NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Western Pacific Region

AIRFRAME AND ENGINE EXAMINATION

WPR18FA218

This document contains 28 embedded photos.

A. ACCIDENT

Location:	Baker City, Oregon
Date:	August 11, 2018
Aircraft:	Mooney M20K, Registration N231EC, S/N 25-0167
NTSB IIC:	Eliott Simpson

B. EXAMINATION PARTICIPANTS:

Eliott Simpson
Senior Aviation Accident Investigator
National Transportation Safety Board
Western Pacific Regional Office
Los Angeles, CA

Robert Nance
Principal Avionics Inspector
FAA FSDO
Boise, Idaho

Mike Council
Air Safety Investigator
Continental Motors
Mobile, Alabama

C. SUMMARY

Examination of the airplane was conducted at the accident site on August 12, 2018 with a follow up examination performed at the facilities of SP Aircraft at BOI Airport, on August 13, 2018. Examination revealed that at the time of ground impact the landing gear and flaps were likely fully extended, the speed brakes were retracted, the stabilizer trim was set to a full nose-up setting, just beyond the power-off landing position. The engine-driven vacuum pump appeared to have failed prior to impact.

D. DETAILS OF THE INVESTIGATION

1.0 Airframe Examination

Model Number: M20K
Serial Number: 25-0167

1.1 Cabin

The fuselage sustained crush damage from the nose through to the leading edge of the vertical stabilizer (Photo 1). The flight controls and instrument panel were heavily fragmented and compressed such that a determination of flight instrument, avionics, autopilot, and circuit breaker settings could not be determined (Photo 2). The firewall had been pushed aft and in line with the wing leading edges, and the engine had folded and was resting over the crushed remnants of the instrument panel (Photo 1).

The control wheel, foot pedals and all associated bellcranks and push-pull tubes were either fragmented, bent or crushed. Each separation exhibited bending failure features. The throttle, mixture, and propeller controls were in the full forward position.

Both front seats were crushed and folded. The left seat remained attached to its rails and was about 2 inches short of full-forward. The right seat appeared about 1 inch short of full-forward.

Both wings remained attached to the main cabin, and both sustained leading-edge crush damage compressing the aileron control cavity and buckling the skins through to the main spar. The crush damage was about 90 ° relative to the wing chord on both wings (Photo 3).

A strong odor of aviation fuel was present at the accident site. About 40 lbs of tools and cargo was located in the aft cabin behind the rear seats. According to the FAA representative, a small backpack was removed from the accident site by the Coroners department.

The Hobbs-hour meter was not located, and the tachometer was damaged such that an accurate reading could not be determined.

1.2 Left Wing

The left wing remained attached to the airframe, and the inboard leading-edge skins of the fuel tank had split and opened forward at the inspection panel (Photo 4). The fuel cap was firmly secure at the filler neck.

The ailerons and flaps remained attached at their hinges, and the aileron balance weight remained in place. Movement of the aileron resulted in movement of the aileron control tube at the root. The aileron bellcranks remained attached to the wing structure and moved freely. The roll servo remained attached to the structure and moved smoothly with movement of the aileron.

The speed brake assembly was intact and retracted. The blades deployed when the control cable was pulled at the root. The brakes did not exhibit any damage to their forward or aft surfaces, which was consistent with retraction at impact.

The stall warning switch sustained crush damage to its forward bracket (Photo 6). The two electrical contacts on the switch were intact. The switch functionality was then tested with an ohm-meter; continuity could be interrupted with movement of the stall tab. The pitot heat probe had bent back against its mounting column.

1.3 Right Wing

The right wing remained attached to the airframe and the inboard leading-edge skins of the fuel tank had split and opened forward at the inspection panel (Photo 5). The fuel cap was firmly secure at the filler neck.

The ailerons and flaps remained attached at their hinges, and the aileron balance weight remained in place. Movement of the aileron resulted in movement of the aileron control tube just outboard of the landing gear. The aileron bellcranks remained attached to the wing structure and moved freely.

