

NATIONAL TRANSPORTATION SAFETY BOARD

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



November 20, 2017

MATERIALS LABORATORY FACTUAL REPORT

Report No. 17-083

A. ACCIDENT INFORMATION

Place : Tahlequah, Oklahoma
Date : July 30, 2017
Vehicle : Piper PA-46, N786MD
NTSB No. : CEN17LA292
Investigator : Jim Silliman, AS-CEN

B. COMPONENTS EXAMINED

Through bolts, 1 through bolt nut, and 2 pieces of engine case from a Lycoming TIO-540-AE2A engine.

C. DETAILS OF THE EXAMINATION

An overall view of the submitted components is shown in figure 1. The components included 2 pieces of the crankcase with two fractured cylinder attachment studs. Two of the eight submitted through bolts were also fractured.

Optical images of the fracture surfaces on the cylinder attachment studs are shown in figures 2 and 3. Crack arrest lines and ratchet marks¹ were observed on the stud fracture surfaces, features consistent with fatigue with multiple origins in the areas indicated with brackets in figures 2 and 3. Fracture features in the fatigue regions had a relatively rough appearance consistent with relatively high cyclic stresses.

Optical images of the fracture surfaces on the two fractured through bolts are shown in figures 4 and 5. Relatively smooth areas oriented transverse to the bolt axis were observed on one side of the thread consistent with fatigue fracture. Brackets in figures 4 and 5 indicate approximate fatigue origins. The fatigue regions in each case transitioned to rougher matte gray features with a shear lip at the side opposite from the fatigue origin, features consistent with overstress fracture across the majority of the cross section.

The machined surfaces of the crank case pieces, including the cylinder attachment flange, the crank case split line, and the cam shaft bore surfaces, all had a gritty or frosted visual appearance. When viewed under an optical stereoscope, the surfaces were rough

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

with generally semispherical pits or craters. Close views of the machined surfaces showing the pits and crater-like features are shown in figures 6 through 9.

Crater-like features were also observed on the stud threads as shown in figure 10. The threads on the through bolts were free from pits or crater-like features.

The threads of the through-bolt nut appeared to be intact but were covered in oxides. In one segment of the internal circumference, oxides and deposits filled the area of the threads between the thread peaks.

In the section relating to cleaning of the crankcase, the overhaul manual for the accident engine states as follows,²

When grit-blasting parts[,] do not use sand or any metallic abrasives. It is recommended instead that mildly abrasive organic substances such as rice, baked wheat, plastic pellets, or crushed walnut shells be used. All machined surfaces must, of course, be adequately masked...

Matthew R. Fox, Ph.D.
Senior Materials Engineer

² *Overhaul Manual – Avco Lycoming Direct Drive Aircraft Engines*, Revision 14, Lycoming Engines, Williamsport, Pennsylvania (July 2011).

