NATIONAL TRANSPORTATION SAFETY BOARD

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

June 26, 2015

MATERIALS LABORATORY FACTUAL REPORT

Report No. 15-071

A. ACCIDENT INFORMATION

Place	:	Littleton, North Carolina
Date	:	June 27, 2014
Vehicle	:	Cessna 182Q
NTSB No.	:	ERA14FA313
Investigator	:	Eric Alleyne, AS-ERA

B. COMPONENTS EXAMINED

Crankcase, crankshaft with 2 attached connecting rods, camshaft, accessory gears, crankcase through-bolts, and bag containing pieces of connecting rod assemblies, piston assembly, tappet assemblies, and crankcase from a P. Ponk O-470-50 engine.

C. DETAILS OF THE EXAMINATION

Overall views of the interior surfaces of the engine case halves are shown in figure 1. The data plate on the exterior of the right engine half indicated the engine was a P. Ponk O-470-50 engine modified from a Continental O-470 series engine in accordance with Supplemental Type Certificate SE 4985 NM. The engine was reportedly overhauled, modified, and reassembled in 2010, and had about 300 hours time in service since overhaul. In this report, cylinder positions and crankshaft journals are numbered from back to front in accordance with the Continental Engines numbering convention.

The engine case halves showed impact damage in the vicinity of the numbers 1, 2, 5, and 6 cylinder locations, including holes in the crankcase above the numbers 2, 5, and 6 cylinder bores. Metallic debris was scattered throughout the interior surfaces. Gray-colored sealant with silk thread was observed around the perimeter of the mating crank case halves. A bead of sealant was observed at the edges of the mating surfaces both on the interior and exterior edges of the mating faces.

A close view of the number 2 main bearing lower saddle boss on the left crankcase is shown in figure 2. Pieces of the number 3 main bearing on the crankshaft are also visible at the top half of figure 2. A dark gray cross-hatch pattern was observed on the saddle boss surface corresponding to fine machining marks on the surface of the saddle boss. A bead of gray sealant was observed at the edge of the saddle boss, and the surface of the bead was stained dark brown or black. The dark gray material on the surface of the saddle boss was easily scraped from the surface by rubbing with a gloved finger or finger nail.

Each of the saddle bosses for the crankshaft had features similar to that shown in figure 2 with a gray cross-hatch pattern with a bead of sealant at the edges of the boss mating surfaces (see figures 3 and 4). No evidence of fretting damage was observed on the main saddle bosses. Some segments of the sealant beads remained attached to the left crankcase half, while other segments remained attached to the right crankcase half. No attempt was made to determine if and segments of the bead were either discontinuous or fractured from both sides.

A view of the number 4 and 5 main journal bearings on the left crankcase half after removal of the crankshaft is shown in figure 3. As with the other saddle bosses, the dark gray cross-hatch pattern was observed, and sealant was observed around the edges of the mating saddle boss contact surface. The closer view of the number 4 main bearing upper saddle boss shows a bead of sealant that was observed around the edge of the saddle boss. Additional sealant was observed in the gap between the saddle boss and the thrust washer and in the gap between the bearing and the saddle within the bearing tab slot.

Views of the number 1 main bearing saddle on the left crankcase half after removal of the main bearing are shown in figure 4. As with the other saddle bosses, the dark gray cross-hatch pattern was observed, and sealant was observed around the edges of the mating saddle boss contact surface. The close view of the upper saddle area (image at the right in figure 4) shows the presence of sealant within the bearing tab slot and within the oil slot.

Beads of sealant were observed around the edges of the lower bosses of the camshaft journal saddles. Some fretting damage was observed on the camshaft saddle bosses for the numbers 3 and 4 camshaft journals.

Bearings for each of the main journals were removed, and the underlying saddle condition was examined. The number 1 main bearing saddle showed crushing and rub damage on the aft 2/3 of the saddle. The aft side of the tab slot was worn consistent with the bearing shifting aft relative to the saddle. The number 2 main bearing saddle showed heavy sliding contact damage where oil porting holes were nearly closed over with deformed metal and bearing tab slots were obliterated. The tab slot on the number 3 main bearing saddle was widened consistent with bearing shift forward and aft, and bearing tab impressions were observed on the saddle bosses. The numbers 4 and 5 bearing saddles showed the least amount of damage, but bearing tab impressions were observed on the saddle bosses consistent with heavy contact with the bearing tabs.

