

National Transportation Safety Board

Office of Aviation Safety

Washington, DC 20594



WPR24FA054

ENGINE EXAMINATION

July 31, 2024

A. ACCIDENT

Location: Topock, AZ
Date: December 10, 2023
Time: 1555MST
0355UTC
Airplane: Beechcraft A36

B. ENGINE EXAMINATION

IIC	Michael Hicks National Transportation Safety Board Federal Way, WA
Subject Matter Expert	Ernest Hall Textron Aviation Wichita, KS
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C. SUMMARY

The examination revealed that a failure of the No. 4 piston connecting rod breached the top of the crankcase. Failure of the connecting rod was attributed to an oil starvation event between the main bearing and the No. 4 piston connecting rod cap. The No. 4 piston connecting rod cap, and bearings, were fracture-separated and parts of each were found in the engine sump. One of the connecting rod cap retention bolts was found lodged under the camshaft. The associated connecting rod cap nut and the opposite side bolt and nut were not readily identifiable, however metallic debris consistent with the bolt and nut were in the oil sump.

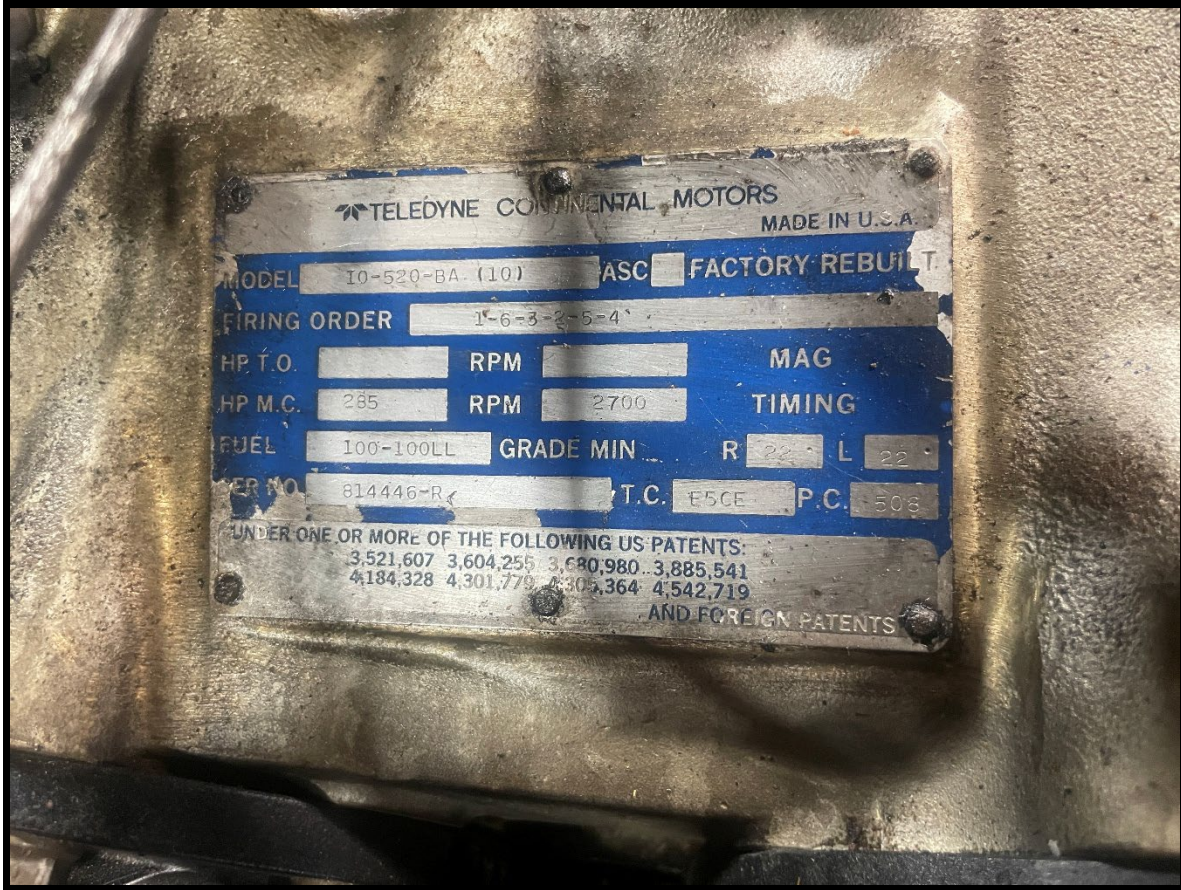


Figure 1: View of the accident engine (N4171S) data plate

1.1 Fuel/Fuel System

Fuel Manifold

p/n: 631427-2A21

s/n: T219931CR

Note: Fuel manifold remained attached with all lines attached to their respective intake.

