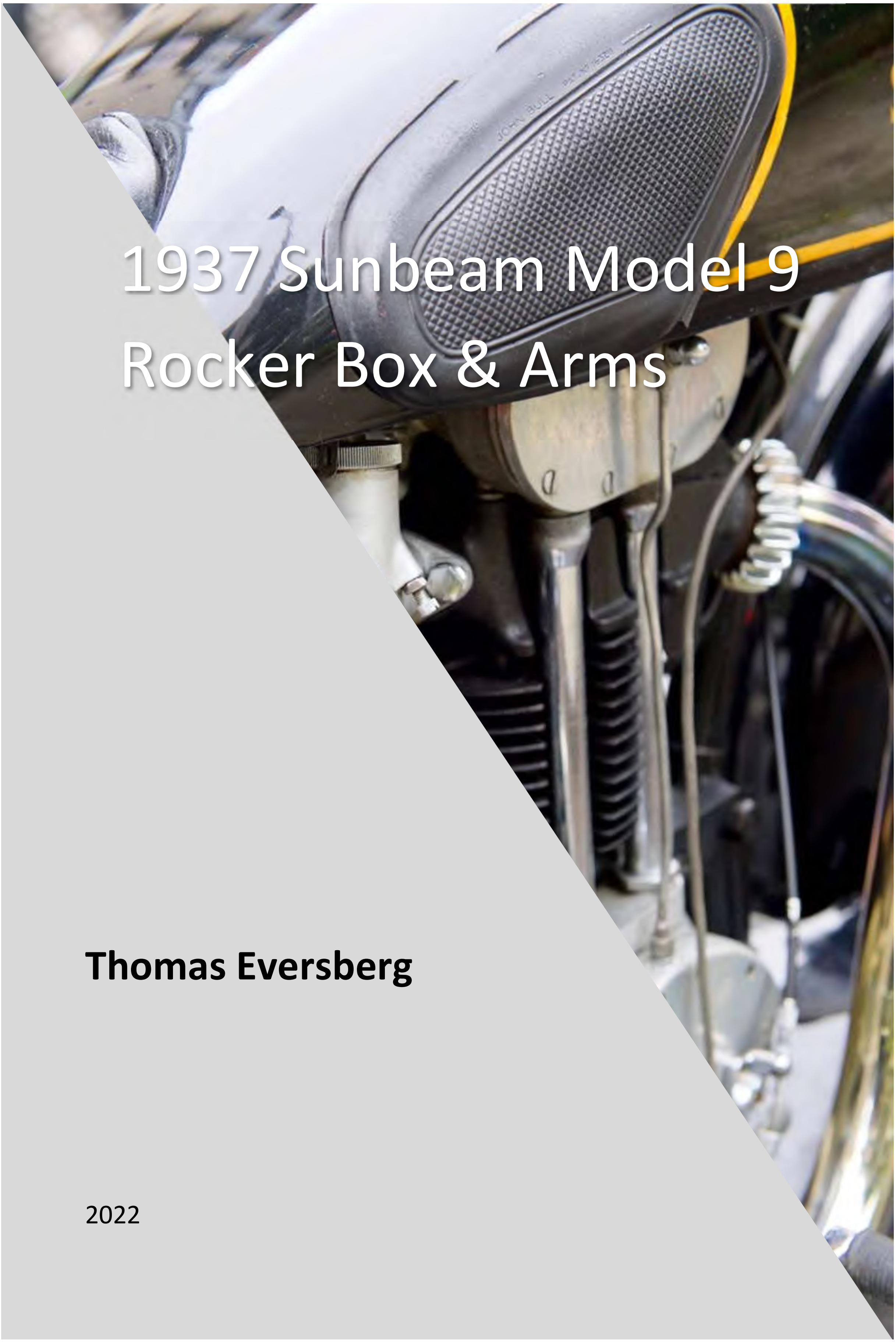

1937 Sunbeam Model 9 Rocker Box & Arms

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Content

After overhauling a 1937 Sunbeam Model 9, the engine showed a significant oil leak at the exhaust valve after only short distances on the road. While dripping oil is a common effect for many British vintage motorcycle it is not for a Sunbeam. As soon as excess drain is observed attention is needed, especially if it occurs suddenly and if it occurs at an uncommon place.

