



NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety

July, 2018

ENGINE EXAMINATION

CEN17FA248

A. ACCIDENT EXAM

Location: Continental Motors, Inc (CMI)
Date: Week of July 9, 2018
Aircraft: Cessna 421, N2655B
NTSB IIC: Alex Lemishko

B. EXAMINATION PARTICIPANTS:

Craig Hatch
Air Safety Investigator
National Transportation Safety Board
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Continental Motors
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Mike Council
Continental Motors
Air Safety Investigator

Turbocharger

Les Doud
Air Safety Investigator
Hartzell Propeller/Hartzell Engine
Technologies

C. SUMMARY

Examination of the recovered engine was conducted on July xx, 2018 at the facilities of Continental Engines, Mobile, AL.

The Cessna 421C twini-engine airplane, N2655B, impacted the ground after an uncontrolled descent and in-flight breakup near Catawba, Wisconsin. The pilot and five passengers sustained fatal injuries, and the airplane was destroyed.

air traffic control (ATC) and radar records, the airplane was flying about 10,000 feet mean sea level when the pilot queried the ATC controller about weather conditions in the vicinity.

Preliminary radar data showed the airplane between 10,000 and 10,500 feet in a slight left turn and then a descending right turn. After the right turn, radio contact was lost, and the airplane descended rapidly.

Both engines were sent to CMI for examination.

D. DETAILS OF THE INVESTIGATION

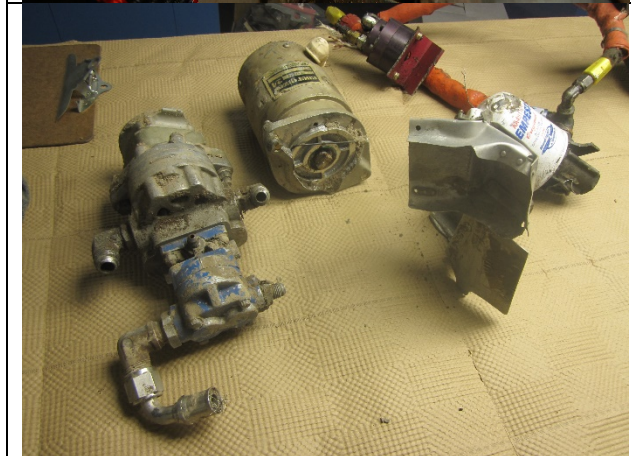
The engine exam started with the engine identified as the left side engine,

1.1 Exam Photos

	Shipping container; left engine noted
	Engine as received; from shipping container. Turbocharger was in the shipping container. Heavy damage impact damage is noted to the engine. Also must of the induction system (located top of the engine) was not in the shipping container. Assumed these components were not recovered/identified on site.



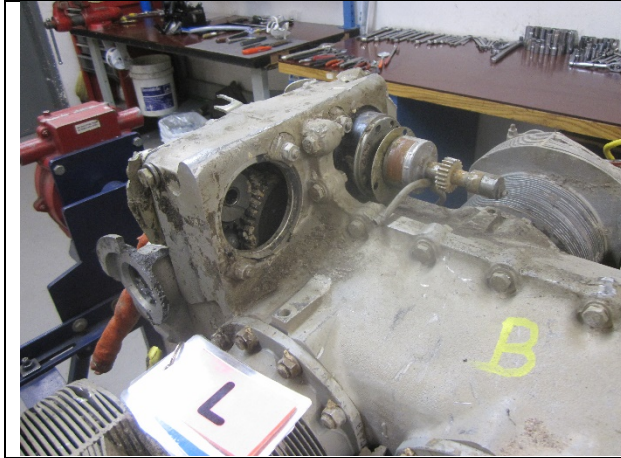
Engine datatag



Various components were removed from the shipping container and placed on the bench



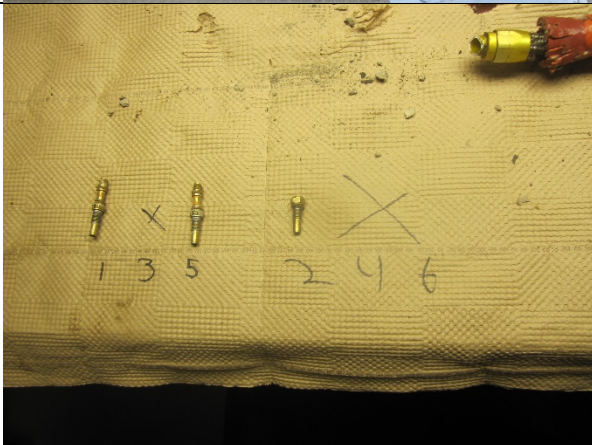
The engine was place on a stand, and readied for disassembly.



Only part of the two magnetos, remained.
A detailed examination of the ignition system
was not possible.



Fuel pump was dissembled



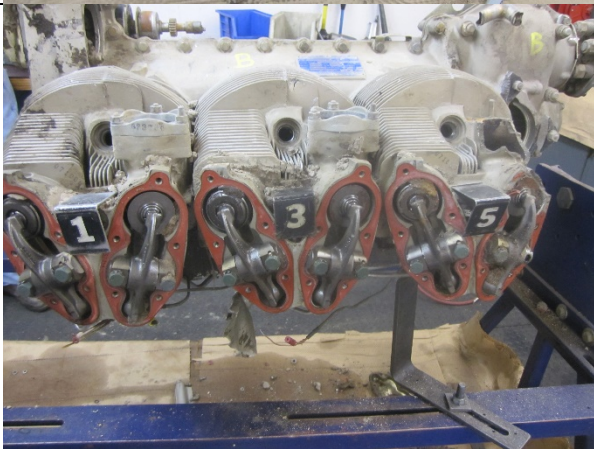
Remints of fuel injectors



Oil filter was cut open, and inspected for contaminants.



Engine oil pump; dissembled.