All main bearings showed evidence of circumferential scoring and contamination on the bearing surfaces. The most extensive damage was to the number 2 main bearing, followed by the number 1 and number 3 main bearings. Part numbers on the number 2 main bearing halves were missing, but all other main bearings were marked “12-07L” “FAA-PMA” “SA642839M10” “GVBS VP3N”.

Each number 2 main bearing half was fractured circumferentially near the middle of the bearing. The Babbitt and copper alloy layers of the bearings were missing, leaving only the steel backing material. The surfaces of the bearing pieces were tinted gold, brown, and black with coked oil present on portions of the surfaces.

Most of the Babbitt layer was missing from the number 1 main bearing, exposing the underlying copper alloy layer. One half of the number 1 main bearing had a circumferential crack near the middle of the bearing intersecting the 3 oil holes in the bearing. The crack branched out to the forward edge of the bearing where a triangle-shaped piece of the bearing was missing. The back of the tab on the cracked number 1 bearing half was worn. Fretting contact damage was observed on the split line contact faces of the bearing halves.

Most of the Babbitt layer was missing from the numbers 3, 4, and 5 main bearings, exposing the underlying copper alloy layer. The bearing tabs on the number 3 bearing halves were worn consistent with bearing movement within the saddles. Some fretting contact damage was observed on one mating pair of the split line contact faces of the bearing halves for the number 3 main bearing.

An overall view of the crankshaft is shown in figure 5. Markings on the side of the propeller flange included “R45707-1” “M010MP” “RN R93/U”. The crankshaft was intact, and the number 3 and 4 connecting rod assemblies remained attached to their respective journals. The sides of the connecting rods were identified with “646126F A16”. Oil tubes in the cheeks between the main journals and the adjacent connecting rod journals were visually examined and appeared to be intact.

The main journals showed varying levels of circumferential scoring and heat damage. The number 2 main journal was tinted black and showed relatively heavy scoring with coked oil and debris on the surface. Relatively shallow circumferential scoring damage was observed on the numbers 1, 3, 4, and 5 main journals. The numbers 1 and 3 main journals had areas tinted blue and gold, and the numbers 4 and 5 main journals had some areas with gold tint.

The diameters of the number 4 and 5 main journals was measured using a micrometer at orthogonal positions on each journal. The diameter of the number 4 main journal measured 2.3652 inches for each of the two measurements. The diameter of the number 5 main journal measured 2.3649 inches for each of the two measurements on that journal.

The connecting rod journals on the crankshaft also showed varying levels of scoring and heat damage. The number 1 connecting rod journal was tinted black with areas of red oxides. The surface of the number 1 connecting rod journal was smeared consistent with flowed metal. The number 2 connecting rod journal was tinted black and gray and also had a smeared surface consistent with flowed metal.

The numbers 3 and 4 connecting rods were not removed. However, the exterior of the number 3 connecting rod was tinted gray and included areas with red oxides at the crankshaft end, was tinted red, black, and dark brown in the middle portion, and was tinted brown at the piston end. The exterior of the number 4 connecting rod was tinted black at the crankshaft end and brown at the middle portion and piston end.

The number 5 connecting rod journal had the least circumferential scoring damage with a light gold tint. Heavy impact damage was present on one quadrant of the number 5 connecting rod journal. The diameter of the number 5 connecting rod journal was 2.2402 inches.

The number 6 connecting rod journal was tinted black and had circumferential scoring and debris on the journal surface. Impact damage was also present on the number 6 connecting rod journal.

An overall view of the camshaft is shown in figure 6. Lobe damage was observed on some of the cams consistent with foreign object damage in areas where the crankcase was also damaged. Each of the camshaft journals showed circumferential scoring damage.

