Camshaft Endfloat Mod GS550 – GS1100
(2 valve engines)

Ian Grant (49er) June 2007 (v 2)

I wish to acknowledge the insight I have gained from the many threads and posts covering this subject, by past and present members of the GS Resources.
One long standing member, Tom ("tomcat24551") encouraged me to produce this document and had a major influence on it's final shape. Brian ("bwringer") and Mike-the flying banana ("tfb"), both offered suggestions and were also involved with moderation of the original version. My work colleague, Glen Fowler also deserves a special mention. I bounced ideas off Glen when I first decided to attempt this fix. He even did some machining for me. Thank you all.

The History

Since the early days of the GSR, it has been obvious that most of the 2 valve, GS engines are prone to a top end engine knock. As their mileages increase, so does the noise level. In most reports, this phenomenon appears at idle, after engines have reached normal running temperature. It is not present when they are started from cold, nor when they have been ridden hard. The noise also disappears when they are revved above 1500rpm.

Some owners contend that the noise is caused by a loose cam chain or malfunctioning cam chain tensioner. Others speculate that it is caused by excessive camshaft endfloat. Long time GS owners all agree that the knocks are insidious but that they do not lead to engine failure. Some owners have reported experiencing these knocks in their engine for over 20 years.

I checked the GSR old Q&A section and found many posts on this subject.
One by Tom Sayles (Nov 98), was answered by Malcolm Evans advising that the excessive end float problem could be fixed with specialised machining, which would cost around $1000. This figure obviously cooled the notion of a cheap fix for many owners at the time. The problem has re-surfaced over the ensuing years. I decided to investigate the phenomenon to see if I could devise a cheap fix. I was motivated by the desire to remedy the problem on my own GS850GN.

The Investigation

Whilst dismantling the top end of my engine, I conducted a thorough examination of the cam chain, cam chain idler, cam chain guides, cam chain tensioner, cam chain drive sprockets, both camshafts, camshaft bearings and their thrust surfaces.

It was obvious that a number of scenarios were possible as a cause of the knock.

The cam chain idler showed signs of wear on one side of the sprocket and also the bearing support pivot. The idler housing on the 850's are made of pressed steel, with the sprocket and bearing being held in place by a solid rivet. The axial alignment in relation to the camshafts is very difficult to confirm, as the idler housing almost completely surrounds the gear when mounted in place. I found some wear on the rivet which would have caused the idler sprocket to be slightly misaligned to the camshaft sprockets. This misalignment would have caused some loading on the camshaft sprockets, which may have caused the camshafts to float under certain conditions. However, I don't believe that this was the main culprit.

The cam chain was original and after 77,000kms displayed little visible wear. The automatic cam chain tensioner appeared to be working satisfactorily. The tensioner guide (on the intake side), had heavy wear grooves on the chain contact surface and pieces of rubber were missing in places. This guide had been under load for a prolonged period. The leading chain guide (exhaust side) had little sign of wear.

Once the head was removed, I completely dismantled it for a visual examination. I found minimal wear in the valve bucket bores, valve stems, guides and seats. I checked the camshaft bearings, especially in the thrust surface area. I could see signs of wear on both inlet and exhaust cam bearings, from contact with the camshaft thrust rings. I mounted the cams in their bearings, without the caps fitted and proceeded to slide them back and forth making contact with both thrust rings. The knocks that followed mirrored the sounds I had heard at idle. The magnitude was slightly less, but it would have been greater when the cam covers were in place.
I felt sure that I had identified the source of the knock.

While the cams were in place, I checked the sprockets for alignment with a straight edge. They were true. I then rotated the cams and checked for runout. True again.

I did a visual check for cam lobe position in relation to the corresponding valve bucket centers. Both cams had one lobe positioned off center. One exhaust cam lobe was 2.5mm off center. I believe that Suzuki's error here is probably the major cause of the endfloat knock we experience. The corresponding cam lobe was slightly tapered, possibly caused by the center misalignment and camshaft deflection at higher revs.

Examination of the cam bearings (including mating caps), revealed that the bearings had worn slightly oval. The bearing ovality was greatest on the sides that faced the idler assembly and on a horizontal plane to it. I deduced that considerable load was being placed on the idler/cam sprockets through incorrect cam chain tension, under certain running conditions.

