

NATIONAL TRANSPORTATION SAFETY BOARD

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



February 27, 2014

MATERIALS LABORATORY FACTUAL REPORT

Report No. 14-005

A. ACCIDENT INFORMATION

Place : Panama City Beach, Florida
Date : March 18, 2013
Vehicle : Piper PA-25-235, N86AB
NTSB No. : ERA13LA174
Investigator : Dennis Diaz, ASI-ERA

B. COMPONENTS EXAMINED

Components from a Lycoming engine: Model No. O-540-B2C5-C-A1D5, S/N RL-12666-40;

- 1) Crankshaft;
- 2) Crankshaft gear, P/N: 67514;
- 3) Crankshaft gear alignment dowel, fractured;
- 4) Crankshaft gear retaining bolt;
- 5) Crankshaft gear lockplate.

C. DETAILS OF THE EXAMINATION

A crankshaft from a Lycoming engine (model and serial numbers given above) was submitted to the Materials Laboratory as shown in figure 1a. The connecting rods had been removed and the crankshaft gear was still attached. There were no signs of thermal or mechanical distress on any of the main bearing or connecting rod journals.

Two views of the crankshaft gear are shown in figures 2a and b. The crankshaft gear sits inside a counterbored pilot hole in the aft end of the crankshaft. The gear is pressed against the face of the recess by a bolt that engages a threaded hole in the end of the crankshaft. A lockplate is installed between the bolt and the gear with ears that fold down against the side of the gear and up against the head of the bolt. The gear is rotationally aligned to the crankshaft by an alignment dowel. The alignment dowel was fractured as shown in figures 2a and 2b. One end of the dowel was retained inside the alignment hole in the gear and the other end was press-fit and retained in the end of the crankshaft. Based on the rotational misalignment of the two dowel halves, the gear had rotated approximately 45° counterclockwise relative to the crankshaft. The lockplate had also rotated in the counterclockwise direction, but to a lesser degree.

The retaining bolt was removed and then the gear was removed. There were no visible discrepancies with the retaining bolt. One of the threads contained a soft dark

material consistent with an anti-seize compound. The bolt was turned into the threaded hole until it nearly bottomed out. The bolt could be turned with fingers up to the thread containing the compound at which point the compound provided some resistance to further insertion (approximately 3.5 in-lbs measured using a torque wrench). Over the area where the gear had been in contact with the face of the pilot hole recess the surface exhibited circumferential scratch marks and had transferred metal adhered to it, as shown in figure 3. The mating face of the gear, shown in figure 4a, exhibited corresponding scratches and gouges, consistent with galling.

The dowel fracture surface was examined on the piece of the dowel that was retained in the alignment hole. The fracture surface had a comparatively flat appearance and exhibited multiple crack arrest marks, several of which are indicated by yellow-dashed lines shown in figure 4b. The morphology of the fracture surface was consistent with a fatigue fracture. The curvature of the crack arrest marks was consistent with the fatigue fracture originating along the surface of the dowel in the area indicated in figures 4b. The fracture features were compared with the mating dowel piece retained in the crankshaft. The comparison indicated the fracture initiated along the clockwise face of the dowel (leading face in the direction of rotation), as indicated in figure 3 and that the dowel fragment retained in the gear alignment hole (shown in figure 4b) had rotated by approximated 180°.

Diameters on the gear, pilot hole, and alignment dowel were measured and compared with the dimensional limits in Lycoming Service Bulletin No. 475C (Lycoming, 2003). The diameter of the pilot flange on the gear was measured three times using a micrometer and the values were 2.1253 inch, 2.1254 inch, and 2.1257 inch. According to the service bulletin, the original dimension of the flange is 2.1250 inch – 2.1255 inch. The diameter of the counterbored pilot hole recess was measured three times using calipers and the values were 2.1270 inch, 2.1275 inch, and 2.1275 inch. According to the service bulletin, if the pilot hole diameter exceeds 2.1262 inch, the diameter should be plated and reground to 2.1250 inch – 2.1260 inch. The reduced diameter on the stepped dowel could only be measured at one location and it measured 0.2504 inch with a micrometer. According to the service bulletin, the original dimension of the dowel is 0.2505 inch – 0.2510 inch.

The hardness of the gear and the alignment dowel were each measured using a Rockwell hardness tester. The gear was placed directly on the stage and the hardness measurements were 38.2 HRC and 37.9 HRC. The piece of the alignment dowel that was retained in the gear was removed from the gear and mounted in a thermosetting compound. The flat end of the dowel was then ground using silicon carbide grinding papers through 600 grit prior to hardness testing. The measured hardness values were 29.7 HRC, 29.8 HRC, and 30.1 HRC. All of the hardness measurements met the material requirements.