The contents of the bag containing pieces from connecting rod assemblies, a piston assembly, tappets, and crankcase were examined visually. An overall view of connecting rod pieces sorted from the bag is shown in figure 7. The piston end and middle portion of one connecting rod was included in the bag as shown in figure 7 (piece labeled connecting rod). The connecting rod was fractured through the yoke at the crankshaft end and was tinted black in the area adjacent to the fracture. The bag also included cap and yoke pieces from 4 connecting rods shown in figure 7. One cap was intact and showed no substantial heat tinting, although it did have impact damage. Two of the yoke pieces also showed little evidence of heat tint. The remaining cap and yoke pieces showed varying levels of elevated heat exposure with dark brown and black tints. Connecting rod nuts and bolts also showed heat tints consistent with exposure to elevated temperature. All fractures of the connecting rod nuts, bolts, cap, and yoke pieces were consistent with overstress fracture.

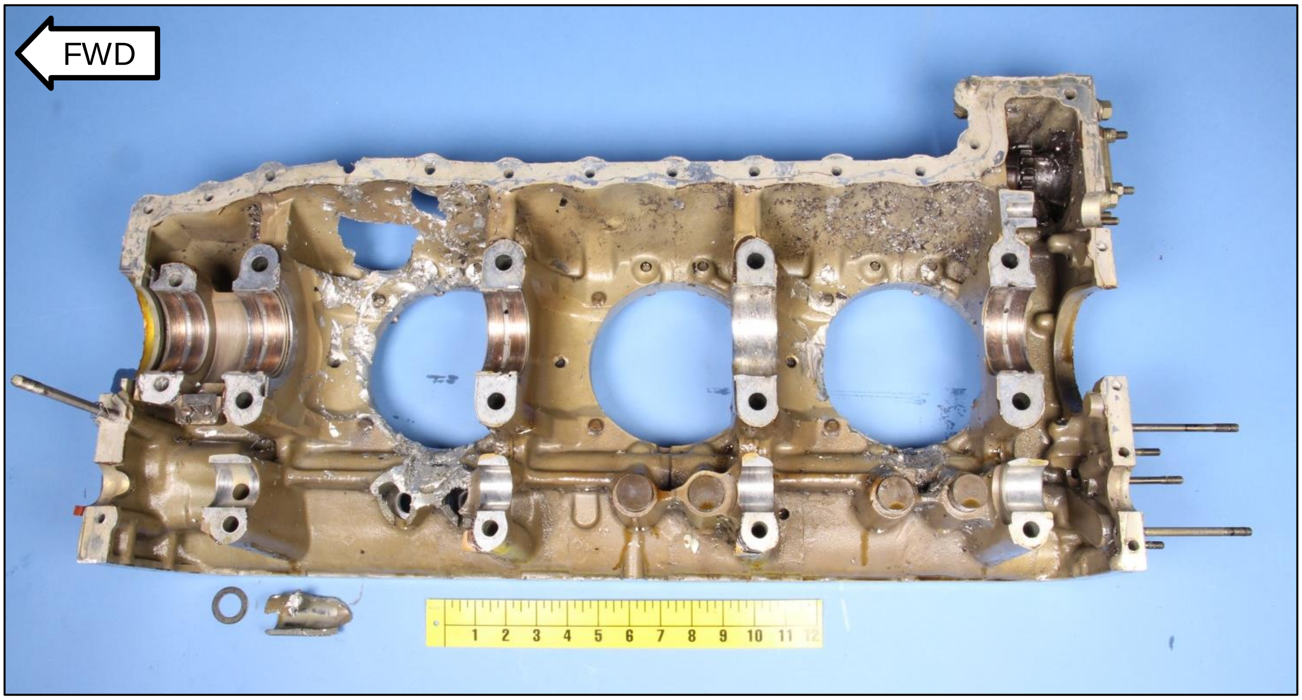
Connecting rod bearing pieces from the bag are also shown in figure 7. Two of the bearing pieces were intact with Babbitt material on the surface. The back of the intact bearing pieces were marked “11-09” “SA630826M10” “FAA-PMA” “GVBS VP3N”. The remaining bearing pieces consisted of fractured, bent, and thinned steel backing material with a black tint.

An overall view of the crankcase through-bolts is shown in figure 8. Gray sealant material was observed on the shanks of most of the through-bolts.

