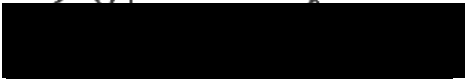




Continental Motors

ENGINE EXAMINATION REPORT

ENGINE MODEL	IO520K (1A)
ENGINE SERIAL NUMBER	557186
AIRCRAFT MAKE & MODEL	Bellanca Viking 17-30A
AIRCRAFT SERIAL NUMBER	75-30753
AIRCRAFT REGISTRATION	N4204B
FILE NUMBER	16-327

NAME	SIGNATURE	DATE
Phillip Grice		05/10/2017

ENGINE EXAMINATION REPORT**FILE NUMBER:**

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ENGINE S/N:

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PAGE 2 of 41**GENERAL INFORMATION**

EXAMINATION		ACCIDENT DATA	
DATE	4-11-2017	NTSB ACCIDENT #	CEN17LA058
FACILITY	CMI Analytical	NTSB INVESTIGATOR	Michael Folkerts
ADDRESS	2039 South Broad Street Mobile, Alabama	FAA INVESTIGATOR	Mike Schurhamer
		ACCIDENT DATE	12-18-2016
		ACCIDENT LOCATION	Blaine, North Dakota

ENGINE INFORMATION

ENGINE POSITION	Single
TOTAL TIME	2956.03
TIME SOH	2956.03 (1015.34 since disassembly, cleaning and reassembly was accomplished 3-12-1990. See "Significant logbook information" on page 3 of this report).
TYPE & TIME SLI	52.03 hours since Annual Inspection performed 2-19-2016
BUILD DATE	10-3-1974
IN SERVICE DATE	Undetermined

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Significant logbook information:

NOTE: The engine logbook entry dated 3-12-1990 at tach time 1940.69 indicates that an engine *disassembly and inspection* was accomplished. However, no overhaul was indicated or signed off. All subsequent log book entries incorrectly indicate **time since overhaul** accumulated from this entry forward.

The engine logbooks indicate a history of erratic oil change intervals. Page 41 of the engine logbook indicated that the engine received an oil change at the last annual inspection dated 2-1-2016, tach time 2904. The next logbook entry was dated 8-19-2016 and indicated an oil and filter change at tach time 2944.9. This interval is 40.90 hours in use. This engine is equipped with a reusable oil screen, not a spin-on full flow oil filter.

According to Continental Motors' Standard Practices Publication M-0, change 3, dated 15 Jan, 2017 (see below) oil change intervals for engines that incorporate a reusable oil screen is every 25 hours or every 4 months.

Since the 8-15-1990 logbook entry (complete engine disassembly and reassembly with new parts), the logbook indicates 3 other oil change intervals exceeding 50 hours. (80, 84, and 66 hours).



Lubricants, Sealants, and Adhesives

3-2. Oil Change Intervals

Refer to the engine maintenance manual and/or the aircraft manufacturers or Supplemental Type Certificate (STC) holders AFM/POH for oil specifications, specified oil change intervals and inspection procedures.

Oil change intervals published in this manual are minimum requirements. Continental Motors believes more frequent oil and filter changes enhance engine service life. Drain and replenish engine oil every 25 hours of operation or 4 months for engines that incorporate a reusable oil screen. On engines with the full flow oil filters, large or small replaceable oil filter cartridge, change the oil and filter every 50 hours and/or 4 months. Inspect oil screens and oil filter elements for contaminants at each oil change. Oil analysis may be used in addition to the oil screen or filter element inspection, but not as a replacement for it.

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INSPECTION & MAINTENANCE RECORD

INSPECTION OR MAINTENANCE PERFORMED
AGENCY & CERTIFICATE NO.

DATE

TOTAL
TIME

Veterans Airmotive Inc.

Model 10-520-K

Serial# 557186

Tach Time 1940.69

Engine was disassembled, cleaned, and inspected. All Steel parts were magnafluxed, all non ferrous metals were zygo inspected. All cylinders were honed, installed all new pistons, new rings, new exhaust valve, reconditioned intake valves, new valve springs, new valve keepers, seats and guides were cut or replaced as needed. Crankcase was assembled using all new main and rod bearings, all new rod nuts and bolts. Installed all new seals, gasket, clamps, rubbers and hoses. Harness was replaced new, mags, starter and alternator were checked and repaired as needed. Fuel system was overhauled see tags. Engine is to be installed back in aircraft and test run by customer.
Zachary S. Stroupe [REDACTED] 3/12/90

INSTALLED ENGINE ON BELLANCA 17-30A N4204B
8-15-90 [REDACTED]

8-15-90

I CERTIFY THIS ENGINE WAS INSPECTED IN ACCORDANCE
WITH ANNUAL INSPECTION + DETERMINED AIRWORTHY

Report Summary:

Search Code(s):

15/12/40

The engine suffered an oil starvation event for unknown reasons. The engine was being operated in an extremely cold environment on the day of the engine failure.

