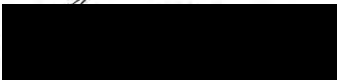




Continental Motors

ENGINE EXAMINATION REPORT

ENGINE MODEL	TSIO-550-C9B
ENGINE SERIAL NUMBER	914393
AIRCRAFT MAKE & MODEL	Columbia Aircraft LC41-550FG
AIRCRAFT SERIAL NUMBER	41594
AIRCRAFT REGISTRATION	N2536T
FILE NUMBER	18-188

NAME	SIGNATURE	DATE
Nicole L. Charnon		11/14/2018

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EXAMINATION		ACCIDENT DATA	
DATE	09/16/2018	NTSB ACCIDENT #	ERA18FA251
FACILITY	Accident Site	NTSB INVESTIGATOR	Ralph Hicks
ADDRESS	19 Minchin Drive Woburn, MA 01801	FAA INVESTIGATOR	Keith Lapierre
		ACCIDENT DATE	09/15/2018
		ACCIDENT LOCATION	Woburn, MA

ENGINE INFORMATION

ENGINE POSITION	Single-Engine
TOTAL TIME	1,395.4hours (at time of last oil change)
TIME SOH	N/A
TYPE & TIME SLI	Oil change on 08/16/2018 at a total time of 1,395.4 hours
BUILD DATE	12/02/2005
IN SERVICE DATE	01/26/2006

Significant logbook information:

Photographs of the last maintenance entries revealed that the engine underwent an annual inspection on December 14, 2017 at an engine total time of 1,339.6 hours. At that time, the #1 and #2 cylinders were replaced with overhauled units. The engine then underwent two oil changes subsequent to the cylinder replacement, the last of which was on August 16, 2018 at a total time of 1,395.4 hours. The last maintenance entry was for a replaced alternator on September 7, 2018 at a total time of 1,404.1 hours.

Report Summary:

Search Code(s):

15-12-68

The engine sustained significant impact damage that precluded functional testing of the engine. However, crankshaft and camshaft continuity were confirmed, and borescope examination of the cylinders revealed no pre-impact anomalies. There were no pre-accident anomalies noted with the fuel, ignition, and turbocharger systems. No anomalies were noted that would have prevented the engine from produced full, rated power.

Disposition of engine following exam:

The NTSB investigator-in-charge (IIC) released the wreckage to the owner's representative.

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NAME	Nicole L. Charnon	NAME	Ralph Hicks
ADDRESS	Washington, DC	ADDRESS	Atlanta, GA
ORGANIZATION	Continental Motors	ORGANIZATION	NTSB – Eastern Region
PHONE		PHONE	
NAME	Keith Lapierre	NAME	Raymond Savard
ADDRESS	Boston, MA	ADDRESS	Boston, MA
ORGANIZATION	FAA – Boston FSDO	ORGANIZATION	FAA – Boston FSDO
PHONE		PHONE	
NAME	Henry Soderlund	NAME	Jennifer Barclay
ADDRESS	Wichita, KS	ADDRESS	Wichita, KS
ORGANIZATION	Textron Aviation	ORGANIZATION	Textron Aviation
PHONE		PHONE	

EXTERNAL ENGINE CONDITION

The engine was separated from the aircraft and came to rest in an upright position. The propeller, starter motor, intercoolers, turbochargers, and turbo charger components were separated from the engine. The left magneto was separated from the mounting pad but remained attached to the engine via the ignition leads. The left cylinders sustained significant impact damage that fractured numerous cooling fins, damaged the top sparkplugs, and displaced the #2 cylinder head in toward the engine centerline. The left intake tubes were separated from their cylinders. There were no external pre-accident anomalies noted with the engine or engine-related components.



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ENGINE COMPONENT EXAMINATION

EXHAUST SYSTEM

Condition:

The exhaust system sustained impact damage and numerous components were separated. However, no pre-accident anomalies were noted with the observed components.



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INDUCTION SYSTEM

Condition: The induction system was fragmented with only the right intake tubes, intake plenum and throttle body remaining attached to the engine. The overboost valve and intercoolers were separated and impact damaged.



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MAGNETO**

Manufacturer: Slick

P/N: 6320

S/N: 08121262

Condition:

The left magneto was separated from its mounting pad and the housing sustained impact damage that deformed the housing in the capacitor area. The left magneto's ignition leads were cut near the harness cap. The magneto drive was manually rotated and a spark was observed in firing order during the audible snap of the impulse coupling.

