



National Transportation Safety Board

Office of Aviation Safety

Washington, D.C. 20594-2000

February 19, 2015

GEAR BOX/PROPELLER EXAM FACTUAL REPORT

ERA14LA272

A. Accident

Location: Suffolk, VA

Date: May 31, 2014

Time: 0944 EDT

Vehicle: RV-6, S/N 23075, N6RP, Experimental Amateur Built

Engine: Eggenfellner Subaru EJ25 Automobile Engine Conversion S/N 338272340265

Propeller: Vari-Prop, Model VP, S/N PC 5001 Rev B

B. Investigators

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C. Summary

On May 31, 2014, about 0944 eastern daylight time, an experimental, amateur built Landrum Vans RV6, N6RP, operated by a private individual, was substantially damaged during a forced landing in Suffolk, Virginia. The private pilot sustained minor injuries. Visual

meteorological conditions prevailed for the personal flight conducted under Title 14 Code of Federal Regulations Part 91. The local flight originated from William Tuck Airport (W78), South Boston, Virginia, at about 0830 and was destined for Suffolk Executive Airport (SFQ), Suffolk, Virginia.

According to the pilot, he was in cruise flight at 2,000 ft. msl. The engine RPM went to redline, the airplane lost thrust and a reddish residue resembling the propeller hydraulic fluid covered the windscreen. The pilot pulled the throttle and then attempted to add power. The propeller rpm responded but the propeller was producing no thrust. Attempts to increase prop pitch were unsuccessful.

The airplane was powered by an Eggenfellner 2.5L Subaru conversion with a Gen 3 V4 Prop Speed Reduction Unit (PSRU). The propeller is a VariProp model VP1 and, according to the designer, it uses Mil Spec 5606 hydraulic fluid to operate the constant speed propeller function.

D. Details of Investigation

The engine, propeller speed reduction unit (PSRU), power train hardware and propeller were examined at the hangar of George McClellan, A&P IA, Suffolk, VA and the NTSB Materials Laboratory in Washington, DC.

1.0 Airframe History

The experimental amateur built airplane was built from a series of kits provided by Vans Aircraft, Inc.¹ Eggenfellner Aircraft, LLC² and Pitch Control Systems³. The airplane was registered as Experimental Amateur Built; N6RP; the airworthiness certificate was issued on August 25, 2006. The engine information system (EIS) showed that the total time for the airframe and engine was 249 hours. On October 1, 2007, at 159 hours, the airplane was involved in a propeller control failure and was forced to make an off airfield landing. The airplane sustained substantial damage. The airplane was returned to service on June 20, 2012.

2.0 Engine History

The experimental Eggenfellner Subaru H4 engine installation was designed and sold by Eggenfellner Aircraft. The design is based on an EJ-25, 2.5L Subaru water cooled 4-cylinder engine and is rated at 160 HP and 5400 rpm. The electronic ignition system was adapted by Eggenfellner Aircraft, Inc. The engine had 249 hours at the time of the accident.

¹ Van's Aircraft, Inc; Aurora, OR

² Eggenfellner Aircraft, LLC; Edgewater, FL; Eggenfellner Aircraft is no longer in business.

³ Pitch Control Systems LLC; Tigard, OR; Pitch Control Systems is no longer in business.

3.0 Prop Speed Reduction Unit (PSRU)⁴

The PSRU was replaced with a new PSRU Gen 3 V4 at 159 hours. The spline was replaced and the original solid flywheel was retained. The spline was lubricated with Royal Red Grease. At 221 hours, a dual mass flywheel and new spline were installed. The spline was lubricated with a mixture of 30% Honda Moly 60 and 70% Wurth Sig 3000 greases (Honda Moly 60/Sig 3000). The PSRU had 90 hours at the time of the accident. The new spline and dual mass flywheel had 28 hours in service, all with the Honda Moly 60/Sig 3000 mixture of grease.

4.0 Propeller History

The experimental Vari-Prop propeller installation was designed and sold by Pitch Control Systems LLC. The propeller is rated at 165 HP and 5600 rpm. The Vari-Prop propeller was installed at 158 hours. The needle thrust bearing in the propeller pitch control unit and the propeller blade bearings were lubricated with Royal Red Grease⁵. At 221 hours, the badly deteriorated blades were replaced with a different design blade. The needle thrust bearing was cleaned and lubricated with Sig 3000 grease. The propeller blade bearings were lubricated with either Sig 3000 grease or the Honda Moly 60/Sig 3000 mixture. The propeller static rpm was set at 2520 rpm. The stop nuts were adjusted so that the washers were slightly loose. The Vari-Prop bearings had 90 hours in service, 62 hours with Royal Red Grease and 28 hours with Sig 3000 grease (needle thrust bearings) and either Sig 3000 grease or the Honda Moly 60/Sig 3000 mixture (propeller blade bearings).