According to P. Ponk Aviation Service Information Letter 001, dated September 24, 2002,[1] the P. Ponk O-470-50 engine should be maintained, repaired, or overhauled in accordance with current Continental O-470 and TSIO-520-C Service Manuals and Service Bulletins. Continental Service Information Letter SIL99-2C, issued March 29, 1999, and revised September 16, 2014,[2] includes information for properly applying sealant to the crankcases of O-470 and TSIO-520 series engines. The diagram for sealant application and silk threading on the Continental O-470 engine is shown in figure 9 as shown in Continental SIL99-2C. As indicated in figure 9, no sealant should be applied on the main journal bearing saddle bosses. Additionally, Continental SIL99-2C further describes in areas where the silk threading is applied, the gasket sealant should be applied in a thin even coat that is allowed to air try to a tacky condition before applying the silk thread.

Matthew R. Fox
Senior Materials Engineer

[1] P. Ponk Aviation, Camano Island, Washington.
[2] Continental Motors, Inc., Mobile, Alabama



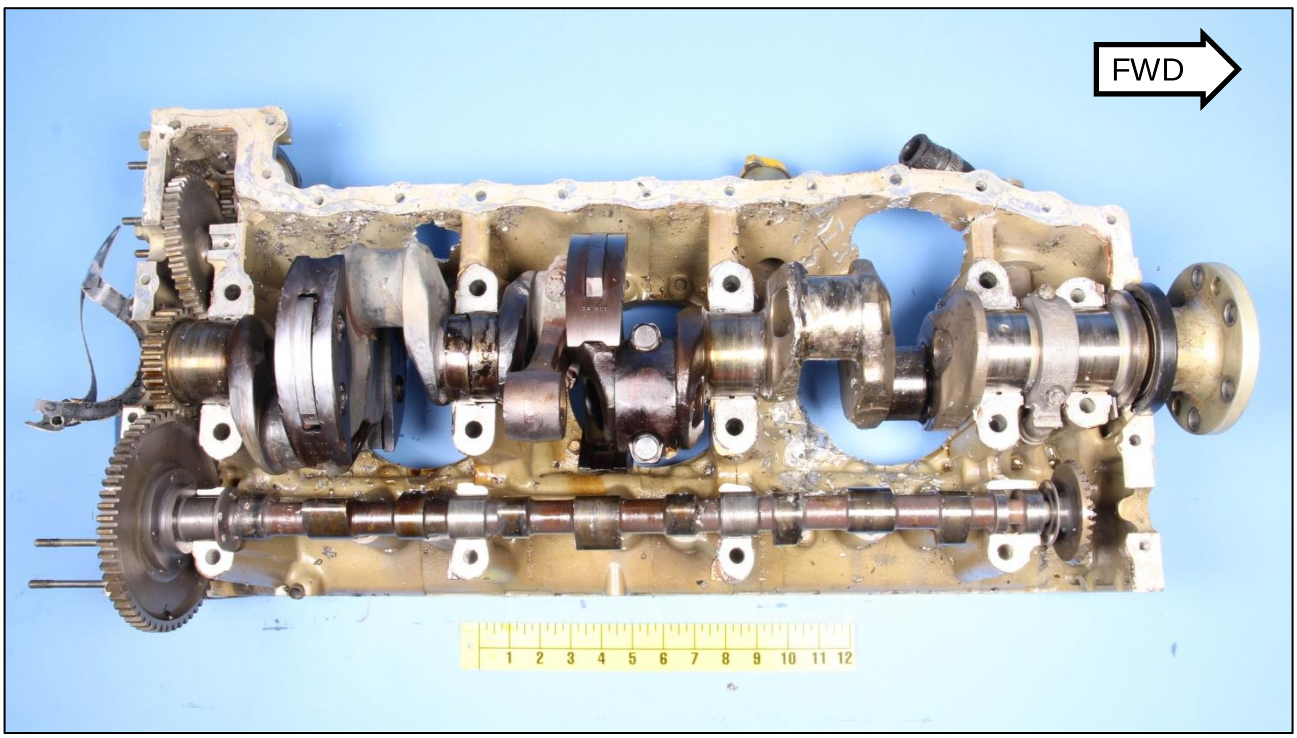
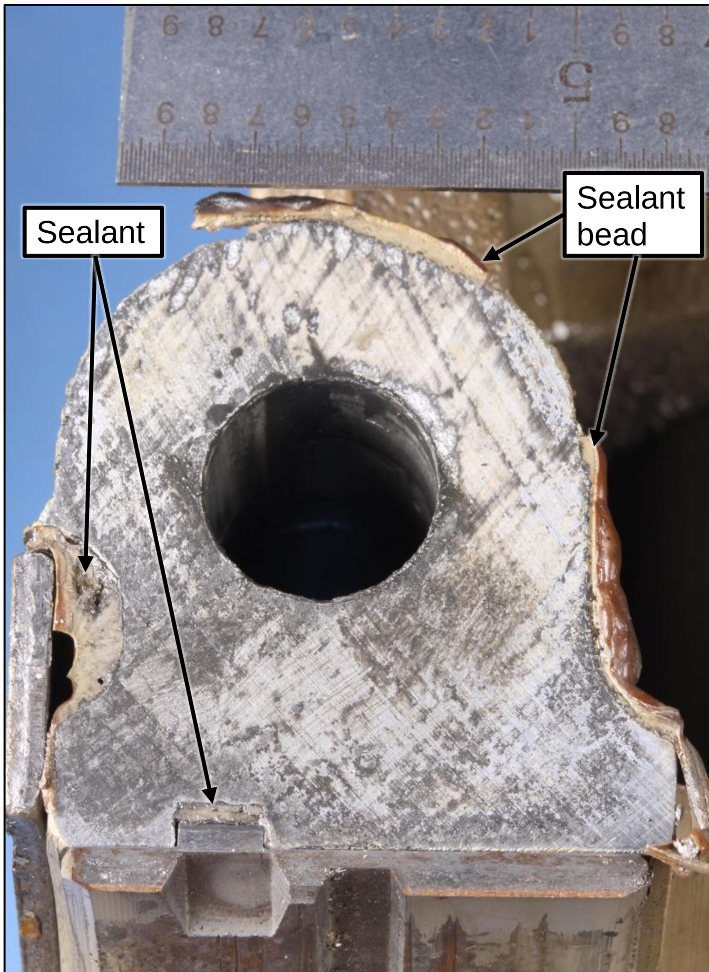