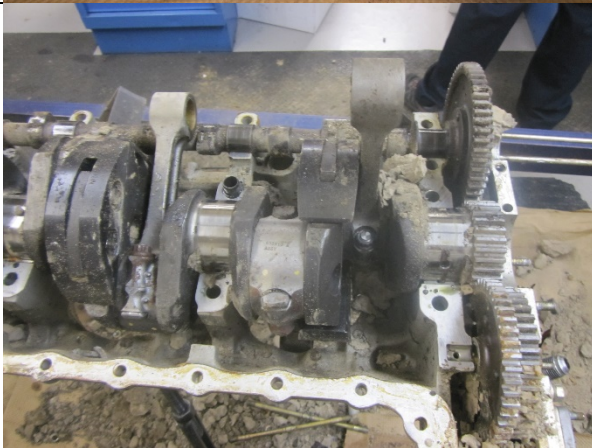
Both left and right side valve covers were removed: no abnormalities noted with valve train



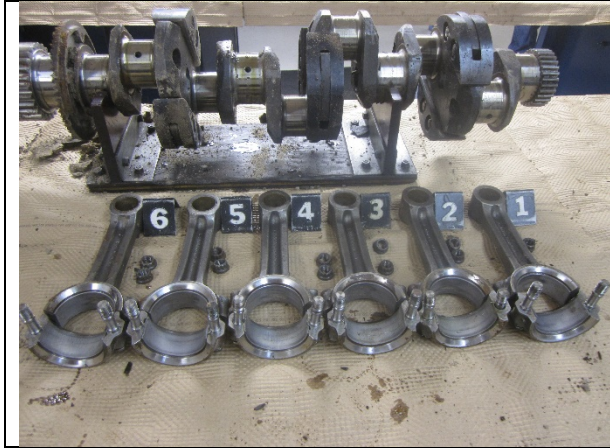
Cylinder were removed before splitting the case.



Cylinder 1: Engine was exposed to water, after accident; otherwise, no pre-impact anomalies noted.



Case was opened. Crankshaft, cam, and rods were visible. Dried mud is noted throughout the engine.



Crankshaft and rod assembly.

The left engine sustained heavy impact, and water damage during the accident. The condition of the engine limited the scope of the examination; however, no preimpact anomalies were noted during the exam of the engine.



Continental Motors

ANALYTICAL SIGN IN SHEET

DATE 9 JUL 2018

AIRCRAFT # N2655B

ENGINE SERIAL # 825104

CMI-ASI FILE # 17-001

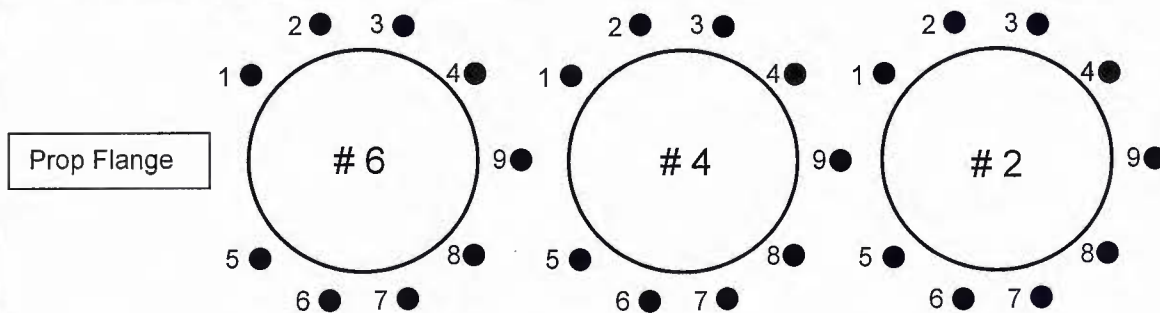
N2655B

PRINT NAME	CRAIG HATCH	PRINT NAME	MIKE COUNCIL
SIGNATURE	[REDACTED]	SIGNATURE	[REDACTED]
ORGANIZATION	NTSB	ORGANIZATION	[REDACTED]
PHONE	[REDACTED]	PHONE	[REDACTED]
PRINT NAME	Ruth Gibson	PRINT NAME	Lisa Tersild
SIGNATURE	[REDACTED]	SIGNATURE	[REDACTED]
ORGANIZATION	[REDACTED]	ORGANIZATION	CMI
PHONE	[REDACTED]	PHONE	[REDACTED]
PRINT NAME	DEBRAK JOSTIS	PRINT NAME	GREG EASTBURN
SIGNATURE	[REDACTED]	SIGNATURE	[REDACTED]
ORGANIZATION	NTSB	ORGANIZATION	CMI
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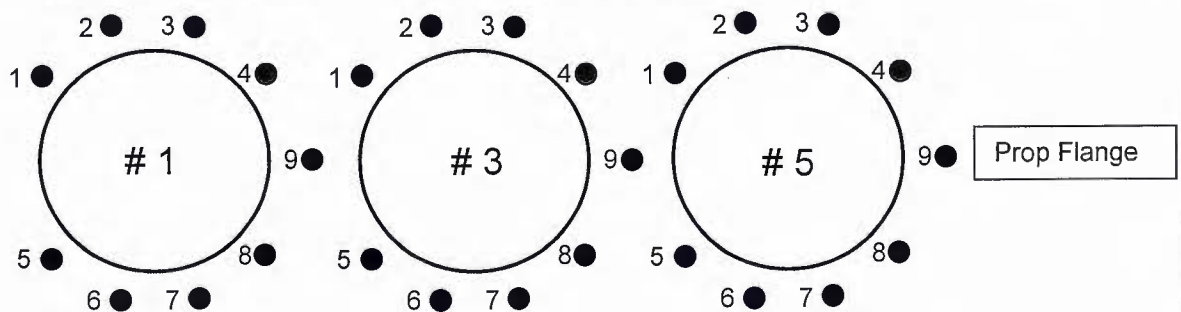
Date	Engine Model	Engine Serial Number	REGISTRATION	Page
07/09/2018	GTSIO520L3B	825104	N2655B	1 of 1

