

National Transportation Safety Board

Office of Research and Engineering

Washington, DC 20594



WPR21LA358

MATERIALS LABORATORY

Factual Report 22-075

October 13, 2022

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A. ACCIDENT INFORMATION

Location: Baker, Nevada
Date: September 11, 2021
Vehicle: Beech 35-33B, N8983M
Investigator: Tealeye Cornejo, AS-WPR

B. COMPONENTS EXAMINED

Numbers 5 and 6 cylinder assemblies, piston assemblies, connecting rod pieces, and bearing pieces from a Continental Motors IO-550-B (4) engine.

C. EXAMINATION PARTICIPANTS

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

D. DETAILS OF THE EXAMINATION

Overall views of the submitted components are shown in figure 1. The crankshaft was intact. The connecting rods for both cylinders were fractured at the big end, and fractured and damaged pieces of the connecting rods, bearings, and fasteners were included as shown in figure 1. The piston assemblies remained within the damaged barrel sections of the cylinders, and the small ends of the connecting rods remained attached to the wrist pins in the pistons. Piston skirts on both pistons were fractured with missing pieces. The barrel skirts on both cylinders were also damaged consistent with contact with the fractured connecting rods.

Closer views of damaged connecting rod journals on the crankshaft are shown in figure 2. Scoring, deposited material, and heat tint damage was observed on the journal for the number 5 connecting rod (C5). Scoring and pitting damage was also observed on the journal for the number 6 connecting rod (C6). The remaining journals for the connecting rods and the main journals had a nominal appearance with no damage noted.

The connecting rod for the number 6 cylinder was fractured on one side of the strap on the beam side of the connecting rod. The cap was separated in one piece and was flattened. All pieces of the connecting rod were damaged from multiple impacts. One of the connecting rod bolts was fractured, and the threaded end of the bolt was missing. The other connecting rod bolt was intact but was bent and had damaged thread peaks. One of the connecting rod nuts was missing, and the other shown in figure 1 was substantially deformed and had sheared threads. The strap fracture had rough matte gray features near the exterior surface and transitioned a smoother smeared fracture surface through the thickness. Overall, fracture features

were consistent with ductile overstress fracture. The connecting rod bolt fracture had rough, matte gray fracture features also consistent with ductile overstress fracture.

The bearing half for the number 6 connecting rod was flattened and had impact damage, but the Babbitt material was mostly intact on the bearing surface. Markings on the back of the bearing included "10-04 112" and "642398". The other bearing half was missing. No evidence of substantial heat tinting was observed on the connecting rod, and the interior surface of the cap piece had limited circumferential scoring.

Closer views of connecting rod pieces and connecting rod bolts from the number 5 cylinder are shown in figure 3. The big end of the connecting rod was tinted dark as indicated in the right image in figure 3 consistent with exposure to high heat. The broken connecting rod pieces shown in the left image in figure 3 also showed tinting consistent with high heat exposure. The corresponding bearing remnants shown in the lower left image in figure 1 were severely worn, deformed, broken, flattened, and darkened consistent with high heat exposure.

Approximately half of the cap and the head end of one of the connecting rod bolts were missing. Fracture features on both bolts and the cap had rough features and deformation consistent with ductile overstress fracture.

The fractured strap pieces from the number 5 connecting rod were arbitrarily labeled "A" and "B" as shown in figure 3 for reference in this report. A close view of the fracture surface of strap piece A is shown in figure 4. A portion of the fracture surface near the exterior surface had relative smooth fracture features separated by ratchet marks¹ and curving crack arrest lines, features consistent with fatigue. The fatigue initiated from multiple origins in the radius of the attachment boss as indicated with a bracket in figure 4. Most of the fracture surface was smeared and obliterated by post-fracture damage, but the relatively small fatigue region transitioned to relatively rough matte gray features in the remaining portion of the fracture surface shown in figure 4.

