NATIONAL TRANSPORTATION SAFETY BOARD

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

August 19, 2011

MATERIALS LABORATORY FACTUAL REPORT Report No. 11-094

A. ACCIDENT INFORMATION

Place	:	Clear Lake, ME
Date	:	3/24/2011
Vehicle	:	Cessna A185F, N724MT
NTSB No.	:	ERA11GA207
Investigator	:	Dennis Diaz

B. COMPONENTS EXAMINED

Attitude indicator, directional gyro, vacuum pump

C. PREVIOUS EXAMINATIONS

Continental Motors performed an initial vacuum pump disassembly during a follow-up exam in Maine, in the presence of an FAA inspector. A NTSB investigator from the Office of Aviation Safety subsequently received the pump and both instruments, photographed the pump, and attempted to disassemble the instruments. The directional gyro case was internally deformed, and was cut to access the inside. The components were then submitted to the NTSB Materials Laboratory for further detailed inspection, with the exception of the directional gyro case.

D. DETAILS OF THE EXAMINATION

A Cessna A185F was substantially damaged when it impacted a frozen lake in Clear Lake, Maine. The purpose of this investigation is to evaluate the indicators from this aircraft for operational abnormalities. Overall views of the submitted indicators are shown in Figure 1.

The attitude indicator was manufactured by Sigma Tek, Inc. in Augusta, KS (PN: 23-501-06-16, MN: 5000B-36, SN: T80903). As received, the attitude indicator had been previously disassembled and the rotor had been removed from the gyro housing. The display panel of the attitude indicator was misshaped, with the ring bent aft and the back plate bent forward toward the gyro case. The football was displaced with the loose end outside of the ring, and experienced limited movement. The attitude indicator without the case is shown in Figure 2 indicating these deformations. The roll yolk operated smoothly, with no resistance to rotation. However, the mechanism to connect gyro to football was missing so that gyro rotation initiated no football movement. The

pitch bearings operated smoothly and there was no sign of wear. “14041” was written on the gyro. The rotor and housing did not show circumferential markings or slap marks.

The directional gyro was manufactured by Kelly Manufacturing Company in Wichita, KS (MN: RCA11A-8, SN: 47C0057). As received, the directional gyro had been removed from the case. The screws were missing from the gyro housing (one out of the four was submitted with the parts) and there were tool marks on the housing. However, the housing was still sealed with the gyro inside. There were tool marks on the attachment hardware (blocked by the gimbal housing when assembled), indicating previous disassembly. There appeared to be no damage to the drive gears from the gyro yolk to the heading adjustment. The pitch bearings and the gyro case bearings were smooth with no indication of hesitation. The yolk movement initiated dial motion. The heading adjustment mechanism was operational. The bolts at the center of the rotor housing were loosened by hand. The rotor was removed from the gyro casing using a scalpel, screwdriver, and pliers. The rotor was stamped with “FEB 23 2007.” The rotor rotated freely on its axis with no sign of hesitation. There were no aluminum shavings in the half-moons of the rotor. The rotor and housing did not show circumferential markings or slap marks, however the housing had stains on the interior, particularly around screw holes. These stains are shown in Figure 3.

The dry air pump was manufactured by Tempest Aero Accessories, Inc. in Gibsonville, NC (PN: AA3216CW, SN: I1957-11). As received, the vacuum pump had been previously disassembled. The screws on the back flange were loosened and two sealing rings were exposed outside the pump adjacent to the pump housing. The back flange showed signs of mechanical damage. There were markings present on the teeth of the drive end of the coupling from engagement with mating drive spline. The drive coupling was fractured in the flex center region (this fracture surface is discussed later).

Disassembly was performed to reveal the interior of the pump. Assembly screws and the back flange were removed by hand. The seals and housing were removed to reveal the rotor and vanes. Vanes showed signs of previous removal, and were already numbered and were reinserted into the rotor slots incorrectly. The vein positions were corrected, and then the vanes were removed and inspected. Vanes 1, 2, 4, and 5 had smooth rubbing faces and no evidence of damage. Vanes 3 and 6 had small areas of damage on the rubbing face toward the forward end of the vanes. The damage to these vanes is shown in Figure 4. All vanes were free to move inside the rotor assembly. The rotor was removed and showed no damage besides rub marks on the forward and aft ends, consistent with operation. The housing was removed and showed five faint slap marks due to impact from the vanes. The shaft assembly, still attached to the mounting flange, had a uniform resistance to rotation, however rotated smoothly. The rubber sleeves were intact on the shaft assembly.