5.0 Hardware

The Vari-Prop Aircraft Propeller is a variable pitch and constant speed system. It has been designed for installation, use, and operation on direct drive and geared aircraft engines in the 80-450 HP range. The Vari-Prop design is a closed, airless hydraulic system that is independent of all other aircraft or engine systems. The operator controlled system has been designed, developed, and manufactured for the experimental aircraft industry. A control unit and hydraulic reservoir are installed in the fuselage. A slave unit is installed with the propeller installation.

Power is transferred from the propeller speed reduction unit (PSRU) to the propeller hub through a propeller drive shaft. One end of the propeller drive shaft is bolted to the output shaft of the PSRU. A key fitting at the other end of the drive shaft mates with a female key slot in the propeller hub.

The drive shaft is inserted through the slave servo. The slave servo assembly is a non-rotating unit that provides pitch angle adjustment to the propeller blades through a blade pin spool. The blade pin spool rotates with the propeller. A needle thrust bearing and ball bearing provides the interface between the rotating and non-rotating parts.

The slave servo sets the propeller pitch angle by receiving hydraulic fluid from a reservoir located in the fuselage. Hydraulic pressure pushes the blade pin spool forward to achieve higher blade angles. As hydraulic fluid is transferred out of the unit, springs and blade aerodynamics

⁴ The PSRU is a mechanism that reduces engine RPM to a lower RPM acceptable for the propeller.

⁵ The owner of Pitch Control Systems, LLC recommended using Lubriplate.

push the spool aft to achieve lower blade angles. In this installation, the builder set blade angles to achieve a static rpm of 2520 rpm. Two stop nuts attached to the slave piston provide a mechanical low pitch stop in the event of loss of hydraulic fluid or other failure of the pitch control system. According to the builder/pilot, the stop nuts that provide the mechanical limit to the low pitch angle were tightened so that the washers were slightly loose when the propeller blades were at the low pitch stop position. At the initial examination, the stop nuts were missing. Further examination of the bolts did not disclose any evidence of damage or remnants that could be attributed to the stop nut being present. The propeller designer provided in-service information where he lost hydraulic pressure and the propeller pitch returned to the low pitch stop set by the stop nuts.

Vari-Prop components:

1. Propeller assembly (including blades and hydraulic mechanism)
2. Propeller controller (hydraulic reservoir, electric drive motor, computer board).
3. Cockpit control (knob, indicator lights, and the operating encoder).
4. Connecting hydraulic fluid lines and joining unions.

6.0 Other Findings

Spline: The PSRU spline had been installed new and had been in service for 28 hours. The spline had been lubricated with the Honda Moly 90/Sig 3000 grease mixture. There was no evidence of wear on the spline.

PSRU: The PSRU had been installed new and had been in service for 90 hours. The PSRU was not examined internally. The unit was connected to a solid flywheel for 62 hours. The dual mass flywheel replaced the solid flywheel at 62 hours and remained in service for 28 hours until the accident.

PSRU input spline: The PSRU input spline is integral to the PSRU and had been in service for 90 hours. The input spline had been lubricated with Royal Red grease for the first 62 hours (while the solid flywheel was in use). The Honda Moly 60/Sig 3000 grease combination was used for the next 28 hours. At examination, the PSRU input spline had some wear. It is unknown how much wear occurred with the solid flywheel/ red grease pair or the dual mass/combination grease pair.

PSRU spline adapter plate: The adapter plate had been in service for 28 hours. The unit had been lubricated with the Honda Moly 60/Sig 3000 combination. There was no evidence of wear on the splined portion of the adapter plate.

If the spline components are worn, free play develops and can be seen in the free movement at the propeller blade tips. The pilot/builder reported that free play measurements during his preflight checks were consistently about ¼ inch. During the examination, the free play at the hub was measured at 0.064 inches at a radius of 3.062 inches. At a tip radius of 69 inches a calculated tip free play would be 1.44 inches.

The slot in the blade pin spool was about 0.52 inches wide. The pin was 5/16 inch in diameter suggesting that the gap could be filled with a 0.104 inch thick Delrin sleeve. The center of the pin was about 1.0 inch from the center of the blade root. The Delrin was melted in this area of contact allowing the blade pin to move 0.104 inch. If the blade pin moved 0.104 inch at a radius of 1.0 inch, the blade pitch angle would change about 5.9 degrees toward a finer or lower blade pitch angle.

