Harley/S&S Engine Build

Part II: Installing the top end

In our last issue, we talked about how this family of early H-D engines, which consists of the 1966-69 (Flatside) Shovelheads, all Panheads and Knuckleheads, and flathead Big Twins, is identified by their distinctive kidney-shaped cam cover. This cover and the similarly shaped right crankcase are designed this way to enclose a series of gears that drive the charging and ignition systems. In Part I, we assembled this section, called the gearcase or cam chest, and talked a little about the engine's generator charging system. We also mentioned the option S&S offers on its Alt/Gen series of engines to run an alternator instead of a generator and yet retain the kidney-shaped right crankcase and cam cover arrangement. This time around, let's talk a bit about the early ignition system used.

TOOLS NEEDED

- Clean rags
- Blue Loctite
- High-temp black silicone
- High-temp copper sealant
- 3/32" Allen
- 9/64" Allen
- 5/32" Allen
- 1/4" Allen
- Flat feeler gauge
- Small flat-bladed screwdriver
- Flat-bladed screwdriver
- 1/4" open-end wrench
- 7/16" open-end wrench (2)
- 7/16" 12-point box wrench
- 3/8" deep socket
- 7/16" 12-point dog bone
- Piston ring compressor
- Torque wrench (in-lbs.)
- Torque wrench (ft-lbs.)

The early OEM engines have an ignition triggering device (circuit breaker) that some people refer to as a distributor, though that's not what it is. This ignition setup, which is mounted on the front corner of the right crankcase, must be manually timed to the flywheels. The circuit breaker has a set of mechanical points that are opened by a small rotating cam, which is connected to a shaft that goes into the gearcase where it's driven by one of the internal gears. As soon as the points open, the externally mounted single ignition coil sends high-voltage electricity to both spark plugs at the same time. Unlike the ignition found on Twin Cams and Milwaukee Eights, Harley-Davidson (for the most part) equipped its bikes with a dual-fire ignition system, where both spark plugs fire at the same time. This doesn't create a problem with engine performance, however, since only one cylinder at a time is on its compression stroke and has an air/fuel mixture to burn. The other cylinder is on its exhaust stroke, so there's nothing really there to ignite.

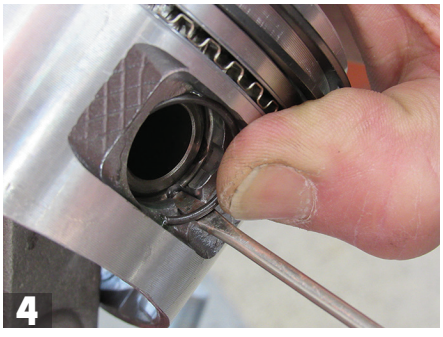
When the Shovelhead was re-engineered to have a cone-shaped cam cover in 1970, the circuit breaker assembly, which still consisted of a set of mechanical points, was moved into the outer end of the cone. Though the circuit breaker assembly is still controlled by a rotating cam, this cam is now connected directly to the outer end of the engine's single camshaft. The rest of the system, with both plugs firing via an externally mounted single ignition coil, still operates the same. Towards the end of the Shovel's production run, the mechanical setup was replaced with an early electronic system, which was triggered by a rotating disc attached to the camshaft instead of a cam. As it is on the Flatside Shovels and earlier engines, both the mechanical and electronic versions of the cone ignition triggering setup must be timed to the flywheel assembly manually. This same dual-fire setup was also used on the Evo, though the electronic ignition was improved multiple times during the Evo's production run. The arrival of the Twin Cam marked the end of dual-fired Big Twins and manually timed ignitions. The Twin Cam's Electronic Control Module (ECM) ignition is timed to the flywheel assembly via a crankcase sensor mounted on the front corner of the left crankcase, right next to the oil filter.

As stated earlier, we're going to be installing our engine's top end in this article. And, as it was for the gearcase

Since the lower end, gearcase section, and lifter assemblies are assembled and installed, we'll start the top-end installation by checking the piston ring gaps in their respective cylinders with a flat feeler gauge.

