NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Western Pacific Region

AIRFRAME AND ENGINE EXAMINATION

WPR20LA176

A. ACCIDENT

Location:	Safford, Arizona
Date:	June 9, 2020
Aircraft:	Vans Aircraft RV4, N173CW
NTSB IIC:	Eliott Simpson

B. EXAMINATION PARTICIPANTS:

Eliott Simpson	Mark Platt
Senior Aviation Accident Investigator	Air Safety Investigator
National Transportation Safety Board	Lycoming Engines

C. SUMMARY

Examination of the airplane was conducted at the facilities of Air Transport, Phoenix, Arizona on July 28, 2020.

The canopy appeared to be in the closed position at impact. Primary flight control continuity was established and hydrodynamic damage to the fuel tanks and carburetor floats indicated that there was fuel onboard at impact. Significant propeller damage signatures, and damage to the crankshaft indicated the engine was likely producing power at the time of impact.

The pitch trim tab was found in the tab down, (nose-up) position at the accident site, however examination revealed that the flap was free to move, and its design meant that the as-found position was possibly a result of impact damage. The trim components in the aft fuselage and elevator were intact and functional, however, impact damage precluded an accurate assessment of the remaining trim components; the trim system appeared to have been modified with the addition of a spring, which was biased towards pulling the pitch trim cable forward, which corresponded to a tab-down, and nose-up pitch attitude. The flap actuator indicated the flaps were fully extended at the time of impact. There was no evidence of bird strike.

Modifications to the vertical stabilizer forward mounting hardware suggested the aircraft structure was not symmetrical. There was no documentation in the maintenance logbooks indicating that the airplane had been damaged in a prior event/accident, or any records of such modifications. However, an entry dated March 1, 2016 (1,150.8 hours total time) indicated that the airplane may have undergone a Phase 1 flight test. It could not be determined why that flight test had been performed.

A previously removed position light lamp socket was located within the underfloor bay area of the stick.

D. DETAILS OF THE INVESTIGATION

1.0 Airframe Examination

Fuselage and Wings

The entire cabin sustained crush damage through to the aft cabin bulkhead (figure 1). The leading edges and forward undersides of both wings sustained crush damage along their entire length, with outward and forward deformation of the skins at the fuel tanks (figure 2, 3). There was no evidence of cracks to the wing spar as noted in Vans Aircraft Service Bulletin 16-03-28.

The pilot appeared to be wearing his lap belt and shoulder harnesses.

Both main landing gear legs had detached from their respective airframe mount points.

The canopy frame was bent but intact, with most of its Perspex screen broken away (figure 4). The canopy latch handle was in the "locked" position (figure 4). The aft canopy lock pin was in the extended, locked position (figure 5), and the forward lock pin had bent around its guide block (figure 4). The airplane was equipped with a canopy lanyard consisting of rope tied between the canopy and the airframe. The lanyard remained attached to the canopy, and its airframe mount (figure 6).

The bulkheads in the aft section of the airplane appeared to have been cut and refitted with doublers in their center sections (figure 8).

There was no indication that the airplane was fitted with an operational autopilot, and maintence records indicated one was removed in 2016.

There was no evidence to suggest a bird strike, and nine tissue samples were removed from the canopy fragments and airframe and sent to the Smithsonian Institution Feather Identification Lab for analysis. None of the samples contained evidence of wildlife DNA.

The aft control stick had been previously removed, and there was no boot around its base (figure 40). The opening in the bulkhead for the stick is about 8 inches square. The belly was breached and was crushed against the lower aft control stick assembly. According to Vans Aircraft, the clearance between the base of the control stick assembly and the belly skin of the is between 2.25 and 2.4 inches (figure 41). A position light socket was located within the underfloor area of the control column assembly. The socket was slightly crushed, and wrapped with electrical insulating tape, which exhibited shredding and dark fretting marks. The conductor wires had been cut, and the metal case of the lamp was still in the socket. The internal surface of the lamp

case appeared corroded and one of its sides was bent inwards. Figure 39 depicts the lamp case in reference to the lower section of the aft control column assembly.

