

National Transportation Safety Board

Office of Research and Engineering

Washington, DC 20594



WPR24LA248

MATERIALS LABORATORY

Factual Report 25-006

March 10, 2025

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A. ACCIDENT INFORMATION

Location: Ritzville, Washington
Date: July 15, 2024
Vehicle: Cessna 150M, N714PW
Investigator: Eric Gutierrez, AS-WPR

B. COMPONENTS EXAMINED

Cylinder and piston assemblies with intake and exhaust rocker arms, valves, and springs from a Continental O-200-A engine.

C. EXAMINATION PARTICIPANTS

Specialist Matthew R. Fox, Ph.D.
NTSB
Washington, DC

D. DETAILS OF THE EXAMINATION

An overall view of the submitted components is shown in figure 1. The intake and exhaust rocker arms had been disassembled from the cylinder assembly as shown. The exhaust valve springs and spring seat were also separated, and both exhaust valve keeper halves were missing. The intake valve and springs remained installed in the cylinder assembly. The piston crown was fractured, and a collection of pieces from the piston were also received as shown in figure 1.

The components had been installed on a Continental O-200-A engine. According to engine maintenance logs, the engine was last overhauled on June 11, 1981. The engine received a top overhaul on July 24, 1988. The entry for the top overhaul included the statement, "ground and laped [sic] valves and seats," which was the most recent entry that would require disassembly of the valves to complete. In the last maintenance entry dated July 10, 2024, the engine was reported to have 1,232.45 hours time since major overhaul and 320.25 hours time since top overhaul.

The piston crown and interior surfaces of the cylinder assembly were covered with impressions from impact damage. The interior end of the exhaust valve guide was fractured. Next to the valve guide, a hole with a diameter matching that of the exhaust valve stem was observed in the cylinder head. The cylinder head damage was consistent with impact with the exhaust valve tip after it had been displaced out of the exhaust valve guide.

A closer view of the exhaust rocker arm is shown in figure 2. The rocker pad had grinding marks on varying faceted planes. Circumferential wear marks corresponding to contact with the valve tip were observed, and the center of the

circumferential marks was offset to the side of the rocker pad. Marks corresponding to contact with the spring seat were also observed on the arm adjacent to the rocker pad as shown in figure 2.

An oblique view of the exhaust spring seat is shown in figure 3. Contact damage was observed on the outboard surface near the inside diameter, a location corresponding to the spring seat contact damage observed on the rocker arm. Wear marks corresponding to contact with the exhaust valve keeper halves were also observed on the center hole bore as indicated in figure 3.

The exhaust valve was fractured through the stem near the valve head, and the stem was bent into an "S" shape. Fretting damage from contact with the keeper halves was observed at the shoulder near the valve tip as shown in figure 4. The valve stem fracture surface was damaged from post-fracture impacts, but remaining portions had a rough appearance with reflective features mixed with matte gray features when viewed under an optical stereomicroscope. The fracture surface was further examined using a scanning electron microscope (SEM), and a view of typical fracture features are shown in figure 5. The fracture surface showed a mix of flat facets with fine tear ridges and shallow dimple features surrounded by rough regions of dimple fracture, features consistent with overstress fracture.

Exhaust valve stem outside diameter and valve guide inside diameter measurements were taken using a telescoping bore gauge, and results were compared to values in a Table of Limits for the Continental O-200 engine provided by a representative of Continental Aerospace Technologies. The outside diameter of the exhaust valve stem measured 0.4343 inch near the tip end of the valve stem, which was slightly above the maximum outside diameter of a new exhaust valve stem. The interior surface of the exhaust valve guide had a wavy appearance at the middle to inboard ends of the guide. The inside diameter of the valve guide was measured at the outboard end where it opened to the rocker cavity. The valve guide inside diameter was 0.4405 inch and 0.4434 inch as measured parallel and perpendicular to the rocker arm spine, respectively. Both values were greater than the maximum bore diameter of a new exhaust valve guide. By calculation, the stem to guide clearance was 0.0062 inch to 0.0091 inch parallel and perpendicular to the rocker arm spine, respectively. The clearance was within allowable service limits in the parallel direction, but the service limit for maximum clearance was exceeded in the perpendicular direction.