According to the engine log book, the engine was removed from another airframe in 2008 after a propeller strike and it received an overhaul on April 9, 2010 at which time the crankshaft gear was removed from the crankshaft, serviced, and reinstalled in

accordance with Lycoming Service Bulletin No. 475C, excluding paragraph 6. At the last inspection on February 22, 2013 the engine had accumulated 4802.6 hours total (TTE) and 1371.5 hours since the 2010 overhaul (SMOH).

D. REFERENCES

Lycoming (2003). *Service Bulletin No. 475C – Crankshaft Gear Modification and Assembly Procedures*, Lycoming, Williamsport, PA.

Donald Kramer, Ph.D.
Sr. Materials Engineer

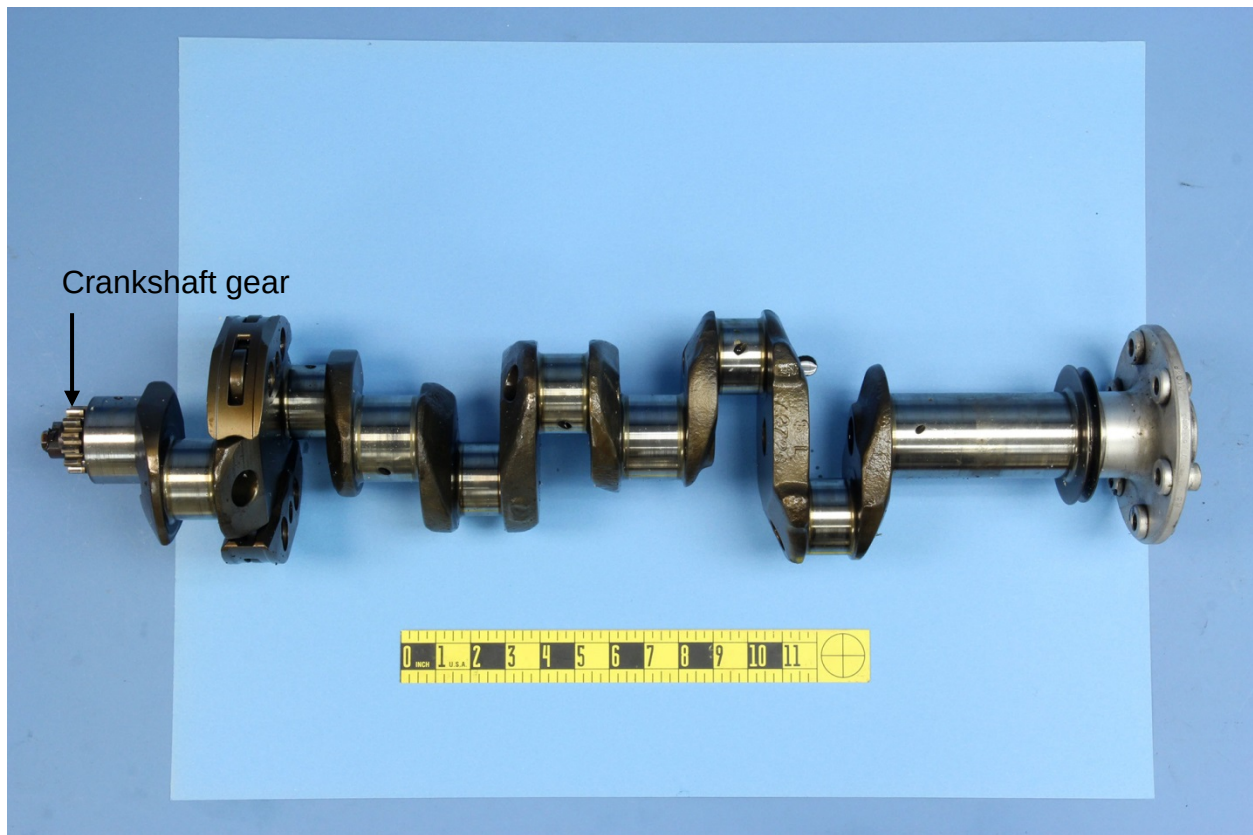


Figure 1: Crankshaft from the Lycoming engine as it was received by the lab.

