The Bottom End

As I mentioned right in the beginning of this book, the top of the piston is a part of the combustion chamber, and those high compression lumps on the top of your pistons can add to, or detract from, the complete combustion of fuel inducted into the engine. They may retard flame travel after ignition and upset complete cylinder scavenging during the exhaust cycle. On the intake stroke, the dome can restrict the critical initial fuel flow and then disrupt final mixture homogenization before ignition.

To improve fuel flow into the cylinder at low valve lift, the intake valve pocket must be laid back to reduce valve shrouding . As the initial flow is along the floor of the port and around the short radius toward the squish area of the head, this modification will assist in cylinder filling. Many tuners worry about removing metal from the piston dome because of the slight drop in compression ratio; however the improved flow and better combustion will far exceed the slight power losses due to the drop in compression ratio.

After ignition, we want the flame to travel smoothly across the piston dome and back toward the squish area. Any abrupt edge on the compression lump will disrupt the flame front as it moves across the piston, leaving pockets of mixture that are either unburned or only partially ignited. Rounding and smoothing the top and sides of the dome does much to reduce this problem.

The exhaust valve cutout must not be laid back as this is usually not advantageous. The sharpness of the exhaust valve pocket does cause some flame disruption but exhaust flow and cylinder scavenging is usually superior when the exhaust valve is shrouded by the cutout.

After the engine has been run for some time, a careful study should be made of piston dome Coloration. This is surprisingly accurate means of investigating combustion completeness Keep in mind that combustion begins before the piston reaches TDC and continues well past TDC. If at any time something happens to cause the flame to stop, the piston colour will indicate where the dome is causing the flame to stop.

All motors with bathtub or wedge chamber heads will show an area of no carbon buildup on both the piston and cylinder head. This is in the squish (or quench) area where no combustion takes place due to the closeness of the fiat face of the head and piston. Are other areas on the piston dome where there is little or no carbon buildup likewise indicate that the dome is coming too close to the combustion chamber and this is retarding the ignition flame at and around TDC.

The approach is to lightly machine the compression domes until the carbon buildup up is more even in quantity and colour. Because the flame moves from the spark plug out across the combustion chamber you will need to keep in mind the direction of flame travel when you come to remove any metal from the dome. Generally, it will not be necessary t machine the entire uncolored area as it is usually the area immediately in front of an around the beginning of the uncolored area, relative to the direction of flame travel, when the dome is coming too close to the combustion chamber wall and creating a pocket c unburned fuel. The place of least flame activity is usually around the high side of the piston dome in the area of the intake valve cutout, close to the cylinder wall. If you cal modify the dome to colour evenly in this area, you are well on the way to achieving goo. combustion.

Engines that are to be supercharged or turbocharger may require a low compression ratio to avoid detonation. To achieve this, dished top pistons should be used for best combustion control. Some feel that flat top pistons that have a lower than standard compression height for use with stroker cranks can be used, but this is not so. If a flat top piston were used with a deck clearance of, say, 0. 150 in to reduce the compression ratio to 7:1, then the top of the piston would be so far away from the squish area of the head that combustion would be upset due to lack of squish. A dished top piston has a flat band around the outside of the crown that will come into close contact with the head and provide the required squish for good burning.

The piston pin is retained by a variety of means in the production engine, the most common being by either an interference press fit in the connecting rod, or by flat circlips. I circlips are used, they should be coated with Loctite. Ensure that the circlip grooves are clean and undamaged so that each circlip can seat securely. The interference press fit (0.0015 - 0.0025 in) is suitable for racing engines, but care must be taken to assemble and remove the piston from the rod without causing any piston damage.

As racing engine speeds are now moving past 8000 rpm, many engine builders are experiencing problems with circlips (either fiat or round wire). At very high rpm they may close up, due to the forces exerted on them, and drop out of the piston into the bore. To overcome this it is necessary to employ another means of pin retention. Some have reverted to the old method of pinch-bolts but generally I prefer to use Spirolox or in extreme instances an interference press fit. '

The fit of the pin in the piston exercises more control over piston dimension than i~ often appreciated. The additional clearance given a piston by cam grinding is nullified if the piston is unable to expand correctly due to a tight pin. The pin clearance (pin to piston and pin to rod) in the high performance and racing engine must be greater to compensate for too tight, piston to cylinder scuffing or seizure may result. In extreme instances the pin will push the side out of the piston.

For most engines I set pin to rod clearance at 0.0008 - 0.0015 in and pin to piston clearance a little tighter at 0.0005 -0.0008 in. This will alleviate any binding between rod and pin or between pin and piston that could lead to piston damage. However, no matter how free the pin is, any con rod misalignment could wreck the piston, so have the rods checked to ensure that they are not bent, twisted or offset.

The piston ring, as it slides up and down the cylinder wall, has to function like a bearing, and as well it has to seal off the combustion chamber to keep the gases from escaping past the piston into the crankcase. Most engines use either two or three rings per piston.

The first or top ring is called the compression ring. Its purpose is to contain the combustion pressure so that maximum power can be obtained. This ring also has the burden of dissipating most of the piston crown heat (about 80%) to the cylinder wall.

Some racing engines do not use a second compression ring, but if yours does, it has the task of backing up the top ring in sealing off the combustion charge. Additionally, the second ring may support the oil ring in scraping excess oil off the cylinder wall.

The bottom ring is the oil scraper or oil control ring. Its job is to scrape oil from the cylinder wall, and ensure that enough oil remains behind to lubricate the upper rings and assist in sealing.

Let's take a closer look to see what goes on when the compression ring seals off the combustion chamber. Many feel that it is the ring's inherent radial tension that holds it against the cylinder wall. Radial tension does help, but it is gas pressure behind the back of the ring that forces the ring face against the wall.

There is a detrimental phenomenon that may occur in a high rpm engine to reduce the ring's sealing ability. This is ring float or flutter. As the piston approaches TDC it is slowed down by the connecting rod, but the rings try to keep on moving and if they have enough weight they will leave contact with the lower side of their grooves and bang into the top of the groove. When this happens, the ring seals off the gas pressure in the combustion chamber so that the gas cannot get behind the back of the ring and force it against the bore wall. Any gas pressure that may have been behind the ring quickly leaks into the crankcase and combustion pressure forces the ring to collapse inwardly. Immediately the ring breaks contact with the bore wall, the combustion gases blow-by into the crankcase.

Radial tension in the ring is unable to prevent blow-by caused by ring flutter. However a certain degree of radial tension is necessary for good sealing, otherwise the pressure at the back of the ring would only be equal to the pressure trying to force the ring off the cylinder wall. This would allow blow-by and it is this type we normally see occurring when the rings are old and have lost their tension.

Ring flutter allows blow-by but it can also wreck engines. When the ring loses contact with the bore wall it is unable to transfer heat from the piston to the water jacket. The end result can be melted pistons or severe detonation, due to increased combustion temperature.

The wider a ring for a given radial depth, the lower the speed at which this effect commences. This is one reason why thin rings are used in racing engines. Assuming the radial depth is 1/26th of the bore diameter, the maximum allowable acceleration for a ring l/16 thick

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