With this short guideline I describe my steps to solve this problem. I do not claim that all information is fully complete and correct but refer only to my own experience including external information. My expertise is limited. For further information I recommend to consult additional information sources like the MSC&R club and forum.

Oil at the Front

Figure 1: Brown oil on the lower motor mount cover indicated a problem with the valve guide.

After a trip of about 100 miles the exhaust valve spring was suddenly covered with brown oil as were the parts below the valve. There was no excess oil at the inlet valve. The cause could have been somewhere between the rocker shaft in the rocker box and the valve guides since the outer side of the rocker shaft was significantly covered with oil, as well (Fig. 1 and 2).

After investigating the barrel and head I discovered that the valve guide was worn, although new. Guides become worn quickly if the forces of the rockers are not axially applied to the valve tip. I therefore focused on the geometry of this unit.

Figure 2: The exhaust valve spring covered by the same brown oil.

Valve Geometry

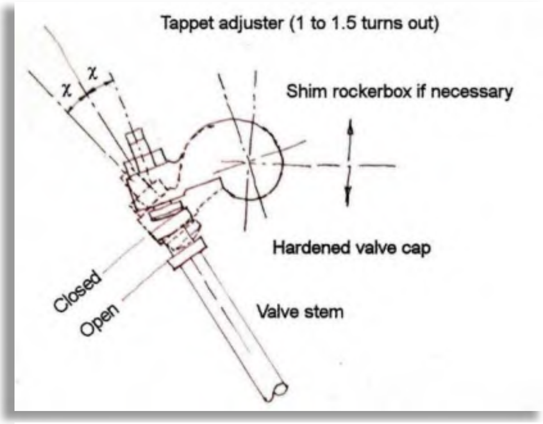

Figure 3: Sketch of the rocker geometry when it works nominally. Courtesy Chris Odling.

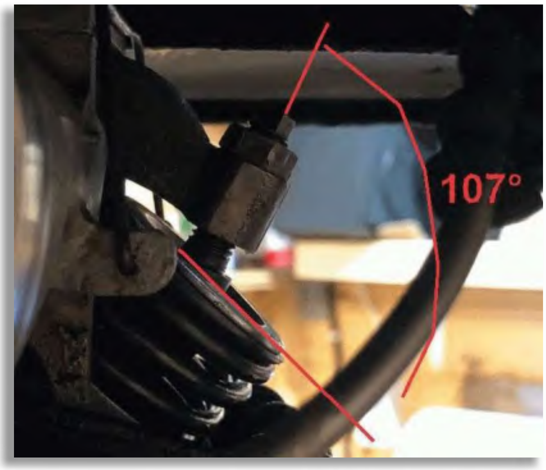

Figure 4: Rocker-to-valve angle for the closed valve.

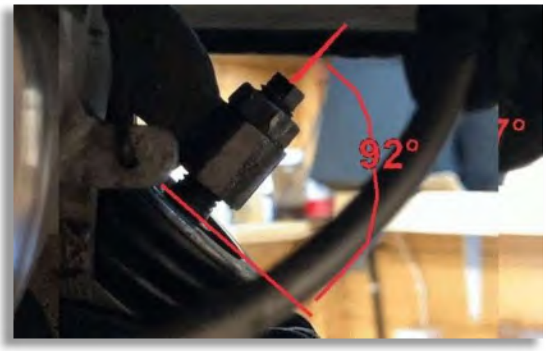

Figure 5: Rocker-to-valve angle for the open valve

When the valve is operated the tappet should apply the force symmetrically onto the valve tip, i.e., only at half way between valve open and closed position acts the tappet exactly axially onto the valve tip (Fig. 3). However, I realised that the rocker collet applied the force axially only when the valve was open and measured the respective angles between the adjuster screw and the valve cup. Normally this is difficult to perform and contains large errors. However, modern smart phones offer respective measurement Apps with their camera. Either in real time or one uses already taken pictures. The situation for my case can be seen in Figure 4 and 5.