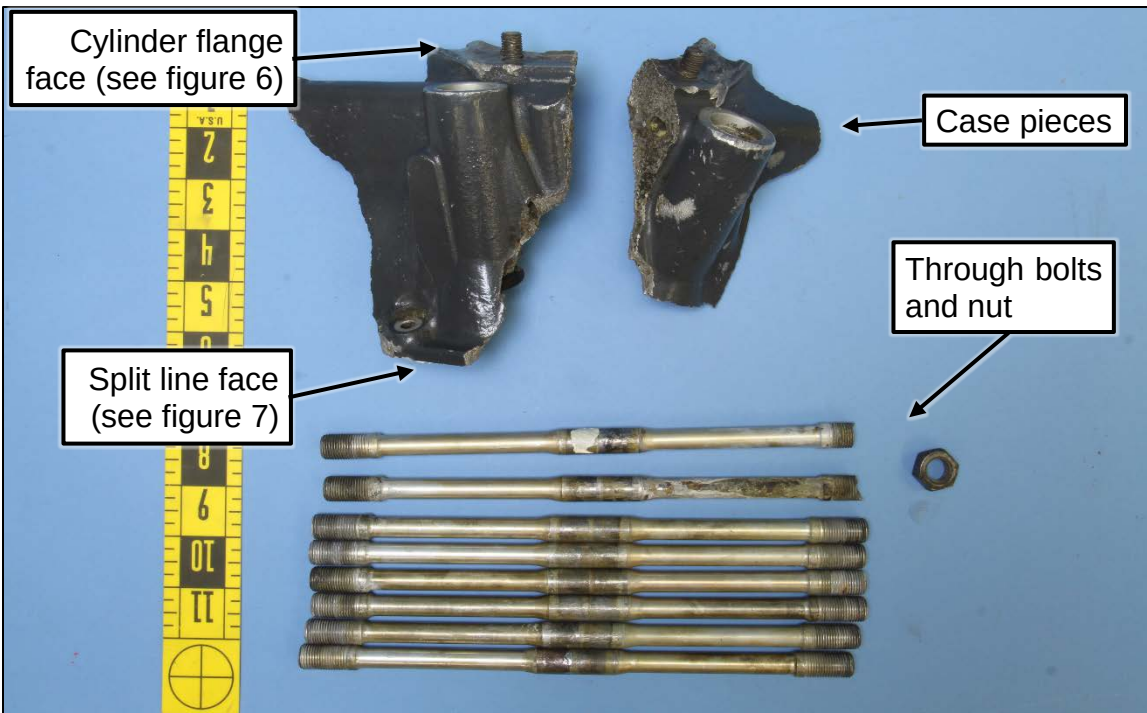


Figure 1. Overall view of the submitted components.

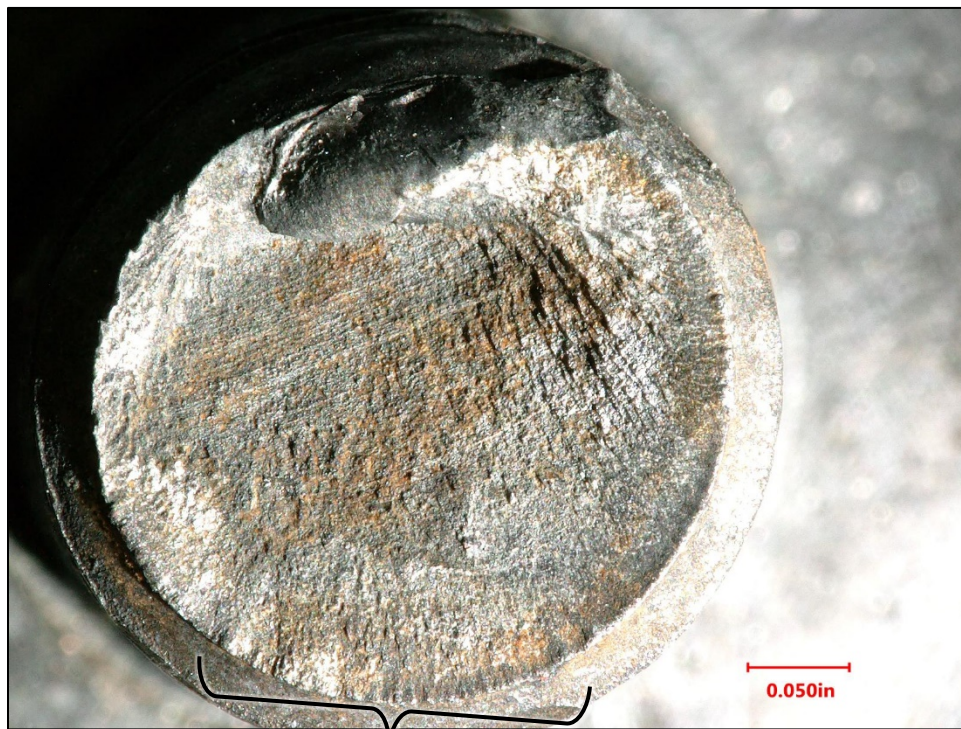


Figure 2. Fracture surface on one of the studs. A bracket indicates the approximate fatigue origin area.



Figure 3. Fracture surface on one of the studs. A bracket indicates the approximate fatigue origin area.



Figure 4. Fracture surface on one of the through bolts. A bracket indicates the approximate fatigue origin area.