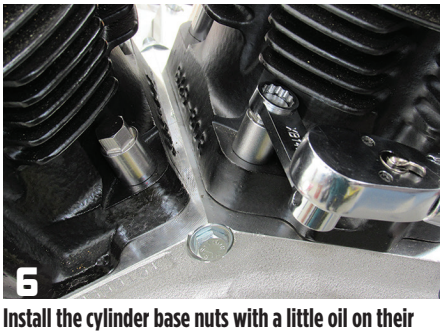
With the rings on their pistons, noting any dots or bevels, position the ring end gaps as per the S&S instructions, which are outlined in Tips & Tricks. If doing a H-D engine, check your piston manufacturer's instructions.

After popping in one of the new wrist pin clips, position the piston onto its rod orientated as per the S&S instructions or your piston manufacturer. Then slip in the wrist pin coated with fresh engine oil.

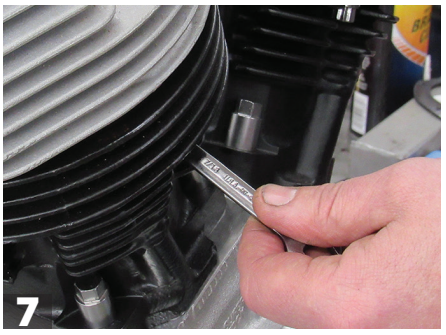


With clean rags in the cylinder spigots so nothing falls in, use a small flat-bladed screwdriver to work the other wrist pin clip into its groove in the piston. Be sure one of the clip's ends is next to the groove's gap.

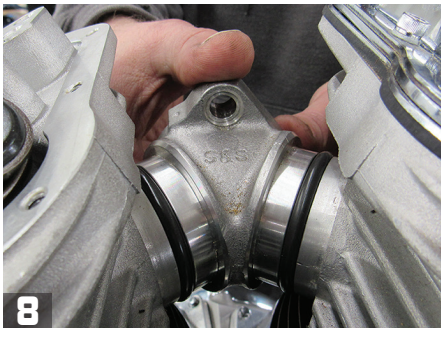
With new gaskets (align the oil holes!) on the cases and the ring compressor coated with oil, position the compressor over the rings. Then gently move the cylinder down over the piston making sure the rings go smoothly into the cylinder's bore.



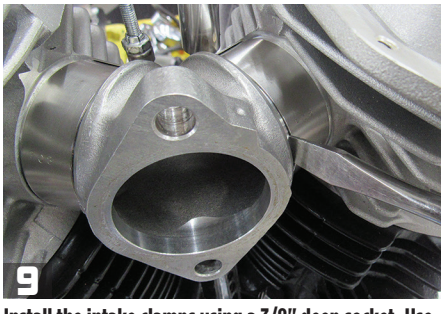
Install the cylinder base nuts with a little oil on their threads using a 7/16" dog bone extension. After you snug all the nuts down, torque them to 20 ft-lbs. and then 35-40 ft-lbs. in a crisscross pattern.



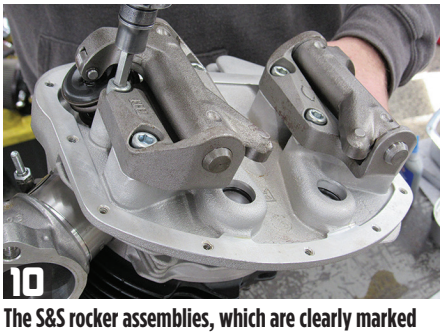
With new copper head gaskets (align the oil holes!) on the cylinders, install the heads using the head bolts and flat washers. Just thread the head bolts in until slightly loose for now using a 12-point 7/16" box wrench.



With the intake manifold between the heads, move the heads as needed so there's no gap between the intake ports and manifold. After you snug all the bolts in a star pattern so the heads won't move, roll the O-rings into their slots.