The position angle difference between the open and closed valve was about 15° with an angle error of the order of 2°. Actually, the two angles should be symmetric around 90°, hence, 97.5° and 82.5° so that the axial force on the valve stem and, hence, the guide is balanced out best (symmetric). Only then is the guide best protected against wear. However, for my situation the situation significantly deviated from the desired positions.

Figure 6: The open rocker box.

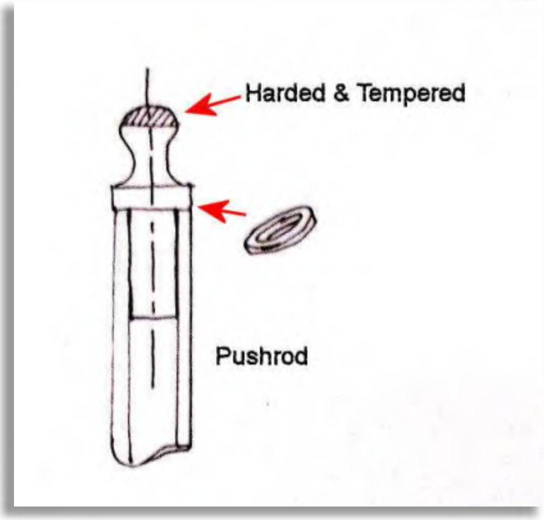

Figure 7: Drawing of the pushrod and the packing ring. The ball ended insert is soft soldered into position. A packing ring out of silver steel can be inserted to adjust the pus rod length. The ring and the ball section (indicated) should be hardened and tempered. Courtesy Chris Odling.

Figure 8: The welded upper part of the rocker box.

At this point it is important to note that the top end of the pushrod and, hence, the inner end of the rocker is always a 'constant' (Fig. 6), i.e., the outer arm angle and, hence, the tappet position cannot be altered by simply turning the tappet adjuster screw. For doing that one has only three options: For increasing the tappet height, one increases the rocker box height by shimming the head bolts. For decreasing the tappet height, one pulls out the shims or one lengthen the pushrods (Fig. 7).

Because I had to lower the outer arm position I should, hence, reduce the box elevation or lengthen the pushrod. I first considered the former because I had no imagination about how to get longer pushrods (but see below). However, the cylinder had bolts were already at a length where shims or washers were not required. Bringing the box to an even lower position would bring it potentially in touch to the head fins.

At his point it is also important to note that the four head bolts need to deliver a virtual plane. Otherwise the rocker box might break when its own bolts are fastened to the head bolts. Remember, a chair with three legs never wobbles but one with four legs can. Exactly this must have happened during the history of the machine because it once had been repaired by a respective welding seam (Fig. 8). So, either the bolts already have the correct length or one needs shims or washers for correction.

To estimate the amount of how much the bolts should be shortened I lifted the box with 2mm washers on the head bolts to lift the outer rocker arms. This amount in degrees can then be directly brought into relation to the respective angle of rotation upwards. And because we talk about relatively small angles we can apply this in a linear approximation. The situation is shown in Figure 9.

Figure 9: The outer rocker arm position after lifting the rocker box by 2mm. Inset: The situation before.

With the inner rocker arm in contact with the pushrod I estimated the angles with respect to the valve cup.