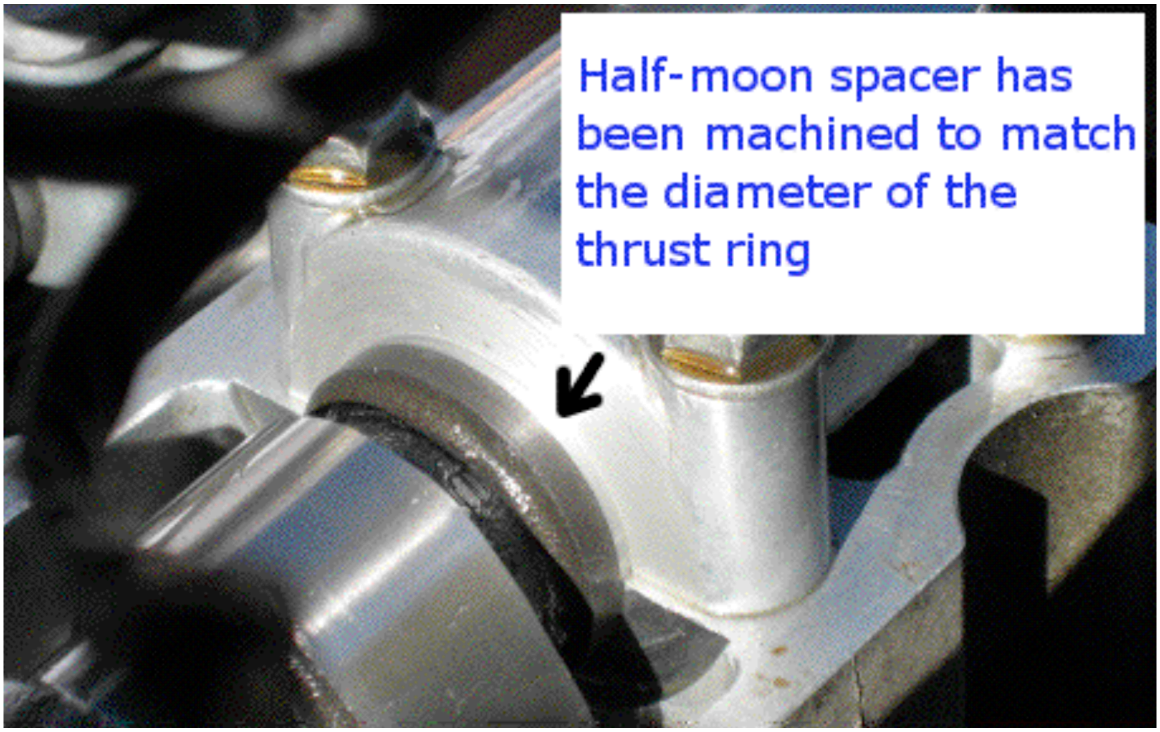
The endfloat is controlled by the bearing end faces making contact with the cam thrust rings adjacent to the bearing surface on the head only. The cap ends are about 1 to 1.5mm short of the trust rings. Each camshaft is mounted in two bearings, the thrust in each direction is controlled by one bearing each.

I measured the gap between the thrust rings and the bearing thrust faces. The inlet cam thrust clearance was 0.005 in, the exhaust was 0.006 in. I calculated that the stock clearances should have been 0.0015 in for each camshaft.

How can the endfloat be reduced and controlled, without costly specialty welding and machining?
Repair welding of the existing thrust faces would cause distortion to the head and cam bearings. It would require some very precise and expensive machining (milling and line boring). Also, the head would need re-surfacing. Not the ideal solution.
Machining a recess deeper into the head's 4 existing bearing thrust faces and making up half-moon spacers that reduced the thrust clearances to the desired figure would require precise machining, with very difficult access. This would be time consuming and quite expensive.

The Solution

Change the thrust control from the bearing faces on the head to the adjacent area on the caps. Would the caps be sturdy enough to take the load? I thought so, as each cap is diagonally dowelled and secured to the head by four 6mm high tensile bolts.



This photo shows a half-moon spacer controlling the endfloat through the bearing cap.

I completed this modification during my recent engine rebuild and the engine has now been running quietly for 3000kms. I believe that the spacers will eventually wear, but replacements can be machined and fitted cheaply without the need for the removal of the head or cams. My engine has since been pushed to and beyond it's redline, with no signs of cam bearing failure.

Endfloat modification Guidelines

This set of instructions is offered as a guide to assist machinists to repeat the modifications I did to control excessive camshaft endfloat on my GS 850. It can also be used by members to present to a machine shop as a means of explaining the work that they require to be done. It is not intended as a step-by-step DIY article.

It is recommended that a record of clearances and spacer specifications be kept so that replacements can be machined at a later date.