The speed brake assembly was intact and retracted. The blades deployed when the control cable was pulled at the root. The brakes did not exhibit any damage to their forward or aft surfaces, which was consistent with retraction at impact.

1.4 Flaps

The control arms for both flaps remained attached to the jack shaft. The rod end for the actuator had broken away from the shaft, and was bent 90 ° at the head. The actuator exhibited about 0.5 inches of exposed thread (Photo 7), which when compared to Mooney documentation represented full flaps.

1.5 Empennage

The moving tail section remained attached to the bulkhead, with the elevators attached at their respective hinges, and the balance weights in place. The elevator and rudder push-pull tubes were continuous from their control arms through to the forward cabin where they had become impinged against the fuselage belly.

The stabilizer aft jackscrew had about 16 exposed threads (Photo 8). According to Mooney documentation, this was consistent with a full nose-up setting, with 12 exposed threads consistent with a power-off landing trim setting. The elevator trim assembly stop was in the forward position, reflecting a similar nose-up setting (Photo 9). The trim actuator torque tube had pulled away from the actuator, but was continuous through to the forward cabin. Separated tube sections were examined, and exhibited crush damage consistent with fuselage contact at impact. The autopilot elevator trim servo remained attached to the trim shaft via it's sprocket and chain. Rotation of the shaft by hand resulted in rotation of the servo input shaft clutch.

The rudder remained attached to the vertical stabilizer, its balance weight was in place. The push-pull control tube was continuous from its control arms through to the aft cabin where it had become impinged against the cabin floor.

1.6 Landing Gear

The landing gear switch had bent to the left and was in the gear-down position (Photo 10). The entire nose landing gear assembly was crushed underneath the forward belly (photo 11).

The right main landing gear appeared extended at the accident site (Photo 12). The front and rear pivot shaft of the main gear leg assembly had come away from the attach points on the main and rear spars, and the rear shaft of the assembly was protruding through the upper wing skin. The truss assembly and retracting links and spring were intact, and the gear could be moved up and down. The shock disks appeared undamaged.

The left main landing gear had folded partially up against the wing at the accident site (Photo 13). The front and rear pivot shaft of the main gear leg assembly had come away from the attach points on the main and rear spars, and the rear shaft of the assembly was protruding through the upper wing skin. The truss assembly and retracting links and spring were intact, and the gear could be moved up and down. The retracting spring mounting bracket had pulled away from the wing structure; the separation surfaces all had a shiny appearance. The shock disks appeared undamaged.

The push-pull tubes were continuous from both main landing gear through to the actuator, although the tubes sustained bending damage in the forward cabin compartment. The jack screw of the landing gear actuator was fully retracted, consistent with a fully extended landing gear (Photo 14).

1.7 Fuel System

The fuel supply lines from the tank through to the forward cabin were intact and all fittings were secure. The remaining components of the fuel system sustained significant crush and fragmentation damage. The gascolator sustained crush damage and was breached. The gascolator fuel filter was clear. The fuel selector valve had become twisted within the cabin frame members and the handle had detached (Photo 15). According to Mooney representatives, the valve was in the left tank position.

2.0 Engine

Engine Model: TSIO-360-LB (1)
Serial Number: 247414-R

The engine had sustained extensive impact damage and remained partially attached to the airplane via fuel lines, electrical wires and engine controls. All four alloy engine mounting brackets had broken away from the engine. The separation surfaces of the brackets were bright and had a granular texture. The induction, ignition, and fuel manifold valve system components on the upper side of the engine all sustained crush damage. The starter motor had broken away from its mount and was held in place by electrical wires, and the alternator was crushed. The starter drive shaft could be rotated by hand.

The engine driven fuel pump remained attached, although its fuel lines and fittings had detached. The pump was removed and a small quantity of fuel (about 1 teaspoon) flowed from the supply line. The fuel pump drive coupling was intact, and the input drive shaft rotated freely. The unit was disassembled, and both the rotor and blades were intact (Photo 16).

