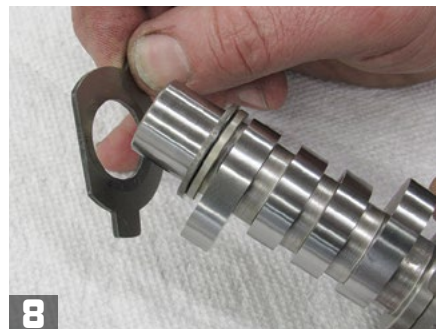
6

Use a steel straightedge and flat feeler gauge to measure the gap between the shim and straightedge on both gears. Once you subtract the 0.006" that the gasket will compress, 0.005"-0.015" of clearance is needed.



7

Slip a cam shim onto the inner end of the S&S camshaft.



8

Slip the thrust washer onto the inner end of the camshaft and against the shim. Then coat the cam lobes, shim, thrust washer, and inner end of cam with assembly lube. Also put some lube on the inner cam bearing's rollers.



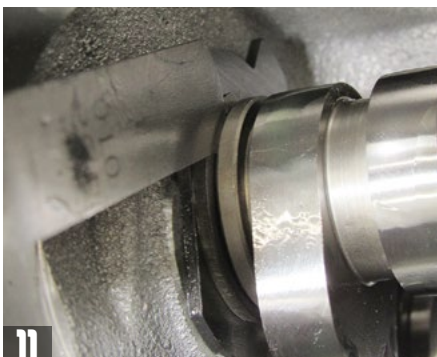
9

Install the cam, with the thrust washer's ears aimed down, with its timing marks aligned to the ones on the breather and pinion gears. We used a black marker to make the pinion gear timing lines easier to see.



10

The cam cover is installed using the 12 bolts and flat washers, blue Loctite, and a 3/16" Allen. Torque the bolts in a crisscross pattern to 90-120 in.-lbs.



11

Check the cam endplay and recheck the drive gears using a feeler gauge through the lifter holes and between the inner end of each one and the right case. If you don't have 0.005"-0.015", remove the cam cover and change the shim(s).



12

After pumping fresh motor oil into the S&S lifters and coating the outside of the lifters and the bores of the lifter blocks with fresh oil, slip the lifters into their S&S lifter blocks.

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13 With a new gasket on the case and with your fingers poking through the other lifter block hole, hold the lifters in place and set the assembly on the case. Install the other assembly with magnets holding the lifters.



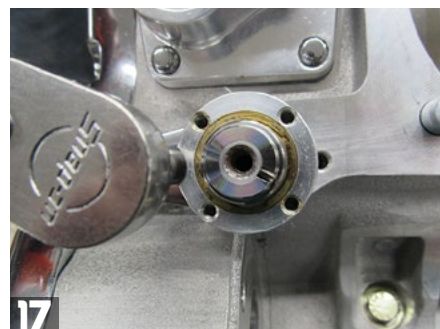
14 With some blue Loctite on the bolt threads, use a 12-point 1/4" socket and a lifter block alignment tool to secure both lifter assemblies to the right crankcase. Torque the bolts to 90-120 in.-lbs.



15 To time the ignition drive, remove the timing plug on the engine's left case using a 3/8" Allen. If your engine has an alternator, remove the rotor so the flywheels can be moved smoothly and not jump past the timing mark.



16 The ignition in our engine gets timed to the front cylinder's Top Dead Center mark (TDC), which on our engine is T:F, on the front piston's compression stroke.



17 With the flywheels and ignition module drive shaft positioned as per the S&S instructions, secure the drive shaft to the case using the S&S clamp and bolt, blue Loctite, and a 1/4" wrench. Only snug the bolt for now. **AIM**

TIPS & TRICKS

Thoroughly clean all used parts that you're going to install using a stiff bristle bottle brush. Check that all passageways in the cylinders, heads, and lifter blocks are clear and clean—no dirt, metal shavings, or packing material. However, don't wash the oil out of the lifters. Check that all used parts are still within useable specs. Also clean out all metal oil lines (if any are installed) and the oil tank/pan to remove any debris or metal from the old engine that would damage your new motor. Install new rubber or stainless steel braided oil lines, which have rubber hoses inside. Yours wouldn't be the first motor to get chewed up by the metal remains of the previous engine.

Place the new gaskets onto the crankcases, cylinders, heads, and rocker boxes to check that all oil passages line up. If you use the wrong gaskets, oil flow will be restricted and engine damage usually occurs.

If you're rebuilding a S&S engine, as we are, two circuit breaker drive gear versions are available from S&S, so be sure you're installing the one needed for your ignition system. The difference in the two drive gears is how they rotate the ignition system's drive shaft, either clockwise or counterclockwise. Which one you need depends on whether you're running an electronic (#33-4209) or mechanical points and condenser (#33-4215) ignition system.

S&S Cycle's SH-, P-, and KN-Series engines are available with a generator right crankcase and an alternator left crankcase. S&S calls them Alt/Gen engines. This configuration allows you to have a modern charging system hidden inside the primary system and run an electric starter while still having the kidney-style right side. S&S offers an oil filter setup that bolts where the generator would go. If your kidney-style S&S engine has an alternator, you must remove the rotor to time the ignition system. However, when pulling off or installing the rotor never get your fingers between the inner edge of the rotor and the crankcase. The rotor's magnets are very strong and pull the rotor against its stator. The rotor will definitely mess up your finger tips if they get caught between the rotor and case. Thread a couple of bolts about three turns into the two threaded holes in the rotor's outer face and use these bolts to control the rotor when moving it.

Resist the urge to fully assemble the ignition housing before installing the front cylinder and head. Stop once you've installed the drive shaft. We found out the hard way that you should install the front cylinder and head before bolting on the ignition housing's top section. With the ignition system fully installed, it's much harder to torque the head bolt right next to it. ■

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