The Modification

The endfloat control modifications should be tackled in the following sequence.

- Measure the existing camshaft endfloat for both cams.
- Face off bearing surfaces on the caps at the thrust end.
- Machine half-moon recesses into the 4 camshaft bearing caps.
- Measure the individual thrust spacers required for both camshafts.
- Machine half-moon aluminium thrust spacers for the 4 bearing caps.
- Confirm the new endfloat clearances.

Materials required

- 100mm length of 28.5mm (1 1/8") OD free machining aluminium rod
- 200mm length of 24 mm OD free machining steel rod. (for 22mm doweling)
- Short length of 10mm OD free machining steel rod. (for two 6.4mm dowels)
- 600-1200 grit wet and dry paper.
- Two 6x50mm bolts, nuts and four flat washers.

Tools and equipment required

- Metric or Imperial feeler gauges
- Dial Gauge - Dial Test Indicator (DTI)
- Vernier or Micrometer
- Boring bar
- HSS cutting tools
- Tungsten carbide tipped parting tool
- Lathe fitted with a three jaw chuck

Measuring existing camshaft endfloat

1. Remove the head from the engine and dismantle the buckets and valves.
2. Wipe any excess oil off the camshaft journals, bearings and thrust rings.
3. Mount both camshafts in their bearings, leaving the caps off.
4. Slide each camshaft sideways until one of the thrust rings contacts the side of the adjacent bearing.
5. Use a set of feeler gauges to measure the endfloat between the thrust rings and the bearing thrust surface at the other end of each camshaft. Record these figures. Now slide the camshafts in the other direction, lightly against the adjacent thrust

rings and re-measure. The same feeler should slide neatly into these gaps as well. This will confirm the accuracy of your original measurements.

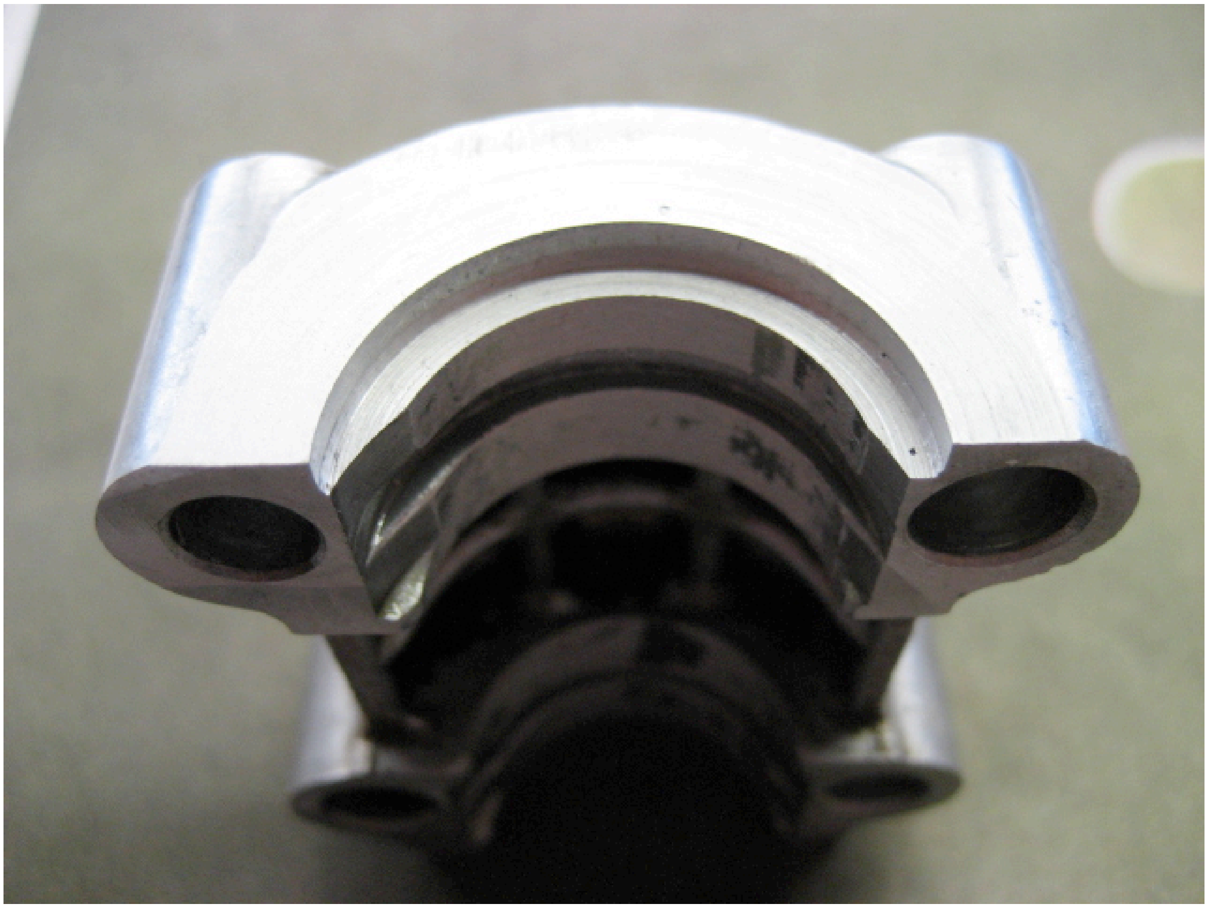
6. Record the measurement of each camshaft's endfloat, so you can refer to it later.

