

Technical Analysis of a Cause of a Vehicle Transfer Case Failure

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Abstract: *The article deals with a transfer case failure of Skoda Octavia Combi and a procedure of a technical expert necessary to detect a cause of this failure. During the operation of the vehicle the transfer case and subsequently the gear box started to show a loss of functionality. In order to find out the cause, the damaged aggregates were dismantled from the vehicle in the car service facility in the presence of the technical expert. Based on his instructions, dismantling and disassembly of the aggregates was carried out and the technical analysis performed.*

Keywords: vehicle, car service facility, transfer case failure, differential failure, diagnostics, detecting a way of damage

1. Introduction

In practice, there are often cases when a car service facility and a vehicle owner have different opinions about the cause of a vehicle failure. It is then a task of a technical expert to assess and decide what caused the vehicle failure. The article deals with one such case, when there is a transfer case failure in a vehicle, which became evident as a malfunction of the gear box. The car service facility insisted that the failure resulted from an incorrect style of driving of the owner. However, the owner of the vehicle believed that, despite the fact that the wear of the vehicle and the transfer case was little, it was damaged as a result of the wear of the material of its components. As in this case the costs for repair were high, it was agreed between the owner of the vehicle and the car service facility to get a technical expert whose task was to assess the technical condition of the gear box and determine the cause of its failure. For this reason, the technical expert proceeded as follows: the gear box, the part of which is the transfer case, was inspected, dismantled and the oil level was assessed. Based on the results of this inspection and its evaluation, the failure was analysed. All tasks were documented by recording with a camera. The described procedure of the technical expert and his analysis of the detected damage is a valuable aid for the work of other technical experts assessing similar cases, as it allows them to compare the nature of damage and the course of the resulting analysis.



2. Data on the vehicle and failure occurrence

Vehicle: Skoda Octavia Combi

Period of use: 20 months

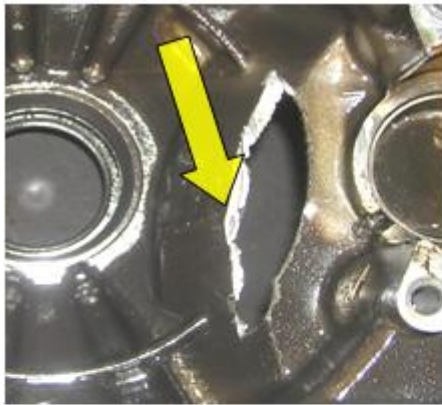
Kilometre reading: 56 019 km

- During the drive with the 5th gear engaged – an increase in rpm at a speed of approx. 90 – 100 km/h – the gear lever remained in its original position
- Re-engaging the 5th gear – an increase in rpm with the 5th gear engaged for approx. 2 minutes – the gear lever remained in the position V
- Not possible to engage the 5th gear any more
- During the next drive – the 4th gear engaged at approx. 20 km/h
- During the next drive – not possible to engage any gears
- Pulling the vehicle up at a place, possible to engage gears I, II, III
- Taking the vehicle to car service facility for a technical analysis
- No sound effects occurred during the drive.

3. Inspection of the aggregate

After dismantling the gear box with the transfer case the following facts were documented:

Gear box and transfer case housing cover:
Traces of contacts around the circumference in the area of the differential



Damaged gear box housing in the differential area as a result of the contact with a part of the differential



A view of the differential satellite pivot



A view of the flexible locking pin of the satellite pivot

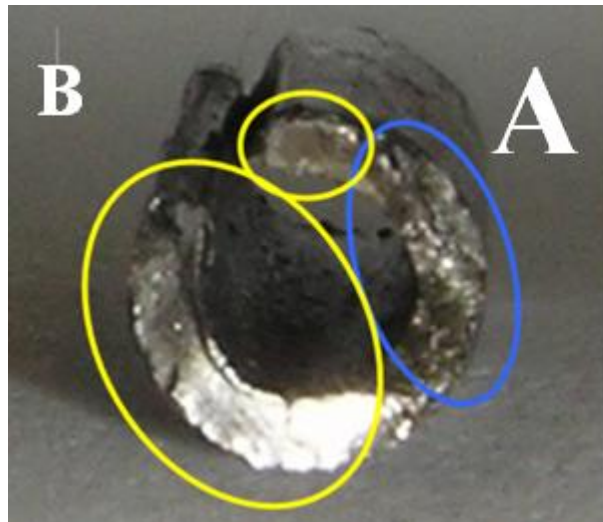


A view of the differential satellites

Figure 1: Findings regarding the condition of the transfer case and differential components during a visual inspection