7.0 Examination

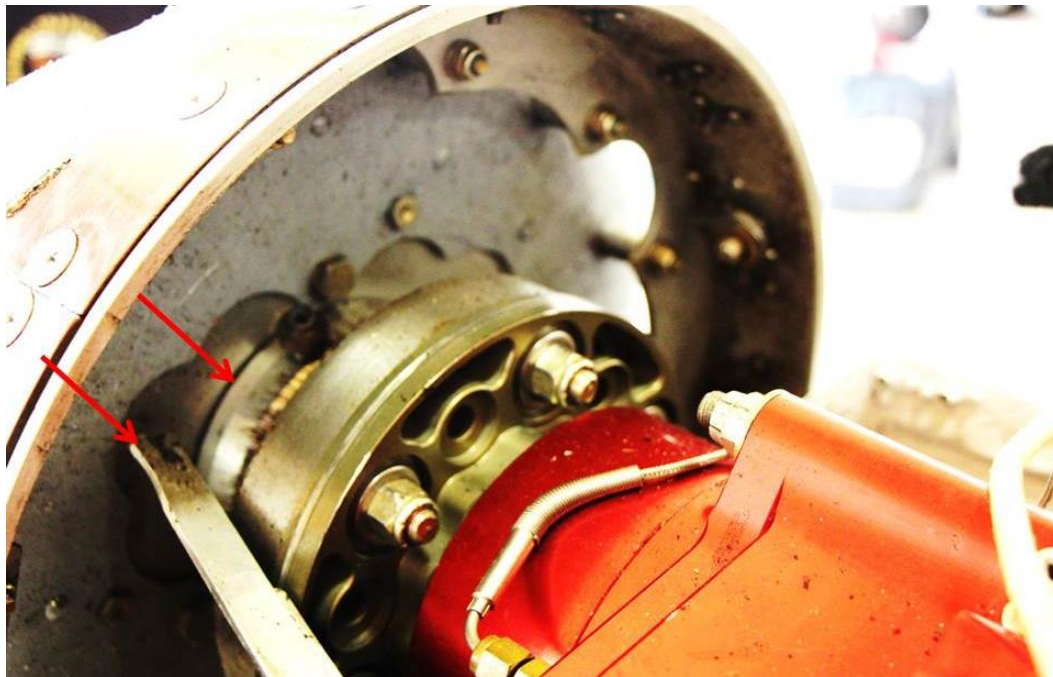


Photo 1 – The left arrow points to the hydraulic hose support bracket. The right arrow points to the slave piston. The slave piston is supposed to be attached to the support arm and remain stationary relative to the engine. The slave piston expands fore and aft moving the blade pin spool (not pictured). The slave servo had been stabilized by securing a bracket to the hydraulic fitting threaded into the slave servo. The bracket consisted of two pieces of angle aluminum attached so that the longer piece was cantilevered from the front of the PSRU. Four wraps of safety wire were wound around the inflow tube and through a hole in the bracket.



Photo 2 -The propeller hydraulic line fitting is designed to fracture if the slave piston starts rotating with the propeller. The fitting at the end of the inflow tube was broken, which allowed the hydraulic fluid to escape and also allowed the slave servo to rotate with the propeller rather than remaining stationary with the engine. In addition, the blades could rotate to a lesser pitch angle.



Photo 3 – The fractured hydraulic line fitting at the slave servo.