Cylinder Through-Bolt and Deck Stud Break-Away (Tightening / Loosening) Torque Measurements (Inch-Pounds)
(Position numbers 1 and 5 are through-bolts)

6 Point Nuts on Through Bolts	Bolt 1	Stud 2	Stud 3	Stud 4	Bolt 5	Stud 6	Stud 7	Stud 8	Stud 9
	Tight / Loose	Tight / Loose	Tight / Loose	Tight / Loose	Tight / Loose	Tight / Loose	Tight / Loose	Tight / Loose	Tight / Loose
Cylinder #2	1155/1932	879/1759	804/1696	874/1749	1115/1771	761/1689	778/1644	785/1806	992/1801
Cylinder #4	956/1822	1099/1820	1021/1803	1082/1716	1240/1759	1048/1879	985/1827	995/1748	904/1643
Cylinder #6	549/1401 CC Fractured	361/1317 CC Fractured	680/583	695/1561	681/1564	410/1378	789/1557	391/1351	692/1595



	Bolt 1	Stud 2	Stud 3	Stud 4	Bolt 5	Stud 6	Stud 7	Stud 8	Stud 9
	Tight / Loose	Tight / Loose	Tight / Loose	Tight / Loose	Tight / Loose	Tight / Loose	Tight / Loose	Tight / Loose	Tight / Loose
Cylinder #1	886/1890	958/1795	935/1715	810/1723	1132/1775	1016/1766	913/1667	919/1680	766/1658
Cylinder #3	1128/1888	1019/1802	884/1713	839/1729	1163/1886	982/1662	854/1645	1122/1643	863/1698
Cylinder #5	1219/1919	919/1670	959/1705	689/1594	1309/1192	1041/1690	914/1750	783/1652	N/A



Date	Engine Model	Engine Serial Number	Aircraft Registration	Page
07/09/2018	GTSIO520L3B	825104	N2655B	1 of 3

ENGINE COMPONENT INFORMATION

COMPONENT	MANUFACTURER / OVERHAULER	PART NUMBER	SERIAL NUMBER / DATE or HEAT CODES / WORK ORDER NUMBERS
Magneto LEFT	TCM	UNDETERMINED	UNDETERMINED
Magneto RIGHT	Not recovered		
Ignition Harness	TCM	UNDETERMINED	
Sparkplugs	Autolite / UNISON	URHB 32 \$	N/A
Fuel Pump	Teledyne	646210-14 A1	BØ6 HA 205 R
Throttle Body Metering Unit			
Fuel Manifold			
Nozzles	UNDETERMINED	1 BROKEN - plugged 2 OPEN 3 BROKEN OFF W/HEAD 4 BROKEN OFF IN HEAD 5 plugged 6 BROKEN off w head	1 19A 2 19A 3 4 5 19A 6
Crankcase	CMI	LEFT 653 871 RIGHT 653 870	RØ6GA??7
Crankshaft	CMI		649??? FORGE NØ5CA100 SER#
Camshaft	CMI	652056 K 06AA	254
Lifters		INTAKE EXHAUST	

PROP
SHAFT
GEAR RED

641475?
633265 R

22?Ø
2163

HEAT CODE WO#
KEAA 5CA102

Date	Engine Model	Engine Serial Number	Aircraft Registration	Page
07/09/2018	GTSIO520L3B	825104	N2655B	2 of 3

ENGINE COMPONENT INFORMATION

COMPONENT	MANUFACTURER / OVERHAULER	PART NUMBER	SERIAL NUMBER / DATE or HEAT CODES / WORK ORDER NUMBERS				
Main Bearings	CMI	634503 - MID	1	05-06			
PROP SHAFT BEARINGS	CMI	530386	2				
REDUCTION	CMI	630571	3	7-05			
			4				
			5	05/06			
Connecting Rod Bearings	CMI	630826 - MID	1	05-06			
			2				
			3				
			4				
			5				
			6				
Connecting Rods	CMI	655910	1	AE06FA093			
			2	AE06FA105			
			3	AE06FA090			
			4	AE06FA089			
			5	AE06FA078			
			6	AE06FA132			
Cylinders	CMI	655474A8	S/N	H/D	W/O	DATE	
			1	NOT REA	7-1-06	071006	
			2	AC06FB649			
			3	AC06FB663			
			4	NOT READABLE			
			5	AC06FB672			
			6	AC0????			

Date	Engine Model	Engine Serial Number	Aircraft Registration	Page
07/09/2018	GTSIO520L3B	825104	N2655B	3 of 3

ENGINE COMPONENT INFORMATION

COMPONENT	MANUFACTURER / OVERHAULER	PART NUMBER	SERIAL NUMBER / DATE or HEAT CODES / WORK ORDER NUMBERS
Pistons	CMI	654840 C	1 WH 2 3 4 5 6
Turbocharger	NO DATA PLATE		
Turbocharger Controller			
Wastegate	Ray Jay	481064-9001	DI010839
Overboost Valve	Not recovered		
Starter Motor	CONT	646275	?-090611
Starter Adapter	CONT	643259A49	8204 MANUALLY Rotated
Alternator			
Vacuum Pump	NO w/e		
Propeller Governor	Not recovered		
Oil Cooler	Not recovered		
Intercooler	Not recovered		
OIL FILTER	TEMPEST	AA48110-2	NA

A. DETAILS OF THE INVESTIGATION

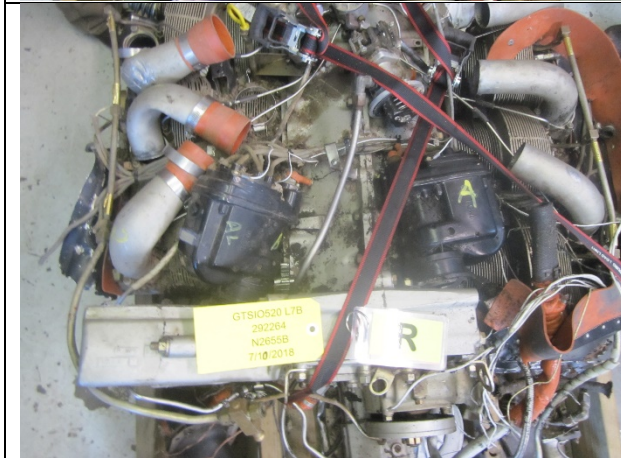
The airplane's right-side engine was examined after the left engine.