4. Analysis of damage to the transfer case and differential components

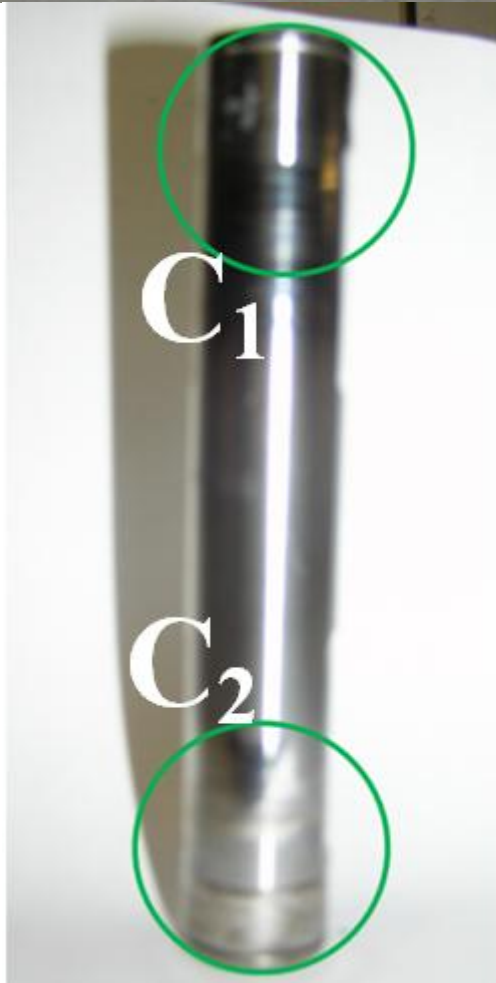
The analysis of the damage to the transfer case and differential components can be found in Fig. 2.



Flexible locking pin of the satellite pivot:

damage A (blue area)
traces of fatigue fracture over part of the area

damage B – yellow area
traces of brittle fracture over part of the area



Satellite pivot:

C₁, C₂ – green area
traces of the pivot turning over in the differential housing segment

Figure 2: Photo documentation of detected damage to the transfer case components

5. Design of the transfer case and the differential of Skoda Octavia Combi

Fig.3 shows the design of the transfer case and the differential in a common housing with the gear box.

