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Identification of Fabrication Related Defect on the Fiat Ducato Vehicle

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Abstract: ***The article deals with the case of damage to the Fiat Ducato engine and technical expert's procedure to determine the cause of its failure. The failure occurred in a way that the camshaft and motion adjustment´s hydraulic system of the second cylinder intake valve were damaged. The result of technical analysis was the fact that the failure of engine occurred as a result of incorrect assembly in the production. The vehicle has been transported to an authorized service center and after the engine has been removed it has been examined by a technical expert. The article describes procedure of a technical expert and, in conclusion, his findings are presented. In order to find out the cause, the vehicle was inspected by a technical expert in the service station and diagnostic and consequently dismantling works were carried out according to his instructions. The procedure of evaluating the specific properties on the individual parts with their display and the resulting evaluation is described.***

Keywords: Vehicle, failure, engine, camshaft, timing belt, technical expertise

1. Introduction

In practice, vehicle defects often occur when there is necessary to assess and decide how the fault in question has occurred or whether it has not occurred as a result of the manufacturer's wrong procedure, what rarely happens and so this article is therefore interesting. Technical experts assess the damaged parts and then evaluate the way the defect originates. In order for their work to be good, contributes, in addition to their knowledge, also knowing of similar cases with which they can get acquainted with the publication of expertises already carried out and their results. This procedure increases the certainty of technical experts that their examination and conclusions will not contradict the already known cases. The failure of engine occurred by the fact that the vehicle was operated for a short time and then the engine failed. In order to find out the cause, the vehicle was inspected by a technical expert in the service station and diagnostic and consequently dismantling works were carried out according to his instructions. All operations were documented by recording with the camcorder.

2. Vehicle data

Vehicle: Fiat Ducato 2.8 TDi, OHC
Mileage: 22 000 km
The view of the vehicle is shown in Fig. 1

Figure 1: Image of Fiat Ducato vehicle

3. Engine Inspection

Tasks: Dismantling of the cylinder head and other parts, inspection of disassembled parts, making video-recording findings of the inspection:

- Pistons: signs of intake valve contacts at the top of all pistons are detected, according to the characteristic features of the long-lasting action, the depression marks about 2 - 3 mm in the pistons, obvious signs of rotation of the valves during the contacts
- Intake valves: signss of piston contacts found on all intake valves, depending on the surface - polished are long-term contacts
- Camshaft: camshaft chipping found on the 2nd cylinder´s intake valve cam, signs of excessive wear found on the 1st cylinder´s intake valve cam
- Tappets with hydraulic valve motion setting: tappet of intake valve for 2nd cylinder is missing - fallen out
- Geared timing belt (152 teeth): no obvious signs of damage, chipping or tooth breaking
- Timing wheels: No damage found

The photo-documentation of the vehicle and engine inspection with description of parts is in Fig. No.2