The fracture surface of the drive coupling flex center was examined. The flex center fractured near the center of the height of the part, in the region with the smallest cross-section diameter. Observation of the polymer revealed that this part was injection molded, and showed the presence of a parting line (due to the two halves of the mold

joining). This parting line exhibited permanent torsional deformation as indicated in Figure 5. The flex coupling was sputter coated with gold-palladium to aid in fracture examination. The fracture surface after sputter coating is shown in Figure 6. A portion of the fracture surface displayed a flat region with crack arrest features. This region starts at the circumference of the flex center near the parting line and continues into the center of the part. Along the circumference in this region are curved ratchet marks. The remainder of the fracture surface displayed elongated fibrils. The fibrils showed signs of a directional elongation, consistent with torsional loading.

Marianne Lindsay
SCEP Employee
Materials Laboratory Division

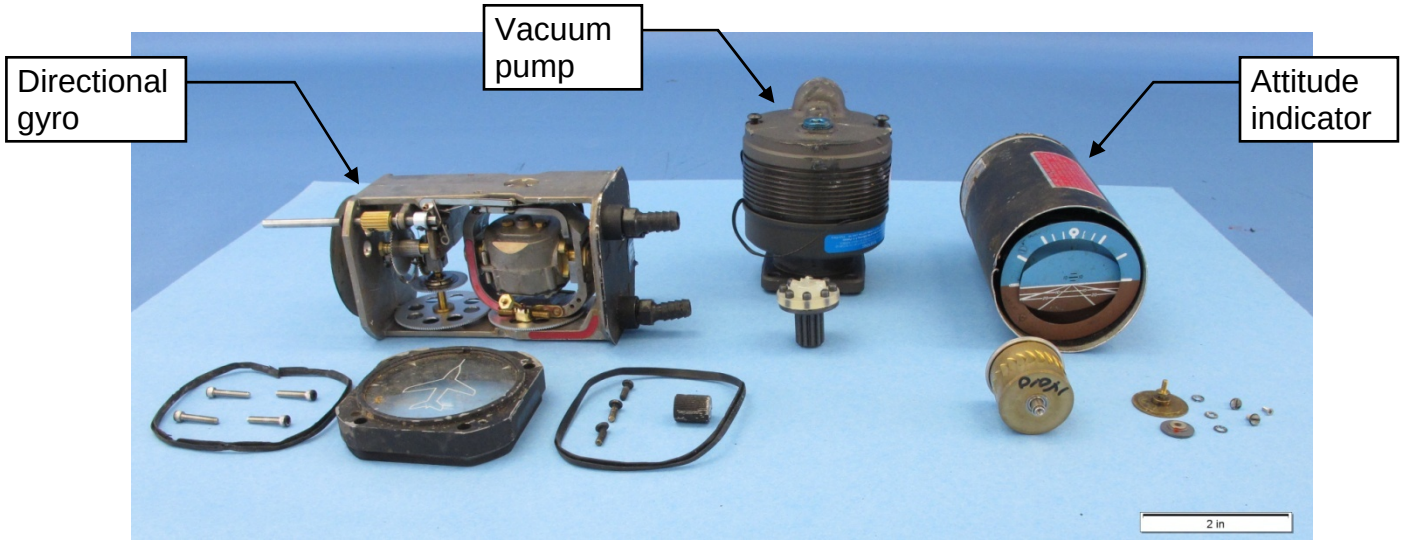

Figure 1. Overall view of submitted parts.