An alternative method is to mount a DTI adjacent to the head.

1. Slide each camshaft against the thrust bearing and set the stylus against the thrust ring.
2. Zero the indicator
3. Slide each camshaft back towards the other thrust face until it lightly makes contact.
4. Read the indicator, this is your total endfloat.
5. Slide each camshaft back to the first thrust surface and read the indicator again. It should have returned to zero, confirming the accuracy of your initial measurement.
6. Record the measurement of each camshaft's endfloat, so you can refer to it later.

Machining recesses into bearing caps

1. Clean all bearing caps, matching them to their thrust faces in pairs, A&B, C&D.
2. Turn up a steel dowel at 22mm diameter. Allow enough dowel length to secure 2 bearing caps, face to face and extra length for mounting the assembly in a three jaw chuck.
3. Turn up two 6.4mm dowels for use as assembly spigots to accurately mate up bearing caps A&B and C&D.
4. Secure the mated caps to the dowel with the assembly spigots and two 6mm (50mm long) bolts, nuts and flat washers orientated diagonally. Lightly tighten the bolts to lock the caps onto the dowel, leaving 10 mm of the caps protruding from the dowel. You will be facing off and machining the spacer recesses at this end.
5. Check for runout.
6. Lightly face off the cap ends removing the casting irregularities.
7. Fit up a boring bar and machine a 27mm diameter x 3mm deep recess into each set of mated caps.
8. When machined, unbolt the mated caps from the dowel, de-burr the sharp edges and then clean them with compressed air.
9. Re-fit the caps over their camshaft bearings and torque them up.



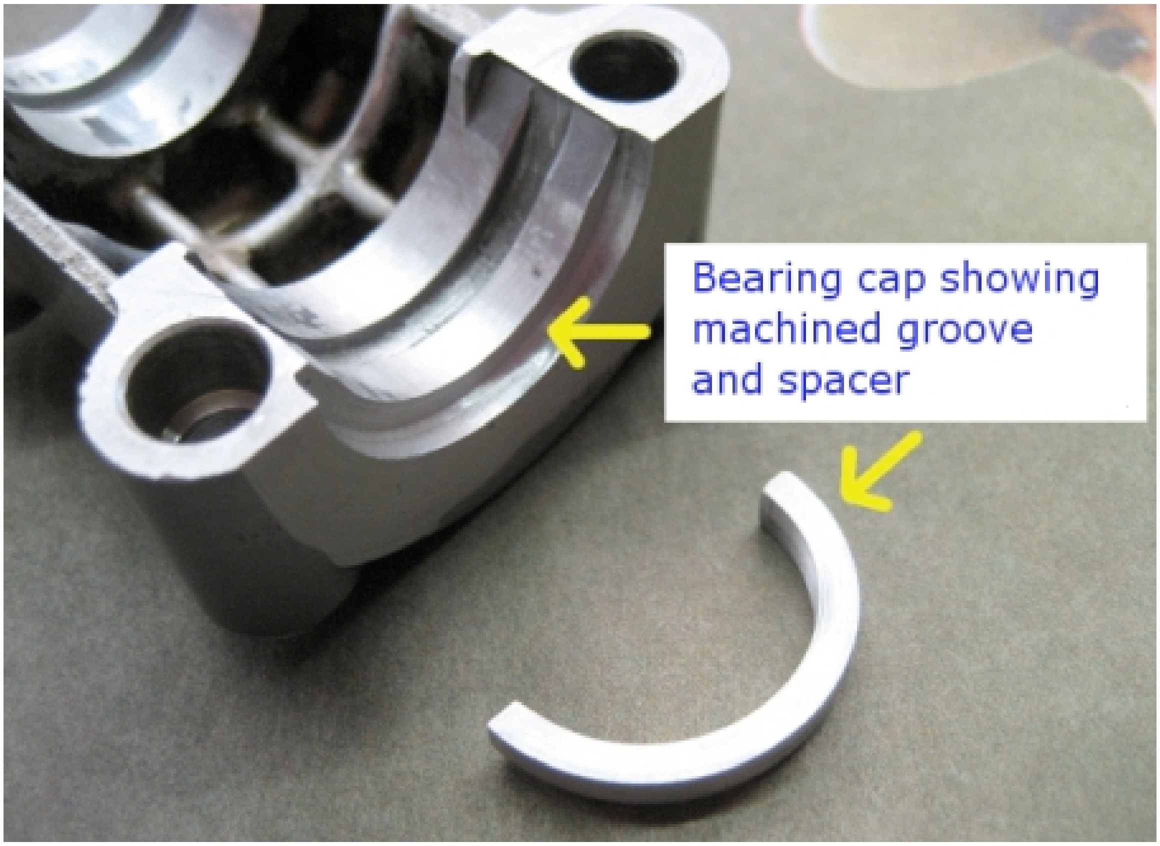
This photo shows a bearing cap after the spacer recess has been machined. Note the slight radius left in the corner of the recess. Thrust spacers are machined with a chamfer to accommodate this fit-up.