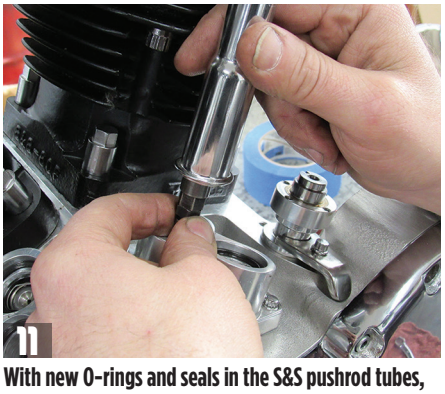
Install the intake clamps using a 3/8" deep socket. Use a flat-bladed screwdriver to keep the clamps centered on the manifold. Then torque the head bolts to spec in a star pattern using a 12-point 7/16" dog bone extension.



The S&S rocker assemblies, which are clearly marked either *FE-RI* or *FI-RE*, go in next. Install them using blue Loctite and a 1/4" Allen. Torque the S&S bolts to 15-18 ft-lbs. in a crisscross pattern.

section, 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 except for the clearance specifications. If you're rebuilding an H-D engine, having the correct year H-D service manual and parts catalog on hand will keep you from making expensive mistakes. We're doing the same with the S&S service manual for this engine. However, and this is a very big exception, when it comes to the rocker arm assemblies, this S&S arrangement is different from what you'll find on a stock Harley, no matter what year engine it is. During that part of the rebuild, you must refer to the proper manual for your year engine, or send the rockers and heads out to a pro and have him install the rockers onto the heads for you. If you're doing a Knucklehead, definitely send the parts to a pro. The H-D Knucklehead rocker arms and cover setup are difficult to get right. As for the rocker assemblies on S&S SH-, P-, and KN- Series engines, though they are similar, they are not the same, so be sure to consult the correct manual. S&S pushrods are the same in all these engines except for different lengths for different engine styles and displacements. Another important difference is whether a S&S Limiter kit is installed in the lifters (tappets), which changes how the pushrods are adjusted.

As stated in Part I, as well as the oil pump install for this engine, when it was time to pick a shop to do this reassembly we went to see our buddies at Rob's Dyno Service. Rob and Dan have done the wrenching on so many of our tech articles I've lost count! These guys are easy to work with, fun to hang with, and excellent at what they do, be it spinning wrenches or dyno tuning bikes.



With new O-rings and seals in the S&S pushrod tubes, heads, and lifter blocks, slip the S&S pushrods (short ones for the intake valves, long ones for the exhaust) into their tubes and position them on the engine.

When checking the piston ring end gaps, S&S wants 0.016"-0.024" for the compression rings and 0.015"-0.035" for the two oil rings. Don't alter the oil ring group's expander. Check your piston manufacturer's instructions for what your ring end gaps should be.

TIPS & TRICKS

When positioning the S&S cylinder base gasket onto the crankcases, the logos printed on the gasket must face the cylinder.

Position the ring-end gaps, with the front wheel of the bike acting as the 12 o'clock position, with top compression ring gap at 8 o'clock, and the second compression (middle) ring gap at 4 o'clock. The top oil ring gap is positioned at 10 o'clock and the bottom oil ring gap should be at 2 o'clock with the expander's gap at 12 o'clock. Check your piston manufacturer's instructions for where your ring end gaps should be.

When positioning the cylinder onto the piston, make sure the notch for the connecting rod is facing the other cylinder spigot. And, yes, there is a front and rear cylinder. The side of the cylinder with the fins shaped for the pushrod tubes goes on the right side of the engine. Noting this and the connecting rod notch will tell you which one is the front or rear jug.

When installing the cylinder base nuts, slip the front cylinder right front headbolt and rear cylinder right rear headbolt into their cylinder boltholes before the cylinder base nuts are installed since you may not be able to get them in afterwards. You'll need a 12-point 7/16" dog bone extension to torque the base nuts to spec. If you keep the dog bone at 90 degrees to the torque wrench as shown in photo 6, you won't have to use the torque conversion formula for using an extension. S&S wants you to torque the nuts to 20 ft-lbs. and then 35-40 ft-lbs. in a crisscross pattern. Check your manual for what Harley wants on your year engine.

If you're using copper head gaskets, as we are, put some high-temp copper gasket sealant on the cylinder's head gasket surfaces. Also put a drop of clean motor oil onto the headbolt threads and both sides of their washers, which go onto their bolts with the chamfer against the bolt head.

