Lilac LS-18/1 Engine Lubrication Improvements to the One-Piece Crankcase Motor

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While this paper addresses the /1 one-piece motor, some of the information contained is appropriate for other 250-300cc V-twins, in particular the LS-18/2, LS-18/3, LS-38, MF-19 and MF-39.

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The pages are 8.25 x 11 inches and are meant to be readily printable on either US Letter or A4 paper.

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Although I am by no means a Lilac expert, I do know of the sad reputation which Lilac LS-18s have earned regarding their reliability. One of the main flaws appears to be the design of the lubrication system. It appears that the system delivers inadequate oil to the big end bearings, as they seem to fail with remarkable regularity.

As a mechanical engineer with experience in the automotive industry, I have looked into this problem and come up with my own solutions to some of them. These solutions are by no means guaranteed, but are just one person's attempt of addressing the shortcomings of a 1950s engine design which appears to be designed, at least in part, by an accountant rather than an engineer (a cheap shot at accountants, sworn mortal enemies of engineers everywhere!).

Figure 1

Figure 1 shows typical big end damage found on an LS-18/1. Note the twin grooves made by the double row of 5 x 5 rollers on the crank. I have discussed the wisdom of employing this double row arrangement with a number of engine designers. The theory behind this arrangement is that the rollers will not run over the oil hole, thus avoiding stressing the edge of the hole, which could result in fatigue failure. The resulting flakes of metal would then damage the bearing, and like a pot hole in the road, the damage will gradually get worse and worse until the entire bearing fails. The disadvantage is that the available load bearing area is significantly reduced. The consensus it that, although the practice is sound in high speed, highly-stressed engines, an engine with a compression ratio of 7.8:1 and a maximum speed of around 7,000 rpm is not going to stress things up that much. High performance four strokes with built-up cranks and much higher specific outputs (*e.g.* the Suzuki GS series, to cite one example I am familiar with) run full-length rollers without problems.

So, recommendation number 1: If rebuilding the crank, or even if you have one that hasn't failed yet (buy a lottery ticket!) replace the 5 x 5 rollers with 5 x 10s. The bearing area will be significantly increased, and so will the life of your big end.

The oil path to the aforementioned questionable big end is another area of concern. From the oil pump (an item which appears to be undersized for its task) the flow splits into two paths. One path travels to the rear of the crankcase, up to a gallery between the cylinders, where it feeds the cam followers and rocker gear (more on this later). The second path travels up to the front main bearing, through a tiny relief in the bearing housing and then into a sealed (well, sort of) area between the bearing and the timing gear. From here it makes its way through a spacer and into the crank.

Figure 2

Figure 2 shows the standard passage between the bearing and its housing (note, a magnifying glass, or better still an electron beam microscope, may be required to see the passage). The passage is so tiny that at best the oil flow would be miniscule. In the early sixties, before multigrade oils with detergent properties were available, a cold start would have seen no oil coming through here, and the slightest buildup of sludge would have blocked it off for good.

Figure 3

Figure 3 shows a modified housing with the passage somewhat larger. This was done with a hand-held Dremel (engraver) fitted with a small grinding wheel. A better job would be done on a milling machine using an end mill.

Figure 4

The next step is to turn our attention to the bearing retainer/face seal. This has a slight depression for the oil to pass through. My initial thoughts were to enlarge this passage and leave it at that. ***Figure 4*** shows before and after pictures. I was concerned, however, that the seal material had taken on the flexibility and suppleness of glass, a result of old material technology combined with age (40 years is a long time for an oil seal). I could not trust the old seal to do its job, so I looked into another solution.

The initial push was to replicate the face seal with a new housing and an o-ring. The catalogues gave the maximum speed of an o-ring in this application as 4,000 rpm. Discussions with other engineers pointed to a cast iron ring contacting the timing gear, backed up with a stationary o-ring providing the seal ring loading and crevice sealing. This was starting to look complicated. I then looked into finding a lip seal to do the job.