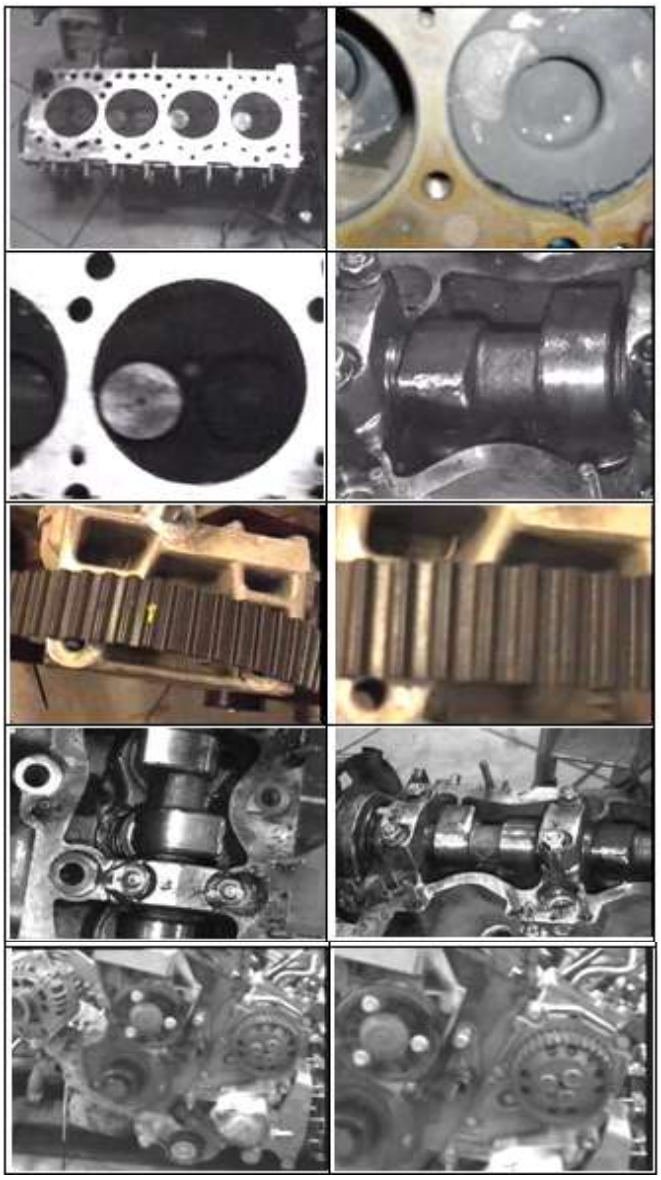

Figure 2: Visualisation of damaged engine parts´ photos

4. Evaluation of Engine Damage Found

1) **Pistons:** signs of intake valve contacts found at the top of all pistons, according to the characteristic features of the long-lasting action, depression marks approx. 2-3 mm in the pistons, obvious signss of rotation of the valves during the contacts with repeated and long-term contacts without evidence of destruction, it is assumed that the functionality of the pistons has not been disrupted but that the lifetime of some parts of the timing group has been significantly reduced
2) **Intake Valves:** signs of piston contacts found on all intake valves, depending on the surface - polished are long-term contacts with repeated and long-term contacts without evidence of destruction, it is assumed that the functionality of the valves has not been disrupted but that the lifetime of some parts of the timing group has been significantly reduced
3) **Camshaft:** camshaft chipping found on the 2nd cylinder´s intake valve cam, signs of excessive wear found on the 1st cylinder´s intake valve cam the damage can be related to the piston and intake valve contacts that have led to formation of additional forces tappets with hydraulic valve motion setting: tappet of intake valve for 2nd cylinder is missing - fallen out falling off the tappet can be related to the piston and intake valve contacts which have led to formation of additional forces and to the change in the mutual positions of the parts and to the effect of changing the timing of the engine leading to the intake valve and piston contacts geared timing belt (152 teeth): no obvious signs of damage, chipping or tooth breaking
4) **Timing wheels:** No damage found

5. Engine and engine head design, timing of timing wheels and consequences of timing wheels´ change

Engine timing description of function and construction:

The engine timing is designed to control the exchange of cylinders´ content, i.e. moments of opening and closing the valves to fill the cylinders by air or a mixture (intake) and removal of the exhaust gasses (exhaust). The engine timing is driven by a toothed crank from the crankshaft, with the driven part being a camshaft with cams that open the intake and exhaust valves directly. The valves are closed by the valve springs and rotate around the vertical axis when they move. As the working cycle takes four times (strokes), i.e. two turns of the crankshaft and the valves open only once during the cycle, the camshaft has a half revolution relative to the crankshaft, i.e., this is a 2:1 transmission.

An overview of the overall operation of the four-stroke engine, piston and valve movement is shown in fig. 3.

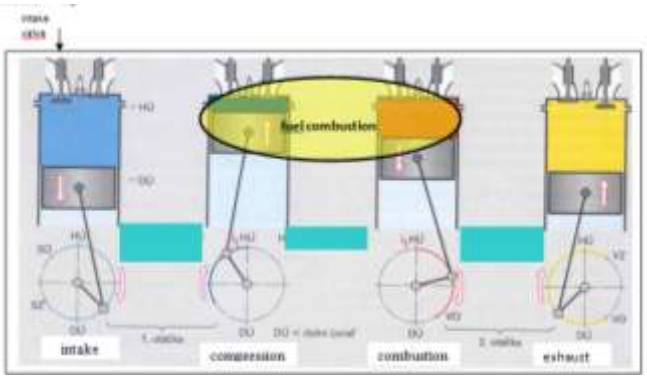

Figure 3: An overview of the overall operation of the four-stroke engine, piston and valve movement

In the four-stroke engine, where the crankshaft has a shape such that the first and fourth cylinders are in the T.D.C. and the second and third rolls in the B.D.C is the ignition sequence of the cylinders 1-3-4-2, which means that the combustion distance is 180 °.

The timing diagram of the engine is in fig. 4

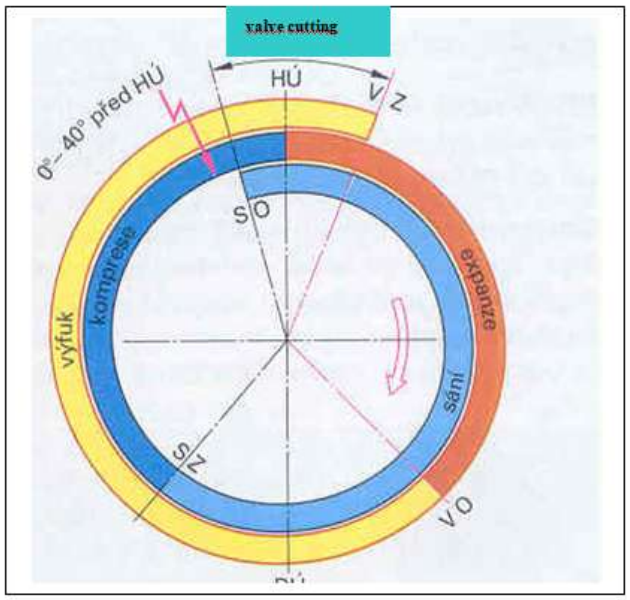

Figure 4: The timing diagram of the engine

The moment when it would be technically possible to contact the intake valve and the top of the piston's bottom without the engine or its given piston group therefore become a non-functional in consequence of extensive damage is the time between exhaust and intake, during which the piston moves upwards into the top dead centre (exhaust) in working cycles. the so called valve cutting occurs, and in the subsequent working cycle, the intake valve is opened while the piston moves downwards into the bottom dead centre. The moment of cutting of the valves is shown in fig. 4