1.1 Exam Photos

 A photograph of a dark blue shipping container. On top of the container, there is a yellow label with a red 'R' and a white label with red text. The white label has 'R' and 'P' handwritten in red. The container has 'CONTINENTAL' and 'MOTOR' printed on it.	Shipping container; right engine noted
 A photograph of a Continental engine mounted on a wooden pallet. The engine is silver and black with various wires and hoses attached. A yellow label with a red 'R' is visible on the engine.	Engine as received; from shipping container. Turbocharger was in the shipping container.
 A photograph of a metal data tag for a Teledyne Continental Motors engine. The tag contains the following information: MODEL 67510-520-L (71), ASO, FACTORY REBUILT, FIRING ORDER 1-4-5-2-3-6, HP I.C. 375, RPM 3350, HP M.C. 375, RPM 3350, FUEL 100-100LL, GRADE MIN, SER NO 292264-R, and a list of US PATENT numbers. A timestamp '07.10.2018 08:43' is visible at the bottom.	Engine datatag



Engine as shipped



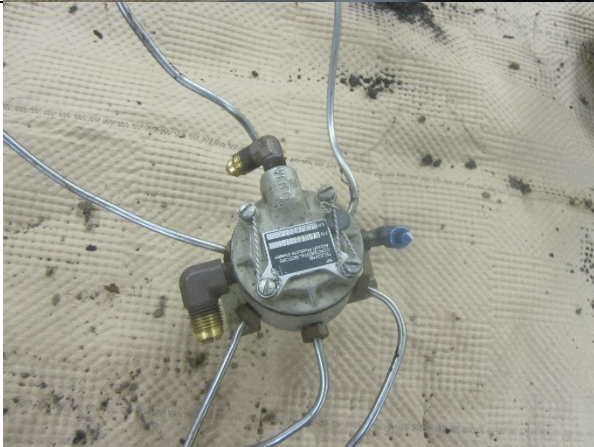
Engine as shipped, magnetos are noted in the photo.



Heavy impact damage is noted to the bottom of the engine.



Fuel injectors



Fuel divider



Fuel pump; the drive shaft, "shear pin" was broken.



The vacuum pump was disassembled. The rotor was cracked, but the vanes were in place.



Oil pump: no evidence of hard metal passage.



Magneto testing



The cylinders were removed and inspected



Rust/corrosion present from post impact water damage: The number six cylinder had heavy impact damage.



Pistons after cylinder removal



Crankshaft and connecting rods

The right engine also sustained heavy impact and water damage during the accident. The condition of the engine and components limited the scope of the examination; however, no preimpact anomalies were noted during the exam of the engine.

Date	Engine Model	Engine Serial Number	Aircraft Registration	Page
0710/2018	GTSIO520L7B	292264	N2655B	1 of 4

ENGINE COMPONENT INFORMATION

COMPONENT	MANUFACTURER / OVERHAULER	PART NUMBER	SERIAL NUMBER / DATE or HEAT CODES / WORK ORDER NUMBERS
Magneto LEFT	TCM	BL349260-7	F031A010 R
Magneto RIGHT	TCM	BL-349220-4	F03LA138 R
Ignition Harness	UNISON FAA/PMA	UNDETERMINED	UNDETERMINED
Sparkplugs	AUTOLITE XL	URHB32\$	
Fuel Pump	TELEDYNE	646210-3	H239907 BR
Throttle Body Metering Unit	TELEDYNE	642386 A6	A03JA223 R
Fuel Manifold	TELEDYNE	641032-1A8	C03JA22-6R
Nozzles	CAMI	1 N/A 2 3 4 5 6	1 19A 2 3 4 5 6 ↓
Crankcase	CMT DIVCO # WDC84148	LEFT 653870 RIGHT 653871	F090006 R ↓
Crankshaft			
Camshaft	CMT	649477	NONE
Lifters	GATE Superior AIRPARTS	INTAKE 628488 SA EXHAUST 646277 SA	NONE

Date	Engine Model	Engine Serial Number	Aircraft Registration	Page
0710/2018	GTSIO520L7B	292264	N2655B	2 of 4

ENGINE COMPONENT INFORMATION

COMPONENT	MANUFACTURER / OVERHAULER	PART NUMBER	SERIAL NUMBER / DATE or HEAT CODES / WORK ORDER NUMBERS		
Main Bearings	CMI ↓	634503- AA10 M010 ↓	1	10/03	
			2	↓	
			3		
			4		
			5	↓	
Connecting Rod Bearings	Superior Airparts ↓	SA 630826 ↓	1	9/03	
			2		
			3	↓	
			4		
			5	↓	
			6		
Connecting Rods	CMI ↓	646126-8 ↓	1	N/A	
			2		
			3		
			4		
			5		
			6		
Cylinders	CMT ↓	655474 A8 655474 A8 655474 A8 655474 A8 655474 A8 655474 A8		S/N	H/D
			1	AC031A475	10/13/03
			2	AC03A909	10/14/03
			3	AC031B315	10/20/03
			4	AC031A876	10/13/03
			5	AC031A869	10/13/03
			6	AC031A467	UNDETERMINED