I found a single lip, non-spring-loaded seal only 4mm thick, made by INA. This was ideal. My first design employed a 38 x 48 x 4 seal, sealing on the spacer ring between the bearing and the timing gear. The ring is 38mm diameter, and so would only require to be polished on the outer surface for the seal to run on. This design has two problems: Firstly, the seal must be installed backwards to avoid the lip running over the cutouts in the spacer. This results in oil pressure lifting the lip, rather than assisting it to seal. Secondly, the bearing inner is about 38mm diameter, and so the oil has very little space to squeeze through between the seal and the ring. I used a bearing which was sealed both sides and removed the seal from one side. The inner ring of the bearing is reduced in diameter where the seal ran, and so, fortuitously, extra clearance was available for the oil to pass.

Figure 5 shows the seal assembled on to the spacer ring.

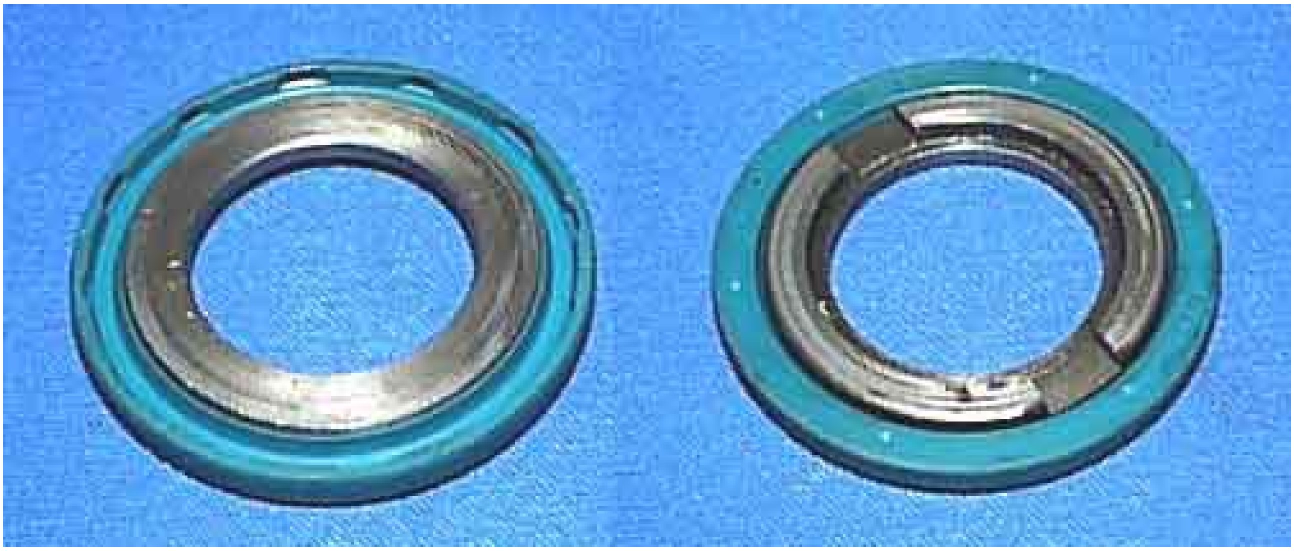

Figure 5

The main problem I felt was the reversed seal, which would probably work satisfactorily, but was just 'not the done thing'. If all I had was a small lathe in my garage, or had to pay to get these modifications done, I would probably use this design as the seal housing could be very easily turned up and the existing timing gear spacer used. Remember that the other side of the chamber is sealed by the lip seal of a sealed bearing, which is very fine and has no rated pressure-sealing capacity. Also, the original face seal was designed 'wrong', in that oil pressure also lifted the seal, rather than assisting it.

Design revision 2 used a 45 x 55 x 4 seal. A new spacer ring was designed to allow the seal to be fitted the correct way around. Oil can flow into the bearing race area, then through the spacer and to the crank drilling.

Figure 6 shows the finished seal assembly. Note the large cutouts for oil to flow into the crank, and the fact that the seal is installed the 'correct' way around.

Figure 6

Figure 7 shows the assembly installed on the motor.