The exhaust valve springs consisted of an outer, middle, and inner spring. The height of each spring was measured fully extended at multiple locations around the circumference. The height varied depending on the measurement location relative to the spring wire runout, with the largest values generally measured on the ground surface of the top wire near the end of the runout. The maximum heights measured on the three exhaust valve springs were 2.16 inches, 1.95 inches, and 1.77 inches for the outer, middle, and inner springs, respectively.

The intake springs were disassembled from the cylinder assembly, and heights of the intake springs were measured for comparison to the exhaust valve spring heights. The maximum heights measured on the intake valve springs were 2.02 inches, 1.91 inches, and 1.77 inches for the outer, middle, and inner springs, respectively.

Submitted by:

Matthew R. Fox, Ph.D.
Chief Technical Advisor, Materials Laboratory



Figure 1. Overall view of the submitted components.



Figure 2. Exhaust rocker arm showing offset contact marks on the rocker pad and seat contact marks on the arm.

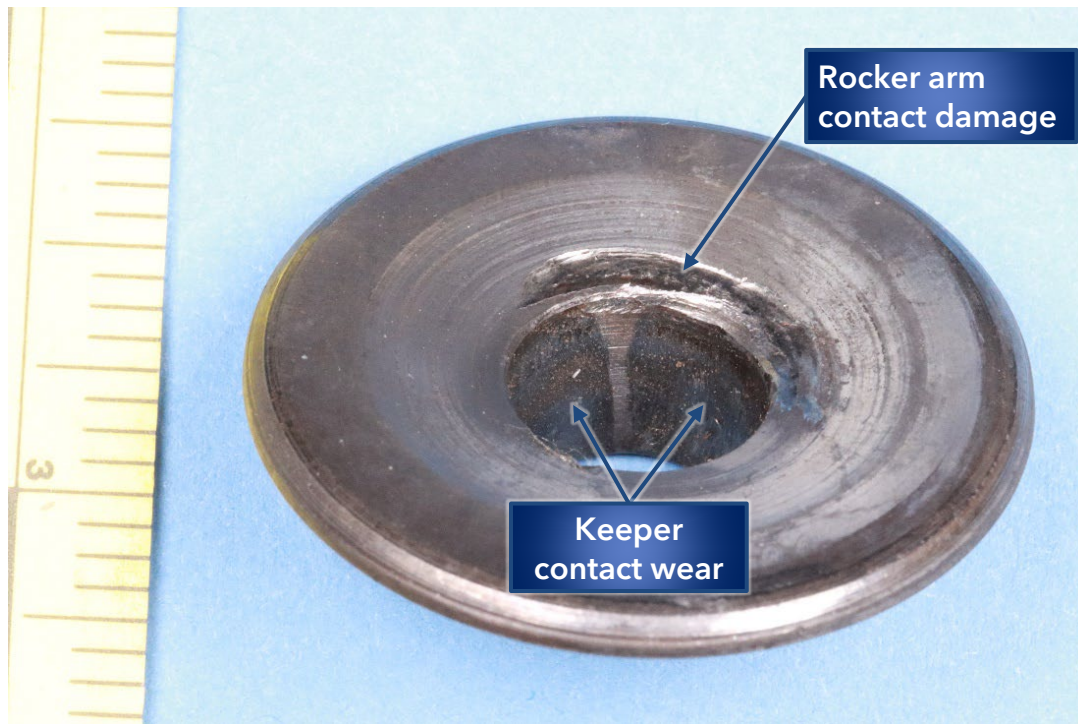


Figure 3. Spring seat showing wear marks from contact with the keeper halves and contact damage corresponding to contact with the rocker arm.