Reduction
GEAR
BEARINGS

630571



2-03

Date	Engine Model	Engine Serial Number	Aircraft Registration	Page
0710/2018	GTSIO520L7B	292264	N2655B	3 of 4

ENGINE COMPONENT INFORMATION

COMPONENT	MANUFACTURER / OVERHAULER	PART NUMBER	SERIAL NUMBER / DATE or HEAT CODES / WORK ORDER NUMBERS
Pistons	Continental ↓	654840 C 654840 C 654840 C 654840 C 654840 C 654840 C	1 WP 2 WP 3 WP 4 WP 5 WP 6 WP
Turbocharger	RAY JAY overhauled Kelley		
Turbocharger Controller			
Wastegate	ACTUATOR R633388-9 GARRETT →		KJR0135
Overboost Valve	OH BY Ray Jay Kelly	C482002-0104	KDR 01366
Starter Motor			
Starter Adapter	CM I	64?297A4	4393
Alternator	CM I OH Aero Tech Louisville, KY	649.304	A28?909.0
Vacuum Pump	AIRBORNE	-441CC	21642
Propeller Governor	UNDETERMINED NO DATA plate	UNDETERMINED	UNDETERMINED
Oil Cooler	NO DATA plate	UNDETERMINED	UNDETERMINED
Intercooler			
Prop Gear	GARRETT	GARR C165006-0113	BAD 25550
Reduction Gear			

DRIVE
DOES NOT TURN
DAMPER w/ MANUALLY
rotated
w/o # 696?9
COTTER PIN
INTACT

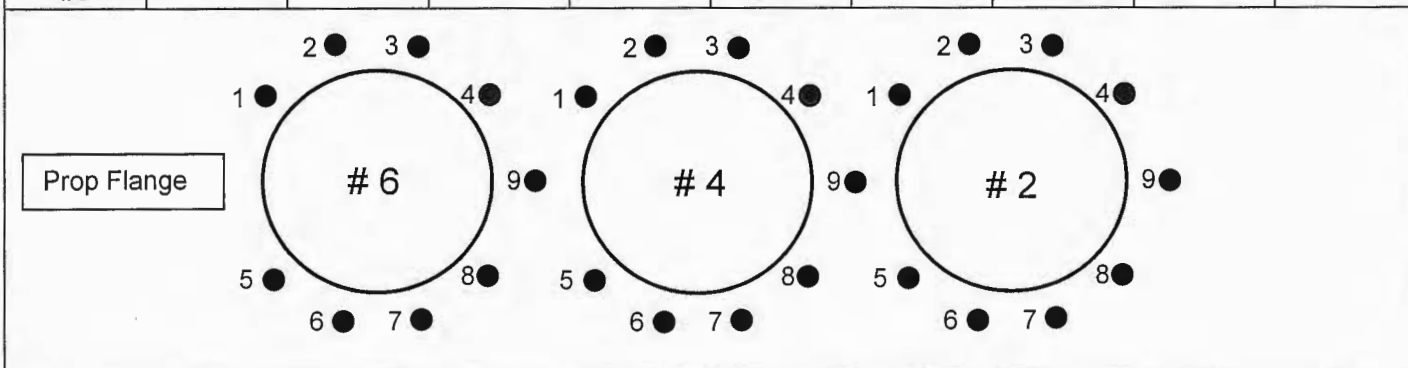
→ Turbq controller GARRETT R633388-9 KJR0136

Date	Engine Model	Engine Serial Number	Aircraft Registration	Page
0710/2018	GTSIO520L7B	292264	N2655B	4 of 4

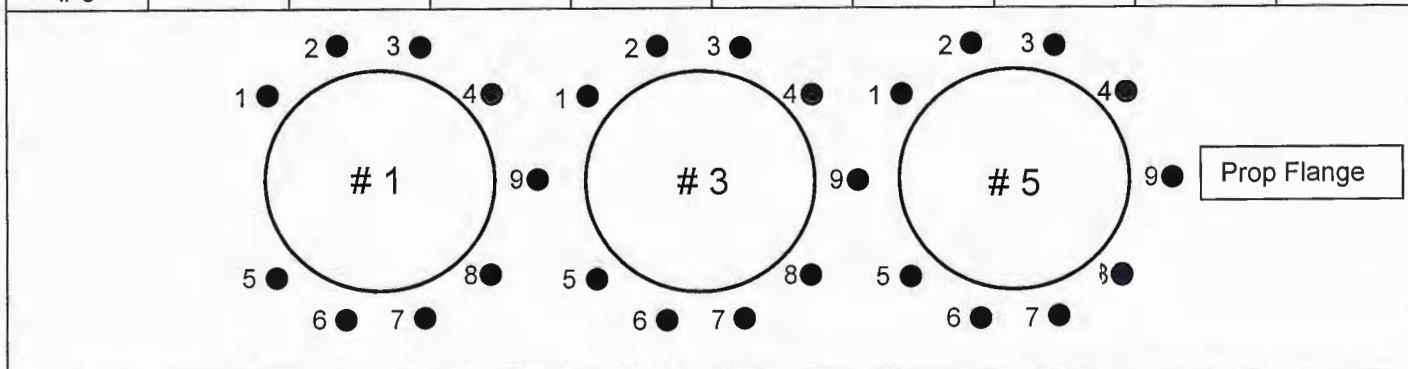
Prop Reduction Gear Bearings	CMI	630 571	2/03
Prop Bearings	CMI	530 386	4/03
PROP GEAR	CMI		1278 ✓

Date	Engine Model	Engine Serial Number	REGISTRATION	Page
07/10/2018	GTSIO520L7B	292264	N2655B	1 of 1