As it was for the cylinder base nuts, you'll need a 12-point 7/16" dog bone extension to torque the cylinder headbolts to spec. Just like with the cylinder nuts, keeping the dog bone at 90 degrees to the torque wrench eliminates the need to use extension torque conversion formula. S&S wants you to torque the bolts in a star pattern to 30 ft-lbs. and then 65 ft-lbs. Check your H-D manual for what Harley wants on your year engine.

The S&S rocker assemblies are clearly marked either *FE-RI*, which means that assembly can be used to operate the front exhaust or rear intake valve, or *FI-RE*, which designates it as an assembly that can be used to operate the front intake or rear exhaust valve.

When installing the rocker covers and D-rings onto their heads, the boltholes in the heads can strip out very easily, so be gentle and make sure you're not cross-threading the holes. Once all the bolts are started in their holes a couple of turns, bring all the bolts into light contact with the D-ring. Then work from the inner bolts out and tighten the bolts until the gasket just starts to bulge out from under the rocker cover. Do not overtighten these bolts! If you're working on a Harley engine, check your manual for what H-D wants on your year motor. ■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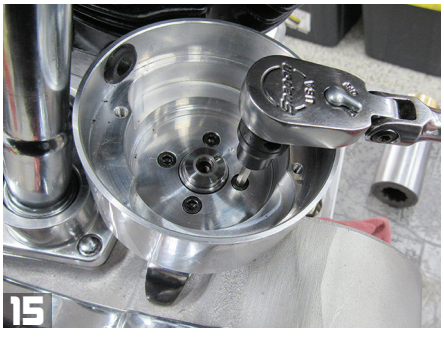
After coating both sides of the new S&S gasket with high-temp black silicone, use a 5/32" Allen, blue Loctite, and the S&S bolts and lock washers to install the covers and D-rings (shiny side up) onto their heads.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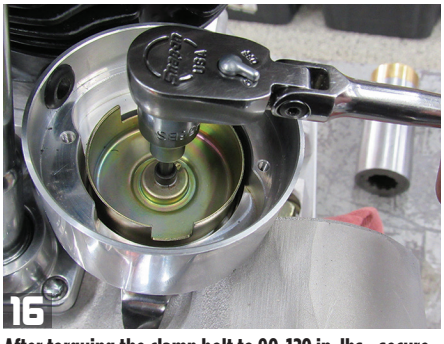
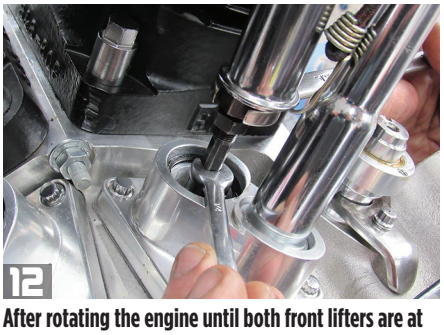
After setting the ignition module housing as per the S&S instructions or your stock setup as per H-D, secure the housing using a drop of blue Loctite on the bolts and a 9/64" Allen. Torque the bolts to 15-20 in-lbs.


16

After torquing the clamp bolt to 90-120 in-lbs., secure the timing cup to the drive shaft using the S&S bolt and lock washer, a drop of blue Loctite, and a 5/32" Allen. Torque the bolt to 15-20 in-lbs.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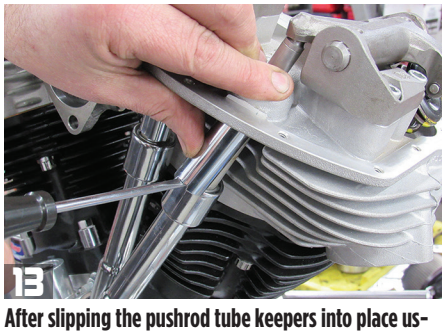
After rotating the engine until both front lifters are at their lowest points, adjust the pushrods using a 1/4" open-end wrench and two 7/16" open-end wrenches. Then wait for the lifters to bleed down.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After slipping the pushrod tube keepers into place using a flat-bladed screwdriver, watch the way the rocker assemblies work to ensure all is well as you rotate the engine to adjust the rear cylinder's pushrods.