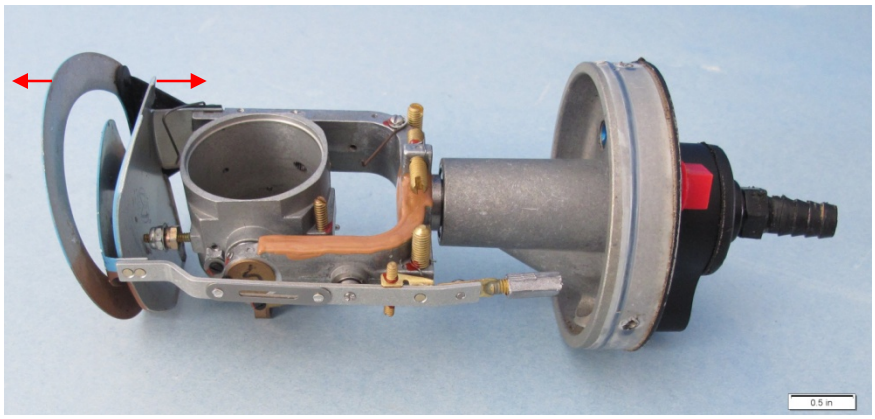

Figure 2. Attitude indicator removed from case. The arrows show the directions of deformation on the display panel.

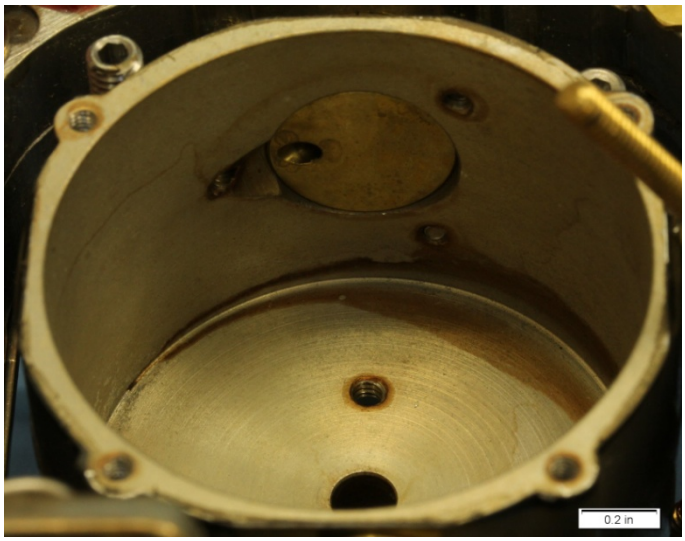

Figure 3. Gyro housing of the directional gyro, showing stains.

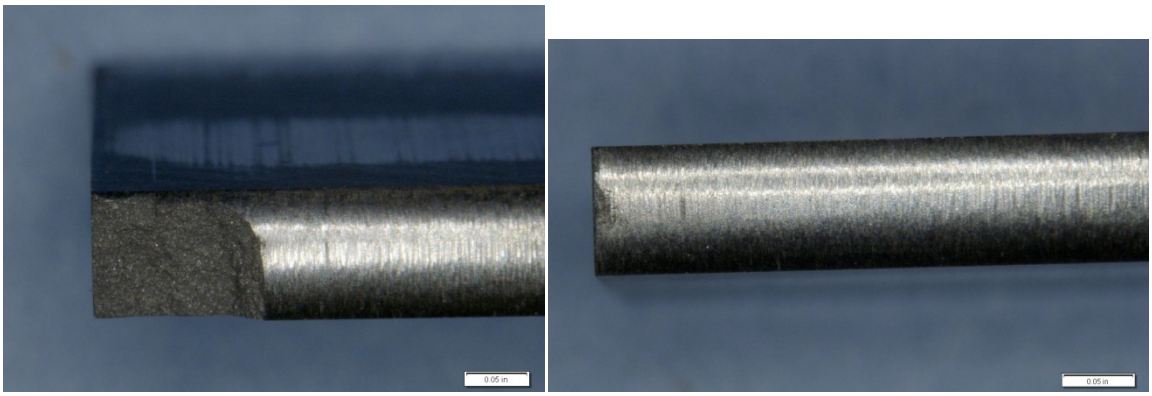

Figure 4. Damage on the rubbing face of vanes in the vacuum pump. Vein 3 is shown on the left and Vein 6 is shown on the right.