A close view of fracture features on strap B is shown in figure 5. The fracture surface on the strap B piece was also substantially damaged. However, relatively smooth fracture features with curving crack arrest lines and ratchet marks were observed consistent with fatigue. Multiple fatigue origin were observed within each of the bracketed areas indicated in figure 5, and areas between the brackets were obliterated by post-fracture impacts. The fatigue origins were located at the radius for the attachment bolt boss, similar to the location on strap A. Partial fatigue boundaries were observed as indicated with dashed lines in figure 5, but impact

¹ A ratchet mark is a small step in the fracture surface formed when two adjacent fatigue cracks originate on slightly offset planes.

damage prevented identification of the entire extent of the fatigue boundary or boundaries.

According to engine service history information supplied by the investigator in charge, the engine had been last overhauled on September 28, 2005, with a tachometer time of 2,310.03 hours. The previous overhaul had occurred on October 2, 2001, at an engine total time of 1,754.38 hours. On March 6, 2021, the recorded tachometer time was 3,705 hours, a difference of 1,395 hours time in service. At the time of the accident, the engine had accumulated nearly 16 calendar years since the last overhaul.

Submitted by:

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



Figure 1. Overall views of the submitted crankshaft (upper image), number 5 cylinder and associated connecting rod pieces, and bearing pieces (lower images), and number 6 cylinder with connecting rod pieces and a bearing half (middle image).

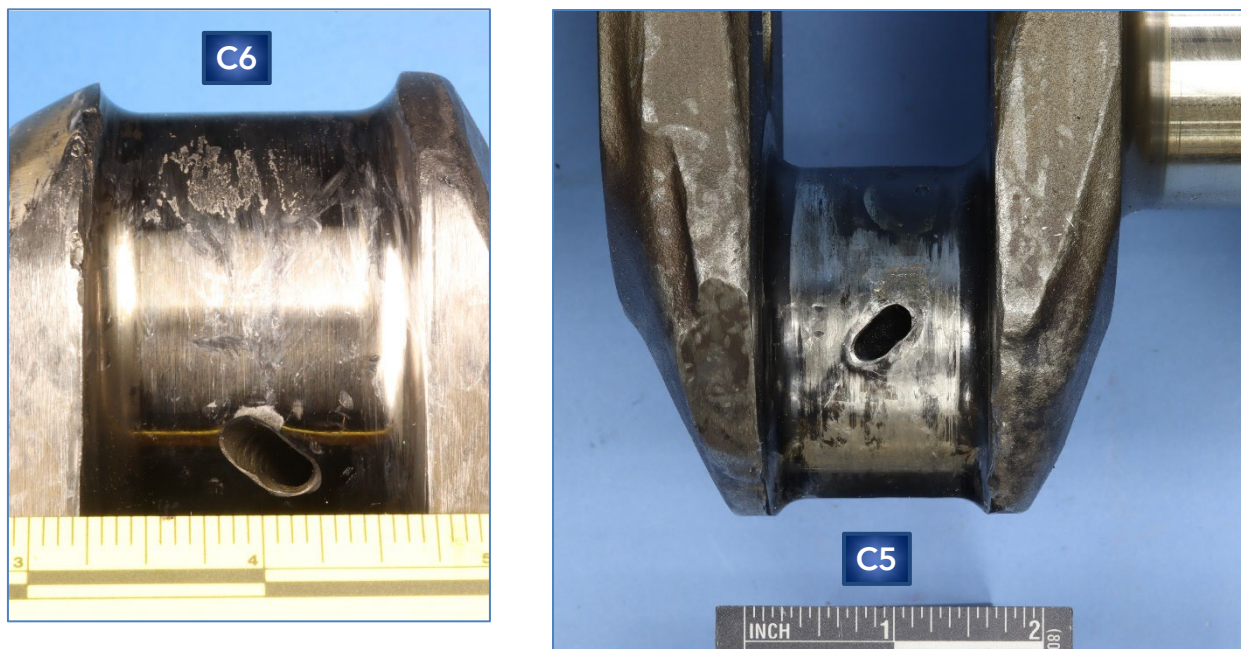


Figure 2. Connecting rod journals C5 and C6.