Disposition of engine following exam: The engine was released by the NTSB IIC 4-12-2017 to be returned to the owner via Bolduc Specialized Services Incorporated, Minneapolis, MN

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PAGE 5 of 41**INSPECTION WITNESSES**

NAME	Phillip Grice	NAME	Greg Eastburn
ADDRESS	Mobile, Alabama	ADDRESS	Mobile, Alabama
ORGANIZATION	Continental Motors	ORGANIZATION	Continental Motors
PHONE	██████████	PHONE	██████████
NAME	Lisa Jersild	NAME	Mike Council
ADDRESS	Mobile, Alabama	ADDRESS	Mobile, Alabama
ORGANIZATION	Continental Motors	ORGANIZATION	Continental Motors
PHONE	██████████	PHONE	██████████
NAME	Michael Folkerts	NAME	
ADDRESS	Central Regional	ADDRESS	
ORGANIZATION	NTSB	ORGANIZATION	
PHONE	██████████	PHONE	

EXTERNAL INSPECTION OF ENGINE

The engine was received in a Continental Motors shipping container supplied to the owner/operator for this purpose. The engine was intact with the following exceptions:

- 1) The electric starting motor was missing
- 2) The top portions of the right and left crankcases were broken-out and material was missing. Damaged internal engine components were visible.
- 3) The engine data plate was missing. The upper right crankcase was damaged where the data plate had been attached. An engine data plate with serial number **557186** was later located in a box shipped with the engine.
- 4) The nose seal assembly was protruding from the crankcase. The oil seal retainer plates and attaching hardware were not installed.

ENGINE EXAMINATION REPORT

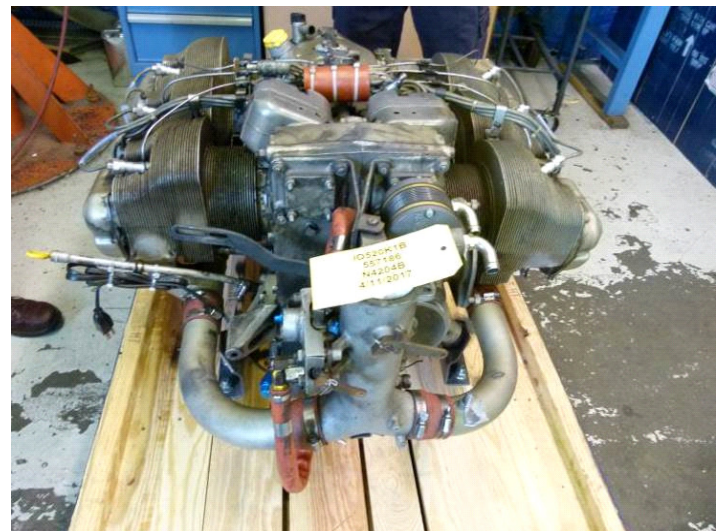
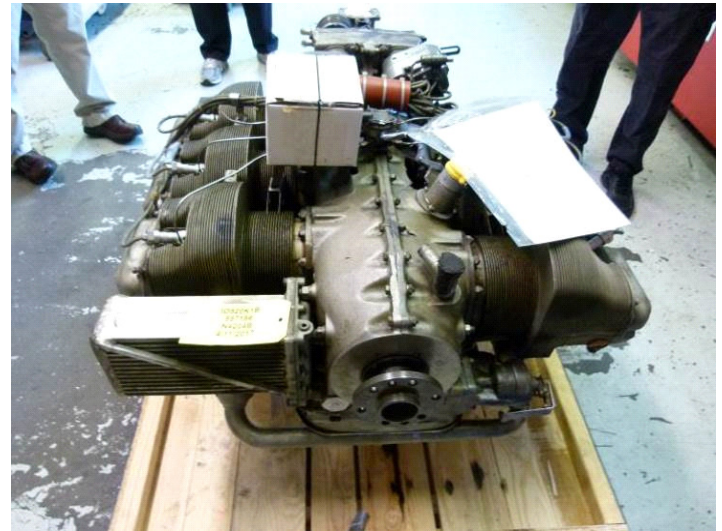
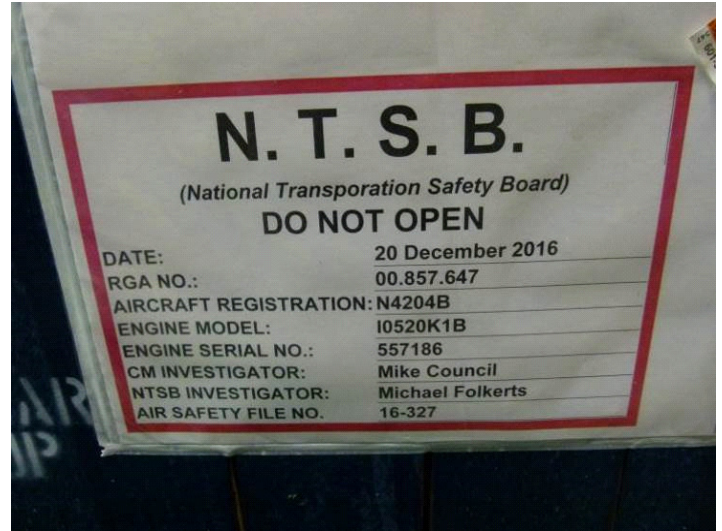
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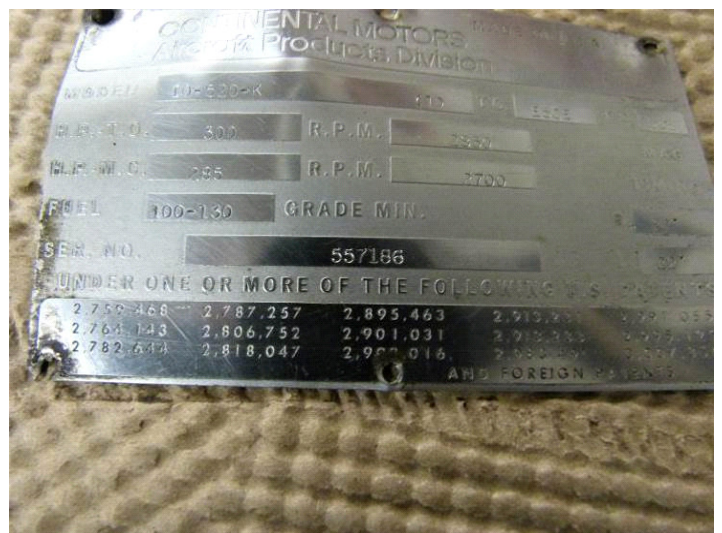
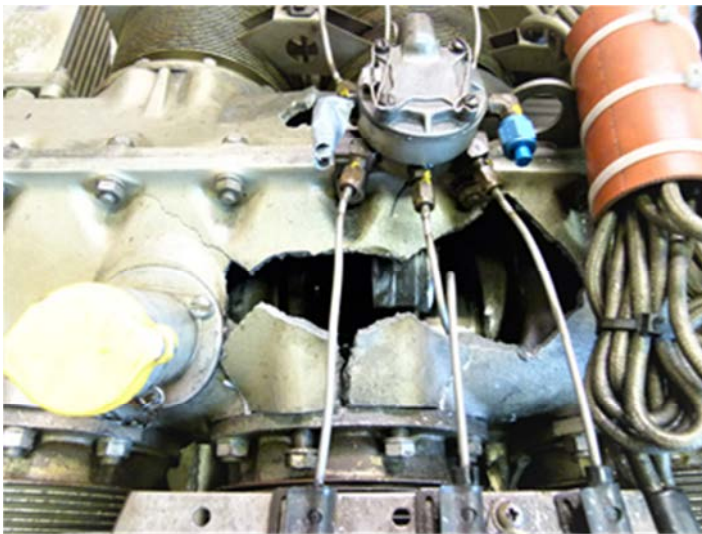
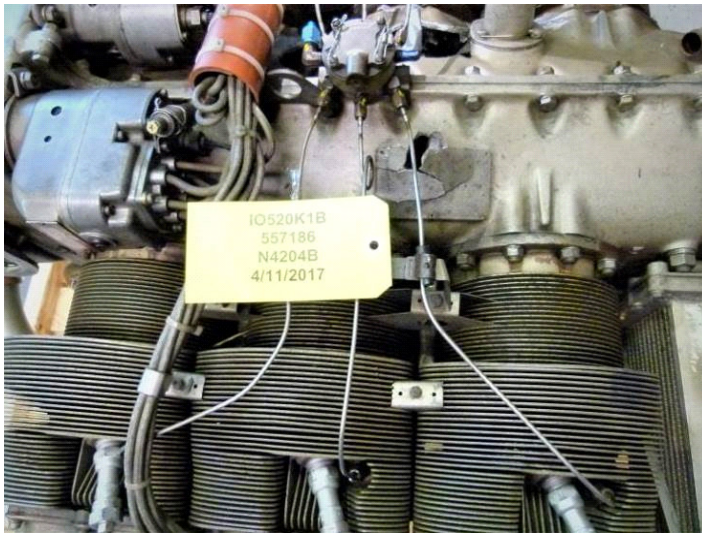
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ENGINE EXAMINATION REPORT**FILE NUMBER:**