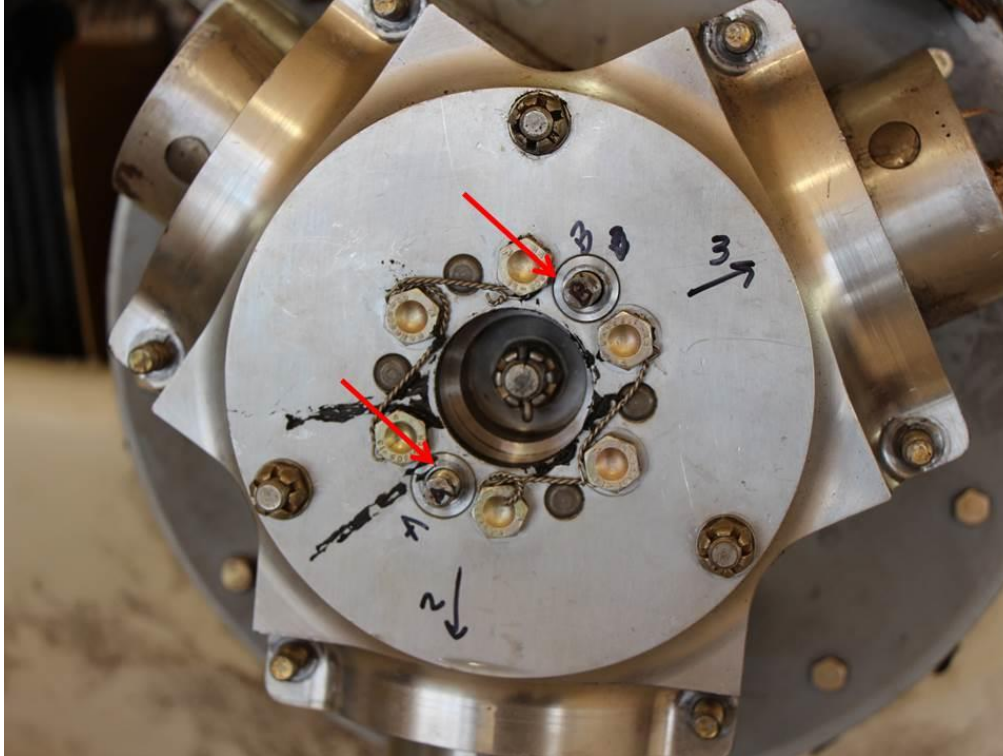


Photo 4 - The fine pitch adjusting nuts (A) and (B) were not present. With the loss of hydraulic fluid and the absence of the nuts, the blade pitch angles would rotate to a blade angle less than the optimum fine pitch blade angle.



Photo 5 - Damage to the fine pitch adjusting bolt (B).



Photo 6 – Fine pitch adjusting bolt (B).



Photo 7 - Damage to the fine pitch adjusting bolt (A).



Photo 8 - Damage to the fin pitch adjusting bolt (A).



Photo 9 - Measurement was 0.41 inches at bolt (A).



Photo 10 - Measurement was 0.46 inches at bolt (B).



Photo 11 – Fine pitch adjusting bolts. Examination of the bolts did not disclose any evidence of damage or remnants that could be attributed to the elastic stop nut being present.

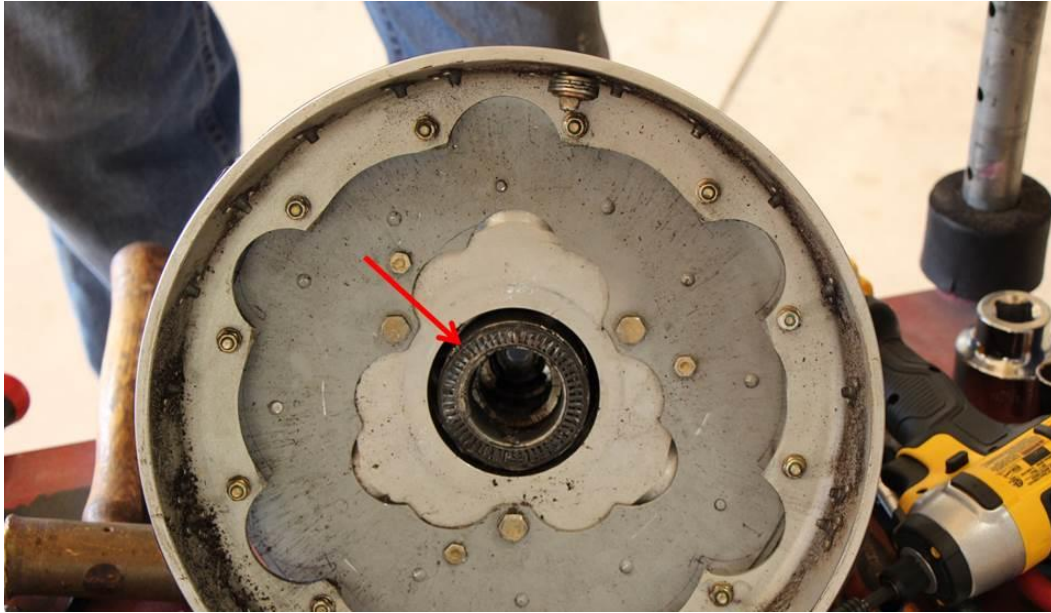


Photo 12 - Damage to the forward needle thrust bearing stuck to the blade pin spool. The needle thrust bearing rides between the blade pin spool and the slave piston collar.