**RIGHT
MAGNETO**

Manufacturer: Slick

P/N: 6320

S/N: Unknown

Condition:

The right magneto remained attached to the mounting pad. Manual manipulation of the magneto revealed it was secured in place. The magneto was removed and the drive was manually rotated. The impulse coupling produced an audible snap, but a spark was not observed from any of the leads.



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HARNESS**Manufacturer: Continental
Motors

P/N: Unknown

S/N: Unknown

Condition:

The ignition harness remained attached to each magneto. The left cylinders' ignition leads were fragmented. The damaged leads were cut from the harness for the functional testing of the magnetos. The terminal ends on the right cylinders' sparkplugs and the bottom left sparkplugs remained in place.

**SPARKPLUGS**

Manufacturer: Champion

P/N: RHB32E

Condition:

The top sparkplugs were removed from the cylinders with the exception of the #2 cylinder, which was displaced and impinging on the fractured cooling fins. The bottom sparkplugs were examined utilizing a lighted borescope. All of the sparkplugs displayed normal wear and light combustion deposits with no signs of lead or carbon fouling.



1T



1B

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3T



3B



5T



5B

No Image Available

2T



2B

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4T



4B



6T



6B

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FUEL SYSTEM

FUEL PUMP	Manufacturer: Continental Motors	P/N: Not Recorded	S/N: Not Recorded
Condition:	The engine-driven fuel pump remained attached to the backside of the engine. The vapor return fitting was fractured, but all remaining b-nuts remained in place with no blue discoloration noted. The mixture control cable remained attached to the lever and the lever remained attached to the shaft. The lever, shaft and nut were marked and rotation of the lever resulted in a coinciding unbound rotation of the shaft. Fuel was recovered in the line between the engine-driven fuel pump and the fuel metering unit. Residual fuel was also recovered from the engine-driven fuel pump. Removal of the pump revealed that the drive coupling was intact. Rotation of the drive coupling while it was installed in the shaft resulted in a rotation of the pump.		



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THROTTLE BODY METERING UNIT

Manufacturer: Continental
Motors

P/N: 656785-2

S/N: A05JA33

Condition:

The throttle body and intake plenum were displaced to the right side of the engine. The throttle cable remained attached to the throttle lever which remained attached to the shaft; however, the shaft was bent. The lever, nut, and shaft were marked and rotation of the lever resulted in slipping of the lever (this was attributed to the bending damage of the shaft). Residual fuel was recovered in the line between the fuel metering unit and the fuel manifold valve even though the inlet fitting of the fuel manifold valve was fractured.



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FUEL MANIFOLD VALVE

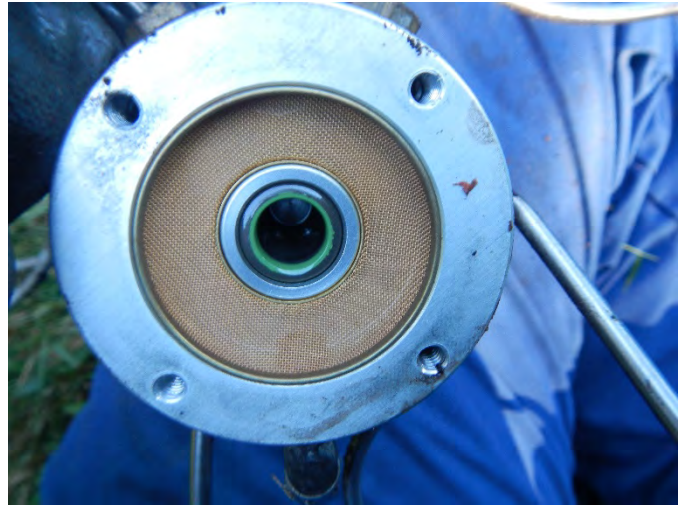
Manufacturer: Continental Motors

P/N: 646433-11A1

S/N: C05JA325

Condition:

The fuel manifold remained attached to the displaced throttle body. The manifold valve was disassembled, and residual fuel was observed in the housing and the screen was clear.



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FUEL NOZZLES AND LINES

Manufacturer: Continental Motors

Condition:

The left fuel injector nozzles were fractured and the right nozzles remained in place with the lines attached. The right fuel injector nozzles were free from obstructions. The portions of the fractured #2 and #6 nozzles were observed and were free from obstructions. The #4 nozzle was not observed.