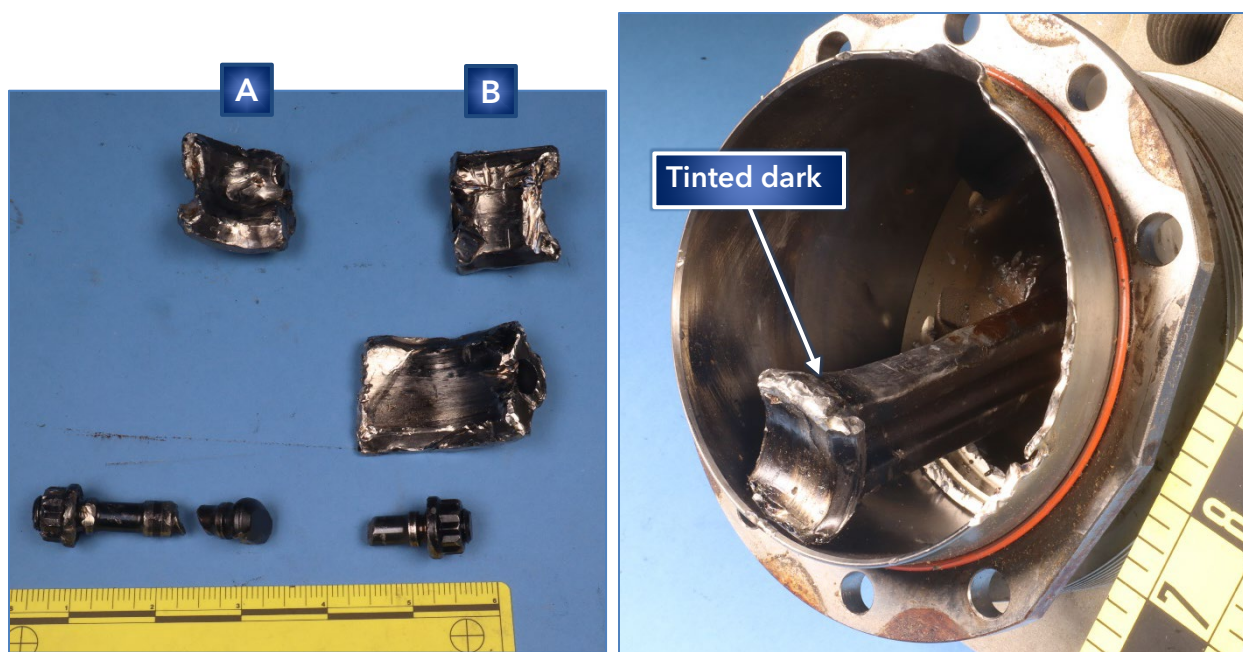


Figure 3. Broken connecting rod in the number 5 cylinder barrel (right image) and closer views of the number 5 connecting rod strap, cap, and attachment bolt pieces (left image). Strap pieces are arbitrarily labeled A and B for reference.