Photo 13 - Damage to the needle thrust bearing. Grease was not present. Many needle rollers were either mispositioned or loose. The examination disclosed that the needle rollers and the bearing race were damaged. All of the needle rollers had separated and were loose or displaced within the bearing. Severe heat damage was present in all parts near the needle thrust bearing.



Photo 14 - Damage to the needle thrust bearing.



Photo 15 – The right arrow points to mechanical and heat damage at the slave piston collar bearing race that supports the needle thrust bearing. Grease was not present. The collar is still stuck to the slave piston cup (left arrow). The collar should be free to move fore and aft inside the slave piston and should not rotate relative to the slave piston. The blade pin spool rotates inside the slave piston collar.



Photo 16 - Galling damage to the three visible walls of the slave piston collar. The galling at the inner core is adjacent to the propeller drive shaft. The galling in the race area is adjacent to the blade pin spool and needle thrust bearing.



Photo 17 - The slave piston cup with hydraulic fittings.



Photo 18 - Galling and heat damage on the slave piston cup.



Photo 19 - The arrow points to the ball bearing snap ring on the slave servo.

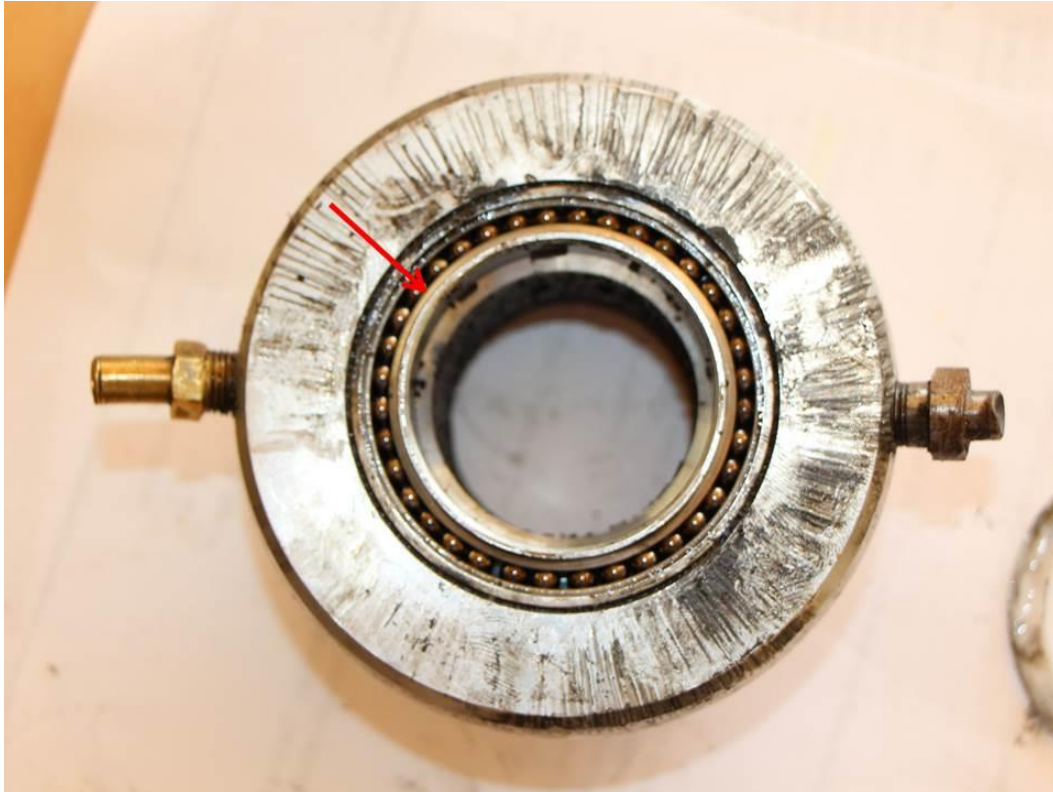


Photo 20 - Each ball had multiple scoring marks. Grease was not present.