1



3



5



2

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4



6

LUBRICATION SYSTEM

OIL SUMP

Condition:

The oil sump was displaced up around the base of the engine and a large tear was present with wood embedded in the torn area. Residual oil was observed leaking from the torn area, and it was caramel in color with no abnormal odors.



OIL PICKUP TUBE & SCREEN

Condition:

The oil pickup tube and screen were not observed.

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OIL PUMP

Condition:

The oil pump cap was removed and residual oil was observed in the pump housing. The gear were intact with no pre-accident anomalies noted with the gear and the housing walls.



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OIL FILTER	Manufacturer: Tempest	P/N: Unknown
Condition:	The oil filter remained attached to the adapter and the safety-wire was intact. There was no sign of lubrication or thermal distress on any of the observed engine components.	



OIL COOLER	Manufacturer: Not Observed	P/N: Not Observed	S/N: Not Observed
Condition:	The oil cooler was separated from the engine.		

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CYLINDERS

NOTE: The photographs that follow each cylinder condition description represent the external cylinder condition, the piston, the intake valve and the exhaust valve in that order.

CYLINDER #1	P/N: 658603A1	S/N: AC08JA998	Head Date: Unknown
Condition:	The cylinder remained attached to the engine with no external anomalies noted. Borescope examination of the cylinder revealed light combustion deposits with no pre-accident anomalies noted with the piston, barrel, valves or valve seats. During the partial rotation of the crankshaft the cylinder produced thumb compression.		



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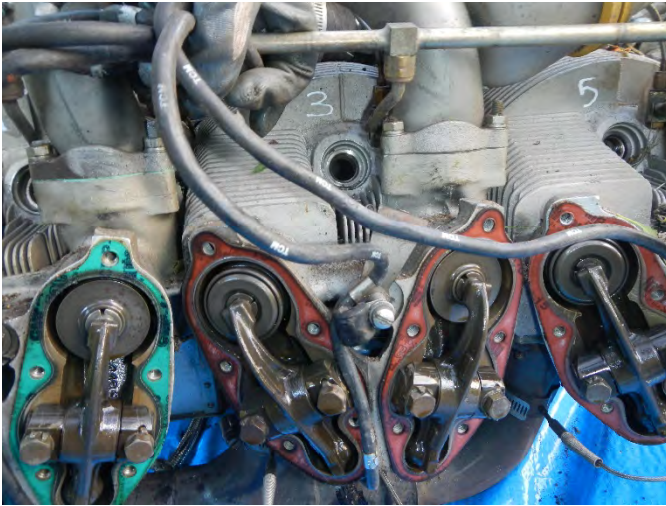
CYLINDER #3

P/N: 658603A1

S/N: AC05JB571

Head Date: Unknown

Condition: The cylinder remained attached to the engine with no external anomalies noted. Borescope examination of the cylinder revealed light combustion deposits with no pre-accident anomalies noted with the piston, barrel, valves or valve seats. During the partial rotation of the crankshaft the cylinder produced thumb compression.



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CYLINDER #5

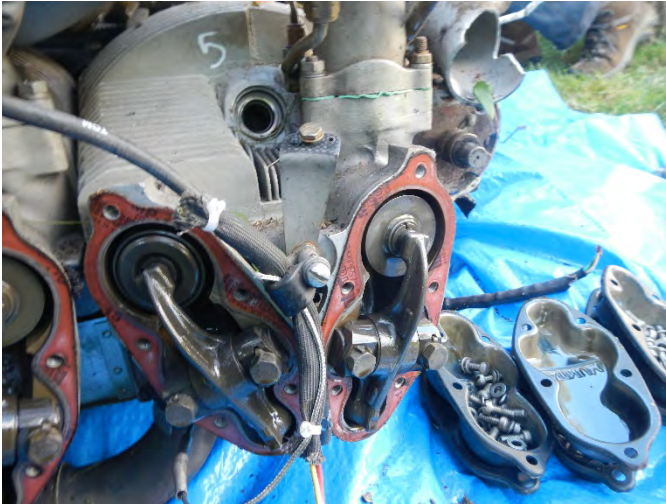
P/N: 658603A1

S/N: AC05JB756

Head Date: Unknown

Condition:

The cylinder remained attached to the engine with no external anomalies noted. Borescope examination of the cylinder revealed light combustion deposits with no pre-accident anomalies noted with the piston, barrel, valves or valve seats. Piston/connecting rod movement was confirmed during the partial rotation of the crankshaft.