Review of the maintence logbooks did not indicate the replacement of the lamp socket, however one entry, dated May 3, 2018, indicated that the lighting was checked, and both the aft and left navigation lamps were changed.

Vertical Stabilizer

The vertical stabilizer remained attached to aft fuselage and empennage structure. There was evidence of non-standard modification to the forward spar (VS-402), attach-point at the F-410 bulkhead in an apparent effort to adjust the leading edge of the vertical stabilizer about ½ inch to the left (figure 7).

The rudder remained attached to the vertical stabilizer by its three hinges (figure 9), and the rudder cables were continuous from the rudder control horn to their respective forward foot pedals in the cabin. *The rudder cables had been cut by recovery personnel.*

The tailwheel assembly had detached from the landing gear spring and pulled away from both control chain/springs.

Horizontal Stabilizer and Elevator Control System

The right horizontal stabilizer appeared undamaged and remained attached to the tailcone. The right elevator remained attached to the horizontal stabilizer by its two hinges. The balance weight was still attached (figure 10).

The left horizontal stabilizer remained attached by its aft spar. The forward spar had detached from the empennage fitting, and the stabilizer was bent back about 20° aft at the separation point (figure 11, 12). The left elevator remained attached by its two hinges, and its inboard root was crushed consistent with impingement against the rudder and vertical stabilizer. *The rudder exhibited black marks indicative of repeated contact with the root of the elevator, however when compared to accident site figures, it was evident that this was caused during aircraft recovery and transportation.* The left elevator balance weight had detached (figure 13) and was located at the main wreckage site. The left and right elevators remained interconnected through the torque tube.

The elevator trim tab remained attached to the left elevator and was in the tab down (nose up) position at the accident site (figure 14). The trim cable was still attached to the tab control arm (figure 15). The trim fitting weldment remained attached to the elevator and appeared to comply with Vans Service Bulletin SB 06-9-20; a logbook entry also reflected this. The outer sheath of the cable in the left horizontal stabilizer exhibited peeling to the outer sheath in the area where it passed through the forward spar, inboard stabilizer rib, and aft spar (figure 16, 17, 12).

The trim cable was continuous through to the forward airframe *(although cut by the recovery crew mid-length)*. The cable and tab could be moved freely, with no evidence of binding. The cable remained firmly attached to the aft airframe bulkheads (figure 8) where it appeared to have been cut by recovery personnel. Forward of the cut, the trim system sustained impact damage including separation of the trim cable from the cable end. The separation surface features were grainy in appearance consistent with overload failure. The damage to the remaining trim fittings, along with the trim control arm and its friction assembly, prevented a determination of its operating status at impact. The trim cable was fitted with a spring that appeared to be configured to apply a forward force on the cable. The direction of this force would have resulted in the trim tab moving down, which corresponded to nose-up pitch attitude (figure 35).

The elevator push-pull tubes were continuous from the elevator torque tube control arm through to the intermediate bellcrank and the cabin control column assembly. The assembly, sustained crush damage, but remained attached to the airframe and could be partially moved forward and aft. Rub marks and contact was noted at the aft fuselage bellcrank between the aft push-pull tube bolt head and the lower left stringer (figure 18). The stringer had twisted in that area. The rubbing was in the area of the access/lightening hole, but there did not appear to be evidence that the bolt head was able to hang up or interfere with the edges of the hole (figure 19). *The rub marks noted on the vertical stabilizer and induced during recovery, indicate that the elevator was moving during transportation, therefore the bolt-to-stringer contact and rubbing was also likely induced during transportation.* The lightening hole on the stringer on the right side had been elongated (figure 20).

Ailerons

Both the aileron control weight pipes had detached from their respective leading edge fittings in the left and right wings.