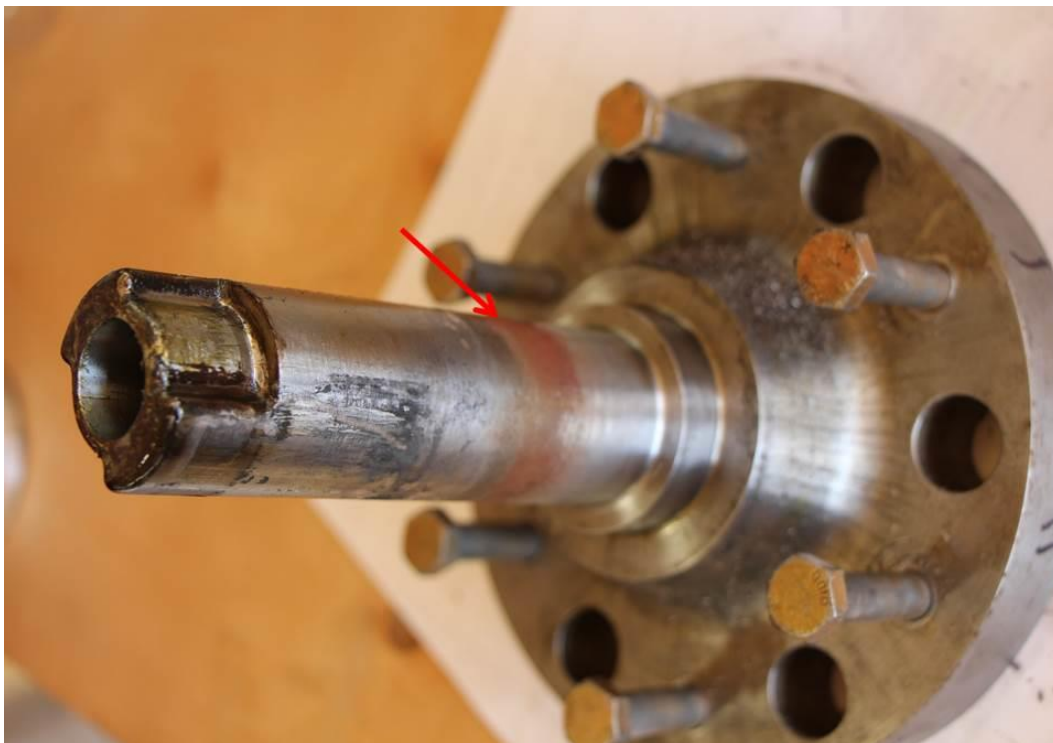


Photo 21 - The rust colored damage on the propeller drive shaft aligns with the galling damage to the inner side of the slave piston collar.



Photo 22 - The arrow points to one of the melted Delrin bushings. The Delrin bushings fit over the blade's pitch change pin. The pin and bushing fit in a groove in the blade pin spool (removed).

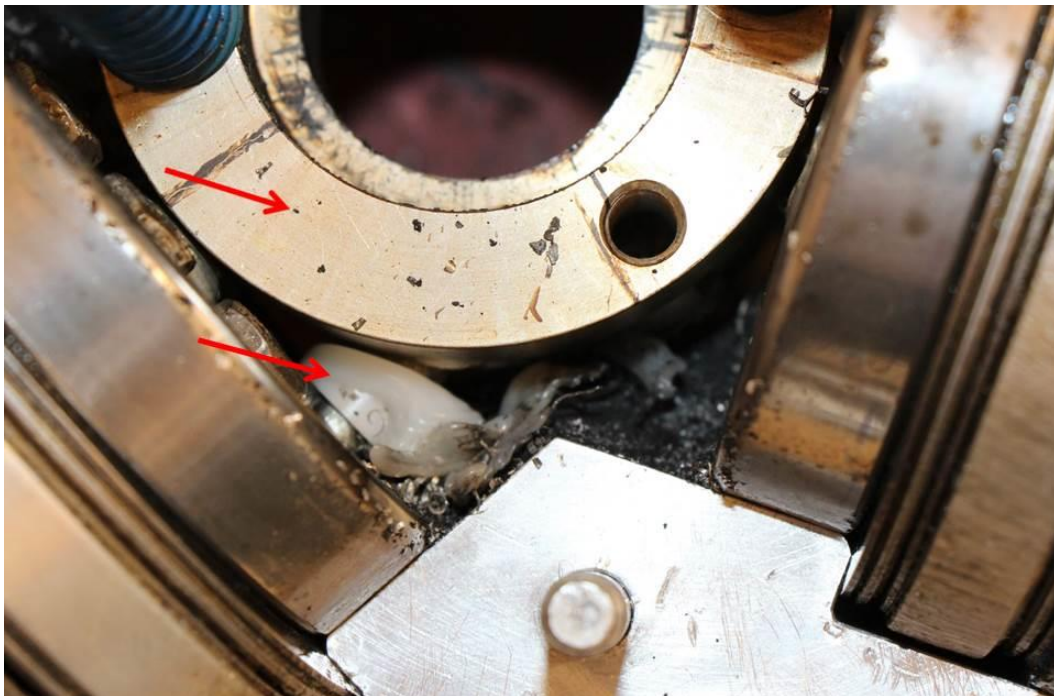


Photo 23 - Melted Delrin bushing with the pitch change pin (lower arrow) positioned in the blade pin spool (upper arrow).