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- 1) Instrument air pump, airborne model 216CW, serial number 1555402.
- 2) Propeller governor, Edo-Aire, part number 34-82801-2, serial number 9??5 (obscured).
- 3) Oil sump preheat pad.

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ENGINE TEARDOWN AND COMPONENT EXAMINATION

EXHAUST SYSTEM

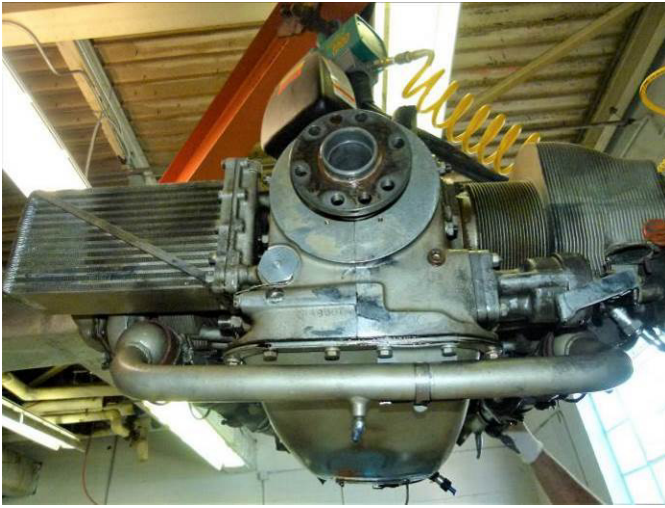
Condition:

No exhaust components were returned with the engine

INDUCTION SYSTEM

Condition:

All induction components were intact and did not exhibit damage



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IGNITION SYSTEM

MAGNETO-TO-ENGINE TIMING

Specification: 22° BTDC

L/H Magneto: *

R/H Magneto: *

*Unable to determine. Internal engine damage prevented rotation of crankshaft

LEFT MAGNETO

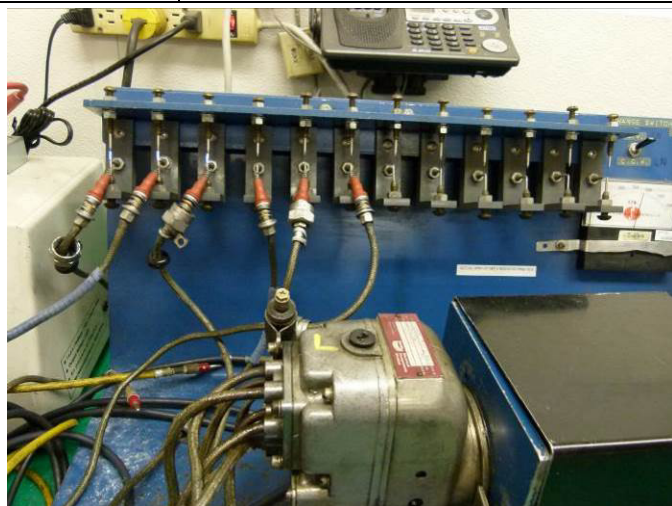
Manufacturer: Bendix

P/N: 10-79020-10

S/N: 106633

Condition:

The magneto was bench tested and performed satisfactorily



RIGHT MAGNETO

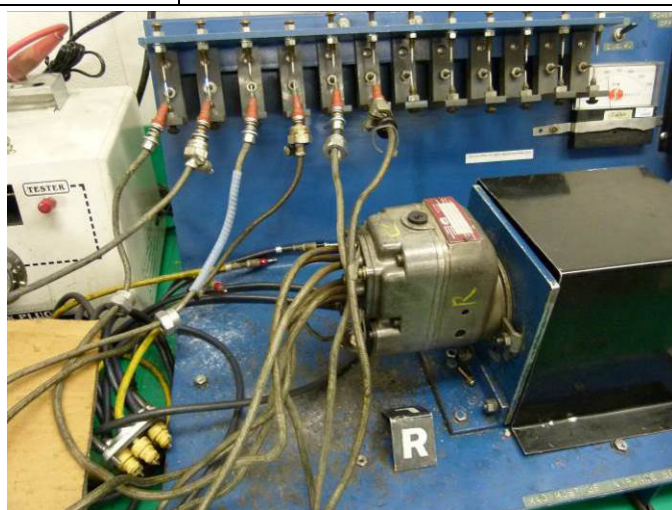
Manufacturer: Bendix

P/N: 10-79020-10

S/N: 106627

Condition:

The magneto was bench tested and performed satisfactorily



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IGNITION HARNESS	Manufacturer: Slick	P/N: Undetermined	S/N: Undetermined
Condition:	The ignition harness did not exhibit damage.		



SPARK PLUGS	Manufacturer: Champion	P/N: RHB32E
Condition:	Top sparkplugs were normal in coloration and <i>normal</i> to <i>worn-out normal</i> condition. Bottom sparkplugs from cylinders 2, 3, 4, and 6 were oil contaminated.	



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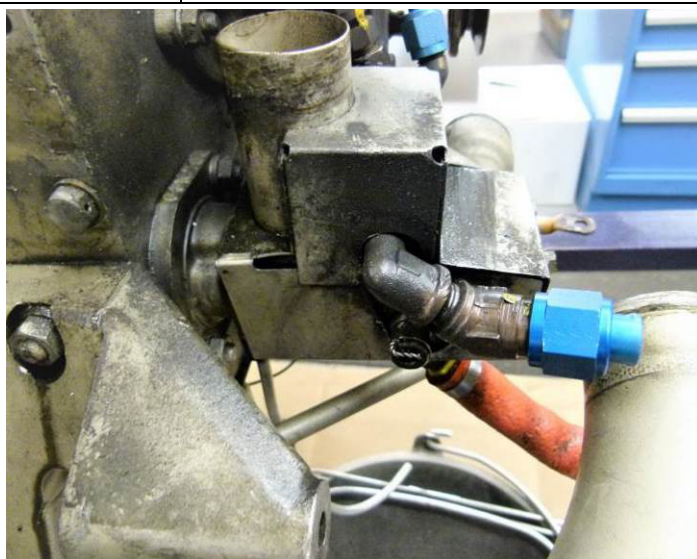
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FUEL SYSTEM

*** - Fuel System Component(s) Flow/Pressure Test:** The "Observed" values (fuel flows and/or pressures) are recorded without adjustment (unless noted) of the fuel system component. The other values in each table are engineering specifications for the original calibration of the component to insure desired performance within the full range of operation. These tests and adjustments are carried out in an environment of controlled fuel supply pressures and calibrated test equipment.

When engines are installed in aircraft, they are subjected to a different induction system, fuel supply system and operating environment and may require further adjustments to compensate for these differences. It is these differences that may be present in the following test bench recorded values and CMI flow/pressure specifications. These tests are conducted to confirm that the fuel system components will function adequately within its' designed limitations.

FUEL PUMP	Manufacturer: TCM	P/N: 638154-1	S/N: L037419B
Condition:	The fuel pump was not damaged. The pump operated smoothly when manually rotated. The drive coupling and gear were intact. The fuel pump was bench tested "as received" and flow results are listed below.		