Both hinges remained attached to the left aileron, which had completely detached from the wing (figure 21). The push-pull control tube remained attached to its inboard aileron arm, and the forward rod end for the ball had separated at the wing bellcrank.

The right aileron remained partially attached to the wing by both its left hinge and the push-pull control tube, which remained attached to the wing bellcrank (figure 22).

Both the right and left wing aileron push-pull tubes remained connected to the outboard wing bellcranks and the cabin control column assembly (figure 23). Side-to-side movement of the control stick assembly resulted in lateral movement of the push-pull tubes at the wing bellcranks. A servo device, which appeared to be the remnants of a previously installed autopilot, was installed on the center section of the wing spar and connected to the root of the forward control column assembly. The unit had sustained crush damage, and the rod end that connected the unit the control to the aileron control assembly was deformed and had detached.

Flaps

The left flap remained attached to the aft wing spar by its piano hinge. The right flap along with its hinge had completely pulled away from the aft spar.

The airplane had been modified in 2009 with the addition of a Vans Aircraft approved "EF-400" electrical flap system. The design required the removal of the manual flap control arm, replacing it with a linear actuator, attached to the steel interconnect assembly (WD-406). The plans called for routing the electrical control wires to a momentary switch mounted on the instrument panel. However, in this installation, the switch appeared to have been installed in the throttle handle within the engine control quadrant.

WD-406 remained attached to the airframe by its nylon clamps. Both flap rod ends remained attached to the outboard assembly, but both of the connecting rods had detached from their respective rod ends. The detachment surface exhibited granular and grainy surface features consistent with overload failure.

The flap actuator was attached to the airframe and its drive motor had broken away against the airframe structure. The output coupling of the flap actuator was bent and had detached from the flap assembly bellcrank (figure 24, 25). The actuator was in the fully retracted position, which according to the assembly instructions corresponded to fully extended flaps. Visual examination of the flap system configuration confirmed this finding. The throttle control had bent almost 180 degrees around the quadrant, resulting in damage to the flap switch, and its electrical cables (figure 34). Similarly, airframe damage had resulted in multiple breaks in the flap electrical system wiring.

2.0 Engine Examination

Engine

The engine remained attached to its mount, which had detached from the firewall (figure 26). The bulk of the engine remained largely intact, having sustained crush damage to the forward pushrod tubes, and rocker covers, along with the detachment of the oil sump, the propeller and hub, flywheel, and ring gear. There was no streaking along the airframe sides or any other evidence significant engine oil leakage.

The right magneto, engine driven fuel pump, and oil filter adapter had separated, leaving their mounting lugs and bolts attached. The separation features were grainy in appearance, consistent with overload failure.

The carburetor had detached from the sump and had broken open at the bowl seam. The float assembly was the brass type and had detached from the assembly. The floats exhibited significant hydrodynamic crushing (figure 27). The data plate information could not be determined, however it appeared to be manufactured by AVSTAR. The mixture control arm had detached, and the throttle control arm was found securely attached at the control arm of the carburetor. The throttle control castellated nut and cotter pin remained secure and the serrated interface at the throttle arm remained securely mated.

The fuel system was compromised forward of the firewall, with multiple line and fitting separations. Opening of the fuel the pump revealed that all diaphragms and valves were intact and undamaged.

The spark plugs were secure at each cylinder. The top spark plugs were removed and examined. The electrodes remained mechanically undamaged, and according to the Champion Spark Plugs AV-27 Check-A-Plug chart, the electrodes displayed grey coloration and deposits consistent with normal operation, and wear signatures consistent with a short service life (figure 28).

The magnetos were removed and rotated by hand at their input shafts, and sparks were observed at each output terminal.

An accessory drive pad cover was removed, and the crankshaft was rotated by hand through the drive pad utilizing a drive adapter tool. The crankshaft could be rotated freely in both directions, and valve train continuity was observed throughout.

"Thumb" compression was obtained in the correct order on all four cylinders, with equal lift observed at each rocker assembly.