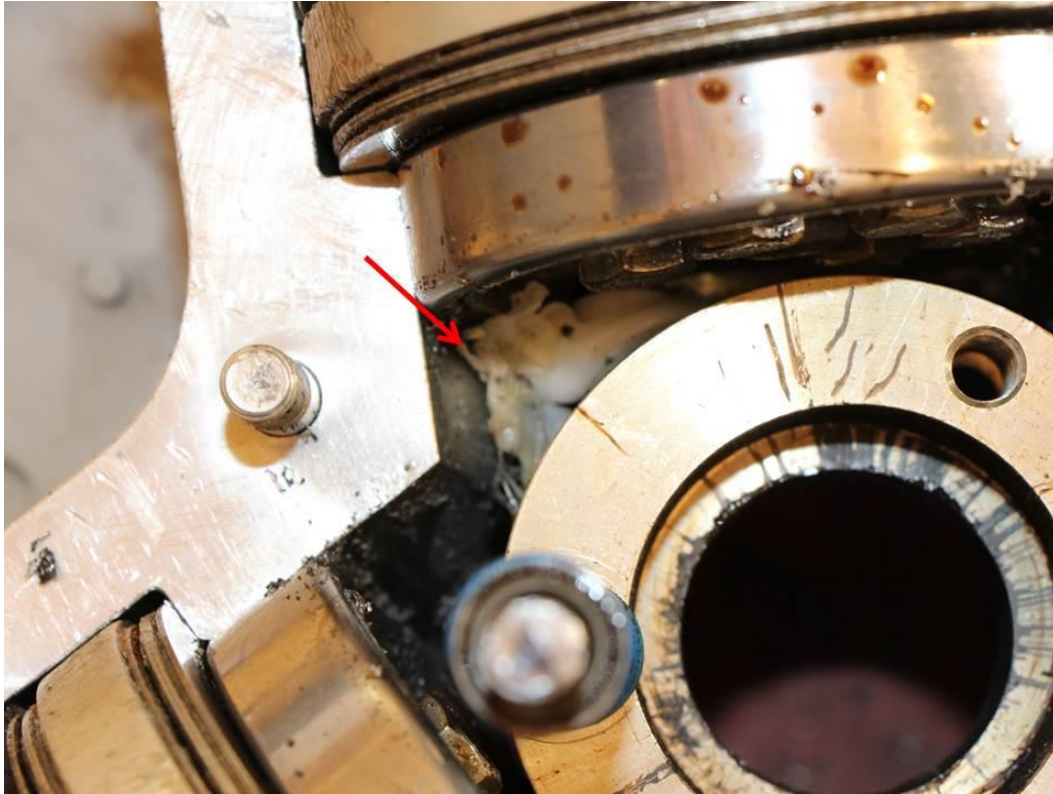


Photo 24 – Melted Delrin bushing with the pitch change pin positioned in the blade pin spool.



Photo 25- Melted Delrin bushing and bent pitch change pin.



Photo 26 - Melted Delrin bushing and pitch change pin.

