National Transportation Safety Board
Office of Aviation Safety
Washington, DC 20594

WPR22FA229

ENGINE EXAMINATION

May 10, 2023

A. ACCIDENT

Location: Kerrville, Texas
Date: June 25, 2022
Time: 1823 LCL
Airplane: Mooney M20J, N4267H

B. ENGINE EXAMINATION

IIC	Eliott Simpson NTSB
Investigator	Starr Blum NTSB
Party Coordinator	David Harsanyi Lycoming Engines

C. DETAILS OF THE EXAMINATION

1.0 Engine Examination

Model Number: IO-360-A3B6D
Serial Number: L-19508-51A

The engine examination was performed on May 9, 2023, at the facilities of Air Salvage of Dallas, Franklin, Texas.

The engine sustained extensive thermal damage, and remained partially attached to the mount, which had detached from the firewall (figure 1). There was no evidence of catastrophic internal failure such as case perforation. All fuel and oil lines sustained extensive thermal damage, but the remaining line fittings were still tight at their respective attachment points.

The propeller remained attached at the hub (figure 2), both blades sustained thermal damage melting one blade outboard about midspan; this blade had partially detached from the hub, was loose within the assembly, and displayed about 45°of pitch in the direction of flight within the hub. The 12-inch section of the other blade had melted, and the blade was bent progressively about 30 degrees aft, with a similar 45° pitch angle. Neither blade remnant exhibited any leading edge nicks, dents or

chordwise striations. The ring gear remained attached to the flywheel, and the starter motor was intact at its pad on the crankcase.

The accessory case had melted, exposing the accessory gear idler drivetrain (figure 3). The engine driven fuel pump had melted, revealing the inner spring, shaft, and diaphragm plate. The right side of the dual magneto had burnt away; the left side was still partially attached to the accessory case through its center drive shaft, which was still attached to the drivetrain (figure 4). Remnants of the vacuum pump mounting plate remained attached to the accessory case, but the pump appeared burnt and its remnants were not located. A burnt secondary vacuum pump assembly was observed within the airframe debris. The propellor governor case had melted, revealing the fly weights and the oil screen which was free of debris.

The oil filter fitting assembly was burnt, and partially melted, displacing the oil filter. The oil filter screed contained burnt black carbon-like remnants.

The inlet manifold/oil sump had partially melted on the left side, the fuel servo remained attached to the remnants. Both the throttle (figure 5) and mixture (figure 6) linkages were still attached to the servo. The mixture arm could be moved, the throttle arm was frozen in the closed position, and the butterfly valve was in the closed position.

The rocker covers were removed in the field examination, and at that time the fins and external cylinder head of cylinder 2 and 4 appeared whitened by thermal damage, and the rocker areas were dry. Cylinders 1 and 3 exhibited thermal damage, but had not whitened, and the rocker areas were still coated in a light oil glaze. All springs and rocker arms were intact, and the pushrods shroud tubes were straight.

The fuel flow divider was intact on the top of the engine, disassembly revealed all the rubber diaphragms and been thermally destroyed with only black carbon fragments remaining. The lines to each fuel injection nozzle were intact and all top spark plugs were tight (the bottom plugs were removed in the field). The fuel injection nozzles were all tight at the heads and were removed. The nozzles for cylinders 1, and 3 were clear, the nozzle for cylinder 4 appeared blocked, but melted material and corrosion deposits were present (2 and 4 were corroded side of engine). The nozzle for cylinder 2 was partially blocked by corrosion deposits.

The turbocharger assembly remained partially attached to the engine. The air inlet tube had burnt away, the outlet tube was still attached to the intercooler, and the intercooler tube was still attached to the inlet of the fuel servo (figure 7). The exhaust pipes remained attached to each cylinder and were continuous to the turbocharger manifold; each slip joint was intact. The turbocharger exhaust inlet, outlet and center V-band clamps were intact (the exhaust pipe outlet clamp was disconnected by the NTSB IIC to facilitate inspection at the accident site). The exhaust fixed orifice tube

had partially broken away from the exhaust pipe. The turbine and compressor wheels could not be rotated, and there was evidence that the compressor housing had partially melted and was sagged against the turbine. The blades of both wheels were intact and undamaged (figure 8, 9). The oil drain line was removed and the center bearing area could be viewed through the opening. The area had sustained thermal damage similar to that observed externally, and there was no evidence of localized heating or debris.

The pressure relief valve remained attached to the inlet manifold and was partially burnt. Its internal bellows and valve head were intact.

The inlet air tube for cylinder number 2 had detached from the cylinder head clamp, all other intake pipes were intact.

The spark plugs were removed, all were the massive electrode type except for the bottom cylinder 3 which was the fine wire type. All appeared to be new with minimal wear signatures. All plugs exhibited varying degrees of black and grey sooting, along with oil deposits (figure 10).

The cylinder bores were examined with a borescope. There was no evidence of catastrophic internal damage. All valves were intact and exhibited concentric discoloration and deposits on their heads. All piston crowns were coated in light grey deposits, cylinders 2 and 4 were coated in rust and oxide deposits consistent with storage after the accident. The corrosion deposits were not present when examined at the accident site. Cylinders 1 and 3 were wet with oil.