The fuel manifold valve remained attached to the top of the engine. The unit was opened, and its screen was clear. About 1 tablespoons of fuel issued from the internal cavity. The fuel had the odor of aviation gasoline and was negative for water when tested with water detecting paste (Photo 17).

A 1-inch square hole was noted in the top of the engine crankcase, adjacent to the manifold valve. A steel control line had been compressed down into the hole. The edges of the hole exhibited slight inward deformation into the case (Photo 18). The engine crankcase was examined through the hole utilizing a borescope. There was no indication of internal damage, and all components appeared to be coated in oil.

The right magneto remained firmly attached to its mounting pad. The left magneto had detached, and its flange had fractured in the area of the engine mounting studs. The magnetos and upper spark plugs were removed to facilitate inspection. The damaged ignition leads were cut away and magnetos rotated by an electric drill and sparks were observed at all of the cut leads. The top spark plugs were undamaged, and their electrodes were coated in light grey deposits (Photo 19), and exhibited "worn out – normal" wear signatures when compared to the Champion AV-27 Aviation Check-A-Plug chart.

The turbocharger remained attached to the engine, and its v-band clamps were secure (Photo 20). The inner surface of the tailpipe was coated in light brown deposits. The turbine wheel was coated in similar deposits, appeared undamaged, and could be rotated smoothly by hand (Photo 21).

The oil filter and mounting bracket had broken away from the engine, and the filter canister was crushed. The rocker covers were removed, and all components were coated in oil. The accessory case gears appeared undamaged and coated in clean oil (Photo 22). The engine was rotated by hand via an adapter fitted to the accessory drive. The engine turned freely, and "thumb" compression was noted on all cylinders. Mechanical continuity was established throughout the rotating group, valve train, and accessory section, and the rockers all moved similar heights.

Visual inspection of the combustion chambers was accomplished through the spark plug bores utilizing a borescope; there was no evidence of foreign object damage or detonation and all combustion surfaces exhibited light grey deposits consistent with normal operation.

2.1 Propeller

The propeller assembly had separated from the engine and become partially buried about 12 inches into the turf just forward of the main wreckage at what appeared to be the first impact point (Photo 23). The turf surrounding the propeller had been sliced open, and an 18-inch square scallop of sod was ejected about 5 ft to the south (Photo 24). Both blades appeared to have sliced through the turf, screwing the propeller into the ground.

The spinner had crushed around the propeller hub. The hub remained attached to the crank flange, which had separated from the crankshaft. The shaft exhibited a conical 45° shear lip around its entire circumference, with serrated, ratchet-like tear features around most of the crown. Circumferential crack marks were present on the radial surface of the shaft adjacent to the ratchet marks. (Photo 25)

The propeller governor sustained impact damage, remained partially attached to the forward engine crankcase, and had cracked open.

2.2 Vacuum Pump

The vacuum pump remained attached to its accessory pad. The unit was removed, revealing that the plastic drive coupling had sheared. The separation surfaces exhibited a spiral scar at the core, with smear damage to the outer radius (Photo 26). Oil was noted within the cavity, the rotor had shattered, and all six blades were intact. (Photo 27). The standby vacuum actuation cable had broken away from the actuation handle, so the operational status of the standby system could not be determined. (Photo 28)