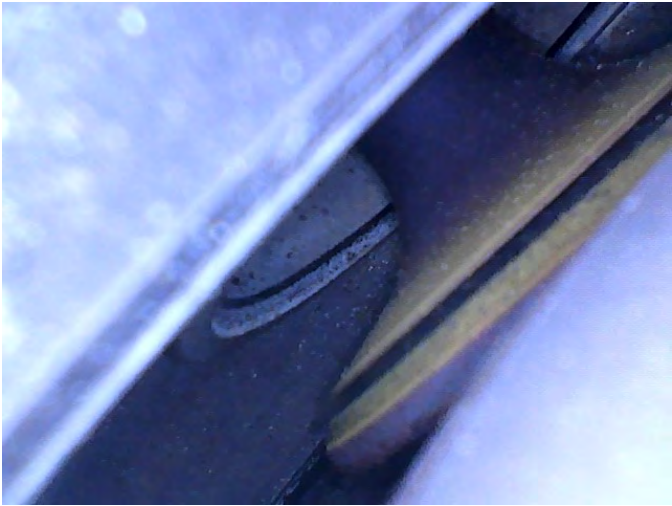


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CYLINDER #2	P/N: 658603A1	S/N: ?????A99?	Head Date: Unknown
Condition:	The cylinder remained attached to the crankcase but sustained significant impact damage that fractured and displaced the head toward the engine centerline. The intake and exhaust tubes were displaced from the cylinder and the sparkplugs were damaged. Only a portion of the cylinder's internal components was visible via borescope placement through the intake port. No pre-accident anomalies were observed with the observed components.		



Piston Image Not Avialable



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CYLINDER #4

P/N: 658603A1

S/N: AC05JB758

Head Date: Unknown

Condition:

The cylinder remained attached to the crankcase. It sustained impact-related damage to the cooling fins, intake port, fuel injector, and top sparkplug. Borescope examination of the cylinder revealed light combustion deposits with no pre-accident anomalies noted with the piston, barrel, valves or valve seats. Piston/connecting rod movement was confirmed during the partial rotation of the crankshaft.



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CYLINDER #6

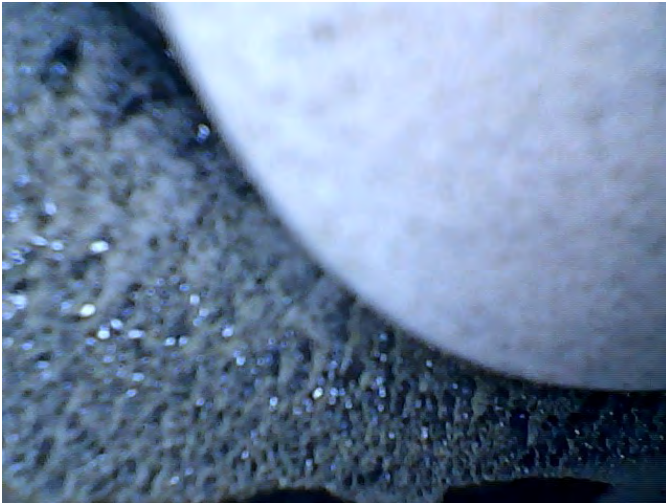
P/N: 658603A1

S/N: AC05JB789

Head Date: Unknown

Condition:

The cylinder remained attached to the engine with impact-related damage sustained by the cooling fins, top sparkplug, fuel injector, and intake port. Borescope examination of the cylinder revealed light combustion deposits with no pre-accident anomalies noted with the piston, barrel, valves or valve seats. During the partial rotation of the crankshaft the cylinder produced thumb compression.



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CRANKCASE ASSEMBLY

CRANKCASE	Casting Number:	1-3-5: Unknown	2-4-6: Unknown	S/N: R05IA847
Condition:	The crankcase remained intact and all the cylinders remained attached to the crankcase.			



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CRANKSHAFT ASSEMBLY

CRANKSHAFT	Forging Number: Not Observed	S/N: Not Observed	Heat code: Not Observed
Condition:	The crankshaft was fractured aft of the propeller flange where it exits the nose seal of the crankcase. The fracture surface displayed 45-degree shear lips. The crankshaft was manually rotated by inserting an adapter into the right accessory drive gear. The crankshaft could not be rotated in its entirety due to the displaced #2 cylinder head, which prevented full movement of its connecting rod/piston. However, crankshaft continuity was confirmed from the aft accessory end, forward to the fractured crankshaft and gear-driven alternator on the front right side, and out to each connecting rod/piston.		