Figure 1. Overall views of the right crankcase half (upper image) and the left crankcase half (lower image) as-received including the crankshaft and camshaft in the left crankcase half.

Figure 2. Close view of the number 2 main bearing lower saddle boss, crankshaft, and bearing pieces.



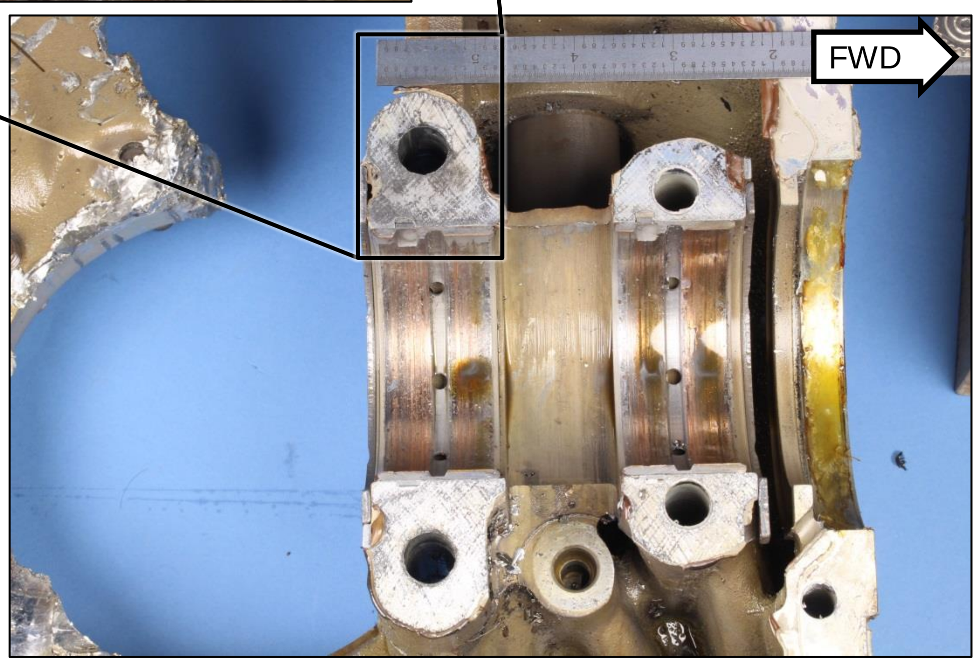
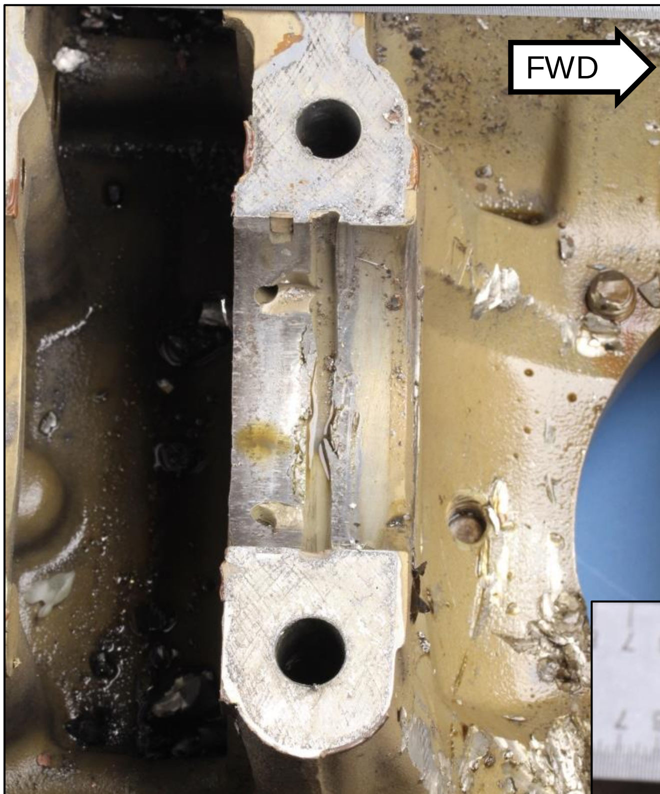


Figure 3. Numbers 4 and 5 journal saddles after removal of the crankshaft on the left crankcase half (lower image) with a closer view of the upper number 4 main bearing saddle boss (left image).