Throttle Body Metering Unit

Manufacturer: Great Planes

s/n: A11GA081R

p/n: FT-B8.5/1-442

Injectors

Manufacturer: GAMI

Remained attached with each line undamaged.

2.0 Engine Examination

Initial overview of the accident engine once removed from the shipping container revealed that the entire engine sustained thermal damage signatures. The accessory case remained attached to the crankcase. All engine mounts remained attached. The left and right magneto remained attached and secure to the accessory case, with each respective wire harness attached and secure. Each rocker cover remained attached to its respective cylinder, and each cylinder remained attached to the crankcase. The No. 5 rocker cover sustained impact damage to the forward lower section. The intake manifold remained attached to their respective cylinders and thermal damage was sustained to the left side under the oil cooler. The intake balance tube was intact, remained attached and unremarkable. The throttle body remained attached, unremarkable, and the butterfly valve was in the open position.

The exhaust system remained attached to their respective cylinders; the turbo charger was disconnected from the left and right side, with the attachment points having sustained thermal deformation. The turbo charger was detached in preparation for transport to the factory. The turbo charger impeller shaft was seized and did not rotate by hand when pressure was applied. Subsequently, a 7/8-inch drive was applied to the turbo charger with corresponding movement observed to the impeller drive, and the intake and exhaust impellers rotated freely. The impeller housing did not reveal rotational scoring. The impeller blades did not rotate, and the blades revealed thermal damage with ash deposits throughout. The waste gate opened and closed freely when turned by hand.

The fuel manifold remained intact and attached to top of the crankcase. A 3-inch x 2-inch puncture existed on the top side of the crankcase above the No. 4 cylinder (Figure 2). The fuel metering valve remained partially attached via the lower mount bolts. The mixture and throttle cables remained attached and unremarkable. The mixture and throttle cables were cut in preparation for transport to the factory for further examination. The oil sump remained attached and unremarkable.



Figure 2: Top view of the crankcase with a 2.5-inch x 2-inch hole above No. 4 cylinder

ACCESSORIES:

Right Magneto
Manufacturer: Teledyne Continental Motors
Type: S6RN 1225
p/n: 10-349350-5
s/n: K066914FR
Function Test: Unremarkable

Left Magneto
Manufacturer: Bendix
Type: Illegible
p/n: 10-349350-4
s/n: K049902FR
Function Test: Unremarkable
Note: Thermal damage sustained

Starter:

Manufacturer: Hartzell Engine Technologies

p/n: 646238-2R

s/n: H-P121166

Alternator:

Manufacturer: Plane-Power / Hartzell Engine Technologies

Model: ALX-9524

s/n: H-T071689

Oil Filter:

Date: 10/05/2023

Tach: 7,806.8 hrs.

Oil Pump:

Manufacturer: Continental

p/n: Illegible

s/n: Illegible

Oil Cooler

Manufacturer: Niagra

p/n: 10278A

s/n: G993264378

Standby Alternator:

Manufacturer: B & C Specialty Products

p/n: BC410-1

s/n: 2C10---- thermal damage

Fuel Pump

s/n: A207252RA

p/n: FT-B8.5/1-632818-2

Note: Fuel pump rotated through when the drive was turned by hand, although thermal damage produced a rough rotation. The fuel pump was bench-tested, which revealed that each of the gaskets sustained thermal damage. The boost pump was applied in the On position, and the pump produced a flow rate of 49.7 lbs. per hour, and 11.7 psi.

Starter

Manufacturer: Hartzell Engine Technologies

p/n: 646238-2R

s/n: H-P121166

Starter Adapter
p/n: 642085A17
s/n: 53659

Note: Rotated freely when turned by hand. The exterior revealed thermal signatures.

The alternator remained attached, undamaged and rotated. The starter generator remained attached and revealed thermal discoloration signatures. The oil filter remained attached and sustained thermal damage. The standby alternator was partially attached to the right accessory drive, and sustained impact and thermal damage, but remained attached to the top of the accessory case by the mount. The left and right magneto accessory drives remained intact and functionally unremarkable with thermal damage sustained to the left magneto. The fuel pump remained attached and sustained thermal signatures. The fuel pump was removed and revealed thermal discoloration and deformation to the surface, with the drive attached and unremarkable. The oil pump remained attached and sustained thermal signatures. The oil cooler remained attached to the accessory case and sustained thermal signatures.