3.0 Examination Photos

Photo 1 – Airplane at Accident Site

Photo 2 – Instrument Panel

Photo 3 – Left Wing

Photo 4 – Left Fuel Tank

Photo 5 – Right Fuel Tank

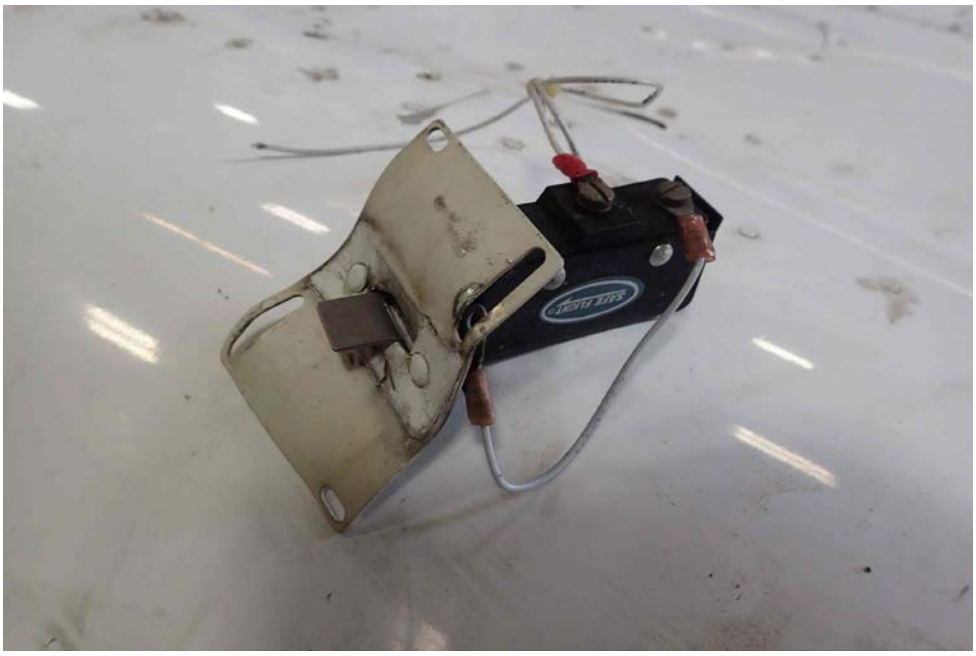

Photo 6 – Stall Warning Switch

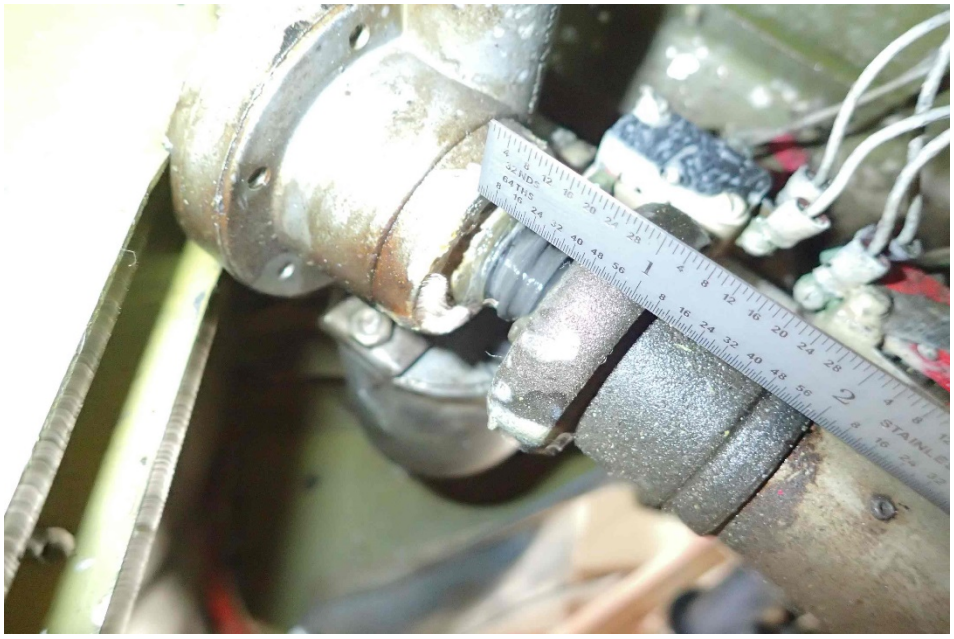

Photo 7 – Flap Actuator

Photo 8 – Stabilizer Aft Jackscrew

Photo 9 – Stabilizer Trim Assembly

Photo 10 – Landing Gear Switch