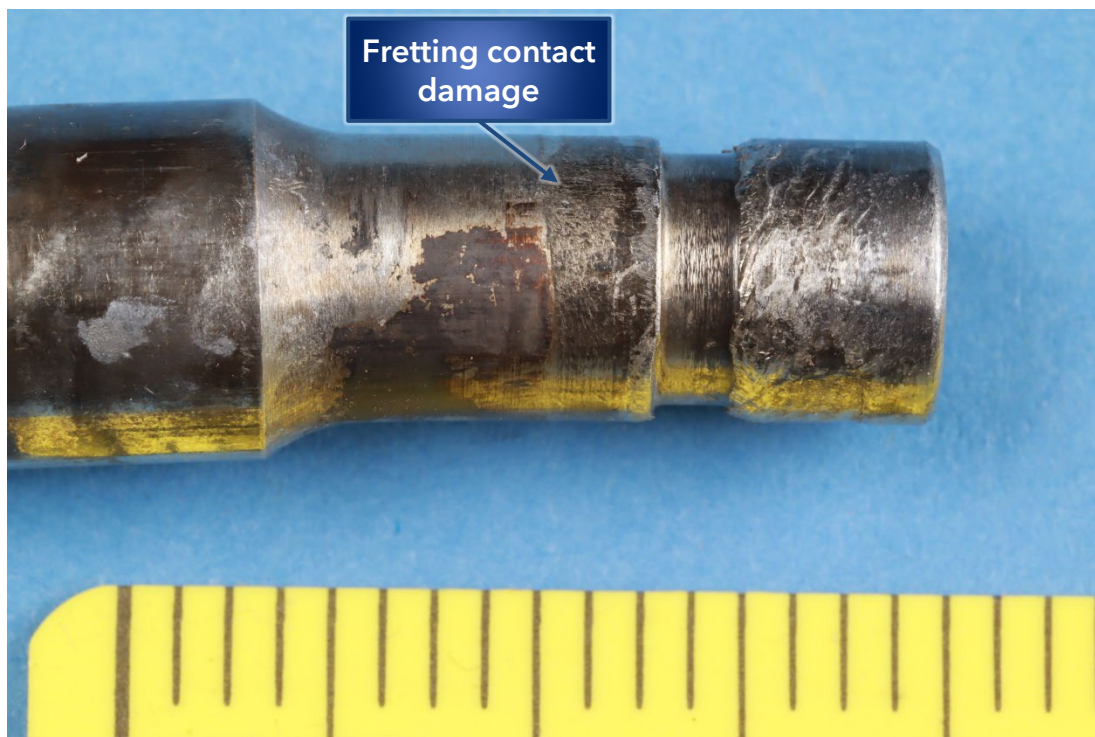


Figure 4. Fretting contact damage on the exhaust valve stem at the shoulder for the keeper.

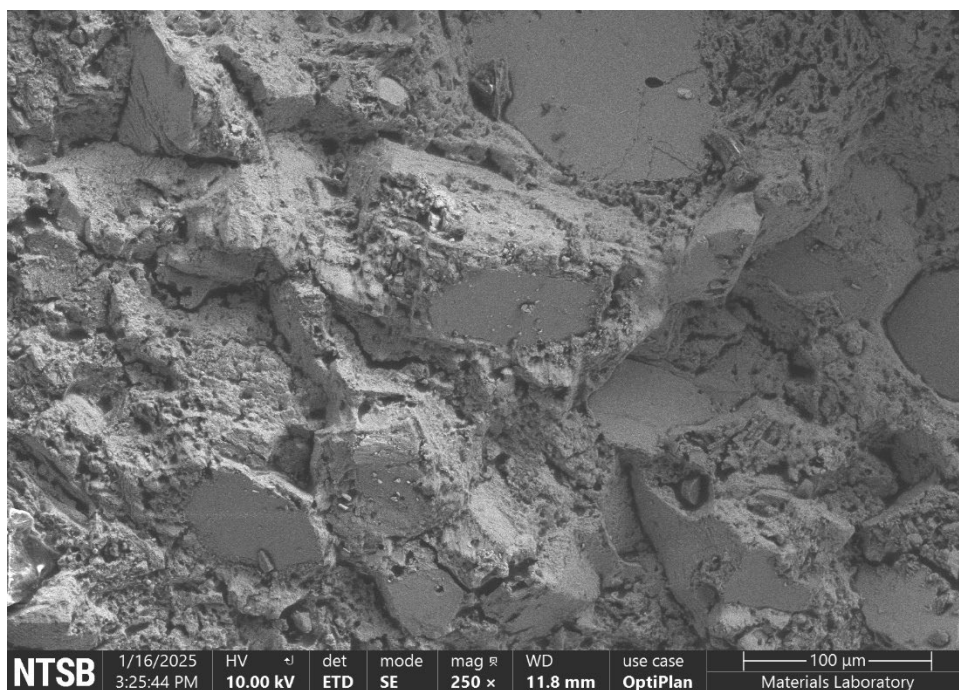


Figure 5. SEM image of typical fracture features on the exhaust valve stem fracture surface.