Spark Plugs (Figure 3)
s/n: URHB32S

Notes: Per Champion Fine Wire Spark Plug Illustration Chart

No. 2, 5, 6 Top: Carbon Fouled

No. 5, 6 Bottom: Carbon Fouled

No. 2 Bottom: Oil Residue and Carbon Fouled

No. 4 Top & Bottom: Lead Fouled

No. 1 & 3 Top & Bottom: Normal



Figure 3: View of top and bottom spark plugs

When the oil sump was removed (Figure 4), metallic debris (piston), along with pieces of the connecting rod, bearings, retention nuts and bolts were found in the sump. The four, sump case half connecting bolts (long) that were installed, were not Continental manufactured bolts. The six, sump case half connecting (small) bolt nuts that were installed, were not Continental manufactured. The oil sump pickup tube screen was unremarkable.



Figure 4: View of metallic debris in the oil sump

The engine would not rotate completely through when rotated by hand (only about $\frac{3}{4}$ of the way through). The rocker covers were removed, the intake and exhaust rocker arms produced partial movement. The push rod tubes were unremarkable. The push rods were unremarkable, except for the No. 4 piston intake push rod, which revealed about a 10° bend, about 3" from the engine case half.

Cylinder No's 1, 2, 3, 4, 5, 6:

Each of the cylinders mentioned above shared the same signatures.

The cylinder walls showed normal wear signatures. The intake valves revealed lean operation signatures with a red-ish center, but no dishing or tulip-ing observed. The exhaust valves revealed normal operational signatures.

Cylinder No's 1, 2, 3, 5, 6:

The piston faces revealed normal operational signatures. The manganese phosphate coating was still present, the Ni-Resist steel ring lands and the graphite coated skirt were unremarkable. The top compression, second compression, oil retention and oil scraper rings and grooves were unremarkable. The piston pins and plugs were present and unremarkable. The connecting rod cap, bearings, bolts and nuts were all present. The No.1, 2, and 3 connecting rod bearings displayed initial oil starvation signatures.

Cylinder No. 4 (Figure 5)

The piston face revealed exhaust valve contact signatures. The manganese phosphate coating was eroded; the Ni-Resist steel ring land was present and unremarkable. The graphite coated skirt was missing about 66 percent and the piston

pin had separated from the piston. The top compression, and second compression rings and lands were unremarkable and traveled freely. The oil retention ring and land were damaged, and the oil scraper ring and grooves were not present. The piston pins and plugs were not present but recovered at the accident site. The airplane impacted rocky desert terrain while oriented on a southeasterly heading.

The first identifiable point of contact was a boulder with blue paint transfer markings found underneath high-tension powerline wires on the north side of (Figure 2). The right wing's green position light lens fragments were found in the debris path underneath the powerlines. Additional debris within the path between the initial point of impact and the main wreckage consisted of right wing skin, a right wing rib, fuel vent line, and a section of a propeller blade. The direction of travel from the initial point of impact to the main wreckage was oriented on a heading of about 212° magnetic and was about 132 ft in length. Additionally, between the initial point of impact and the main wreckage was a swath of terrain about 50 ft in diameter, which sustained thermal signatures.



Figure 2: Wreckage and debris path diagram

The main wreckage came to rest on a heading of 333°magnetic. The engine had partially separated from the airframe and came to rest inverted. The cockpit to engine control cables for the propeller, throttle, and mixture sustained thermal damage. The propeller spinner sustained minor impact damage, while all three of the wood propeller blades separated between 9 inches to 12 inches outboard of the propeller

hub. The instrument panel and cabin sustained impact and thermal damage. The right wing sustained impact and thermal damage, with the landing gear retracted within the wheel well. The left wing sustained impact damage but was largely intact, with the landing gear retracted within the wheel well. The left wing fuel cell was intact and was not breached. The right wing fuel cell was consumed by fire. Control continuity of the left and right wing aileron and flap were confirmed. The empennage was not damaged and unremarkable. Control continuity from the cockpit to the rudder, elevator, and both trim surfaces, were confirmed. The engine compartment upper cowling was separated from the airframe and came to rest about 3 ft from the engine. The left and right forward areas of the cowling, revealed puncture signatures emanating from the inside of the cowling, with the skin curling about the exterior of the cowling (Figure 3). The left side cowling sustained multiple protrusions, while the right side cowling sustained a single protrusion.