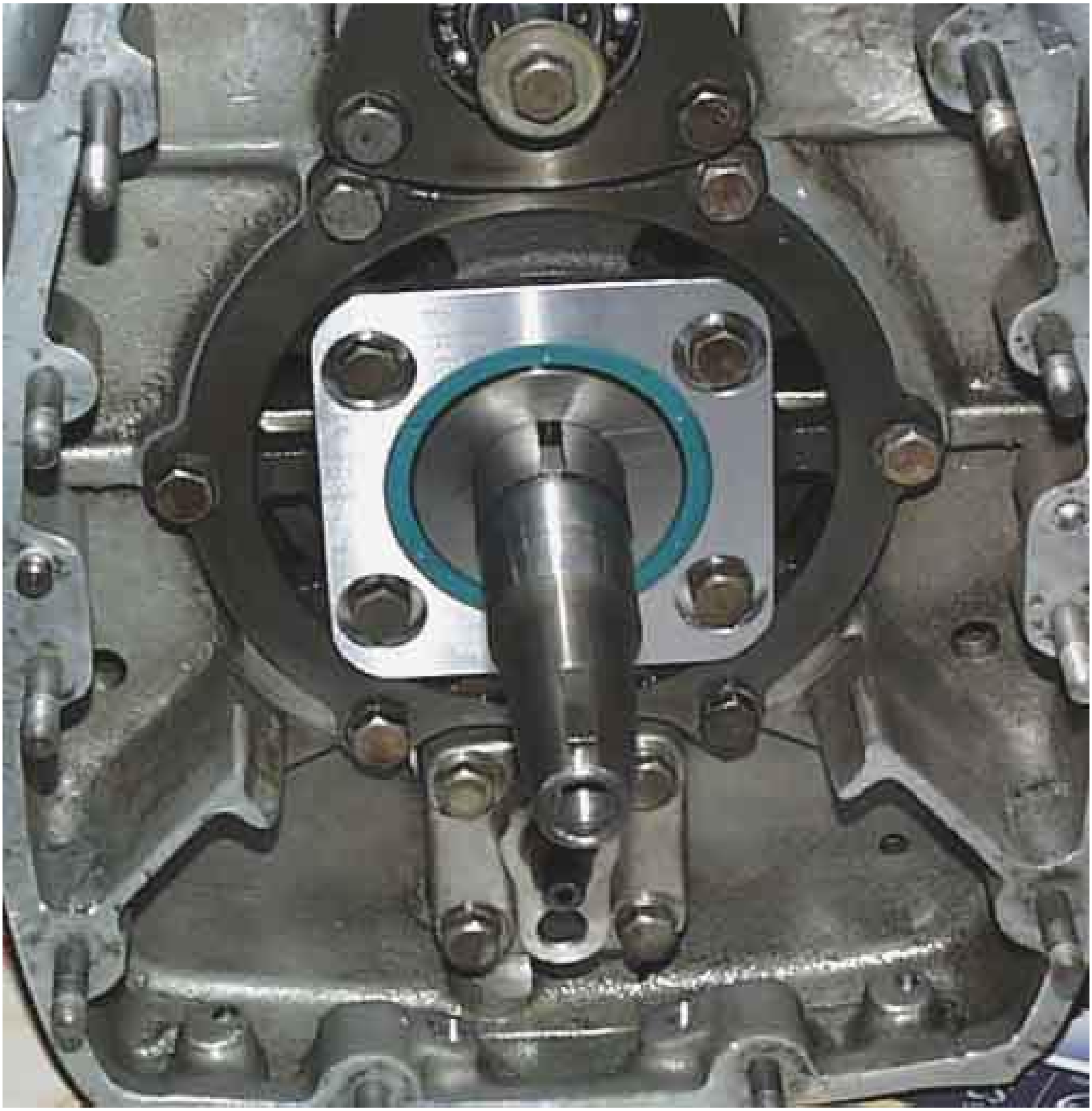

Figure 7

Another area of concern to me is the lubrication of the valve and rocker gear. Most pushrod engines flow oil into the cam follower, up through a hollow pushrod, then into the rocker and, via drillings in the rocker, to the rocker shaft. The LS-18 flows oil up the OUTSIDE of the pushrod, in the pushrod tube, and then it is supposed to splash around in the rocker box, in the slim hope that some may miraculously find its way into the tiny drillings in the rocker to allow some lubrication for the rocker shafts. Although not too badly damaged, all my Lilac engines show some signs of picking up or galling of the rocker shafts. A quick and easy modification I made was to put large countersinks in the rocker oil holes to try and funnel a little more oil into the shaft. In my opinion it can only help.