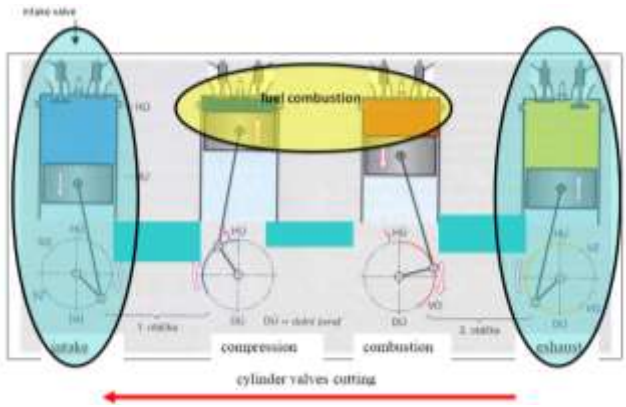

Figure 4: Showing the valve cutting time for the overall way of four-stroke engine performance

In case the intake valve opens with a certain advance, it is obvious that it will contact the upper part of the piston's bottom moving in the T.D.C. and "going" into the B.D.C.

The described untimely motion of the intake valve would result in its contact with the upper part of the piston's bottom, but the contact would not induce a type of force whose size would lead to the immediate destruction of the contacting surfaces, and if direct destruction of these would not occur, the engine would work for a long time without external signs that its intake valve has contact with the upper part of the piston's bottom between working cycles until the impact of parasitic additional forces induced by said contacts led to destruction of another part of piston or timing group of the engine.

As the signs of intake valve and piston top contacts are found on all intake valves and on all cylinders, it is possible to assume that all valves have an untimely movement of intake valve. As the marks on the top of the pistons (valve profile curl, signs of valves´ rotation) and on the valves (glossy surfaces due to rotational contact) are so characteristically, I consider the technically reasonable view that contacts have taken place over a relatively long period of time.

6. Engine Timing Changes - Way and Causes

For changing of engine timing, this is considered to be a permanent disruption of crankshaft and camshaft rotation synchronization by a certain angle in that in the so called zero position of crankshaft is camshaft in a position other than its zero, i.e., is incorrectly turned.

Mentioned rotation results in a permanent time shift timing - valves motion due to movement of piston between T.D.C and B.D.C.

This may be the result of:
- Incorrect installation
- Skipping the toothed belt of timing wheels

Picture no.5 shows timing toothed belt structure

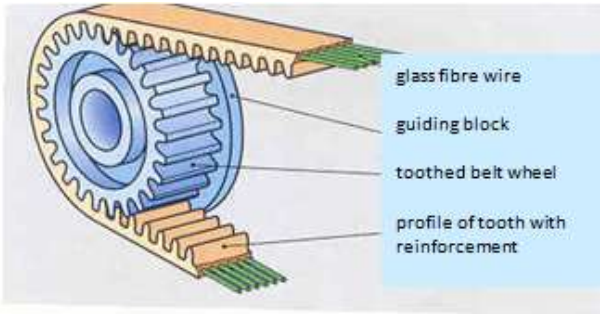

Figure 5: Structure of timing toothed belt

In case of skipping toothed belt of timing, characteristic signs remain, in particular tearing of the teeth at their base and the disturbance of smooth profile of teeth , which skipped over the teeth of the toothed belt.

Since, when checking the toothed belt of timing wheels of engine in question, no specific signs were found suggesting that it would be skipped, I find it technically acceptable that the timing shift of that engine was displaced when assembled.

Note: Mentioned specific signs would have to be on the number of teeth corresponding to the number of teeth engaged in toothed belt on the toothed belt wheel.

7. Estimated camshaft turning rate

Intake valve depression depth: 0.5 - 0.7 mm

- Approximate track of the piston from B.D.C to T.D.C: 100 mm
- Number of teeth on toothed belt: 152 (turning 1.2o per tooth)
- Piston track per 1 tooth: 0.65 mm
- Determination of displacement direction: The camshaft has been rotated by 1,2^{o} in the direction of its rotation

In this case, it is technically reasonable to assume that it is most likely shifting the angle of the camshaft by 1,2^{o} in the direction of its rotation.

7. Conclusion

I consider the reason for the occurrence of an emergency motor fault of the above-mentioned motor vehicle Fiat Ducato an incorrect engine timing, which most likely occured when the engine was installed. Mentioned incorrect engine timing has resulted in contacts of the upper piston parts with valves as well as subsequent damage to the hydraulic valve motion setting and valve cam.

References

[1] Ing. František Vlk, DrSc.: Vozidlové spalovací motory (Vehicle combustion engines), Brno 2003, ISBN 8023887564
[2] Professional business literature