Fuel Pump Assembly Flow vs. Pressure Test

RPM	Specified Pressure (PSI)	Specified Fuel Flow (PPH)	*Observed PPH @ PSI
600	10.5 – 11.5	6.5 – 7.0	6.59 @ 12.00
1600	19.0 – 22.0	37.0 – 38.0	36.88 @ 21.6
2600	34.0	149.0 - 151.0	150.81 @ 32.83

ENGINE EXAMINATION REPORT

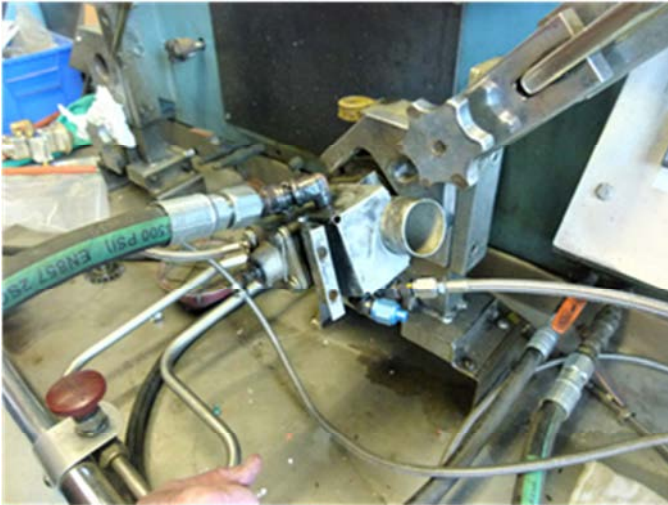
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RPM	PPH	PSI
600	6.5-7.0	10.5-11.5
1600	37.0-38.0	19.0-22.0
2600	149.0-151.0	34.0
600	6.5-7.0	10.5-11.5

NOTE E DOES NOT APPLY
SEE INSTEAD NOTE M



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THROTTLE BODY METERING UNIT

Manufacturer: TCM

P/N: 629703-2

S/N: C217403A

Condition: Control arms were secured correctly. The throttle plate operated correctly. The fuel screen was uncontaminated. A small amount of fuel drained from metering unit when storage caps were removed.

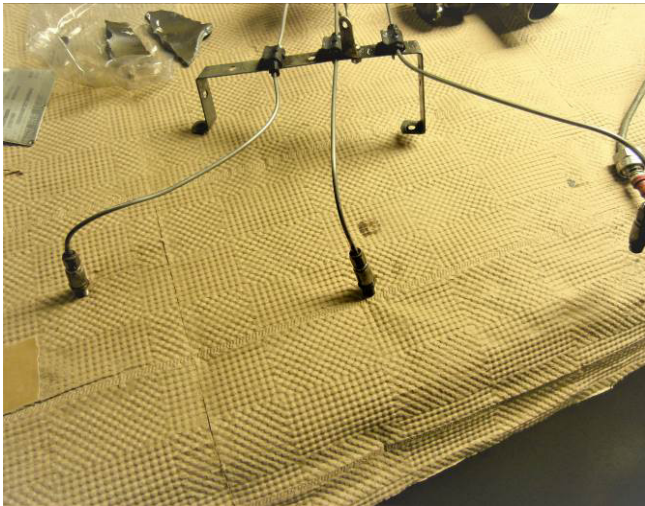
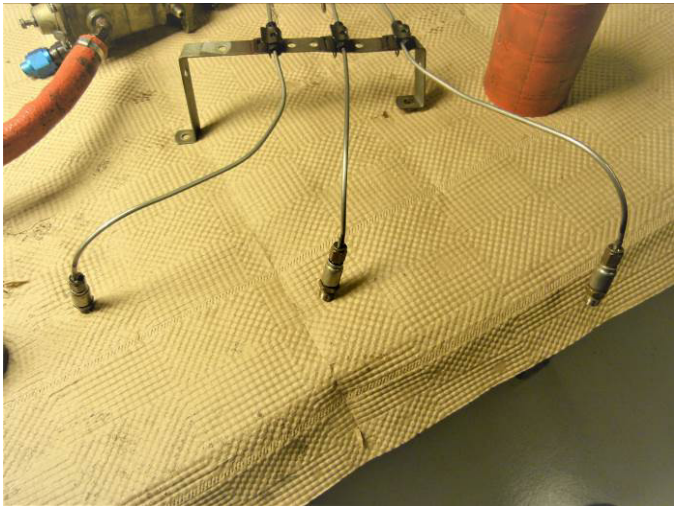


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FUEL MANIFOLD VALVE	Manufacturer: Undetermined	P/N: 631351-5	S/N: I217401C
Condition:	Assembly screws were secured and a lead seal was in place. Data plate missing.		



FUEL NOZZLES AND LINES	Manufacturer: Undetermined					
Position	#1	#3	#5	#2	#4	#6
Size	D13B	D13B	D13B	D13B	D13B	D13B
Condition:	All fuel injector nozzles were open					