Cylinder Through-Bolt and Deck Stud Break-Away (Tightening / Loosening) Torque Measurements (Inch-Pounds) (Position numbers 1 and 5 are through-bolts)									
6 Point Nuts on Through Bolts	Bolt 1	Stud 2	Stud 3	Stud 4	Bolt 5	Stud 6	Stud 7	Stud 8	Stud 9
	Tight / Loose	Tight / Loose	Tight / Loose	Tight / Loose	Tight / Loose	Tight / Loose	Tight / Loose	Tight / Loose	Tight / Loose
Cylinder #2	597/509	670/555	670/538	701/601	/	/	/	/	865/781
Cylinder #4	649/696	685/539	512/434	638/548	/	/	/	/	/
Cylinder #6	1151/744	762/614	688/566	649/539	/	/	/	/	812/702



	Bolt 1	Stud 2	Stud 3	Stud 4	Bolt 5	Stud 6	Stud 7	Stud 8	Stud 9
	Tight / Loose	Tight / Loose	Tight / Loose	Tight / Loose	Tight / Loose	Tight / Loose	Tight / Loose	Tight / Loose	Tight / Loose
Cylinder #1	109/1698	565/477	624/515	578/479	/	/	/	/	865/784
Cylinder #3	760/640	571/468	599/479	572/469	/	/	/	/	832/822
Cylinder #5	955/930	764/595	722/587	689/561	/	/	/	/	N/A



IMPACT DAMAGE TO lower crankcase prevented TORQUE VALUES FOR lower fasteners.

N. T. S. B.

(National Transportation Safety Board)

DO NOT OPEN

DATE:	10 July 2017
RGA NO.:	01.243.398
AIRCRAFT REGISTRATION:	N2655B
ENGINE MODEL:	GTSI0520L7B
ENGINE SERIAL NO.:	292264
CM INVESTIGATOR:	Mike Council
NTSB INVESTIGATOR:	Alex Lemishko
AIR SAFETY FILE NO.	17-001



Continental Motors

Engine Component Information Sheet

Printed: 08/01/2017

Serial: 292264

Assembled: 05/02/2014

Spec: GTSI0520L7B

Shipped: 05/29/1997

New/Rebuilt: (REBUILT)

Notes: 218001

Packed: / /

Shipper No.: M06871

Sales Order No.: 218001

Tested: / /

Customer Name: COOPER AVIATION INDUSTRIE

Shipping Address: 22 WAYPOINT DRIVE

Component	Serial Number
CRANKSHAFT	E049011N
CRANKCASE	J8A39660RB
DRIVE GEAR	2395V
DRIVEN GEAR	TN668
L MAGNETO	D239708FR
R MAGNETO	C109706FR
FUEL PUMP	C149721BR
MANIFOLD VALVE	C149712CR
METERING UNIT	C149708AR
STARTER	P059786
ALTERNATOR	D179707.0
L. TURBO	AA021392
CONTROLLER	AB023561
OIL COOLER	C971875466

All of the information provided herein is subject to verification by the user. Continental Motors, Inc. makes no representation or warranty concerning the accuracy or completeness of the information and assumes no responsibility with respect thereto.

NTSB File No. CEN17FA248
Cessna 421C, Catawba, WI 7/1/17

Hartzell Engine Technologies
Turbocharger Examination Field Notes

Accident

Accident Date: July 1, 2017

Location: Catawba, WI

Aircraft: Cessna 421C N2655B

Engines: GTSIO-520-L (Left S/N: 825104, Right S/N: 292264)

