Ring Seal

In this article, I would like to go over the importance of sealing in a performance engine. It goes without saying that if any of the sealing points are compromised; your power is going to suffer. I'll leave the valves (including guides and seals) up to experts in that area. Have your heads done by a company specializing in H-D performance- not the local auto parts shop. I will concentrate on our specialty: the rings, pistons, and cylinders.

Ring seal and its effect on engine output cannot be overstressed. The rings have two sealing responsibilities: the cylinder wall and the piston groove. We have seen power jump significantly by replacing the pistons and rings and restoring the bore integrity. Sometimes the pistons looked fine but the ring lands had been damaged during break-in due to heat; I'll give an example later that was particularly vivid.

Lets discuss the cylinder wall first. Ideally, the cylinder bore should be straight and round when in use. In use means stressed---HOT---and trying to make enough power to get you up that mountain or down that track.

Quality control checking is done in a temperature-controlled environment with a measured amount of mechanical stress applied to the cylinder. But in the real world, the cylinder body has large temperature variances- from top to bottom and front to back. Its stress load changes with temperature and power output, yet we ask it to remain stable. It is in the design and engineering stages that the stability has to be built in. Some cylinders, no matter how carefully machined, are just not designed well enough to stay straight in use. A cylinder bore that is out of round isn't desirable, but one that is tapered or wavy is much worse. As the piston travels up and down, the rings have to contract and expand to follow the bore. In certain rpm ranges, the ring loses its seal (with the bore) and blow-by occurs (ever have your breather puke on your leg?). Pistons that rock in the bore due to short skirts and sloppy running clearances also doom effective long-term sealing.

When we break in an engine we are asking the machined surfaces that contact each other to get "happy". Break in has been described as " the final machining process". For some areas of the engine that means very little material removal, just polishing. Other areas might use a cross hatch or "file" finish to help the two surfaces to get "happy". I believe the more out of round a bore is, the rougher the cross hatch has to be in order to mate up the parts before the hatch is worn down. Conversely, the straighter a cylinder bore is the less the required crosshatch. Same logic on rings---place your new rings individually into a round bore and hold up to a light. If you can see light between the rings and cylinder, go get another ring.

The ring also has to seal "to the groove" to prevent air and/or oil from going where we don't want it. The machining quality of the ring and piston must be very high. If not, the engine output will be mediocre and overall engine life will be short. If you want some gray hair, take a set of new rings and examine them under a microscope. What looked to be smooth to the naked eye is anything but!

The top ring has a terrible environment in which to do a hard job. It lives in the highest pressures and temperatures with the least amount of lubrication. It must seal both high and low pressure while carrying heat from the piston dome to the cylinder wall. It is sometimes pummeled by detonation or pre-ignition and rocked by piston to cylinder clearance. The modern ring does an amazing job when broken in properly, but that is the challenge.

Hastings Ring Company's engineers tell me that all rings will turn in the groove until properly seated. Until this happens, heat transfer is limited because the mating surfaces are small in area. This

raises the temperature levels in the areas in which the surfaces are mated; it's like evacuating a city across a drawbridge. If the ring temperature gets too high, the aluminum groove will be ruined by micro-welding. This is an exchange of a small amount of material from the piston groove to the ring. Once this happens, the engine is forever a mediocre player until the pistons and rings are replaced.

A Ring Seal Story to Beat All

A customer contracted us to build a XL engine soon after the Evo came out. I knew that 120 hp was possible, but promised him 115 to have a cushion to fall back on in case the donor engine wasn't real happy to start with. Anyway, we get the engine built and on the dyno. We were pretty familiar with the combination and in no time we were ready for a power run. This engine pulled clean up to 6500rpm, but the dyno said 102hp. No problem- put in more fuel. Next run nets 97hp. What the hell??? We must have gone the wrong way- lean it down. Dyno says 92 hp. I am amazed…. The engine sounded so good we figured it must be the dyno. So, out came the deadweights and we re-certified. Damn dyno was ok. Changed carbs, pipes, timing…nothing, the Evo is parked at 92hp. Friday night- lets quit.

When building this engine, one of my technicians had installed base gaskets which we normally don't use on Sportsters, and they were starting to push out a little. He came in on Saturday and pulled the cylinders off and went to sealer instead of the gaskets. He told me Monday that he also replaced the rear ring set because it felt spongy!?

I thought that description was pretty un-scientific, but what the hell--- his heart was in the right place. So off we go…. Warmed engine and oil and made a pull…. 92 damn hp!! I am astounded because the engine showed no visible ailments. I had the tech pull the top end off the engine and stared at everything…. It looked great!! I was wandering around muttering to myself and stumbled on to the rings that were removed over the weekend and examined them closely. They had a light speckling that was aluminum colored on the sides. I had never seen this before and finally called J-E to ask if they had.

YUP…you micro-welded the rings.

Never heard of such a thing, how does it happen??

"Early on in the break-in the rings got too hot- replace the pistons, they're shot." I could not believe it---the pistons looked new except for normal combustion on the top, how could they be the problem?

This time the new pistons and rings were installed with well-oiled grooves. Since we had not disturbed the bottom end we knew the timing was good so we went back to the old-school heat cycling that we hadn't used in years. This gentle ramping up of heat in the engine gives the rings more time to nest to the groove before real heat and pressure is seen. First run---stand on the gas----123hp!!!! I am both astounded and tickled because a valuable lesson was learned… I am pretty sure that if this had not happened on a controlled dyno, this lesson would have been lost. Without measurement, the discrepancy in horsepower would not have been known and highway miles would have polished off the speckles. I also now had an answer for another half-dozen mediocre engines that I had been in contact with!

The harsh truth behind this story is that there are unseen demons at work in your motor. If you want to get your old engine to really shine, rings may not be enough; replace those pistons!! And to avoid ruining the new ones, heat cycle your motor on break-in.