1. No washers on the head bolts:
    a. Open valve: 92°
    b. Closed valve: 107°
       → Angle interval: ± 7.5°
2. 2mm washers on the head bolts:
    a. Open valve: 99°
    b. Closed valve: 114°
       → Angle change: 3.5°/mm

Taking these values into account I obtained the following angles intervals for respectively shorter head bolts:

- 100° and 85° for 2mm shorter bolts
- 98,25° and 83,25° for 2.5mm shorter bolts
- 96.5° and 81.5° for 3mm shorter bolts

The second option matches best a symmetric rocker position which result in +8,25° and -6,75° from the perfect 90° position (axial force on the valve tip). So, taking these numbers into account the bolts should be shortened by 2.5mm. For this case, however, two central head fins should be ground off by 3mm so that they do not touch the rocker box.

All this contains a fundamental problem, though. We can assume for good reason that the works had adjusted everything well taking all necessary parameters into account. This includes the right angles and a matching rocker box to the head. Hence, some reasonable questions occurred:

- Why should it suddenly be necessary to make a compromise between the correct angles and the box-head adjustment?
- Why do I now should grind the fins?
- Why should the pushrods suddenly be too short?
- Why should the valves suddenly be too long?

And most important: Changing the height position of the rocker box would also change the geometries of both valves, which is not desired here.

Something was obviously still not as it should be.

Rocker Arm & Valve Caps

I regularly discuss technical questions in the Sunbeam forum and I introduced my idea to shorten the head bolts. A fellow forum member mentioned to better adjust the pushrod length. It would be simpler and less final. Because I still did not know that one actually can adjust the pushrod length this was not a real option at this time (but see below). When thinking it over I first realised that rotating the rocker has the same effect on the rocker arm position as lengthening the pushrod. The missing millimeters at the valve side could be compensated for by slightly rotating the inner rocker arm towards the pushrod. I could even slightly rotate the arm by hand. But there are respective keys in the tapered part of the rocker arm shaft to avoid any rotation on the axle. However, maybe the workshop which installed the new valves somehow did not correctly place the inner arm onto the shaft. Or something happened to the two keys. I decided to open the rocker assembly – and discovered another problem.

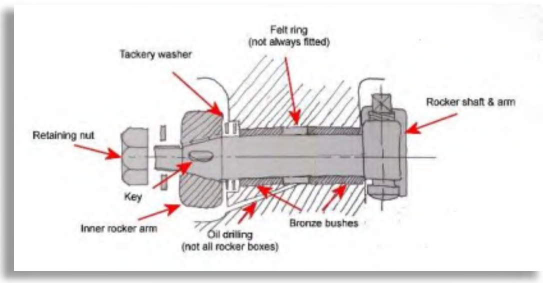

Figure 10: Drawing of the rocker assembly. Courtesy Chris Odling.

Figure 10 shows a sketch of the rocker assembly drawn by our club fellow and technical expert Chris Odling which helps to dismantle is. He says: "*Slacken nut about two turns and give tht a sharp tap with a hammer. This will lift the inner rocker off the shaft taper. Note the two keys on the taper also the Thackery washer behind the inner rocker arm. The rocker "pulls" the shaft and outer rocker arm against the outer bronze bush to create a seal (sort of).*" And indeed, it requires unusual force to get the inner arms off the shaft. One loosens the nut and gives the axle a strong punch with a brass drift (Fig. 11). With keeping the nut on the thread, one avoids punching the conical axle part with its protruding keys through the bronze bush.

Figure 11: Applying a brass punch to loosen the inner rocker arm from the tapered shaft.

Figure 12: Worn keys in the shaft key ways.

Figure 13: The loose inner rocker arm with its two grooves for the keys.

Figure 14: The tapered rocker shaft end with the two key ways and the new keys.

Otherwise the keys would potentially damage the bush.

In theory one first pulls the keys out of their keyways and only then pulls the axle through the bush. For my case, though, the two worn keys were heavily worn and sheared off. I found almost the same situation for the inlet valve (Fig 12). Obviously the two keys which go into the two rocker arm grooves take most of the pushrod load (Fig. 13). This seems to be confirmed by their worn surfaces. Many thousand hits by the pushrods will have a long-term effect. It was, hence, not surprising that the inner rocker arm was not hold in its regular position.