Due to thermal damage that caused the accessory case to melt into the drivetrain, the engine could not be rotated. Holes were therefore drilled into the top of the crankcase to facilitate inspection using a borescope.

The cam lobe tips were well defined, with no evidence of wear or deformation. The observed tappet heads were clean, with no obvious evidence of galling or surface damage. The crankshaft appeared intact and there was no evidence of catastrophic internal failure or localized heating.

The fuel flow divider was opened, and the diaphragm appeared thermally destroyed with only black carbon remnants remaining.

The fuel servo had a Bendix data tag, rather than the Precision Airmotive tag (figure 11). Precision Airmotive purchased Bendix in 1988 and have since required the servo type be overhauled every 12 years. The overhaul kit contains a replacement Precision Airmotive data tag that should be installed at overhaul.

The fuel inlet screen was burnt, and there were no observable debris within it. The safety wire appeared to be thicker than standard, and no safety wire seals were observed. The butterfly valve within the fuel servo was in the closed position. The air inlet was clear, and the air impact tubes were intact.

The servo was disassembled, and all internal diaphragms were burnt and black. A Precision Airmotive manufacturing mark was observed on one of the internal components figure 12. Therefore, without maintence logs, it could not be determined who installed the Precision Airmotive components, and when.

FAA airworthiness directive (AD) 2009-02-03, applicable to the RSA-5AD1 fuel injection servo requires the compliance with Precision Airmotive Service Letter RS-87, issued July 14, 2008. The AD warns that a loose regulator hex plug can cause a lean fuel mixture, and possible loss of engine power. If during the inspection the hex plug was found loose, it is required to be removed and replaced with an alternate gasket, then retightened and a "G" be stamped into the regulator hex plug. If looseness was not observed, no stamp was required, however a 50 hour re-examination was.

No "G" was observed on the accident plug; the hex plug was tight, but the surrounding aluminum housing displayed evidence of distortion and thermal damage (figure 12). Due to the maintence logbooks being destroyed in the fire, it could not be determined if the AD had been complied with.

2.0 Examination Photographs

Figure 1 – Engine before examination

Figure 2 – Propeller and hub/spinner

Figure 3 – Accessory case remnants

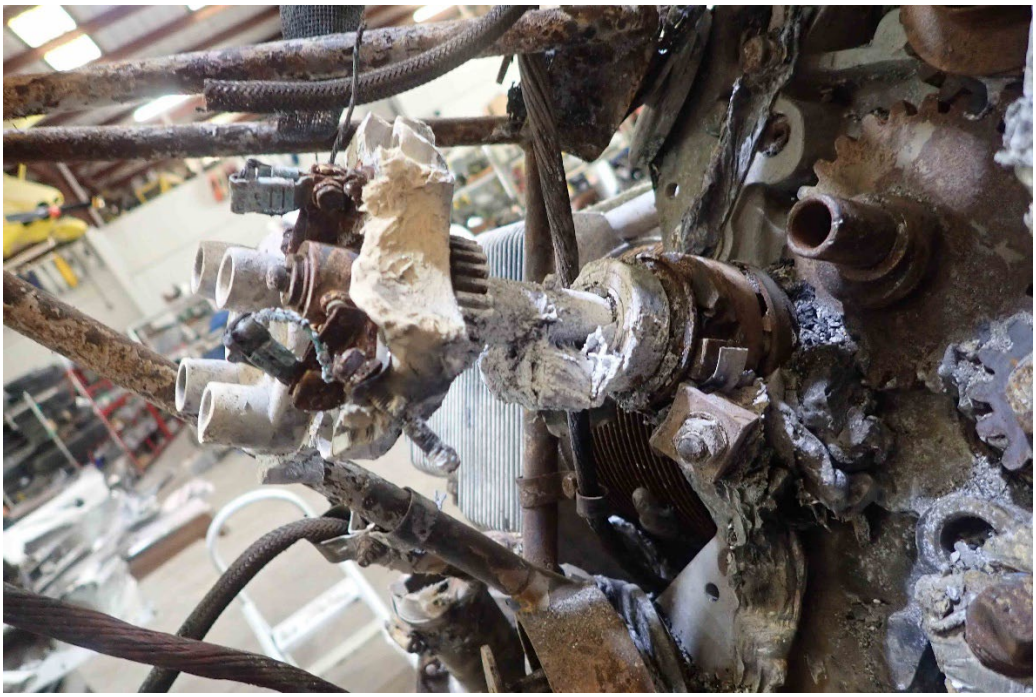

Figure 4 – Magneto remnants

Figure 5 – Throttle control

Figure 6 – Mixture control

Figure 7 - Turbocharger

Figure 8 – Turbocharger compressor wheel

Figure 9 - Turbocharger turbine wheel

Figure 10 – Bottom spark plugs at accident the site

Figure 11 – Fuel servo data tag

Figure 12 – Fuel servo hex plug and diaphragm plate

Submitted by:

Eliott Simpson
Senior Aviation Accident Investigator