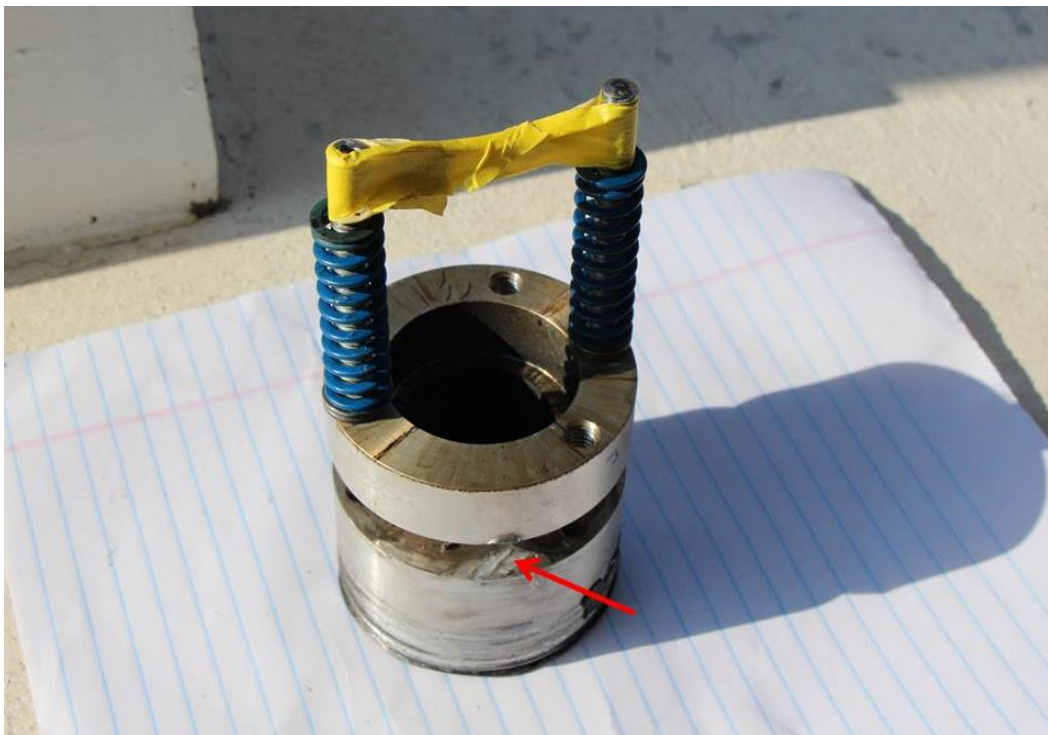


Photo 27 - Blade pin spool with damage on aft side of slot; damage is from pitch change pin at the butt end of the blade. When the pin moves from centered in the slot to the aft side, the blade pitch angle would change about 6 degrees to a lower pitch angle.



Photo 28 - The arrow points too galling damage to the side of the blade pin spool. The damage is consistent with damage to the inside of the slave piston collar. The blade pin spool should rotate while the slave piston collar remains stationary.



Photo 29 – Damage to the blade pin spool from the blade pitch change pins after the Delrin sleeve has melted.

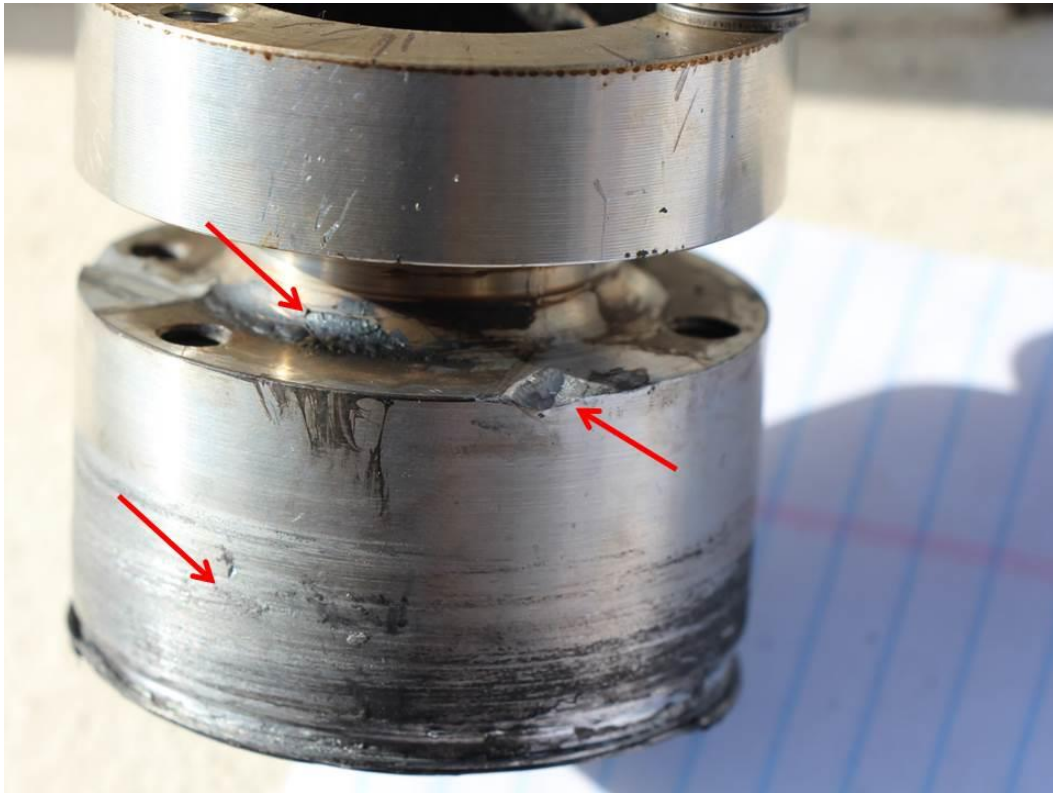


Photo 30 - Galling damage and impact damage from the pitch change pins.

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