The combustion chamber of each cylinder was examined through the spark plug holes utilizing a lighted borescope. The combustion chambers and bottom spark plug electrodes were mechanically undamaged and there was no evidence of foreign object ingestion or detonation. The valves were intact and undamaged. There was no evidence of valve to piston face contact.

The exhaust pipe exits exhibited light tan deposits, and there was no oil residue observed in the exhaust system gas path. The pipes did not show any evidence of exhaust leak.

Propeller

The propeller remained attached to the crankshaft flange, which had broken away from the engine at the forward crankshaft bearing. The crankshaft separation surfaces exhibited a radial 45° radial lip around its circumference (figure 33).

Both propeller blades exhibited leading edge gouging, torsional twist, chordwise striations across the cambered surface and trailing edge “S” bending (figure 29, 30, 31,32)

3.0 Airframe Examination Figures

Figure 1 – Complete Wreckage

Figure 2 – Right Wing

Figure 3 – Left Wing

Figure 4 – Canopy

Figure 5 – Canopy locking pin

Figure 6 –Canopy lanyard

Figure 7 – Vertical stabilizer forward spar

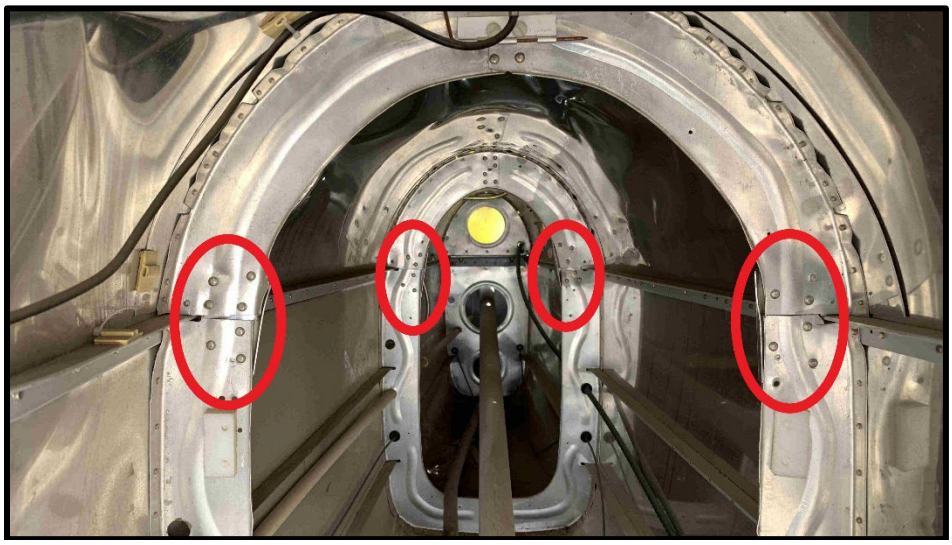

Figure 8 – Tail section (doublers highlighted)

