

NATIONAL TRANSPORTATION SAFETY BOARD

Office of Research and Engineering
Materials Laboratory Division
Washington, D.C. 20594



April 14, 2022

MATERIALS LABORATORY FACTUAL REPORT

Report No. 22-018

A. ACCIDENT INFORMATION

Place : Lodi, California
Date : March 3, 2021
Vehicle : Cessna 150J
NTSB No. : WPR21LA121
Investigator : Stephen Stein

B. COMPONENTS EXAMINED

Crankshaft and associated pieces from a Continental O-200 series engine.¹

C. DETAILS OF THE EXAMINATION

Photographs of the as-received crankshaft and associated pieces (#3 piston, fractured #3 connecting rod arm, #3 cylinder and tappets, camshaft, intact push rods for the #3 cylinder, and intact thrush washer halves) are shown in figures 1 through 5. The crankshaft was intact. The #3 connecting rod arm fractured approximately 1 inch from the piston pin (wrist pin) boss area, as shown in figure 1. A small fragment of the bottom skirt fractured from the #3 piston. The fractured portion of the bottom skirt was in the general area that lined up with the rotating motion of the #3 connection rod arm. A portion of the ring from the #3 piston also was fractured. All the connecting rod arms on one side were marked with raised characters "5561" indicating the part number. Connection rod arms "1" through "4" were marked in raised characters "ATLAS 15", "ATLAS 17", "ATLAS 13", "ATLAS", respectively.

Bench binocular microscope examination of the #3 connecting rod arm revealed the fracture face exhibited crack arrest marks typical of fatigue cracking that emanated from one corner of the arm in the area indicated by a bracket in figures 1, 6, and 7.² A large portion the fatigue crack region contained mechanical damage that obliterated major portions of the fatigue crack features. The origin of the fatigue crack exhibited no evidence of mechanical damage, such as a gouge. The surface texture of the arm appeared to be consistent with a shot peened surface. The fatigue crack extended through approximately 40 percent of the arm cross section and terminated in the area indicated by a dashed line in figure 6. The area outside of the fatigue region and the fractures from the remaining parts exhibited coarse texture fracture features on a slant plane consistent with overstress separation.

¹ Engine model from NTSB Aviation Accident Factual Report (source is from SAFTI).

² The cross section of the connecting rod arm has four corners that resembles the cross section of an I-beam.

Visual examination of the #3 piston revealed the outer crown portion contained evidence of heavy combustion deposits (see figure 8) and the internal surface of the corresponding cylinder in the general area of the spark plugs, intake and exhaust valves exhibited similar heavy combustion deposits (figure 9).

Detailed examination of the crankshaft revealed the exposed surfaces of the main journals and the #3 rod journal showed no evidence of scratches, gouges or burn marks. The #1, #2, and #4 connecting rod arms were easily rotated by hand about their respective rod journals. The piston pin for the #3 connecting rod was disassembled and the outer surfaces of the pins showed evidence of oil coverage and no evidence of gouges or burn marks.

A cross section was made through the #3 connecting rod arm in the area indicated by section line "A-A" in figure 1. The prepared cross section was etched with 2% Nital reagent. Examination of the section revealed the arm contained a microstructure of tempered martensite with no evidence of a decarburizing layer at the surface.

Prepared by:

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Senior Metallurgist

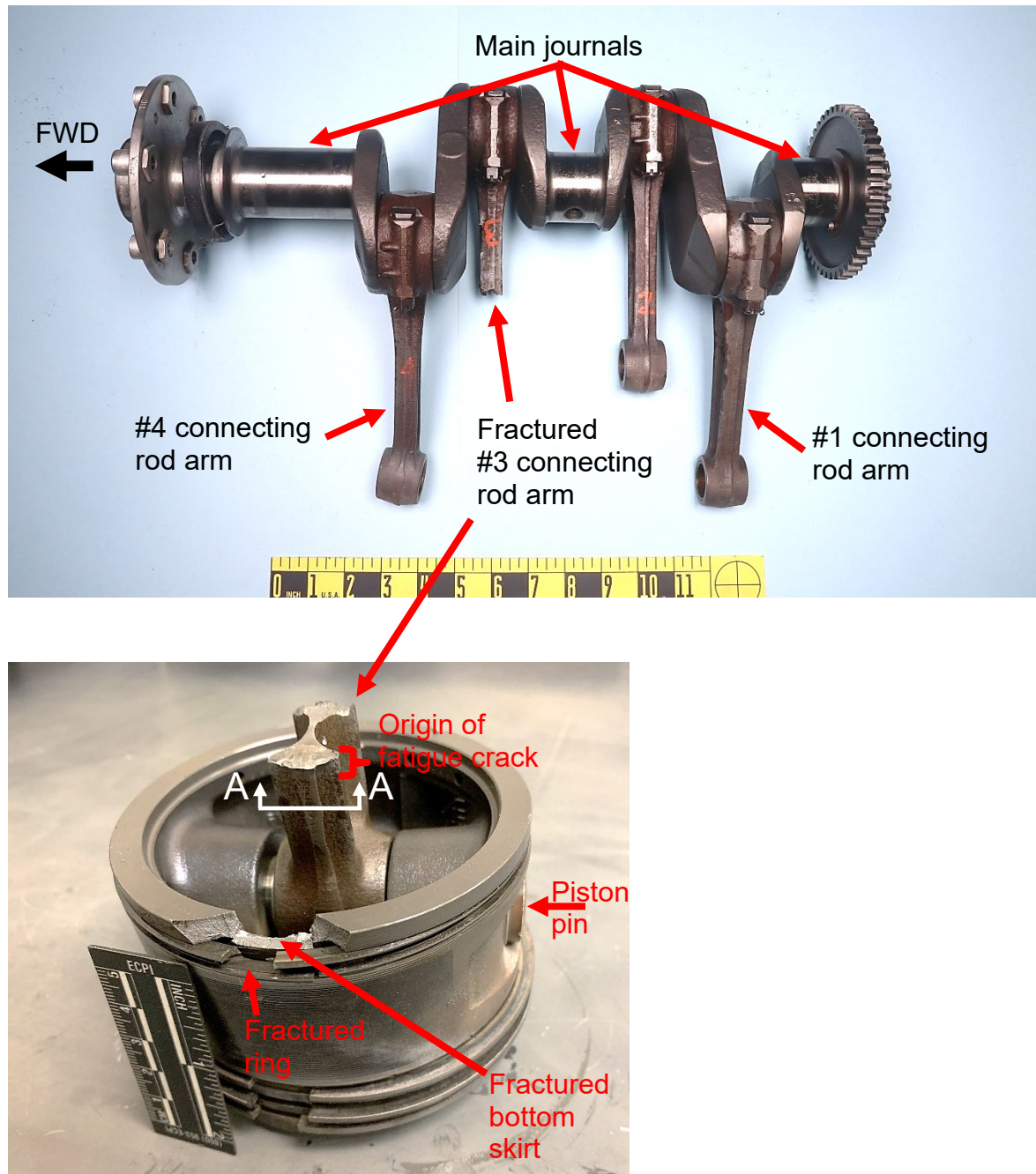


Figure 1. As-received crankshaft with fractured #3 connecting rod arm (top of page); and mating fracture of the #3 connecting rod arm (bottom of page). The #3 connecting rod arm fractured approximately 1 inch from the piston pin boss area.

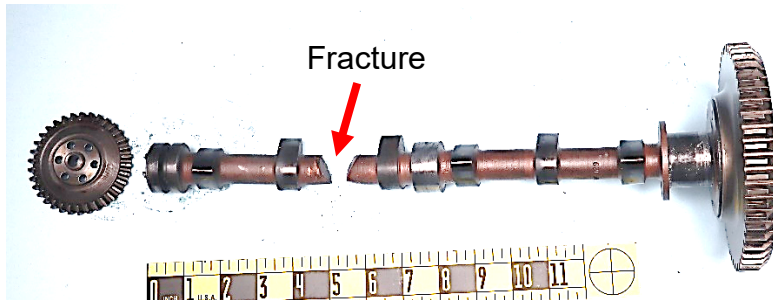


Figure 2. As-received fractured camshaft.



Figure 3. As-received #3 cylinder. Push rods are in the background and are not visible.



Figure 4. As-received tappets for the #3 cylinder. One of the tappets fractured at the shank portion.

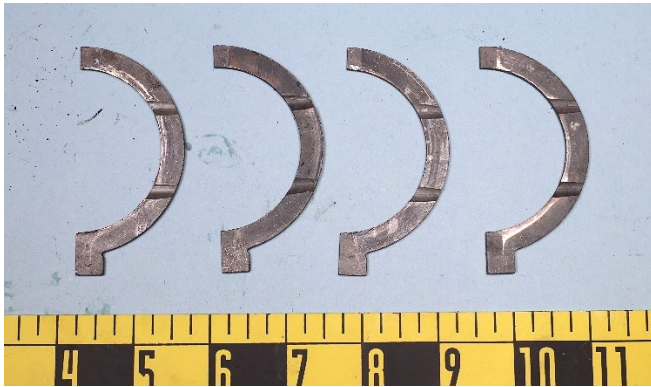


Figure 5. As-received thrush washer halves.