Turbocharger Examination

Location: Continental Motors Group Analytical Lab, Mobile, AL

Date: July 12, 2018

Participants: Les Doud – Hartzell Engine Technologies Air Safety Investigator

Craig Hatch – NTSB Sr. Air Safety Investigator

Deepak Joshi – NTSB Aerospace Engineer Structures Lead

Mike Council – Continental Motors Group Air Safety Investigator

Turbocharger Description

Model: TH08A70

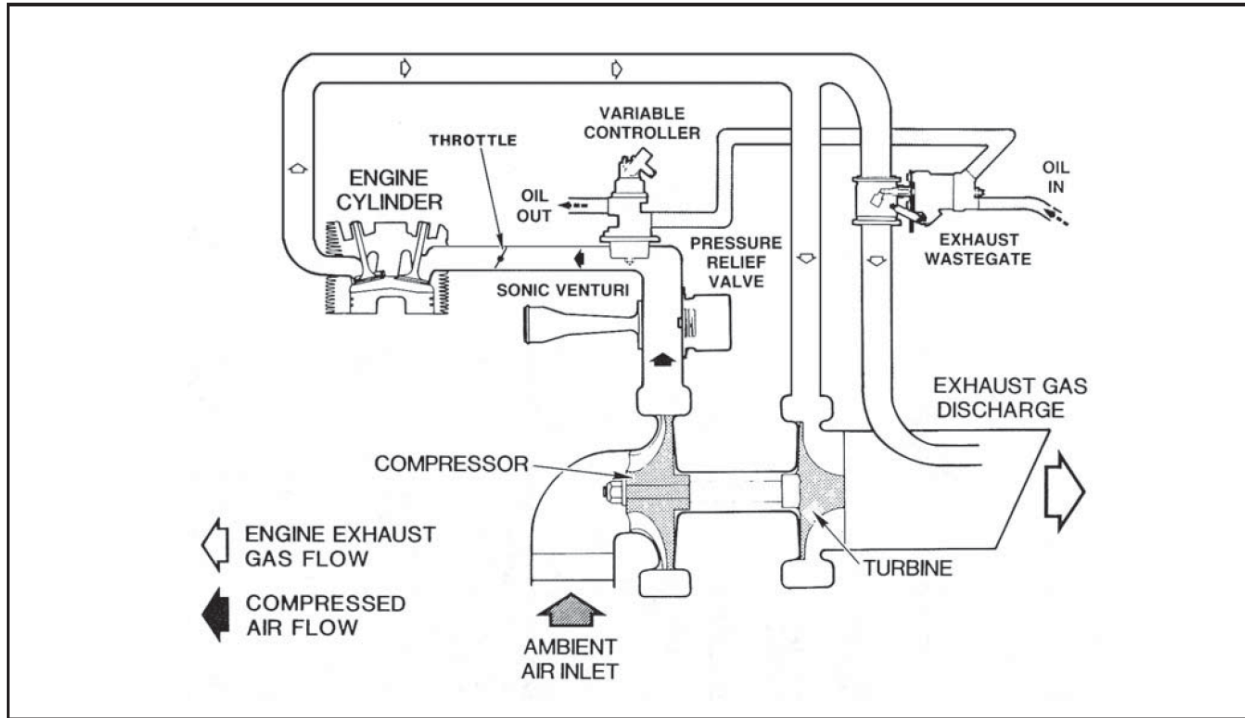
P/N: 465930-3

OEM P/N: 641672-3

Left S/N: Unknown, Right S/N: WHL05188

Description: The GTSIO-520-L engine on the Cessna 421C uses a “Variable Absolute Pressure” turbocharger system. A single turbocharger is controlled by a variable controller that senses deck pressure (upstream of throttle valve), compares it to a reference absolute pressure, and adjusts the wastegate butterfly (controlling turbocharger speed) to maintain sea-level horsepower at varying altitudes. It differs from the non-variable version, however, in that it is directly linked to the engine throttle, and through a system of cams and followers, adjusts itself to varying power settings, achieving the optimum deck pressure for a given throttle movement. A pressure relief valve, set slightly in excess of maximum deck pressure, is provided to prevent damaging overboost in the event of a system malfunction. A sonic venturi is incorporated to provide a constant source of compressed air to the cabin pressurization system. An intercooler is added to cool the compressor outflow and increase cylinder charge air density. A system schematic is shown in Figure 1.

Figure 1: Variable Absolute Pressure Turbocharger System



As Received Condition

The turbocharger systems were removed from the engines during the engine examination at Continental Motors Group and presented for examination in the condition shown in Photos #1 and #2. The left turbocharger had noticeably more mud, dirt and debris lodged and packed into both the compressor and turbine areas.

The right turbocharger had a yellow “field overhaul” data tag with “Rajay/Kelly Aerospace” names presented. This data tag indicates the turbocharger was overhauled by a repair station at some date prior to approximately September 2010. The name of the repair station and the precise date may be available in the engine logbooks. The compressor housing had separated from the turbocharger assembly during the inflight breakup or impact; the V-band clamp was still in place and secured. All of the intake and exhaust ducting was removed. The turbine blanket was still in place and a mounting bracket was still attached. The oil supply line was removed and the oil drain line was still attached. The compressor backplate had one visible fracture/crack extending from the center to the edge.

The left turbocharger data plate was torn from the unit during the inflight breakup or impact. It’s serial number and service history are unknown. The compressor housing backplate was fractured and fragmented; the compressor housing was displaced and contacting the compressor wheel. There was a large amount of mud, dirt and debris packed into the compressor and turbine areas.

Photo #1 – Left turbo



Photo #2 – Right turbo



Turbocharger Examination Findings

A teardown inspection of the turbochargers was conducted, including removal of the rotor group. The oil outlet drain fitting was removed before disassembly for visual access to the Center Housing. The interior of the right turbo was wet with oil; the left had a small amount of oil visible in one area but was mostly dry and corroded with dried mud/silt deposits. The following observations were made (see Photos #3 through #12):

1. Both turbo chargers had fractured compressor backplates (right was cracked, left was fragmented).
2. The rotor group was intact on both turbochargers. Blade clearances varied on both turbochargers and appeared to contact the compressor housings. The right rotor could be spin by figure force and the left could not be spun.
3. Balance cuts were present on the turbine wheel hub of each turbocharger.
4. There was some evidence of compressor wheel contact/rub on both turbochargers; the compressor housing had light rub marks and there was evidence of light rub on some compressor blade tips.
5. There were also what appeared to be stationary blade impact marks on both compressor housings. Both compressor wheels had blade impact damage indicating contact with the housing.
6. Both compressor wheel nuts were present and secure.
7. There was NO visible FOD damage on either the compressor or turbine side on both turbochargers.
8. There was NO excessive exhaust build-up on the turbine housing walls or wheel surfaces of either turbocharger.
9. There was NO evidence of oil leakage on either the compressor or turbine side; no oil residue or oily buildup on the wheels or in the compressor or turbine discharge ports.
10. The compressor-end bearings appeared to have normal wear; radial holes clear and chamfers visible indicating sufficient lubrication.
11. All piston rings on both turbochargers (compressor and turbine sides) were free of excessive coking, and free to expand and rotate in the grooves.
12. The right turbocharger inboard thrust bearing had tooling marks adjacent to the pin on the upper surface, likely made from installation of the anti-rotation pin; it did not appear to interfere with function or performance of the bearing.
13. The left rotating shaft was bent and the bend was consistent with the compressor housing/backplate and wheel impact damage.

14. When viewing the internal cavity of the Center Housings after disassembly, the following was observed:
 - a. There was evidence of sufficient oil/lubrication
 - b. There was NO evidence of coking
 - c. There was NO evidence of excessive heat.
 - d. There was NO evidence of FOD in the oil prior to impact with terrain.
 - e. There was NO evidence of lubrication blockage prior to impact with terrain and all oil passages and radial holes were clear.
15. The left turbocharger Center Housing had silt and water damage/corrosion suggesting it was submerged in water or water saturated soil for a period of time.
16. The right turbocharger turbine housing had burnt/charred vegetation-type debris suggesting the housing was hot when it impacted terrain (Photo #12)

Turbocharger System Components

The following turbocharger system components were visually examined but not disassembled or tested.

Right Engine

Wastegate actuator (Photo #13)

Garrett/Allied Signal Automotive data tag – Red color, “Factory Rebuilt”

Customer P/N: C165006-0113

Garrett P/N: 481064-9001

S/N: BA025550

The right wastegate actuator was fracture-separated from the wastegate assembly and the body was dented/impact damaged.

