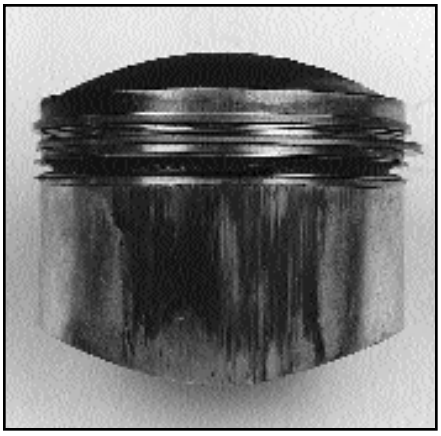
Proper Engine Break–in

When a discussion about engine life of the Harley engine occurs, the participants, directly or indirectly, are usually talking about how long the pistons survive. At S&S it is no different. Many of the performance kits we offer have engine life ratings based on how long we feel the pistons will last. It is for this reason that "proper engine break-in" is critical and be addressed, because without a good foundation the structure collapses.

The expression "proper engine break-in" is often misunderstood by many riders and enthusiasts. Misunderstanding what "proper engine break-in" means can lead to a variety of mechanical problems, the most common being "scuffed" or "galled" pistons. While defective parts are sometimes the culprit here, the trouble usually is traced directly to improper break-in. To clarify "proper engine break-in" and minimize damaged pistons, we must first look at a few important related elements. These are: piston fit, engine assembly, ignition timing, carburetion, and engine maintenance.



If proper engine break-in procedure is not followed with closely fit pistons, results can be disastrous, as evidenced by extreme skirt "gauling."

Piston Fit

Essentially, piston fit is the measurement, or clearance, between the piston skirt and cylinder walls that enclose it. The object for long piston/engine life is to fit the pistons to as tight a running clearance as possible which allows the pistons to function without generating excessive heat.

Basic piston design elements dictate what the running clearance range of a piston will be. Looser than minimum piston fits mean the pistons are free to move around in the cylinder bores more than usual. Tighter fits eliminate these extra movements. Less movement means reduced wear on the skirts and better piston ring life since the rings will have to work less to contain the upper portion of the piston during movement. S&S supplies two fitting ranges for each piston we sell. This is done to accommodate the many riders and riding applications.

Close fit - Fitting pistons to the minimum side of the clearance range requires accurate assembly procedures - careful measuring of the pistons and precision boring and honing of the cylinders for proper fit. Close fit pistons also require a careful break-in. The minimum side of the clearance range is recommended for the patient street rider who puts a lot of miles on his machine and wants the most out of each engine overhaul. Generally speaking, cast piston types offer the rider better longevity although numerous reports of excellent service from customers using S&S forged pistons have been received.

Loose fit - S&S "loose fit" specifications give the rider more break-in leeway as they allow him to run the engine at higher rpms sooner without generating significant amounts of extra heat. Less heat means the pistons will be less likely to "seize" in the cylinder bores with the resultant galling. The sacrifices that he makes are: less total miles because the clearance/wear established over many miles of operation is taken away right from the start, poorer piston ring seal and less overall ring life, and more piston noise because the pistons are free to move around more in the cylinders. Looser piston fits are recommended for the rider who desires a minimum of break-in time such as in racing applications. If a lot of racing is intended, the rule of thumb is used forged pistons because they are stronger.

As a last word, try to fit the pistons more towards the tight side rather than the loose side.

Engine Assembly

While lubrication is important for every motorcycle engine, newly-built motors usually require an extra supply of oil to reduce the friction and heat that occurs during break-in. This is because the "new" surfaces are actually rough. Eventually, after break-in, these surfaces wear smooth, which in turn reduces the amount of friction that causes excessive heat buildup inside a new engine.

To insure that the pistons get proper lubrication during the break-in process, the builder must put a crosshatch pattern of fine scratches on the cylinder walls. These tiny grooves act as oil troughs and are put in the cylinder walls by running a honing tool up and down the cylinder bore. S&S has found that a crosshatch pattern with a 60° angle tends to retain oil best.