Figure 9 – Rudder

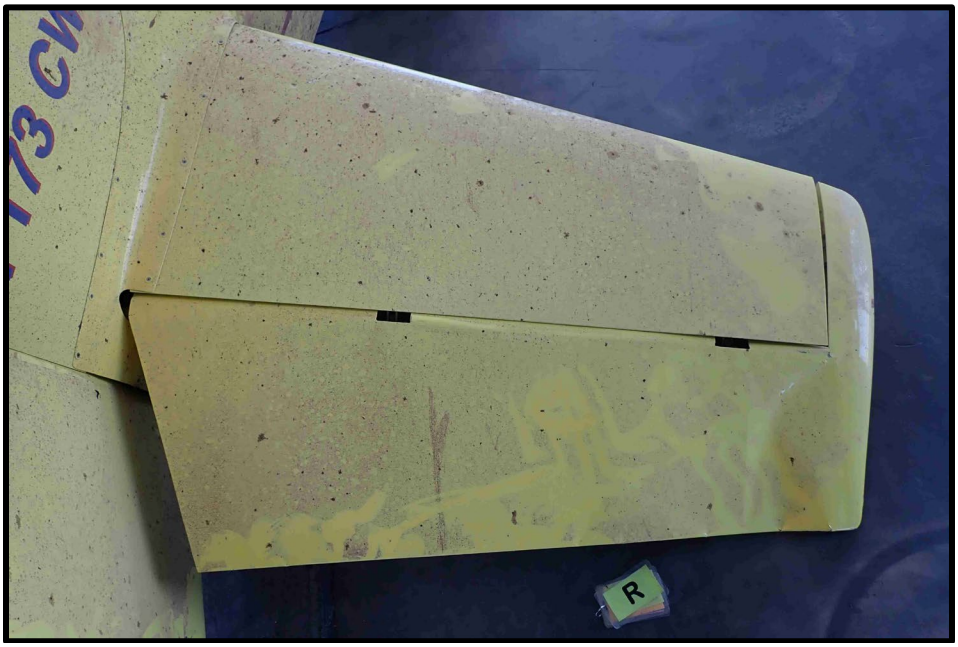

Figure 10 – Right horizontal stabilizer

Figure 11 – Left horizontal stabilizer

Figure 12 – Left horizontal stabilizer forward mount

Figure 13 – Left horizontal stabilizer and elevator tip

Figure 14 – Empennage at accident site (figure courtesy of Safford Police Department)

Figure 15 – Pitch trim assembly

Figure 16 – Left horizontal stabilizer forward spar and pitch trim cable

Figure 17 – Pitch trim cable

Figure 18 – Aft fuselage bellcrank bolt contact area

Figure 19 – Aft fuselage bellcrank bolt head (left side)

Figure 20 – Aft fuselage bellcrank (right side)

