

Stem Fractures on Intake and Exhaust Valves

Situation

As a result of the increasing life time of present-day combustion engines, the number of valve and cylinder head failures has recently risen significantly. Broken toothed belts are a result of lack of maintenance and represent a large proportion of such damage. For cost reasons, cylinder heads are frequently only partially overhauled or given makeshift reconditioning. In the course of such partial repairs, often only the defective parts are replaced but not the relevant contact/associated parts.

Origination of Damage

In the case in question, only the deformed valves were replaced in the course of a cylinder head repair (the toothed belt had broken). A short time after the vehicle was on the road again, there was another damage of the valve train. On dismantling the engine, a valve was discovered that was broken on its valve stem end and valve head. An examination of the parts showed that the valve stem end has been broken first, namely in the area of the lower recess for the valve cotters.



Fig. 1

During further course of the damage, the valve fell into the combustion chamber where it collided with the piston and has been destroyed.

Diagnostic of Damage

After cutting through the point of fracture at the lower recess for the valve cotters (Fig. 2 to 4), another crack parallel to the main point of fracture is perceptible. Such parallel cracks are a clear indication of overload fractures. Due to the high transversal load on the valve stem end, several incipient cracks formed which, in the course of the further spreading of damage, resulted in the development of one the main cracks and consequently in the main point of fracture. A particularity of this damage is the fact that there was an impurity inside the incipient crack by a foreign metal (Fig. 4). The material analysis showed that this was a copper-zinc alloy, definitely a valve guide material.

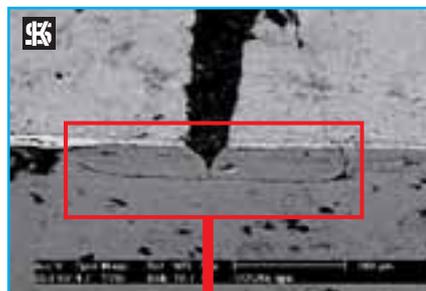


Fig. 2

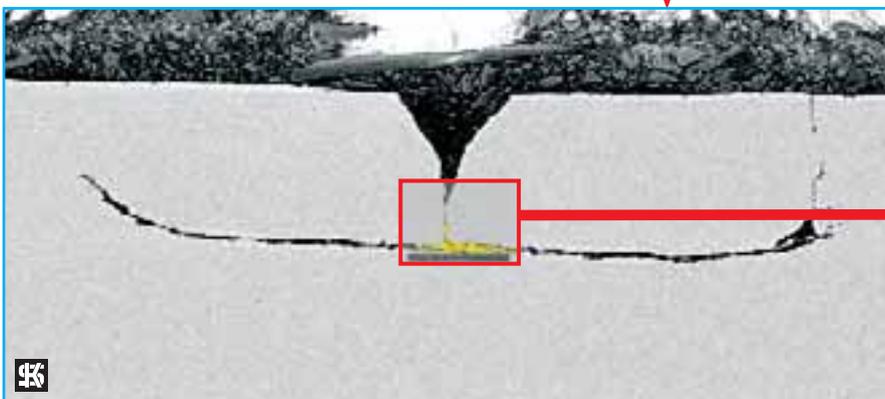


Fig. 3

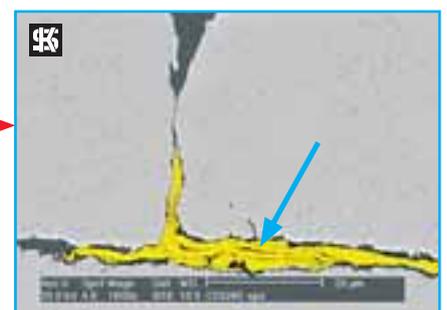


fig. 4

Development of Damage

Due to the short period of time between repair and occurrence of damage and the result of the material analysis, the damage was caused as follows:

On inserting the valve, material from the valve guide settled in the lowest of the three cotter fastening grooves. Presumably the guide was not completely cleaned subsequent to machining or the material was scraped off by the valve during insertion. The foreign material became jammed in the recess while assembling the valve-spring resulting in a slant fit of the valve-spring retainer. In addition, the valve was hindered in its natural rotation.

