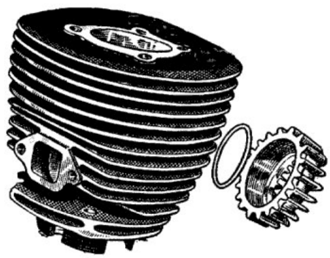
5 Pistons and Cylinders



Villiers 9E iron barrel

Pistons are many and various, but watch out for changes in the ring peg positions as some less sporting types may place the pegs into the larger ports of a tuned cylinder. The original circlips used to retain the gudgeon pin are adequate for normal usage but have a tendency to break at the eyelet holes during continuous high speed, and should be replaced with ordinary wire circlips. The circlip grooves being recut to a half round profile to suit. To further prevent mishaps the ears of the wire clips are cut off after fitment. If the Seegar clips are to be retained they should be replaced each time the gudgeon pin is refitted, and positioned so that the sharp edge is facing the cylinder wall. Actually this is true of all circlips, they have a rounded side and a flat or sharp side, and it is the sharp side that faces the direction of movement to be resisted.

During its lifetime the Villiers engine was fitted with a large variety of pistons that sported an even larger variety of rings. Originally they were manufactured with thick rings, which became progressively thinner as power outputs and rpm increased. With its single ring the high domed Omega piston is without doubt the best available for a sporting or racing 197. The 197 range of Omega and TKM pistons, which have large transfer cutaways, are available in steps of 10 thou, up to a maximum of 1.75 mm over the standard 59 mm bore. Having a high silicone content, these pistons can be run with a low skirt clearance, 3 thou for the Omega or 1.5 to 2 thou for the TKM variety, this applies to well cooled alloy barrels. For cast iron barrels the clearances should be doubled. To eradicate gudgeon pin problems these pistons feature larger circlips, which stay in their grooves even under racing conditions.

Many 250 pistons are still available, from the original Villiers with the fat rings and single peg, through the thin ring types with two equi-spaced pegs, to the Dykes ring racing types. The gudgeon pin supplied with these pistons has a large diameter hole through the centre, and is not really suitable for racing as they have a history of breaking under stress, and should be replaced with one that has a smaller diameter hole, which should be sealed as discussed earlier. By modern standards the gudgeon pin looks very thin at 0.5 in, and can be replaced by a cut down Greeves Oulton 16 mm pin, a tactic used by Brian Woolley on 250 Silverstones to alleviate the problem of the phosphor bronze bushes moving in the piston. Gudgeon pins for the 9E are not without their problems, and in the early nineties a batch were produced that were too hard and fractured under racing use. Nametab

Engineering are producing some forged racing pistons which have worked successfully at the IOM Manx GP, no test is more severe than this.

Clearances

Piston and ring clearances are critical if the engine is to run correctly in the normal or competition role. Modern pistons are not round or cylindrical when cold, they are wider at the bottom and thinner across the gudgeon pin holes (see Fig 20). When hot, the piston is hottest at the top and front, it changes shape - but so does the cylinder. To counteract this a specific amount of cold piston skirt clearance is given, depending on the job in hand. On a modern liquid cooled motor, that suffers less cylinder/piston distortion than our air cooled type, a skirt clearance of 1.0 to 1.5 thou can be used, but this would be a disaster on a 9E, resulting in frequent seizures. A clearance of 5.0 thou is specified for a standard tune motor, which should be increased to 6.0 thou for racing. The reason for such a large amount of clearance is the heat which distorts both the piston and cylinder. Modern cylinders liners are not uniform in their construction but are thicker in certain places and thinner in others according to the heat profile of that cylinder, which equals out the distortion, this ensures that the heat retention and transfer to the casting is controlled and distortion minimised. The Villiers cylinder was not manufactured with this idea in mind.