Photo 11 – Nose Gear

Photo 12 – Right Main Landing Gear

Photo 13 - Left Main Landing Gear

Photo 14 – Landing Gear Actuator

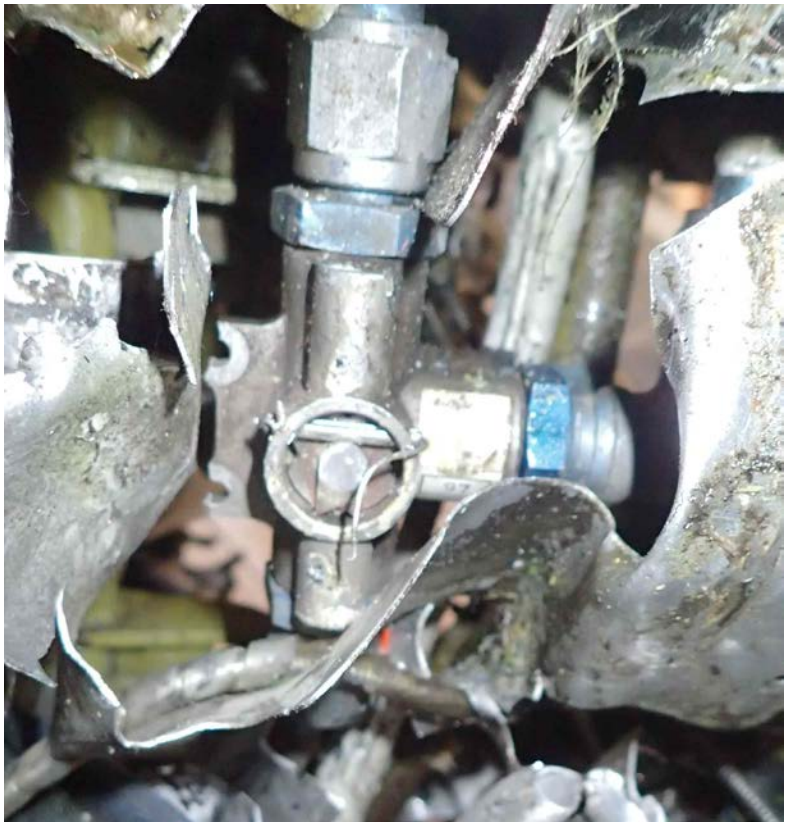

Photo 15 – Fuel Selector Valve

Engine Driven Fuel Pump Components

Photo 16 – Engine Driven Fuel Pump Components

Photo 17 – Fuel Recovered from Manifold Valve

Photo 18 – Hole in Engine Crankcase

Photo 19 – Top Spark Plugs