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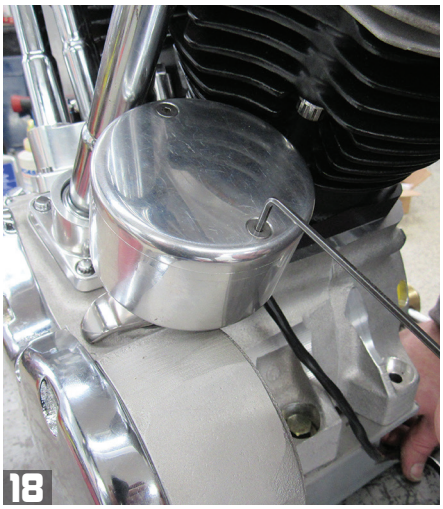
Position the ignition of your choice in the S&S ignition module housing, time it as per your ignition's instructions, and lock in that setting via the two standoffs (no Loctite!) and a flat-bladed screwdriver.



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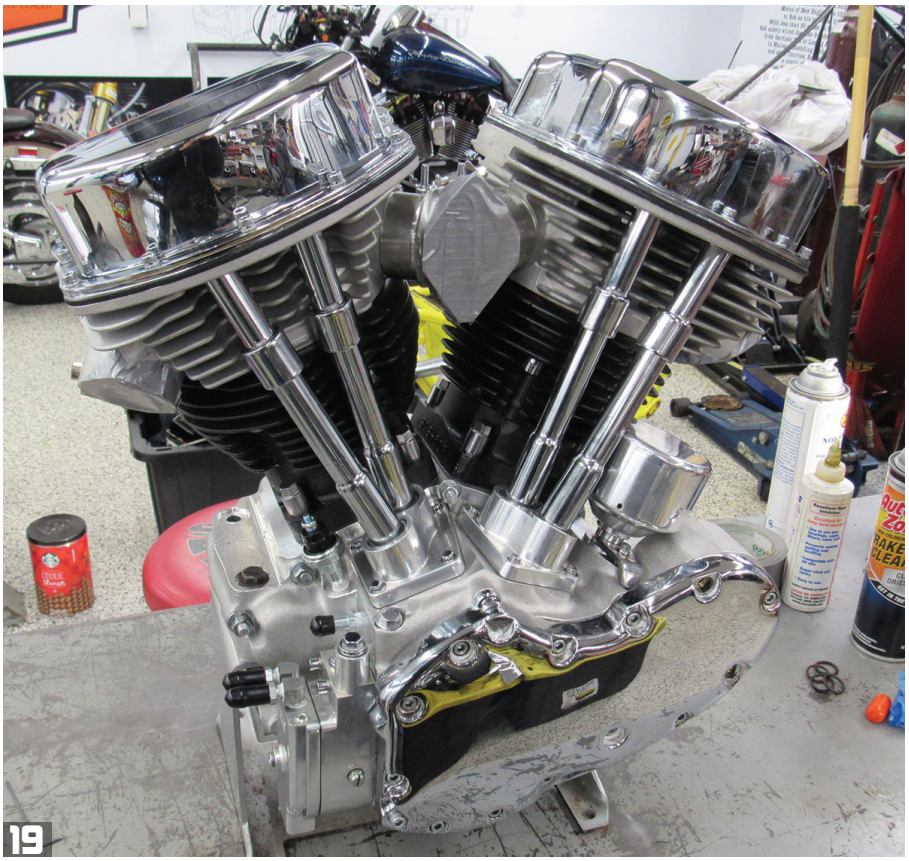
Install the S&S housing cover using the two supplied bolts, a drop of blue Loctite, and a 3/32" Allen. Torque bolt to 15-20 in-lbs.

SOURCES

Rob's Dyno Service
978/895-0441
RobsDyno.com

S&S Cycle Inc.
608/627-1497
SScycle.com



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Here's our finished engine! All that's needed now is a carb and air cleaner. **AIM**