As a result of the slant position of the valve-spring retainer, a bending moment occurred on the valve stem end (Fig. 5) and result in the fracture of the valve in the lower fastening groove.

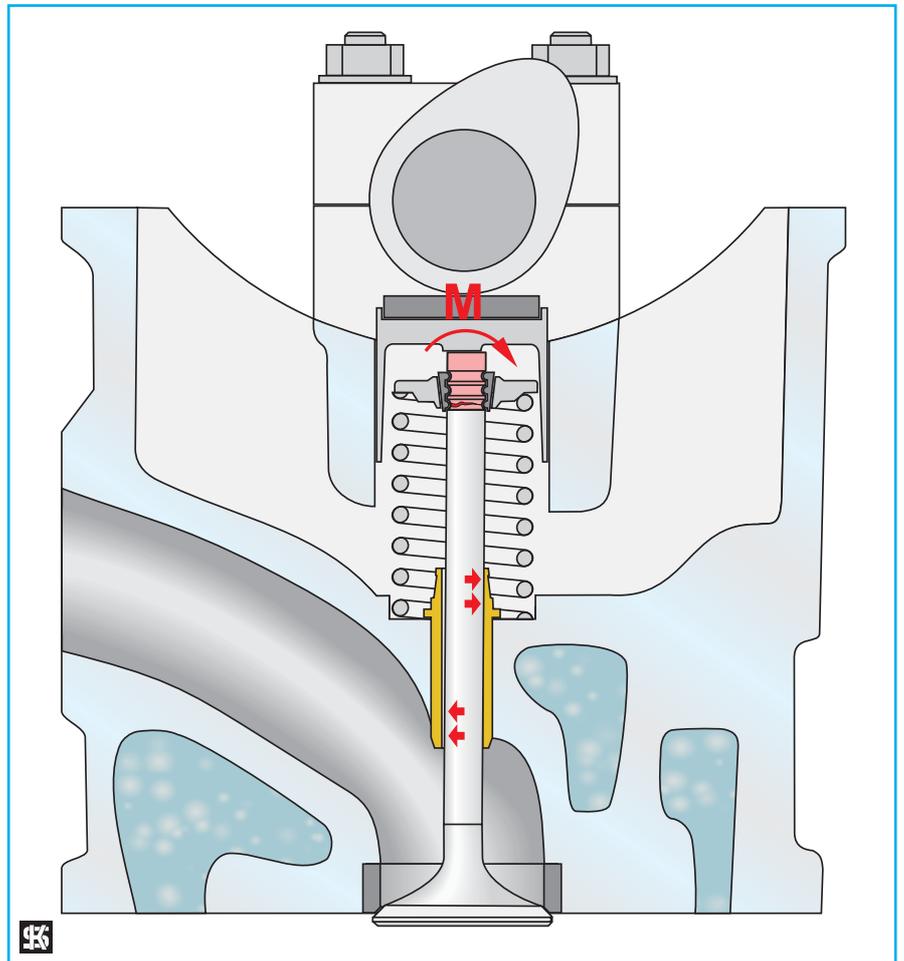


Fig. 5



Warning!

In order to avoid valve fractures, it is urgently recommended to pay attention to cleanliness and to also consistently replace the interacting sliding parts of the valves. In particular newer valves with valve stem diameters of 7 mm or less react sensitively to alignment errors and inaccuracies of shape. It is therefore also recommended always replacing valve cotters as well, any time the valves are changed.

Valve Timing Errors

If an open valve collides with the piston, as is frequently the case when the toothed belt breaks or skips, it is inevitable that one of the valve train components will deform due to a lack of clearance.

In the worst case, the camshaft or its bearing support will break. More frequently, however, valves or hydraulic valve tappets are bent which react in an even more sensitive way due to smaller

material thickness. Figure 6 shows a hydraulic valve tappet which has been severely dented by the valve stem as a result of a toothed belt fracture on the working surface of the valve. Unfortunately, damage of this kind is often overlooked, especially if they are not very distinctive, and the tappets are reinstalled. It is then only a matter of minutes until the engine fails again after repair.

To avoid costly follow-up repairs, hydraulic valve tappets should be always replaced when repairing cylinder heads with a mileage of 120,000 or more.



Fig. 6