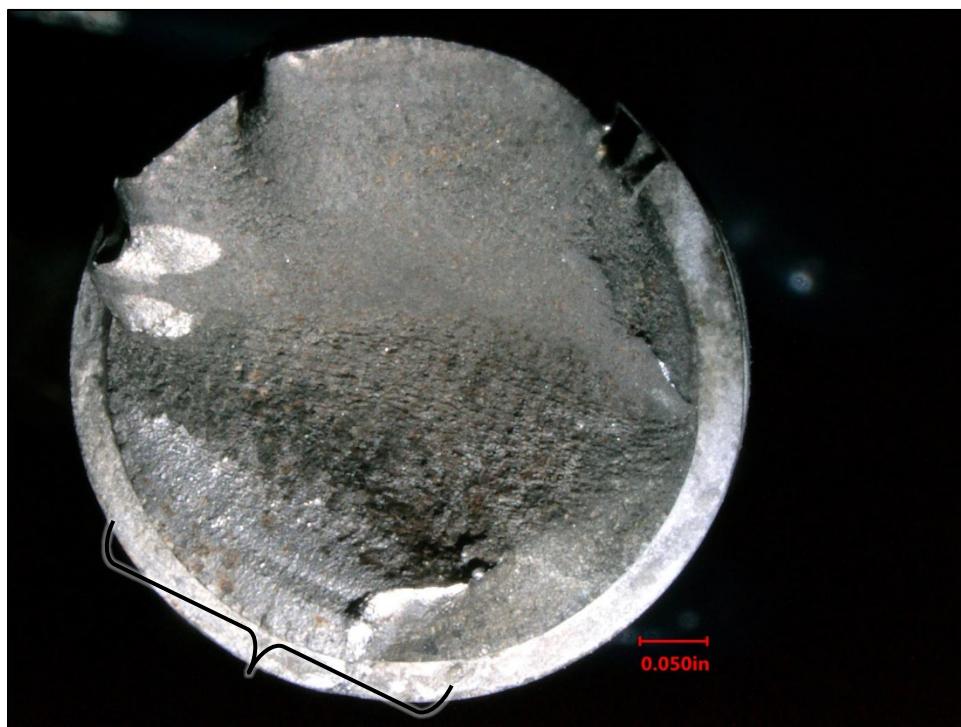


Figure 5. Fracture surface on one of the through bolts. A bracket indicates the approximate fatigue origin area.



Figure 6. Magnified optical image of the cylinder flange contact face illuminated with low-angle lighting from the right side of the image.



Figure 7. Magnified optical image of the case split line contact face illuminated with low-angle lighting from the right side of the image.

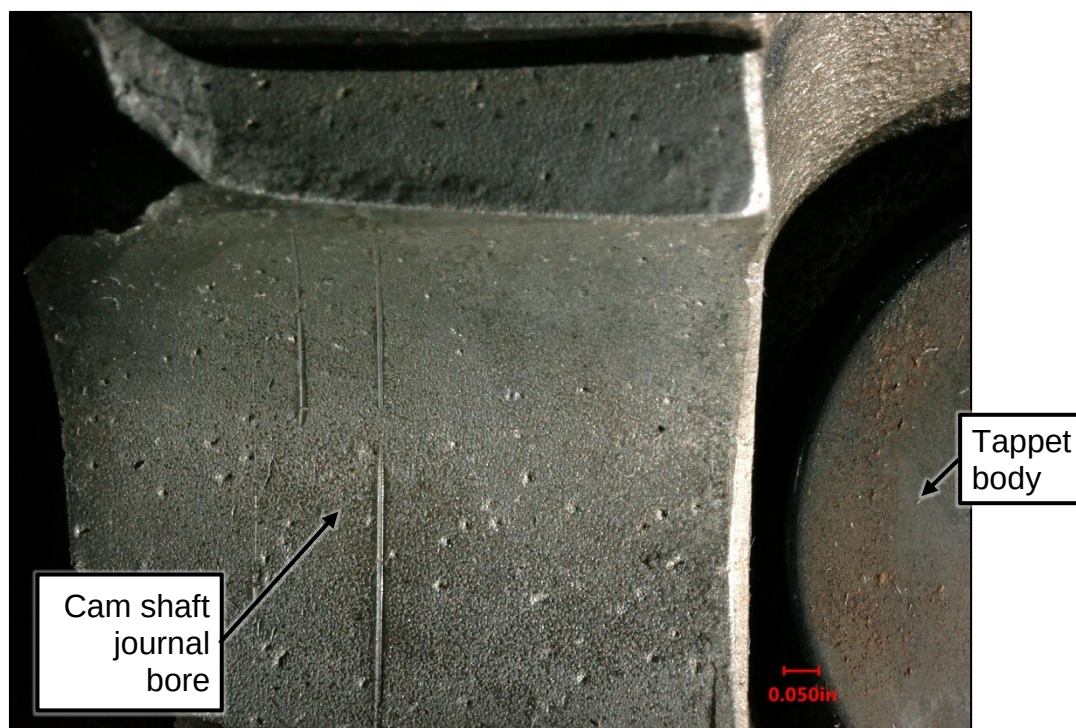


Figure 8. View of the case interior showing the cam shaft journal bore.