Just as proper lubrication is important to piston life during initial break-in, proper piston alignment in the cylinder bore is a key factor that determines an engine's longevity. Correct alignment will assure a better ring seal and longer ring life and minimal thrusting on parts of the

piston where thrusting doesn't normally take place. Piston alignment should always be checked. Using a new set of connecting rods which the builder assumes to be straight will not always insure that the pistons will be properly aligned. It is sometimes necessary to "tweak" a new rod to compensate for slight crankcase and cylinder machining deficiencies. We strongly recommend following the rod alignment procedure outlined in our S&S stroker and Sidewinder kit instructions to ensure that the pistons are properly aligned in the cylinder bores.

Good general engine assembly procedures are a must too. Remember the old saying, "Cleanliness is next to Godliness?" An engine assembly is no exception. Many of the scratches found on pistons after disassembly result from dirt particles that were left in the engine during building. There is no substitute for a clean engine assembly. And for cleaning individual parts before assembly, nothing beats plain soap and water for removing dirt.

Ignition Timing

Excessive heat in a new engine will ultimately destroy the pistons if allowed to build up. Improper ignition timing can cause additional heat. During initial break-in of a new engine, be sure the engine is timed correctly. We recommend using factory stock ignition timing specifications at the start. Later, after the engine is broken in and heat has become less of a factor, you can experiment. The final ignition timing setting usually depends on the modifications done to the engine, the way the motorcycle will be used and the grade of gasoline available.

Carburetion

Another way to offset heat in a new engine is with slightly rich carburetor jetting. Richer mixtures burn cooler. Conversely, a carb with a lean mixture can destroy new pistons (as well as a few older ones), because lean jetting will cause the mixture in the combustion chamber to burn "hotter." If there is any question about the carb's fuel/air mixture, remember that it is better to jet slightly rich than too lean. The rich/lean question is especially critical for engines that are equipped with sophisticated high performance carburetors. Frequently these types of carbs, especially when installed on high performance, big inch H-D engines, have leaner jetting for optimum performance. If you have made some performance changes in your engine and intend to use the stock carb, always check the jetting. If you are going to use an aftermarket carburetor, find out what jetting is installed. Inform the carb manufacturer about your engine modifications, and then ask their recommendations about jetting. Ask if they have actually performed tests using their carburetors on engines similar to yours. Obviously, you don't want your newly assembled 96 cubic inch Evo Sidewinder to be their "guinea pig." A meticulously assembled engine, even with proper break-in procedures, will be ruined quickly with too lean a carburetor jetting. Be certain of your carb and its jetting so it won't be a problem during and after break-in.

Engine Maintenance

The first rule for proper engine maintenance is to use a good air cleaner that actually filters the air. It is amazing how much junk and foreign matter a non-filtered carburetor will suck in.

And to keep the engine's internal parts clean and well lubricated, use high quality motor oil and change it often. We have used Aero Shell (grade 100, 50 weight), Valvoline Racing oil (50 weight), and of course Harley oil, all with success in most of our S&S street engines. For Bonneville and drag racing, we use Torco racing oil. We recommend that you use what has been working well for you in the past.

In addition to high grade oil, engine longevity can be prolonged by changing oil on a regular basis. Many of our customers who change oil regularly (usually from 200 to 800 miles between changes) report terrific engine/piston life. If cost is a factor, we recommend that you at least change the oil after the first 100 miles of new engine break-in. After that, try and change oil every 1000 or so miles.

Gasoline octane rating is critical to an engine's life and peak performance too. As a rule, low octane fuel as well as old or bad gasoline burns poorly causing heat and detonation. Continual detonation will quickly damage the pistons, rings, and even the cylinder heads. Your safest bet is to burn the highest octane gasoline that you can.

Now, let's get back to the "proper engine break-in."

The purpose of engine break-in is to establish the overall piston, ring and cylinder wear patterns without causing damage to any of these parts. This "break-in" usually takes from 50 to 2000 miles, depending on the engine and how it was built.

For a better understanding about engine break-in, we should examine what really happens inside the cylinders during the break-in period.