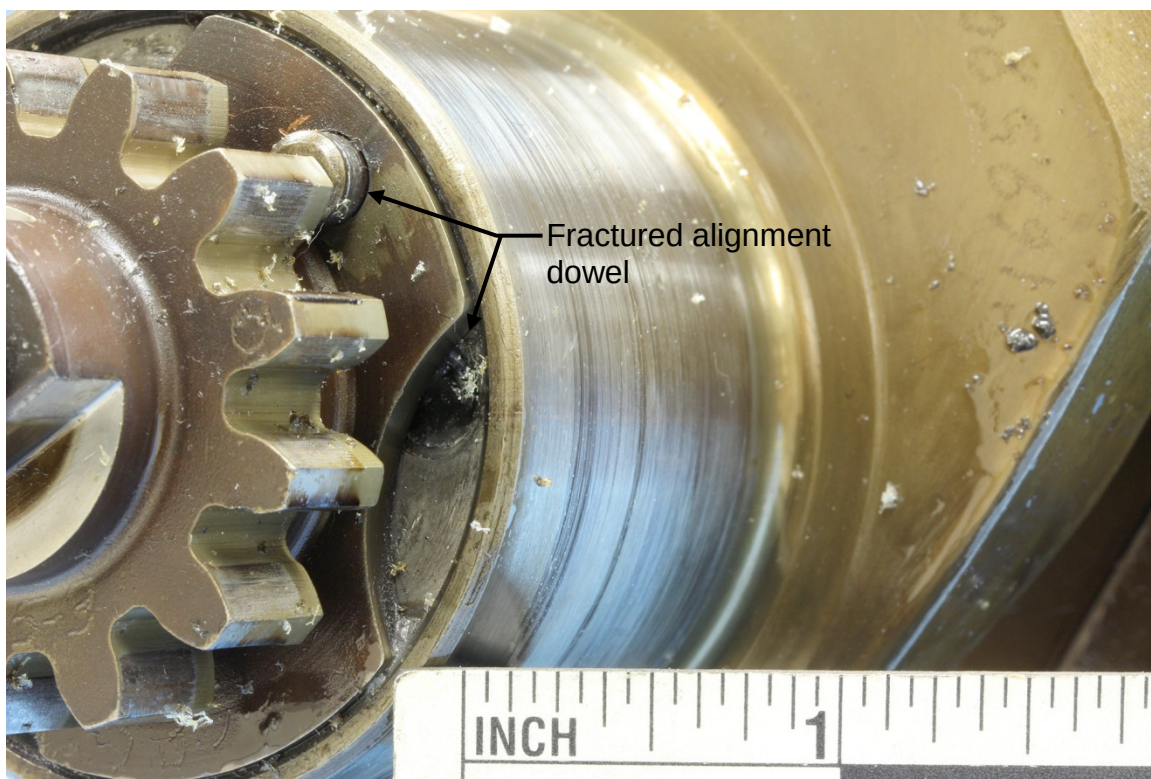
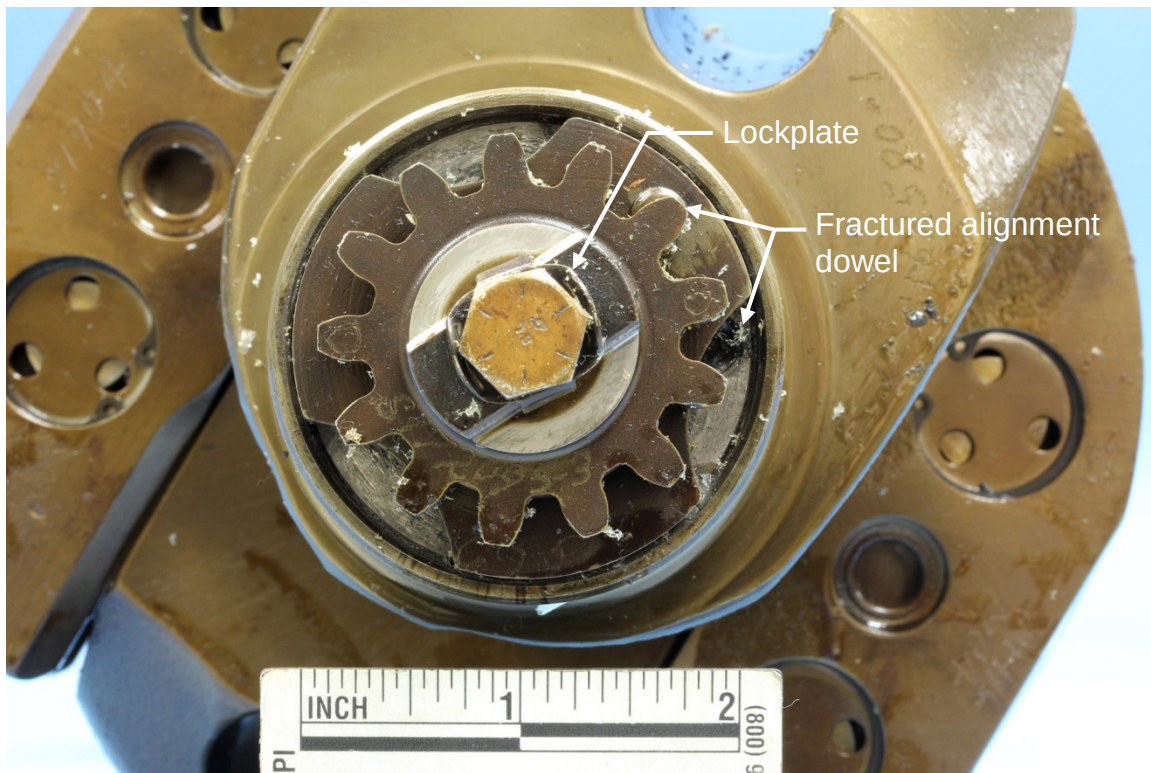