Figure 3: View of the left and right upper engine cowling protrusions

Postaccident examination of the engine revealed that the No. 4 connecting rod was separated from the crankshaft and piston and was located adjacent to the engine. The No. 4 crankshaft journal sustained material deformation with dark grey/black thermal signatures. The main bearing gallery was unobstructed, and the crankshaft oil passage was unobstructed. The No. 4 connecting rod bearing shoulders were not present, with material deformation at the base of the bearing housing and into the i-beam. The bearing end of the i-beam showed a thermal discoloration that appeared white/light grey in color, with dark grey progression emanating from the trapezoidal contour at the tower base and web to flange transition radius. The piston pin bushing was present with material deformation observed around bushing and housing radius on both sides. The No. 4 main bearing provided lubrication to the No. 4 piston crankshaft journal. The No. 4 piston connecting rod cap, and bearings, were fracture-separated and parts of each were found in the engine sump. One of the No. 4 piston's connecting rod cap retention bolts was found lodged between the camshaft and the crankcase. The associated connecting rod cap nut and the opposite side bolt and nut were not readily identifiable, however metallic debris consistent with the bolt and nut were found in the oil sump (Figure 4).



Figure 5: View of No. 4 cylinder removed from crankcase and its associated piston



Figure 6: View of the remaining No. 4 cylinder piston



Figure 7: View of No. 4 piston connecting rod at the accident site

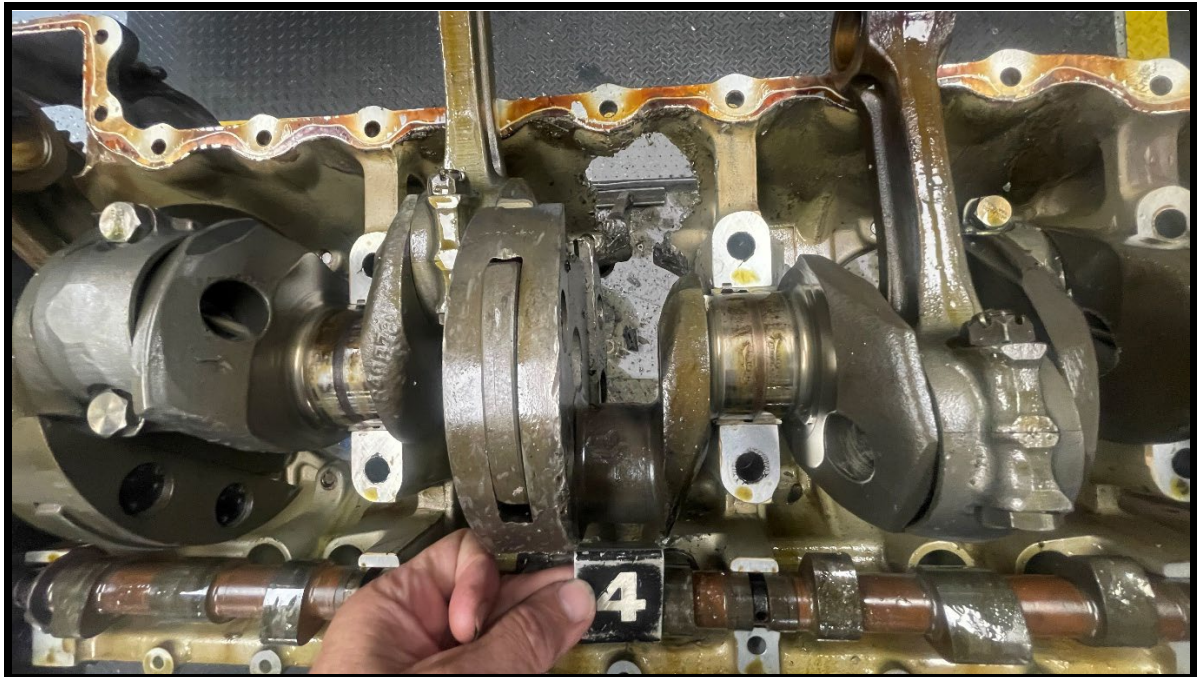


Figure 8: View of the crankshaft No. 4 piston connecting rod journal

3.0 Propeller

Propeller

Manufacturer: MT Propeller

p/n: MTV-9-D/210-58

s/n: 221061

Spinner Assembly: P-512-7

Propeller Governor

Manufacturer: Woodward

p/n: D210680

s/n: 1194533S

Note: Remained attached and unremarkable. The control cable linkage remained attached, and the oil screen was clean and free of debris.



Figure 9: View of impact damage to propeller blades and spinner

Submitted by:

Michael Hicks

Investigator-in-charge