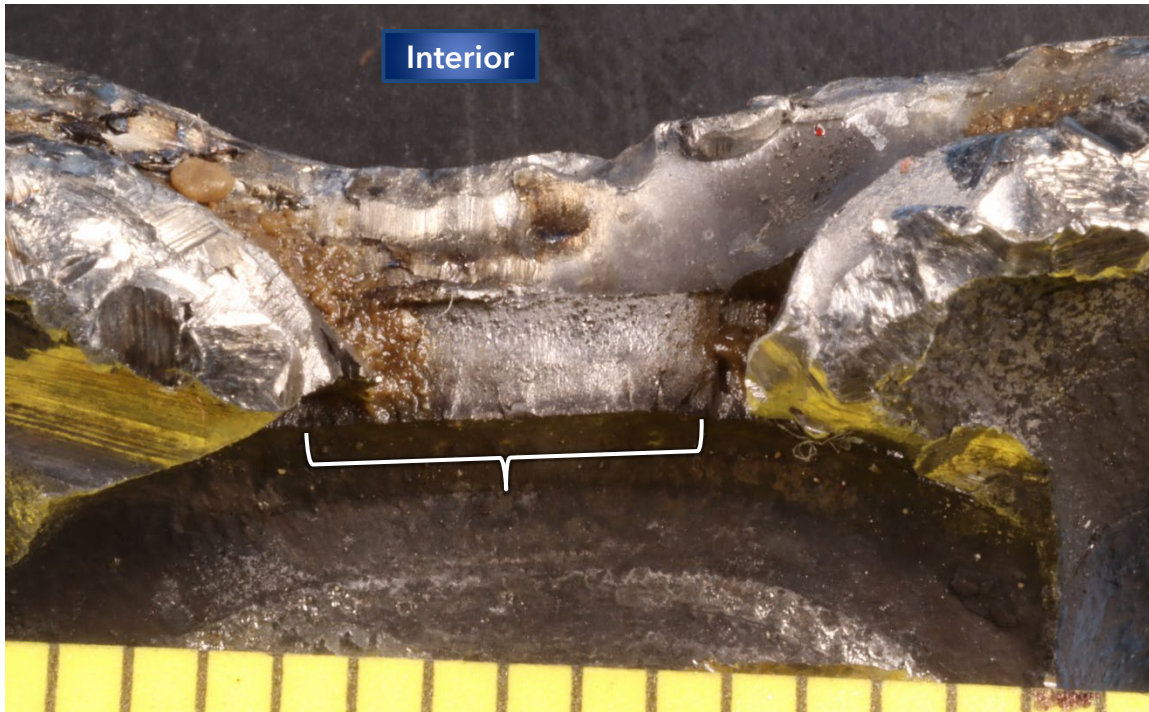


Figure 4. Fracture surface of strap A showing a fatigue region with multiple origins in the bracketed area at the radius of the attachment bolt boss.

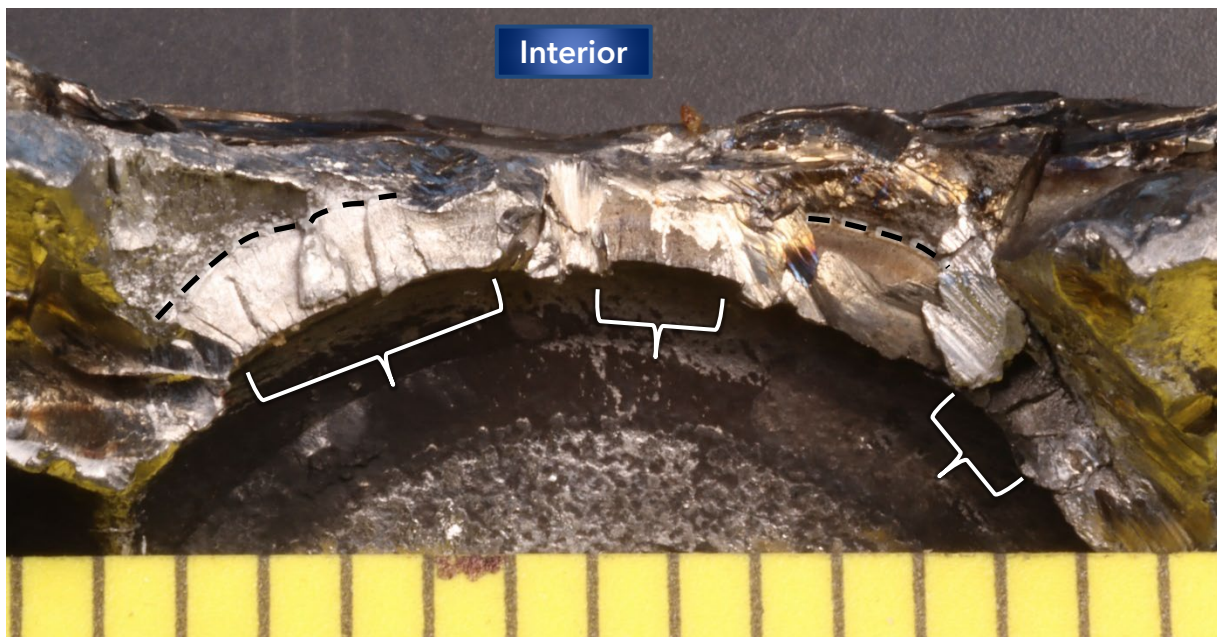


Figure 5. Fracture surface of strap B showing fatigue regions with multiple origins at the radius of the attachment bolt boss. Brackets indicate origin areas, and dashed lines indicate partial fatigue boundaries.