Measuring the width of the half-moon spacers

1. After centering the thrust rings equidistant from each thrust surface on the head, measure the gap between the thrust ring and the bearing cap end face. This exercise should be repeated on all 4 thrust rings and the measurements recorded.
2. Now add these individual measurements to the 3mm recesses on each cap to give the exact width of each half-moon spacer. ***There is no allowance for running clearance at this point.***

Machining and fitting half-moon thrust spacers

1. Mount the 1 1/8" (28.5mm) piece of free machining aluminium rod in a three jaw chuck and turn the outside diameter down to 27mm. Turn enough material to allow for the machining of 4 spacers approximately 4mm wide. Don't forget to allow for the material that is lost during the parting off process and any spares that may be needed.
2. Measure your camshaft journals with a micrometer to confirm their size. Some GS camshaft journals may vary from model to model.
3. Rough out the bore with a 19mm (3/4") drill and finish the sizing with a boring bar to 22mm.
4. Cut a 1mm chamfer at 45 degrees on the outer edge of the spacer material. This is to allow for a precise fit with the recess in the bearing cap. It needs to be done now before parting off the spacer ring.
5. Part off the first spacer ring to the required width.
6. Repeat this sequence, chamfering and parting off until you have the 4 rings required to make all the half-moon spacers.
7. Check each ring for width with a vernier.
8. Clearance can now be gained by laying the ring flat on a piece of 1200 grit wet and dry, and lightly rotating the ring through a figure 8 pattern. Regularly recheck the width with the vernier until the correct size is attained.



9. Mark each ring with a centerline and hand cut each one slightly off center. This will produce an oversized half-moon that when fitted to its cap, will protrude just below the cap's mating surface.
10. Using 600 grit paper, gently reduce the half-moon's size until there is 0.001 in (0.025 mm) protruding below the cap surface. This minor protrusion will help trap the thrust spacer inside the cap when bolted up to the bearing assembly.
11. Total endfloat clearance for each camshaft should be 0.0015 – 0.002in. This should be verified with a feeler gauge or DTI after final assembly and before the engine is run.

12. Disassemble both camshafts from the head, carefully marking the spacers with an ID matching each bearing cap. Now clean all components and matching galleys in solvent and blow dry with compressed air. Lubricate all mating surfaces with engine oil before re-assembly. Be sure to fit the chamfered edge on the spacers against the bearing caps.

13. When correctly fitted, the spacers should be trapped in place by the clamping action of the bolted caps, the shape and depth of the recesses and the proximity of the thrust rings on the cams. In the worst case scenario, sudden wear will mean that the endfloat will take up its original position on the engine side of the

bearings and the engine will start knocking again. In this case, new spacers will have to be re-fitted to take up the excess clearance.

14. Some members may wish to experiment with alternative spacer material other than aluminium. I chose not to, as I considered it was preferable to replace the worn aluminium spacers than have to build up or machine camshaft thrust rings at a later date.

I trust that many of you will attempt this mod and enjoy the experience of a quieter running engine, as I have.