Since it was impossible to get the keys out I let it be done by a local workshop on a mill. They also made make new keys (Fig. 14). It is important that the keys have some little play on top so that the rocker arm can correctly bed on the taper and the Thackery washer can pass along the keys

Figure 15: The exhaust tappet at its rocker arm. Its face seems to be flat at first sight but has a radius matching with the arm length.

Figure 16: The inlet tappet at its rocker arm. As for the exhaust tappet its face radius matches with the arm length. However, the outer part has been once unnecessarily ground off.

Figure 17: A hardened valve cap on the valve tip. New caps should be made out of silver steel with an inner diameter to a good fit to the valve tip. The top material thickness is 0.06". Then harden and temper.

Another important part to check is the valve tappet. I first thought that the exhaust valve tappet has a rectangular cross-section in contrast to the inlet tappet (Fig. 15 and 16). The faces of the hardened tappets should not be flat, though, but should have a certain radius equal to the distance between the centre of the shaft and the centre of the tappet. This gives as near as possible a rolling action. This radius is about 45mm and the tappet has a diameter of about 10mm. With these numbers the resulting height for the tappet surface from edge to centre is only 0.3mm (calculated from the equations for a circular segment). Checking the two tappet faces again shows that both are slightly convex, indeed, and match well with this number. Hence, the outer phase at the inlet tappet is just "faking" the required round cross-section. It appears that a previous owner has exaggeratedly ground off the edge without calculating the required form.

Three remarks about the valves:

- Extensive valve guide wear can be introduced by austenitic stainless steel because it acts very aggressively against guides out of cast iron in a poor lubrication situation. This can be avoided by nitriding the valves.

- Overhead valve Sunbeams have valve caps installed (Fig. 17). Failing that one would have to have the top of the valve hardened. A valve cap however is a better solution.

- Because of missing drafts and comprehensive information many people drag a valve out of a Sunbeam engine and think it is an original item. A lot of parts manufactured are wrong because they are copying a part out of a machine which are assumed to be original. For instance, meanwhile G&S Valves have over 30 drawings for a Model 9 Sunbeam valve.

I have installed phosphor bronze guides and nitride valves from GS Valves. The valves tips are hardened.

Re-assembling

Figure 18: The new keys in the rocker shaft.

Figure 19: The ball section separated from the pushrod.

Figure 20: The balls section and the 2.5mm distance ring.

For assembling the shaft, I inserted the keys and applied some Loctide to the nuts and the tapered shafts. Note that the keys can only be fitted before the Thackery washers. One must therefore ensure that the keys do not protrude too high (Fig. 18).

Then I assembled the rocker box again. As expected, the open/close position of the exhaust rocker arm was still not as desired (see Fig. 4 and 5). Now the only option was to lengthen the exhaust pushrod by the above measured 2.5mm. Following Chris Odling's advice (see Fig. 7) I detached the ball from the pushrod by heating it with a blowtorch (Fig. 19) and ordered a matching packing ring out of silver steel at my local workshop for a tip into the coffee cup (Fig. 20). I then fixed the ring and the ball section to the pushrod with electronic solder (Fig. 21 and 22).

Figure 21: Soft soldering with a blow torch.

Figure 22: The finished pushrod with the distance ring.

Figure 23: The final rocker arm geometry for the closed valve.

The resulting geometry with the exhaust valve closed and open now meets the requirements Fig. 23 and 24). It seems that a slightly thicker ring (3mm) would have been better. However, the rocker arm would have been very close to the valve cup. Therefore, and in view of the small difference, I waived that.

Figure 24: Figure 23: The final rocker arm geometry for the open valve.

Acknowledgements

I thank Joe Rayner and Chris Odling for support and helpful information as well as all involved forum members of *The Marston Sunbeam Club & Register* for sharing their knowledge.