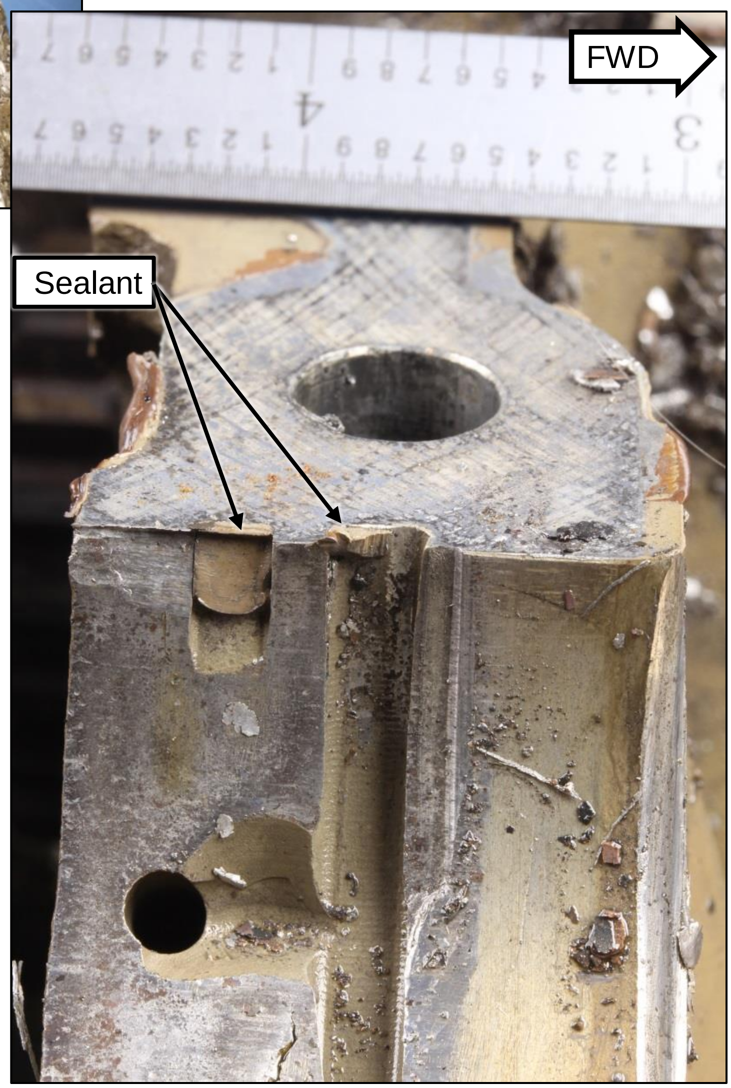


Figure 4. Close views of the number 1 main journal saddle on the left crankcase half.

Figure 5. Crankshaft after removal from the crankcase.

Figure 6. Camshaft after removal from the crankcase.

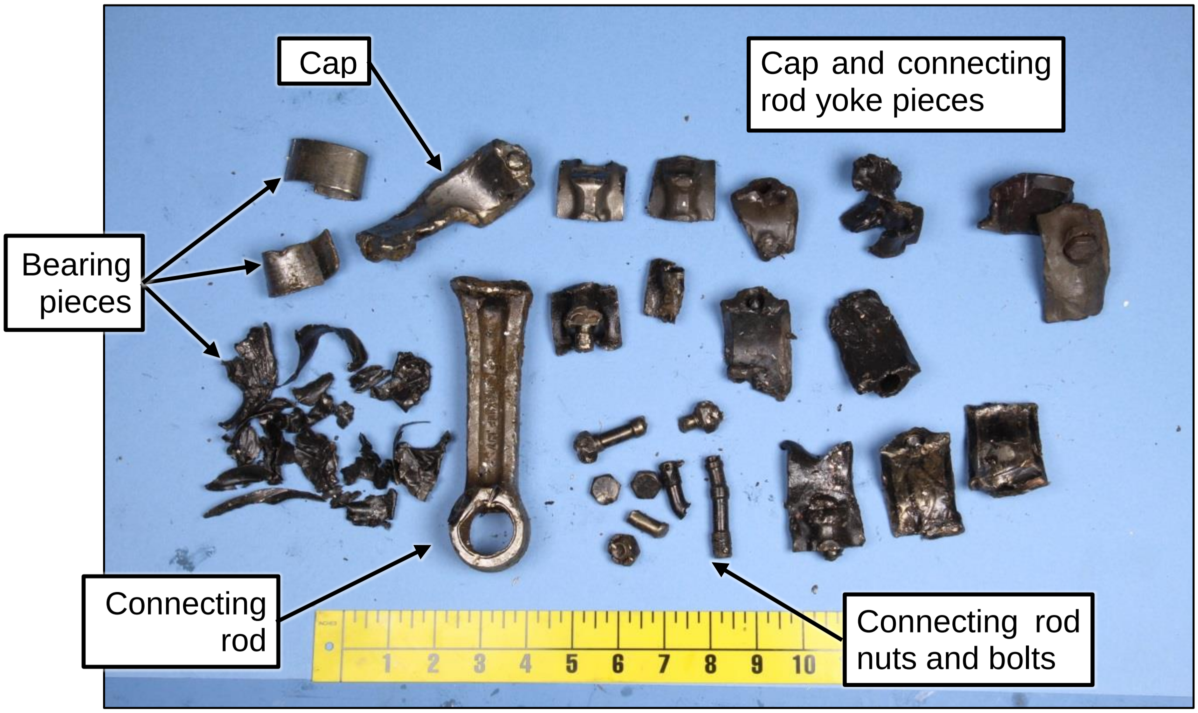


Figure 7. Connecting rod assembly pieces from within the bag containing pieces of connecting rod assemblies, piston assemblies, and crankcase.