Figure 21 – Left aileron

Figure 22 – Right aileron

Figure 23 – Aileron push-pull tubes in underfloor

Figure 24 – Flap control assembly

Figure 25 – Flap motor

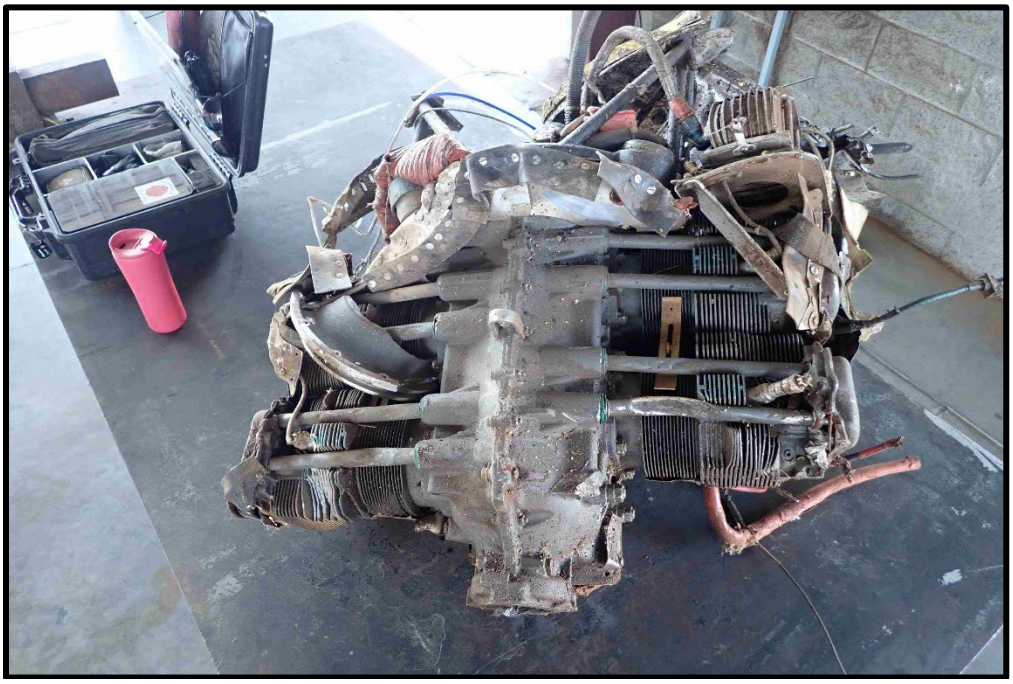

Figure 26 – Engine

Figure 27 – Carburetor floats

Figure 28 – Top spark plugs

Figure 29 – Propeller