Pressure Relief Valve (Photo #14)

Rajay/Kelly Aerospace data tag – Yellow color, “Factory Overhauled”

Customer P/N: C482002-0104

Rajay P/N: 470930-9005

S/N: KDR01366

The right Pressure Relief Valve remained attached to the upper deck manifold and was not removed or inspected. The cover/housing appeared intact. Based on the current Hartzell Engine Technologies application table, the 470930-5 Pressure Relief Valve is used on the GTSIO-520-D and –H engines installed on the 421A and B models. The 421C with the GTSIO-520-L uses the 481040-1 Pressure Relief Valve. Both valves are set to a maximum of 43.9” but the 481040-1 is altitude compensated.

Turbocharger Controller (Photo #15)

Garrett/AiResearch Industrial Division data tag – bare metal “Factory Overhauled”

Customer P/N: R633388-9

AID P/N: 470836-3

S/N: KJR0135

The turbocharger controller was removed by Continental Motor Group personnel and was not disassembled or tested.

Left Engine

Wastegate actuator (Photo #16)

Rajay/Consolidated Fuel Systems data tag – Blue color, “Factory Rebuilt”

Customer P/N: C165006-0113

Garrett P/N: 481064-9001

S/N: DIO10839

The left wastegate actuator mount was fracture-separated from the wastegate valve but the actuator shaft remained attached to the valve shaft.

The left Pressure Relief Valve and Turbocharger Controller were not presented for examination and presumed not recovered from the crash site.

Conclusions

The turbochargers exhibited characteristics of normal operation with no evidence of distress prior to inflight breakup/impact. There were no discrepancies noted that would prevent or degrade normal turbocharger operation prior to the inflight breakup/impact.

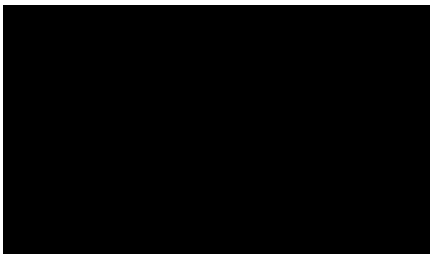


Photo #3 – Compressor inlet/wheels

Left



Right



Photo #4 – Turbine exit/wheels

Left



Right



Photo #5 – Compressor housing rub and wheel impact marks

Left



Right



Photo #6 – Center housing internal condition
Left Right

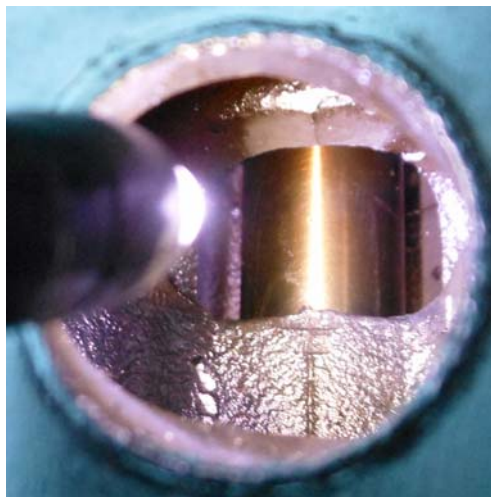


Photo #7 – Thrust bearing/collar condition
Left Right
(note silt deposits on left)



Photo #8 – Compressor-end bearing condition
Left Right



Photo #9 – Left shaft, piston ring and turbine wheel



Photo #10 – Left shaft bent



Photo #11 – Right shaft/piston ring condition



Photo #12 – Charred/burnt debris from right turbine housing



Photo #13 – Right wastegate actuator



Photo #14 – Right Pressure Relief Valve



Photo #15 – Right Turbocharger Controller

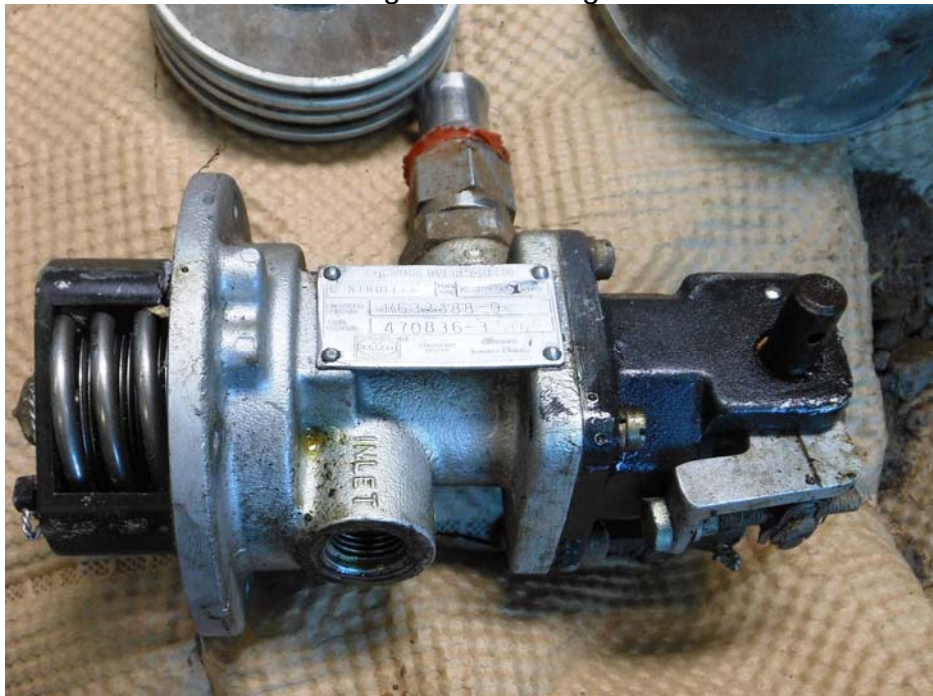


Photo #16 – Left wastegate and actuator