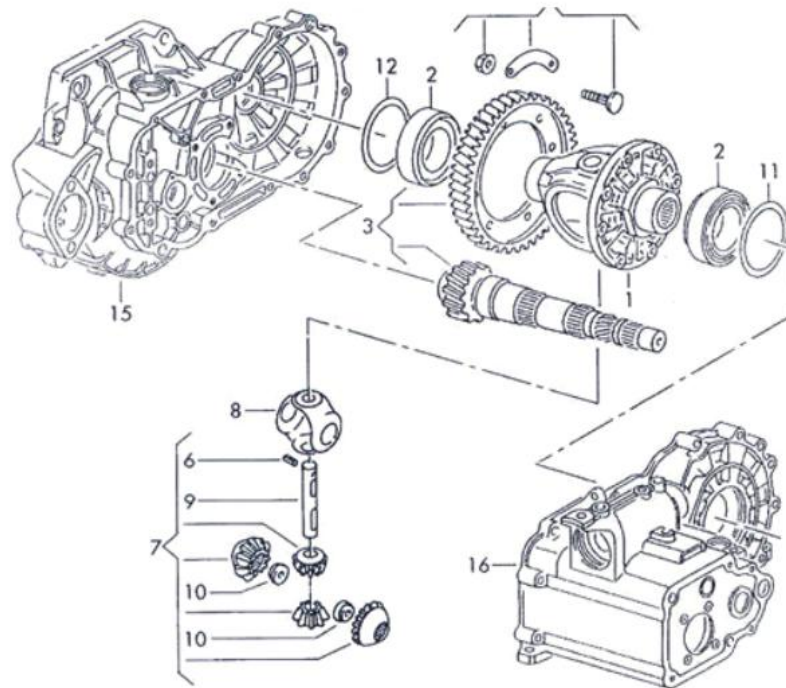


Figure 3: A view of the design of the transfer case and differential

Fig. 4 details a view of the assembly of the satellite pivot, pin, satellite and planetary wheels

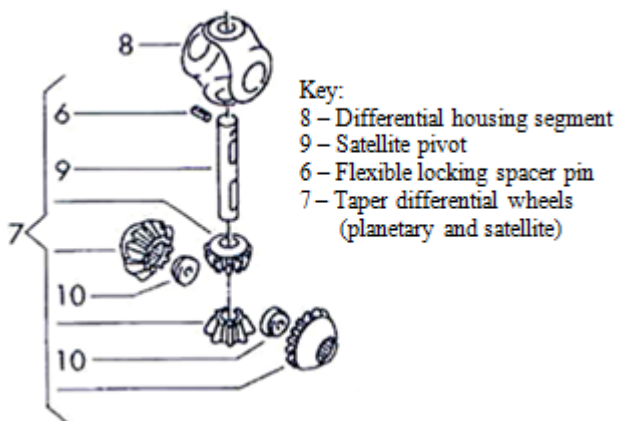


Figure 4: A view of the design of the transfer case and differential

6. Determining the cause of the catalectic failure of the differential of Skoda Octavia Combi

Based on the known facts, it is possible to determine the following course of the differential failure resulting in the damage to the gear box:

1. Stage

- Occurrence of fatigue fracture on the flexible locking pin of the satellite pivot
- Breaking off the flexible locking spacer pin of the satellite pivot (position 6, Fig. 4), the active cross-section of which was reduced by the area of fatigue fracture

2. Stage

- Rotation of the satellite pivot (position 9, Fig. 4) in its position in the differential housing segment (position 8, Fig. 4) and its gradual release

3. Stage

- Disengagement of the satellite pivot from its position in the differential housing segment

4. Stage

- Movement of the end of the satellite pivot outside the differential housing segment
- Destruction of the gear box and transfer case cover by the satellite pivot

Alternatives to fatigue fracture of the flexible locking pin

The fatigue fracture of the flexible locking pin might have occurred as a result of:

- Excessively loose fastening of the satellite pivot in the differential housing segment, as a result of which the pivot was subjected to forces caused by the friction of the satellites on the pivot and pressures caused by the engagement of the satellite and planetary wheels in their gearing
- A partial seizure of the satellite on the pivot, e.g. when one of the wheels slips on the surface with uneven adhesive conditions or as a result of improper lubrication of the friction surfaces

In both cases, a manufacturing defect was considered to be the cause of the failure, namely

- In case a. it is an assembly or technological defect concerning the fastening of the satellite pivot
- In case b. it is a defect of the design, as one of the basic requirements for the construction of a differential is its resistance to the described influences (slipping) or restriction (insufficient lubrication), while this defect is not stated in the operation manual.

7. Conclusion

Based on the known facts and findings, the technical expert came to a conclusion that the detected failure of the transfer case of Skoda Octavia Combi was caused by fatigue fracture, as shown in Fig. 2 – area A, on the flexible locking pin of the satellite pivot, the expansion of which subsequently caused brittle fracture – area B. As a result, the satellite pivot started rotating, gradually released and finally disengaged from its original position. Consequently, the end of the satellite pivot moved outside the segment of the rotating differential housing and the gear box and transfer case cover was destructed by the end of the satellite pivot. The estimated occurrence of the fatigue fracture of the flexible locking pin of the satellite pivot was determined within a longer period of the vehicle operation until the fracture B occurred.

It follows from the above that the failure of the gear box was not caused by incorrect operation of the vehicle by the driver.

References

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