Figure 2: a) axial view of the crankshaft showing the relative rotation of the gear and the lockplate relative to the crankshaft and b) off-axis view showing the two halves of the fractured alignment dowel.

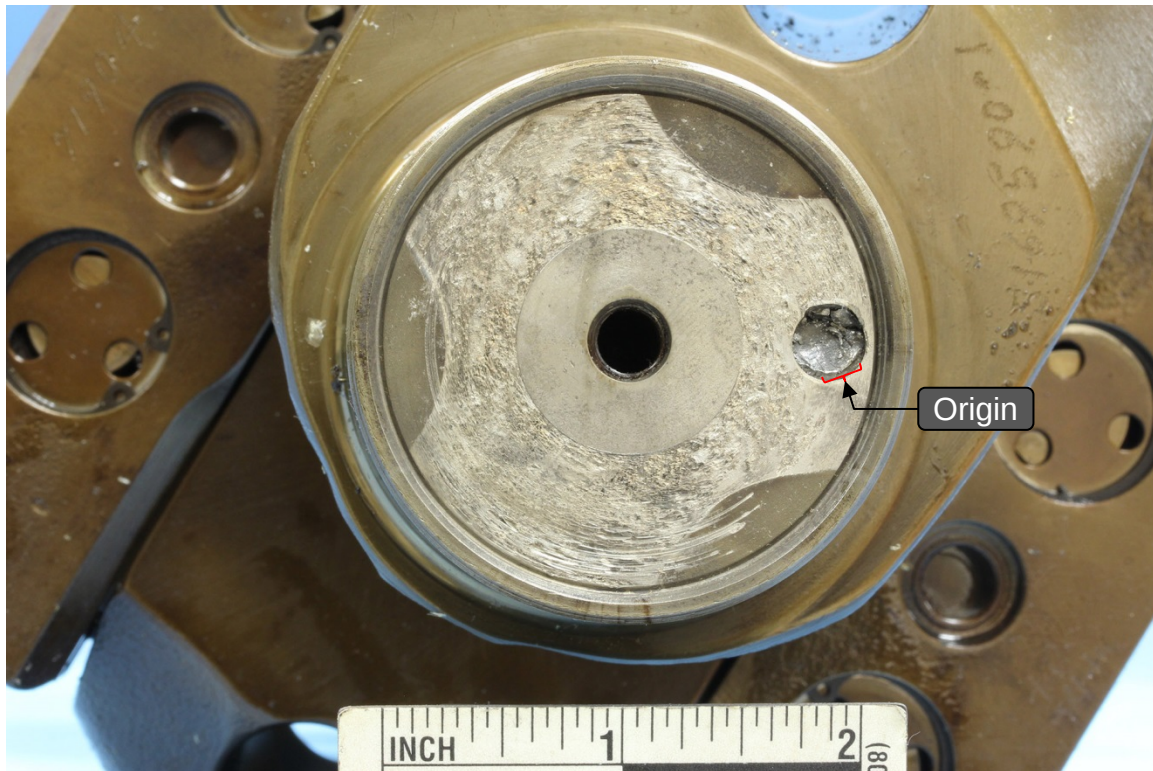


Figure 3: Image of the counterbored pilot hole after the crankshaft gear had been removed. In the area where the gear had been in contact with the face of the pilot hole, the surface exhibited scratch marks and adhered material.



Figure 4: a) Image of the face of the crankshaft gear that mates with the face of the counterbored pilot hole and b) image of the fractured alignment dowel. Crack arrest marks were observed and the fracture had a flat appearance, consistent with a fatigue fracture. The piece of the dowel rotated approximately 180° after it fractured.