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P/N: Not Observed

S/N: Not Observed

Condition:

The camshaft was not observed, but camshaft continuity was confirmed during partial rotation of the crankshaft.

ACCESSORIES**STARTER**

Manufacturer: Not Observed

P/N: Not Observed

S/N: Not Observed

Condition:

The starter motor was separated from the adapter and was not observed.

**STARTER
ADAPTER**

Condition:

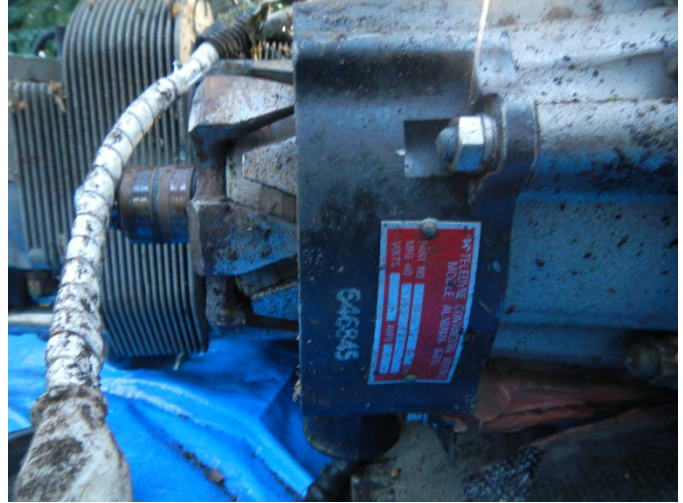
The adapter remained attached to the backside of the engine and rotation of the drive pulley was observed during partial rotation of the crankshaft. No pre-accident anomalies were observed.



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ALT/GEN #1	Manufacturer: Continental Motors	P/N: 646845	S/N: Not Recorded.
Condition:	The engine-driven alternator remained attached to the front right side of the engine but sustained impact damage. It was not examined as part of this investigation.		



ALT/GEN #2	Manufacturer: Not Observed	P/N: Not Observed	S/N: Not Observed
Condition:	The belt-driven alternator Remained attached to its bracket which sustained deformation damage. It was not examined as part of this investigation		



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TURBOCHARGER COMPONENTS

TURBOCHARGERS

Manufacturer: Unknown

P/N: Unknown

S/N: Unknown

Condition:

The two turbochargers were separated from the engine. One turbocharger remained intact with no pre-accident anomalies noted with the impeller or turbine blades. The other turbocharger induction housing was separated, and impacted with wood fragments. The associated turbocharger's impeller blades were fractured and wood fragments were observed at some of the fracture points. The turbine blades were intact.



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TURBO CONTROLLER	Manufacturer: Continental Motors	P/N: 646318-4	S/N: IJN00143
Condition:	The pressure controller was separated from the engine and residual oil was observed in the inlet line, which remained attached. The cap of the controller was partially displaced.		



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WASTEGATE

Manufacturer: Continental Motors

P/N: Not Legible

S/N: Not Legible

Condition:

The waste gate actuator remained with a piece of exhaust. The actuating arm remained attached to the wastegate with no pre-accident anomalies noted.



OVERBOOST VALVE

Manufacturer: Unknown

P/N: Unknown

S/N: Unknown

Condition:

The overboost valve remained attached to a flattened and distorted piece of intake tubing. No pre-accident anomalies were noted with the poppet valve.





PROPELLER

PROPELLER GOVERNOR	Manufacturer: Unknown	P/N: Unknown	S/N: Unknown
Condition:	The propeller governor remained attached to the front left side of the engine, but the control lever/shaft was separated from the housing.		



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PROPELLER

Manufacturer: Hartzell

P/N: HC-H3YF-1RP

S/N: LX216B

Condition:

The three-bladed propeller hub remained intact and all three blades remained attached to the hub. All of the blades rotated independently within the hub, indicative of pitch change link fractures. The blades were arbitrarily labeled A, B, and C for descriptive purposes. Blade A displayed chord-wise paint burnishing, significant blade twisting toward low pitch, and s-bending on the trailing edge. Blade B was bent in half with impact-related damage on the trailing edge. Blade C was bent aft, twisted toward low pitch, with slight s-bending on the trailing edge. Two tree branches were observed at the accident site that displayed an angular cut with gray paint transfers.



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