As the piston travels up and down within the cylinder bore, friction generated from the new piston rings on the freshly bored cylinder walls causes the edges of the rings to get extremely hot. This process is necessary to properly "seat" the rings, pistons and cylinder wall mating surfaces. If they get too hot, they begin to wear excessively and prevent the seating process from

taking place. The result is hot combustion gases blow by the rings down the piston skirts. As this "blow-by" increases, the pistons, piston rings and the surrounding cylinder walls get hotter and hotter. The heat literally burns and dries the oil film on the cylinder walls faster than the lubrication system can replenish it. The key word here is heat, because if it continues unchecked, scuffing occurs between the cylinder walls and the piston skirts. As the piston skirts get hotter, the piston begins to expand causing more friction and more heat. This vicious circle continues until the piston gets too large for the cylinder bore; the piston skirts begin to melt and stick to the cylinder walls; the skirts become galled and the pistons seize in the cylinders. Destruction of a piston can literally take place in seconds.

Scuffed pistons due to extreme heat can normally be avoided by running the engine at various speeds during the break-in period, rather than maintaining a constant rpm. By gently increasing and decreasing engine rpm, heat buildup between the pistons and cylinder walls becomes more tolerable as oil is replenished to reduce friction and cool the mating surfaces. Be sure that the time of acceleration is not too long. Several short bursts are adequate to generate enough heat to assure proper piston ring seating while not harming the engine.

It is also important not to lug the engine. Lugging an engine means putting the engine under an extremely stressful load. A common way to lug an engine is to operate it at an extremely low rpm while the transmission is in a higher gear (for instance, leaving the transmission in fourth gear when it should be in second or third where engine speed is better matched to transmission speed). Lugging causes extreme stress between the rear thrust faces of each piston and the cylinder walls. Small bits of piston skirt can break away causing the rear surface to scuff. The best prevention for lugging an engine (either old or new) is to downshift to a lower gear where the engine runs more freely, and the transmission assists the engine in delivering peak power to the rear wheel.

Well, that should do it. To summarize what we've talked about, here is the sequence we recommend for "proper engine break-in":

1. Fit the pistons on the tight side of the recommended fitting range.
2. Use good general engine assembly habits, keeping in mind the earlier points we discussed, including ignition timing, carburetion and maintenance.
3. On initial engine startup, don't just sit and idle the motor while you admire your work or tinker with minor adjustments. Heat buildup at this point can be excessive.
4. The first 50 miles are the most critical for new rings and piston break-in. Most engine damage will initially occur during this period. Remember that if proper ring seating does not take place, the resultant blow-by will set the stage for possible future damage because there won't be sufficient oil on the cylinder walls for proper lubrication. So keep the heat down by not exceeding 2500 rpm. And vary the speed.
5. The next 500 miles should be spent running the engine no faster than 3500 rpm or about 50-55 mph. Do not lug the engine and continue to vary the speed.
6. Up to 1000 miles, the speed can be run up to 60 to 70. Continue to run the engine at different speeds including the lower 40-45 mph ranges. When the 1000 mile mark is reached, most Evolution engines should be broken in. Evolution engines tend to run slightly cooler, and therefore do not require as long a break-in period as earlier engines using iron cylinders.
7. From 1000 to 2000 miles basically use the same procedures as before, but you can be a little more liberal with the rpm range. Avoid overheating the engine and putting any hard strain on it (drag racing, trailer towing, sidecar operation).
8. 2000 miles and up, have fun!

Just remember, while our recommendations sound good and normally work, there is no cook book formula for proper engine break-in. Common sense and knowing what is really happening inside those cylinders are the best tools for break-in.

We at S&S realize that after riding a stocker, a Sidewinder or Stroker feels very strong and the temptation to "turn it on" is overwhelming, even hard to resist. If this urge to run the engine hard overcomes you before engine break-in is completed, extensive engine damage can result. The obvious way to help prevent sticking the pistons is to give them a loose fit which naturally will detract somewhat from piston life and quiet running. This may be the best route to follow for those riders who want to go fast immediately. Keep in mind though, even loosely fit pistons should be allowed at least 50 to 100 miles of break-in for ring seating purposes. And, pistons and rings fit in this manner will have to be changed more frequently.

Happy motoring.