Figure 30 – Propeller blade tip

Figure 31 – Propeller blade tip

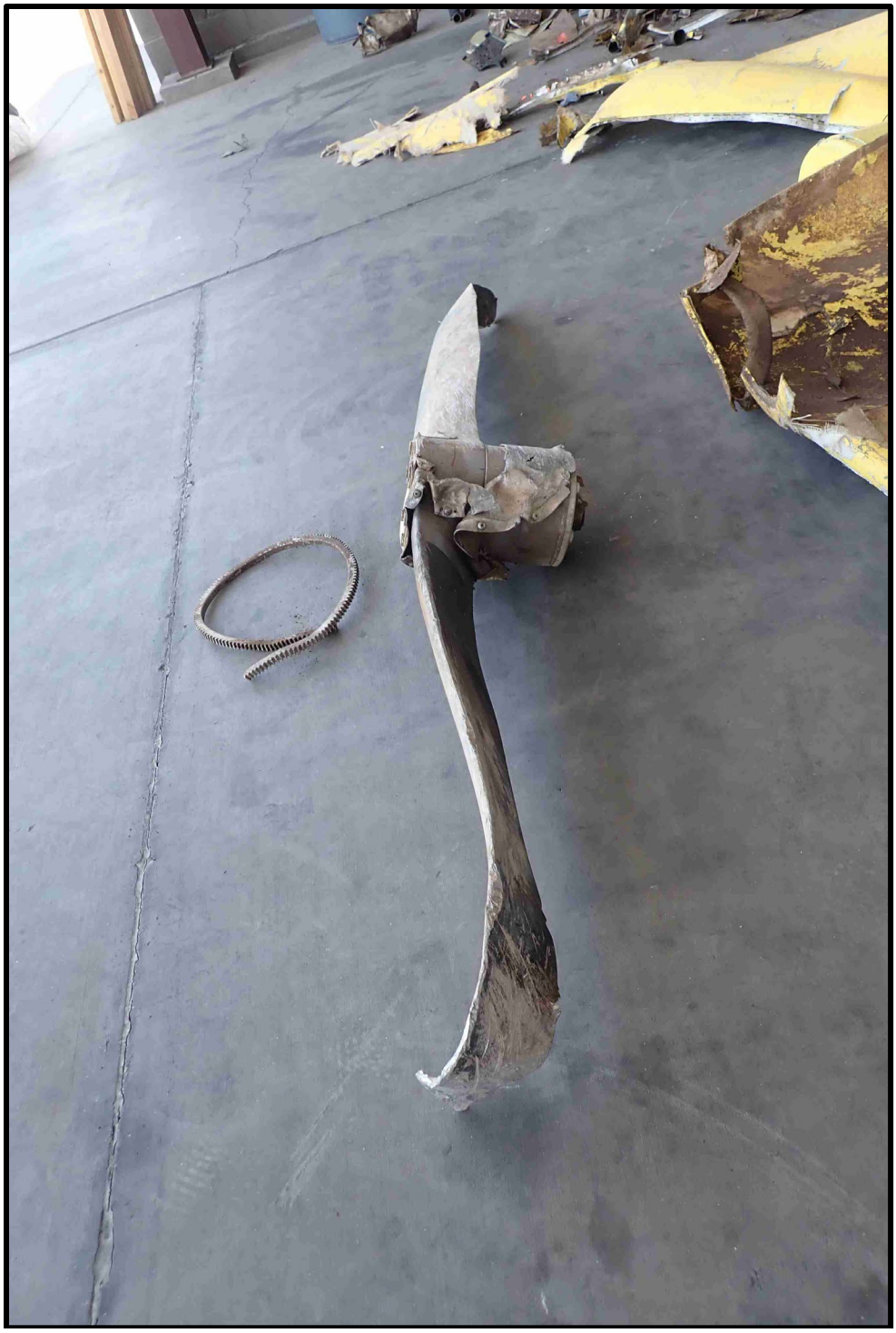

Figure 32 – Propeller and ring gear

Figure 33 - The crankshaft separation surfaces

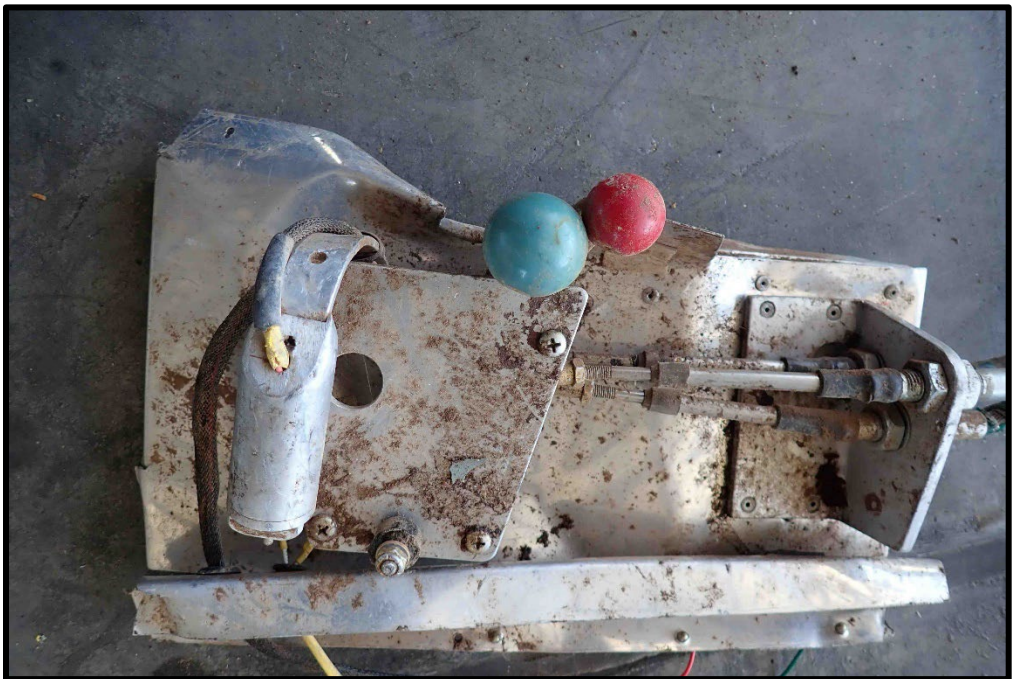

Figure 34 – Throttle quadrant with flap switch (bottom left)