Figure 8 shows the modified rockers.

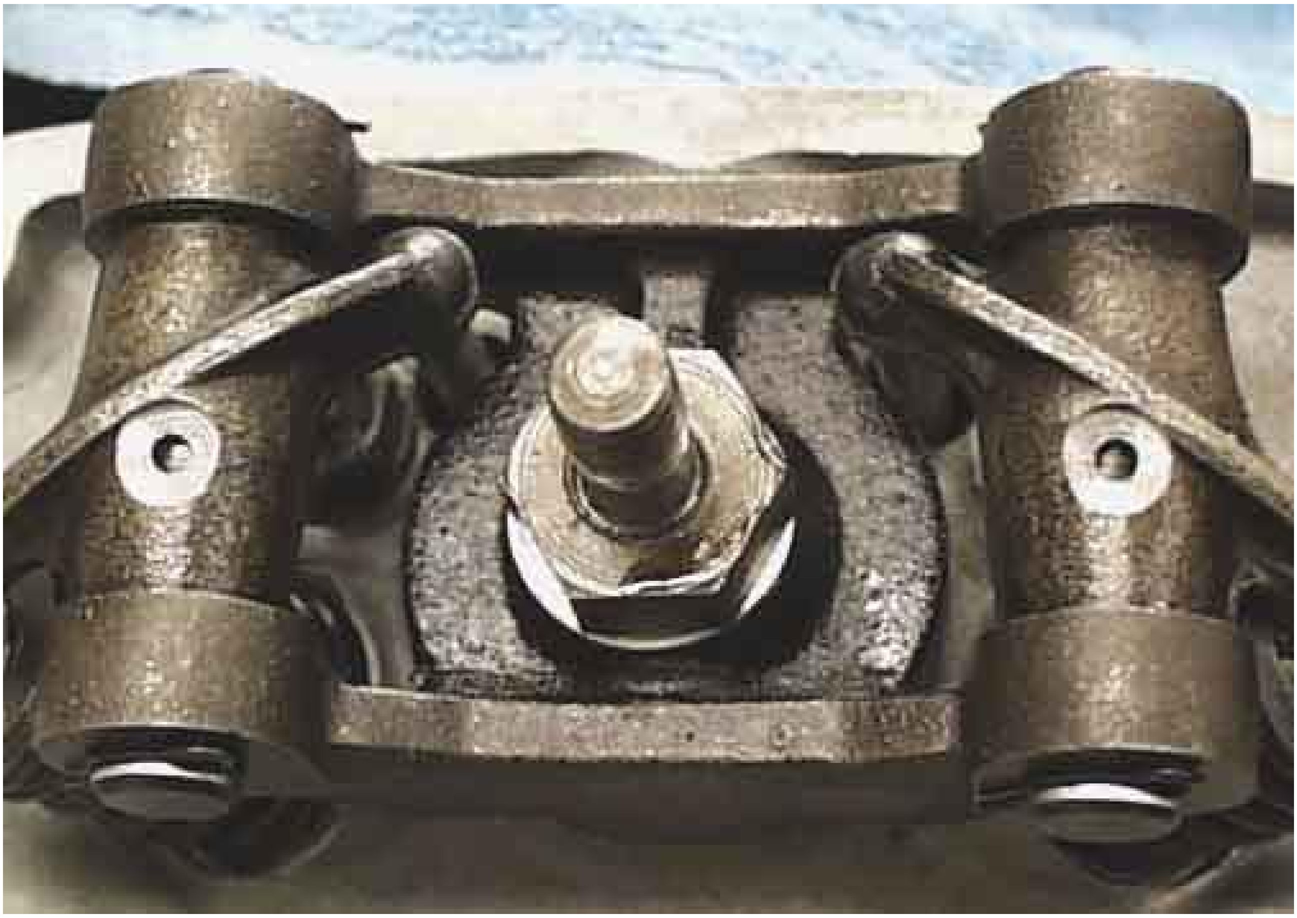

Figure 8

As of the time of writing, the engine rebuild is not complete, and so the success or otherwise of these modifications is unknown. Stay tuned for updates!