Photo 20 – Turbocharger V-Band Clamp

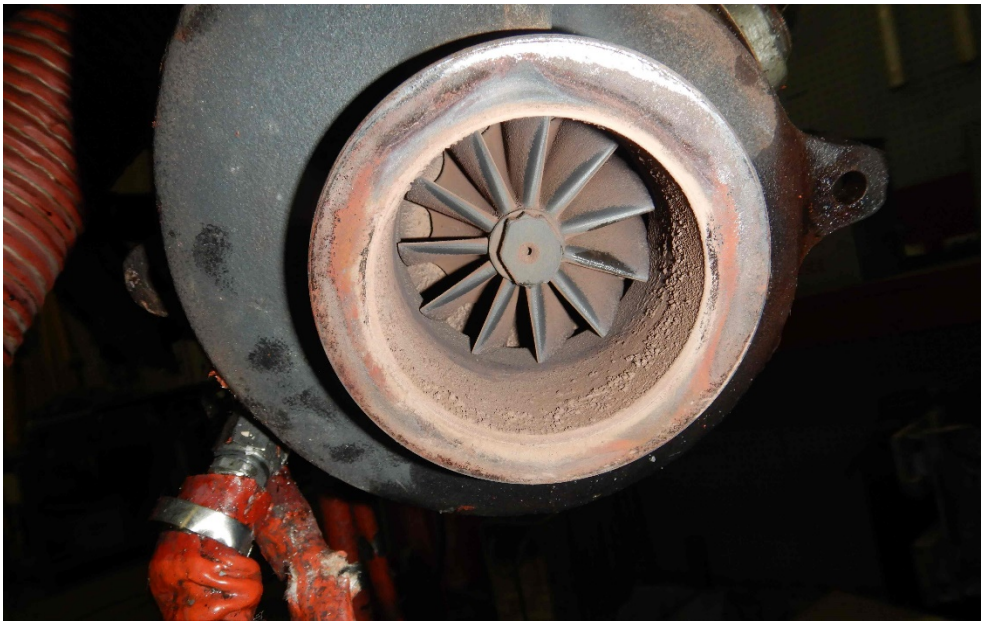

Photo 21 - Turbine Wheel

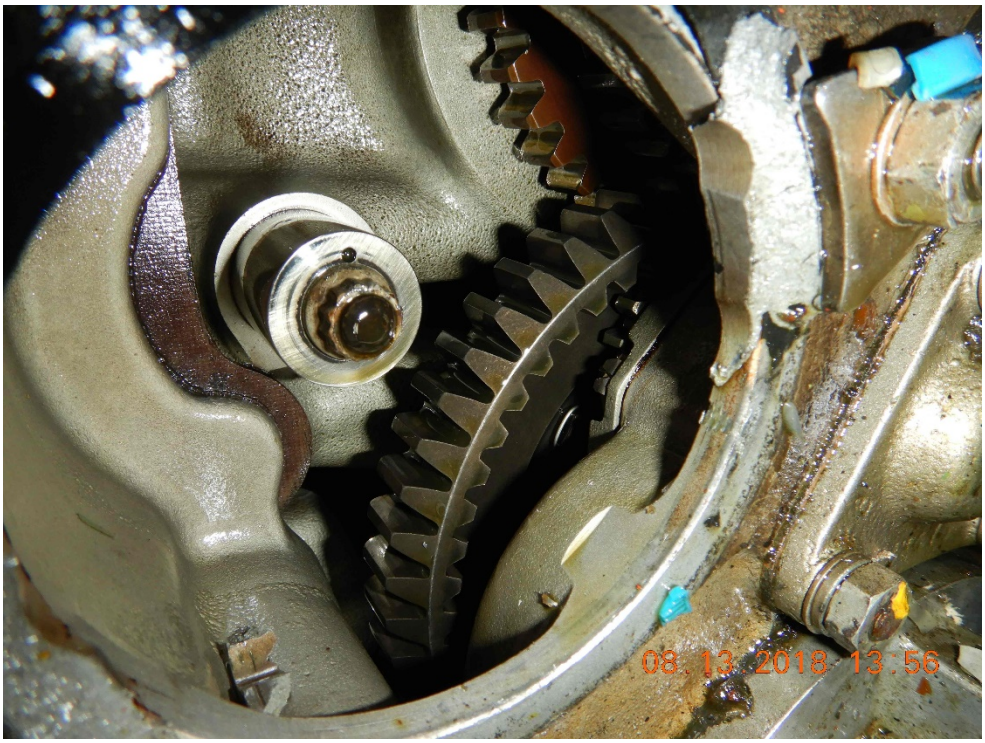

Photo 22 – Accessory Gears

Photo 23 – Propeller at Accident Site

Photo 24 – Displaced Sod

Photo 25 – Propeller Flange

Photo 26 – Vacuum Pump Coupling

Photo 27 – Vacuum Pump Internal Components

Photo 28 – Standby Vacuum Control

Submitted by: Eliott Simpson