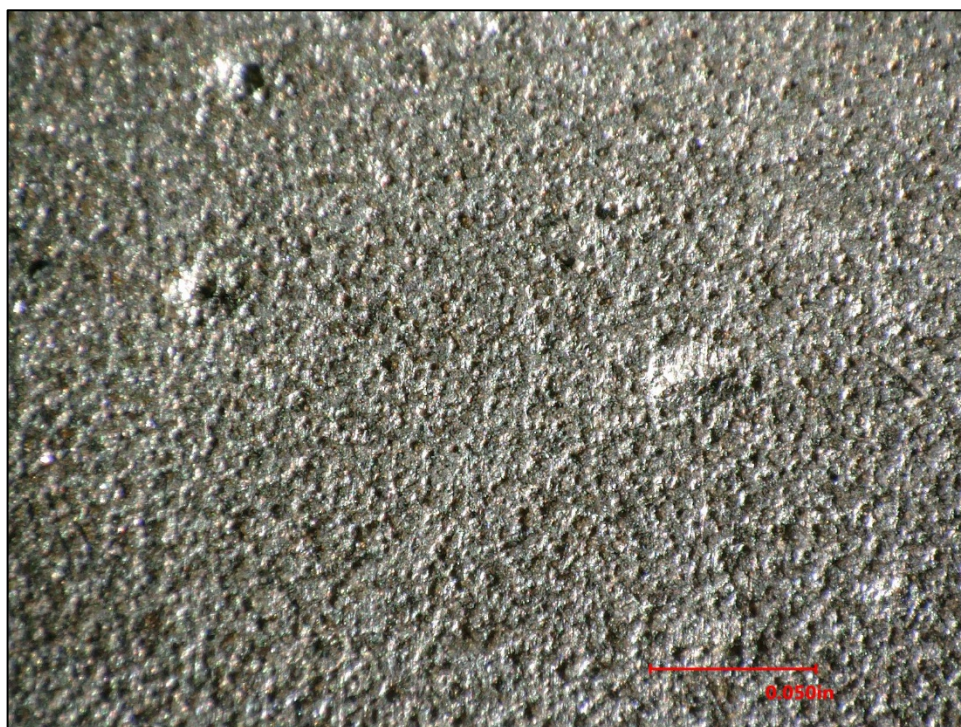


Figure 9. Magnified optical image of the cam shaft journal bore surface illuminated with low-angle lighting from the right side of the image.

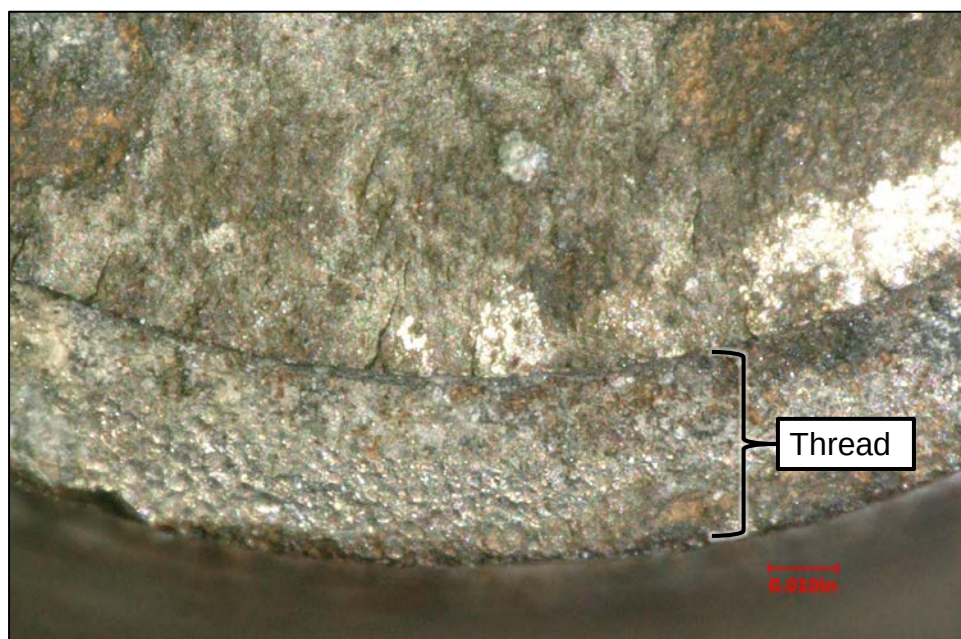


Figure 10. Magnified optical image of the stud shown in figure 3 illuminated with low-angle lighting from the upper side of the image.