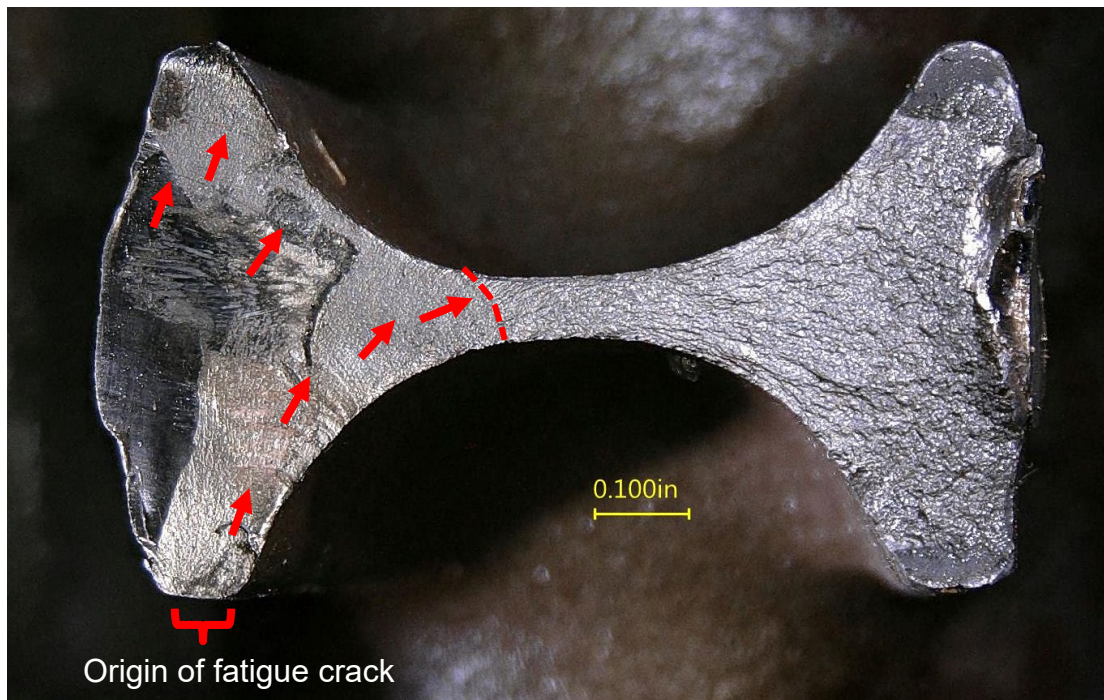


Figure 6. Fracture face from the #3 connecting rod arm (view looking at the piston side of the fracture face). A fatigue crack emanated from the bottom left corner. Fatigue propagation was in the general direction indicated by arrows and terminated in the area indicated by a dashed line. The dark-luster region on the left of the photograph is post-fracture impact damage.

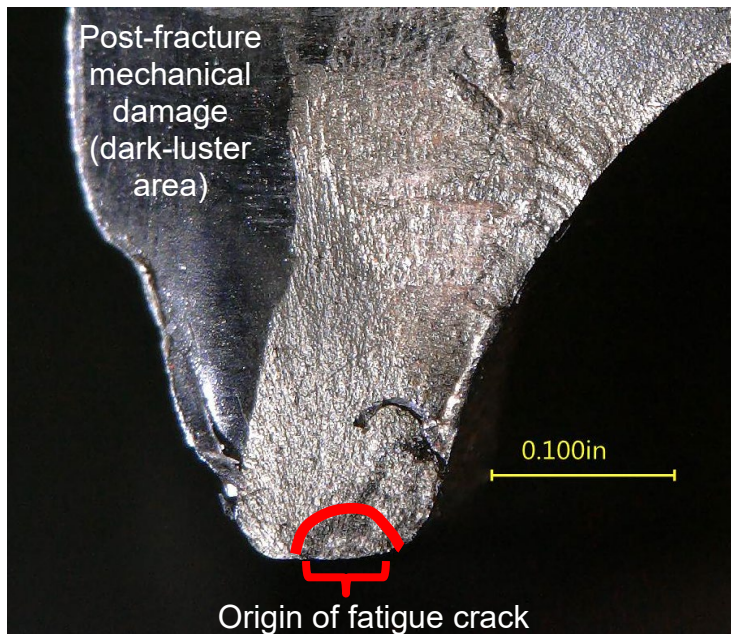


Figure 7. Close-up photograph of the fatigue crack origin area. A semi-spherical dark tinted band is located outside of the origin in the general area indicated by a solid line.



Figure 8. Photograph of the #3 piston showing heavy combustion deposits on the outer surface of the crown portion.



Figure 9. Photograph of the #3 cylinder inner surface showing heavy combustion deposits in the general between the spark plugs, intake and exhaust valves.