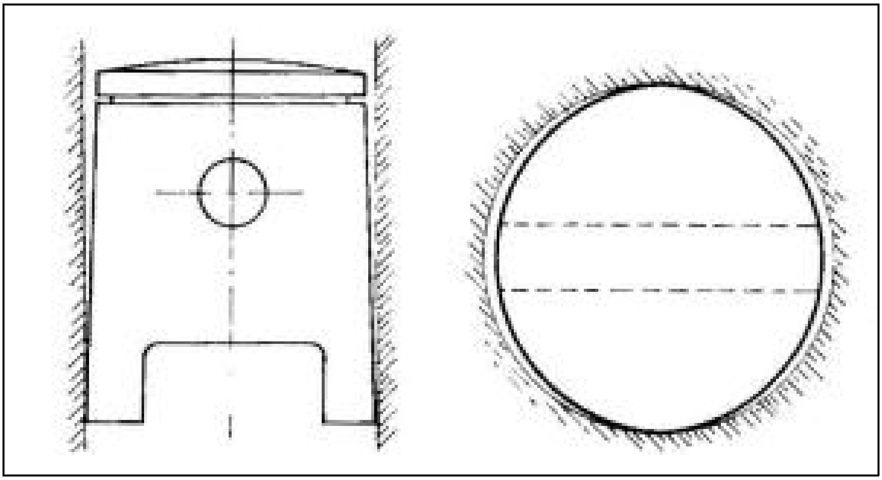


Figure 20 Piston shape

Piston rings also demand a specific clearance to ensure that they do not nip up in the cylinder when hot. Don't be tempted to fit a new set of rings without first gapping them. Always check the rings in the bore, the gap being 0.5% of the bore diameter. The gap specified by the makers is 8 to 12 thou, with a maximum clearance of 30 thou. Another critical clearance is the ring clearance in the piston groove. Given as 4 to 6 thou this clearance should not be exceeded or damage will occur, and it must not be confused with the dreaded "ring flutter". The bigger the gap, the harder the rings will hit the groove faces, resulting in wear which means even bigger gaps and even more wear. This will eventually result in compression loss and ring breakage.

Ring flutter

To understand the piston ring flutter phenomenon we must discuss piston speed and acceleration, which are related to conrod length and stroke. While the trend today is for square or over square motors, there is much to commend the older long stroke two stroke, as they are able to utilise a more compact expansion chamber design which makes for more efficient combustion and lower thermal loading on the piston, and the smaller bore in relation to swept volume presents a smaller piston crown to absorb heat. The long stroke engine usually concedes to the short stroke design because of the short strokes ability to rev much more freely.

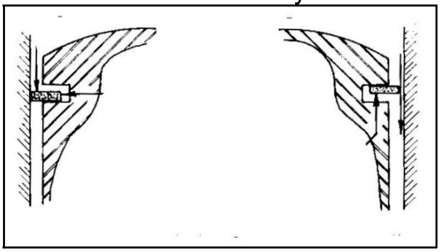


Figure 21 Ring OK (left) and flutter (right)

The biggest problem in crank train design is piston acceleration and the effect it has on piston rings. It is often thought (without due consideration) that the ring seals against the bore by virtue of its spring pressure. With a combustion pressure of over 700 psi it would easily over come the ring spring pressure. It is the gas pressure on top of the ring which pushes the ring hard down to the bottom of the groove, and it is this pressure on the inside of the ring which pushes it out to the cylinder wall. At very high accelerations the inertia forces lift the ring off the bottom of the groove which allows gasses to get under the bottom face of the ring (see Fig 21). Now that there is no differential pressure sealing the ring, the full force of the combustion gases burst past the ring on both sides. This is all over in an instant and at the bottom of the stroke if not before, normality will be restored. The short blast of high pressure high temperature gasses have heated the skirt of the piston and burned away the oil film that was lubricating the piston, a situation which obviously favours a seizure. The initial research was done by Paul Dykes (of Dykes ring fame) who determined that thinner rings are less susceptible to flutter than the fatter rings. Based on his research he designed an "L" shaped ring which could never suffer from flutter.

The onset of ring flutter is determined from ring width and the maximum piston acceleration during its cycle. The old rule of thumb gives :