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LUBRICATION SYSTEM

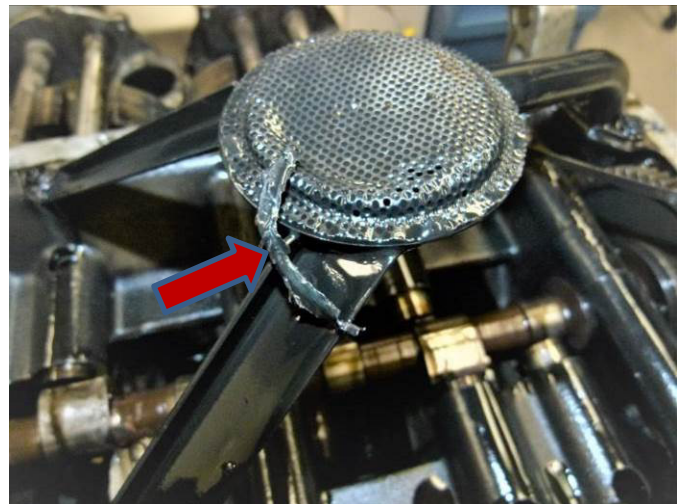
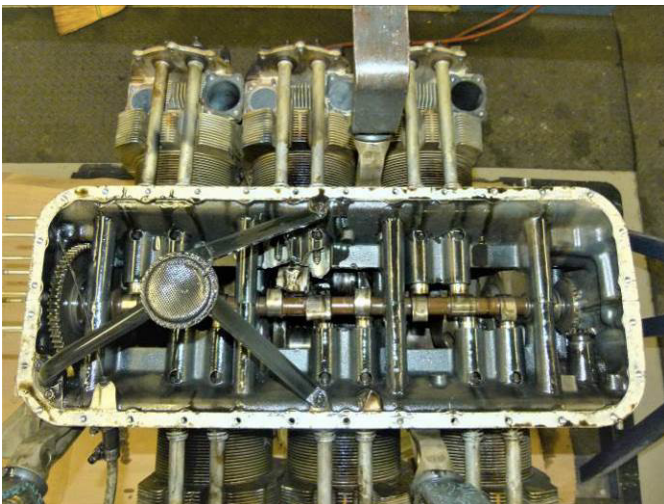
OIL SUMP

Condition: The oil sump was undamaged. Metal contamination was exhibited when the oil sump was removed. **NOTE:** The oil sump heat pad was tested and found operational. Red arrow points to installed oil sump heat pad.



OIL PICK-UP TUBE & SCREEN

Condition: A small quantity of metal debris was present on the pick-up screen. Red arrow points to debris.



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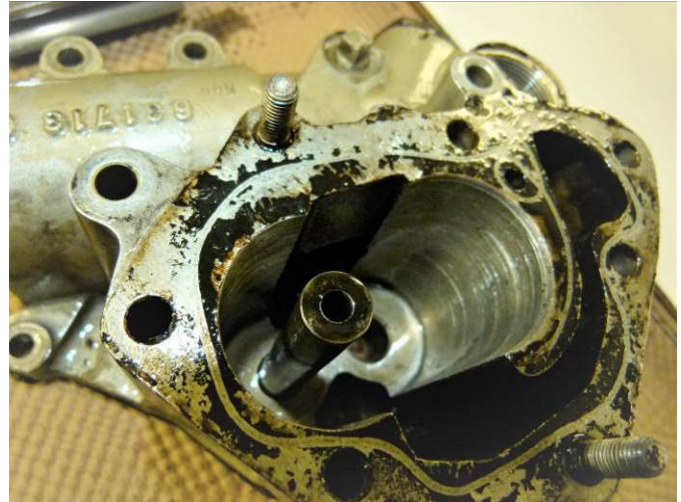
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OIL PUMP

Condition:

The oil pump was disassembled and inspected. The sealant on the parting surface does not appear to be sealant used by CMI at this location. The pump chamber and cover plate exhibits evidence of hard partial passage and pitting. Pump gears indicated wear and light scratches from metal contamination.

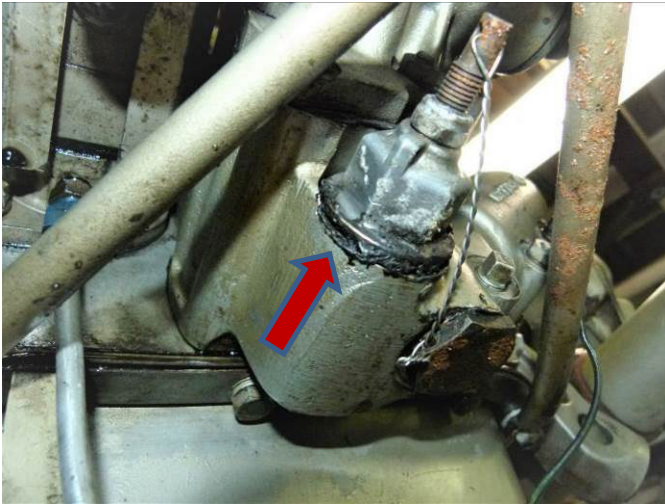


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OIL PRESSURE RELIEF VALVE

Condition: The oil pressure relief valve had evidence of sealant on the oil pressure relief valve body. A copper gasket (crush washer) part number MS35769-26 is the proper interface for this component. A red arrow points to sealant.

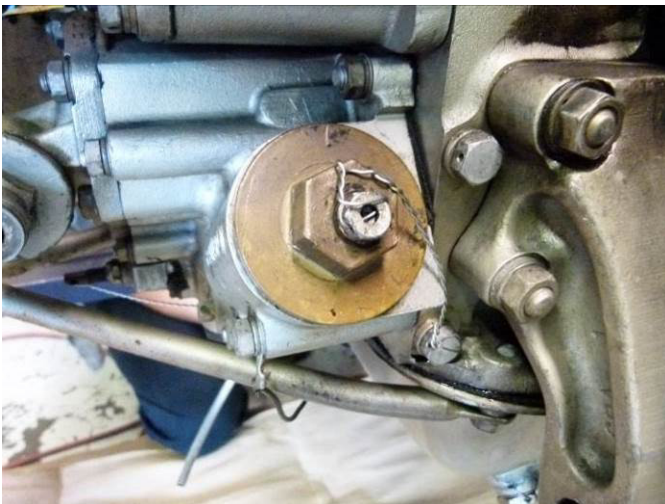


OIL SCREEN

Manufacturer: TCM

P/N: 538727-2

Condition: The reusable oil screen contained ferrous and non-ferrous metal contamination.