Figure 35 – Pitch trim control with spring

Figure 36 – Lamp socket

Figure 37 – Lamp socket

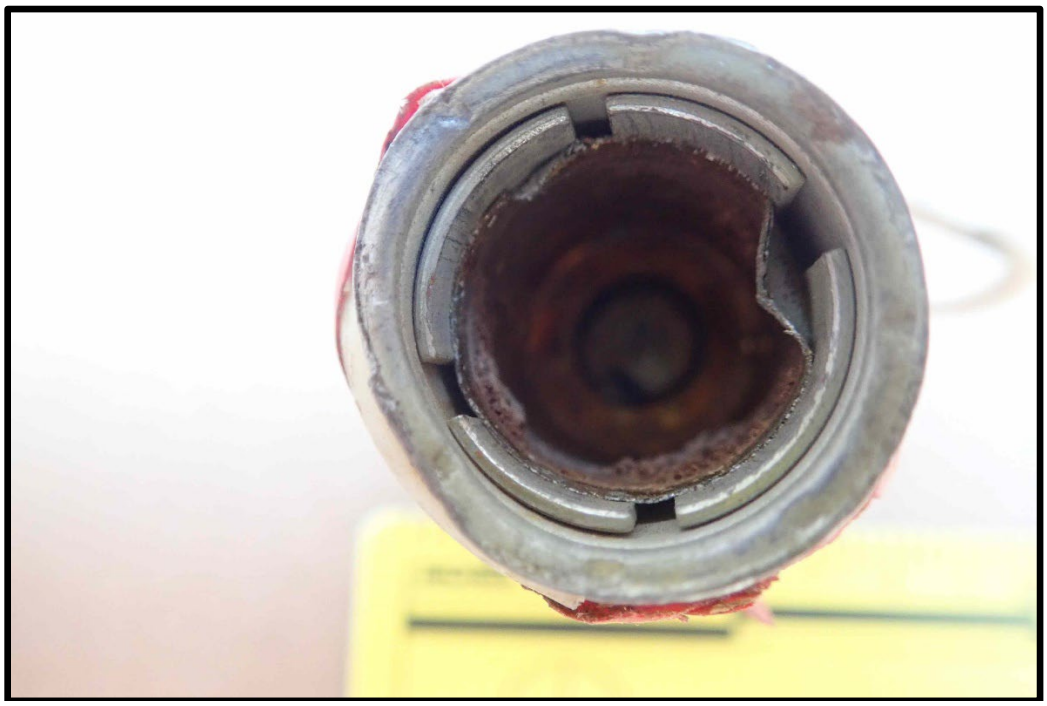

Figure 38 – Lamp socket

Figure 39 – Lamp socket and lower aft control column assembly

Figure 40 – Aft control stick and column with no boot

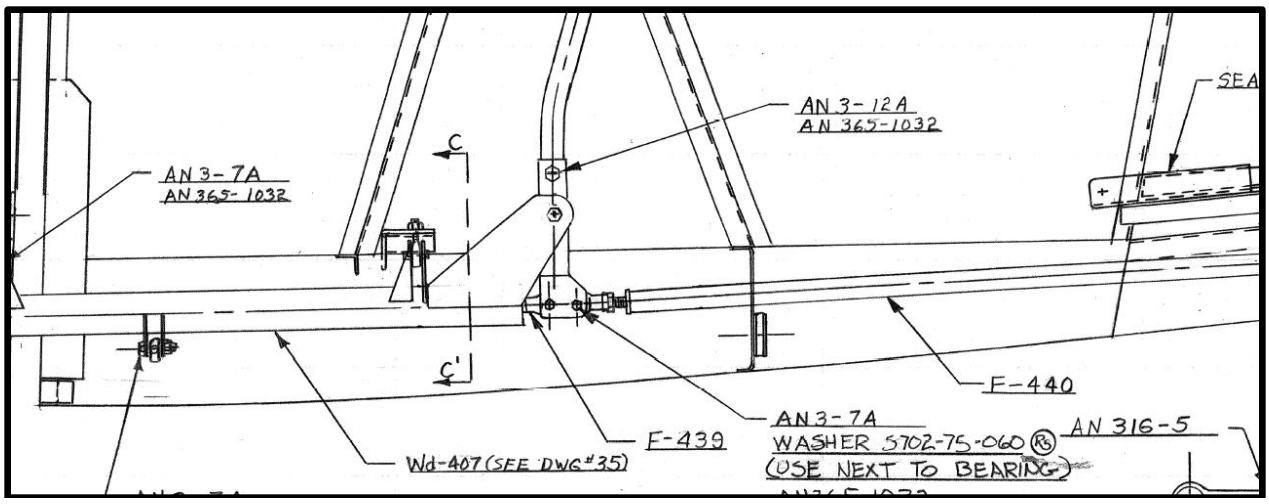

Figure 41 – Aft control stick plan view showing belly bay (forward to left)