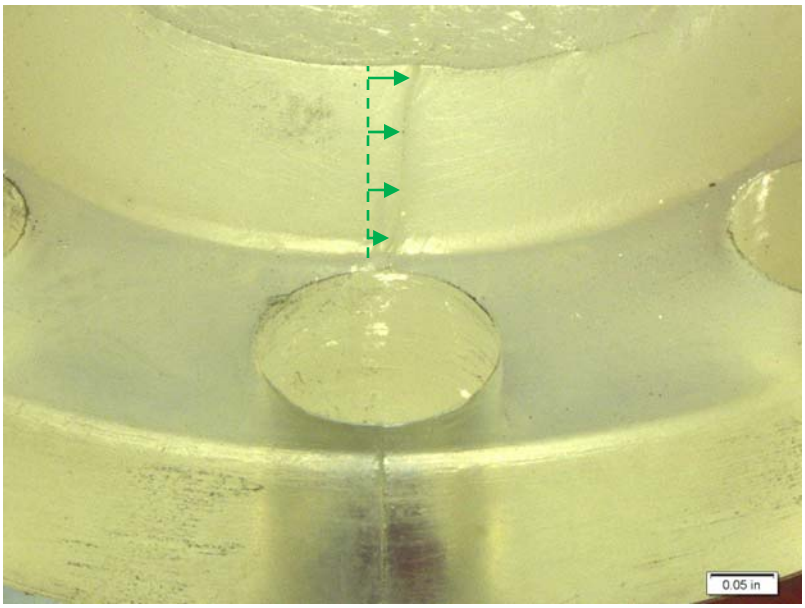

Figure 5. Displacement of the parting line in the drive coupling flex center. The approximate original location is shown by the dotted line.

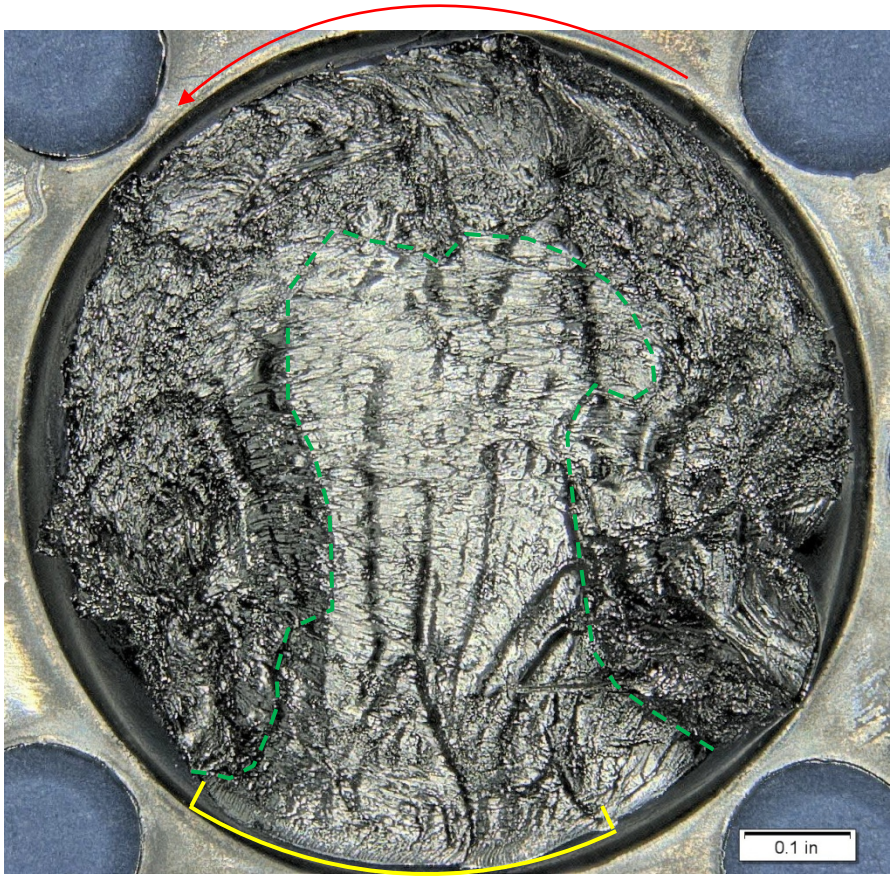

Figure 6. Fracture surface of the drive coupling flex center after sputter coating. The region of curved ratchet marks is shown by the yellow arc. The flat region is outlined by the dotted line. The red arrow shows the direction of the elongated fibrils.