Figure 8. Engine crankcase through-bolts.

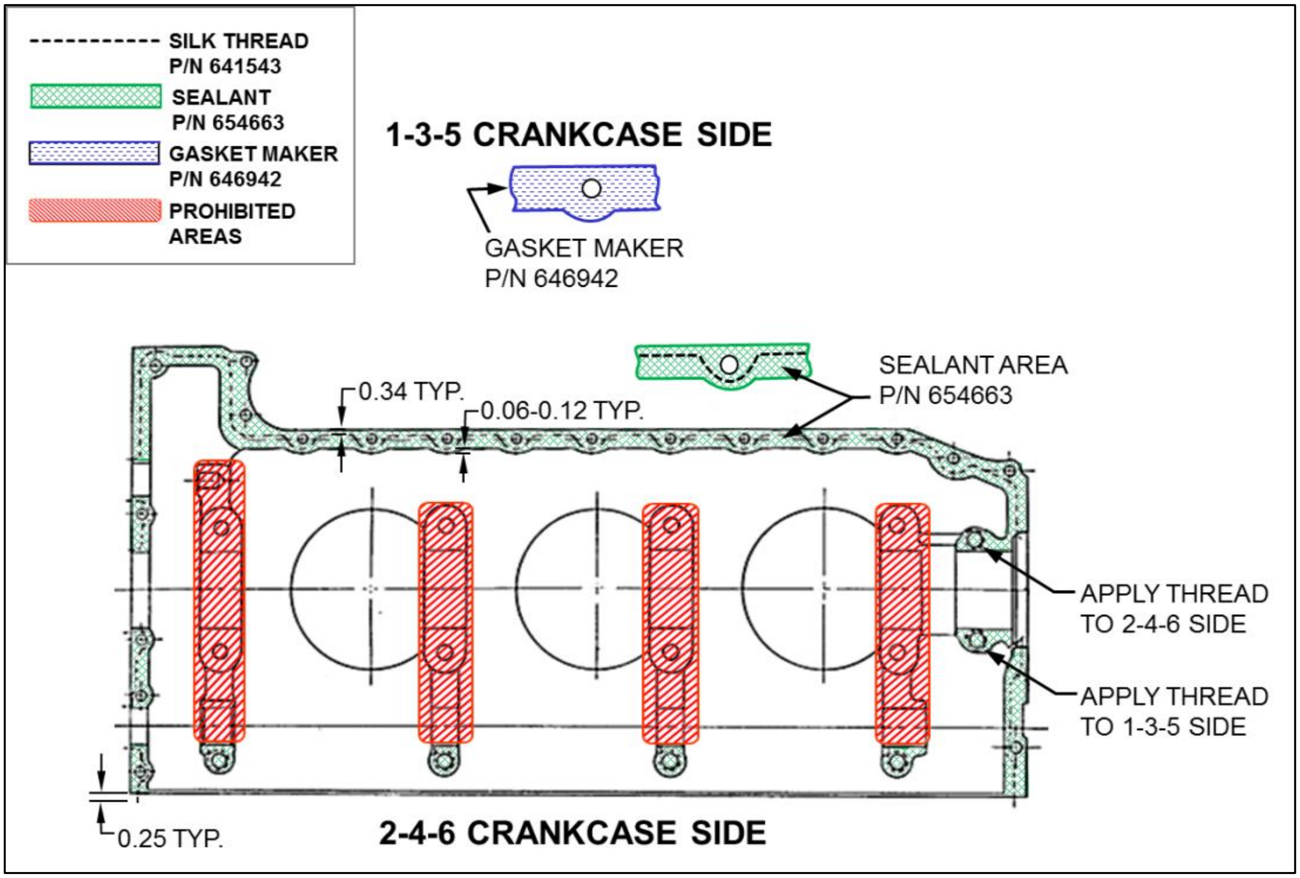


Figure 9. Sealant application diagram for the Continental O-470 engine as illustrated in Continental SIL99-2C.