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OIL COOLER

Overhauled by: American
Cooler Service

P/N: Undetermined

S/N: 001732RC

Condition: The oil cooler did not exhibit damage



VERNATHERM

Manufacturer: Undetermined

P/N: 649304

S/N: 7529

Condition: The vernitherm was removed and functionally tested. When heated in liquid, the spring extends fully at 178 °F. Specified travel range is from 3 inches to 3.262 inches. This component met specifications during the functional test.



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CYLINDERS

CYLINDER #1	P/N: 639272D	S/N: Undetermined	Head Date: 9/74
Work Orders:	S.S.R+010 25966-1		
Condition:	Externally, cylinder 1 did not exhibit impact damage.		



CYLINDER #3	P/N: 639272D	S/N: Undetermined	Head Date: 9/74
Work Orders:	S.S.R+010 25966-2		
Condition:	Externally, cylinder 3 did not exhibit impact damage. Internally, the cylinder skirt was damaged by released rotating components.		



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CYLINDER #5	P/N: 639272D	S/N: Undetermined	Head Date: 9/74
Work Orders:	S.S.R+010 25966-3		
Condition:	Externally, cylinder 5 did not exhibit impact damage.		



CYLINDER #2	P/N: 639272D	S/N: Undetermined	Head Date: 9/74
Work Orders:	S.S.R+010 25966-4		
Condition:	Externally, cylinder 2 did not exhibit impact damage.		



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CYLINDER #4

P/N: 639272D

S/N: Undetermined

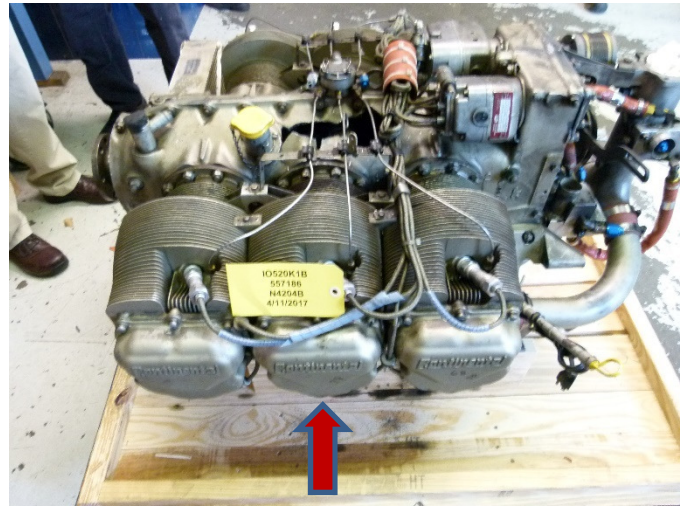
Head Date: 9/74

Work Orders:

S.S.R+010 25966-5

Condition:

Externally, cylinder 4 did not exhibit impact damage. Internally, the cylinder skirt was damaged by released rotating components.



CYLINDER #6

P/N: 639272D

S/N: Undetermined

Head Date: 9/74

Work Orders:

S.S.R+010 25966-6

Condition:

Externally, cylinder 6 did not exhibit impact damage.



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FILE NUMBER:

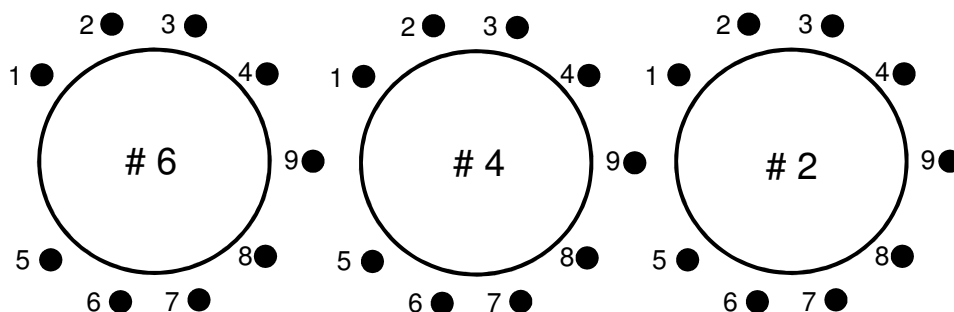
16-327

ENGINE S/N:

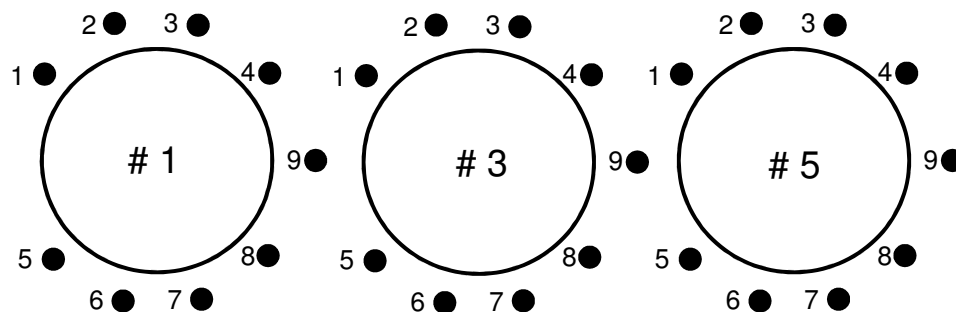
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	Bolt 1	Stud 2	Stud 3	Stud 4	Bolt 5	Stud 6	Stud 7	Stud 8
	Tight / Loose	Tight / Loose	Tight / Loose	Tight / Loose	Tight / Loose	Tight / Loose	Tight / Loose	Tight / Loose
Cylinder #2	539 / 458	808 / 626	808 / 642	693 / 562	649 / 506	670 / 534	670 / 540	611 / 477
Cylinder #4	717 / 560	* /	* /	555 / 423	781 / 590	644 / 503	630 / 458	574 / 431
Cylinder #6	666 / 548	838 / 705	862 / 699	826 / 672	747 / 593	668 / 553	666 / 563	684 / 578



	Bolt 1	Stud 2	Stud 3	Stud 4	Bolt 5	Stud 6	Stud 7	Stud 8
	Tight / Loose	Tight / Loose	Tight / Loose	Tight / Loose	Tight / Loose	Tight / Loose	Tight / Loose	Tight / Loose
Cylinder # 1	654 / 546	708 / 580	734 / 626	853 / 584	769 / error	626 / 501	720 / 578	523 / 439
Cylinder # 3	528 / 449	738 / 642	742 / 579	585 / 482	622 / 482	613 / 472	573 / 467	479 / 369
Cylinder # 5	729 / 564	443 / 353	736 / 559	780 / 630	982 / 735	607 / 468	617 / 453	645 / 463



* No measurable torque. The nut was cracked and had backed off.

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VALVES AND GUIDES

Condition:

All valves were intact with normal combustion signatures. No photo available for cylinders 3 or 4



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ROCKER ARMS AND SHAFTS

Condition:

All rocker arms and shafts were intact and did not exhibit damage.



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#1 PISTON, RINGS AND PIN

Piston P/N: SA631892 (Superior Air Parts)

Condition:

The piston dome exhibited normal combustion signatures. Rings and piston pin were normal.



#3 PISTON, RINGS AND PIN

Piston P/N: SA631892 (Superior Air Parts)

Condition:

The piston skirt was mechanically damaged. The piston had to be cut from the damaged cylinder.



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#5 PISTON, RINGS AND PIN

Piston P/N: SA631892 (Superior Air Parts)

Condition: The piston dome exhibited normal combustion signatures. Rings and piston pin were normal.



#2 PISTON, RINGS AND PIN

Piston P/N: SA631892 (Superior Air Parts)

Condition: The piston dome exhibited normal combustion signatures. Rings and piston pin were normal.



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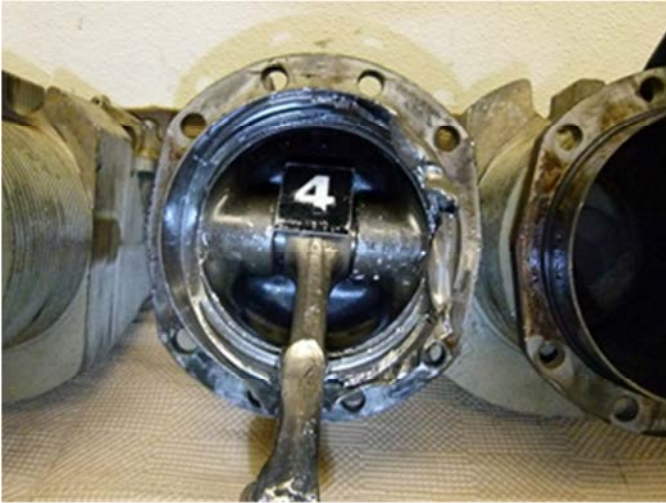
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#4 PISTON, RINGS AND PIN

Piston P/N: SA631892 (Superior Air Parts)

Condition:

The piston skirt was mechanically damaged and the piston was cut from the damaged cylinder. Piston rings and pin were intact.

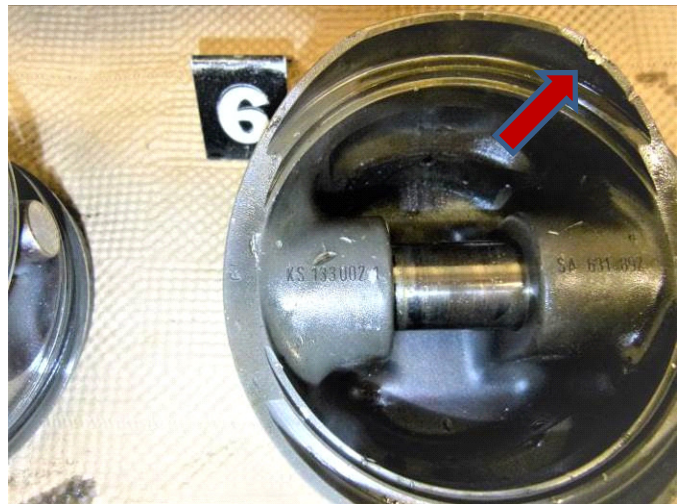


#6 PISTON, RINGS AND PIN

Piston P/N: SA631892 (Superior Air Parts)

Condition:

The piston dome exhibited normal combustion signatures. Rings and piston pin were normal. The piston skirt was mechanically damaged. Red arrow points to skirt damage.

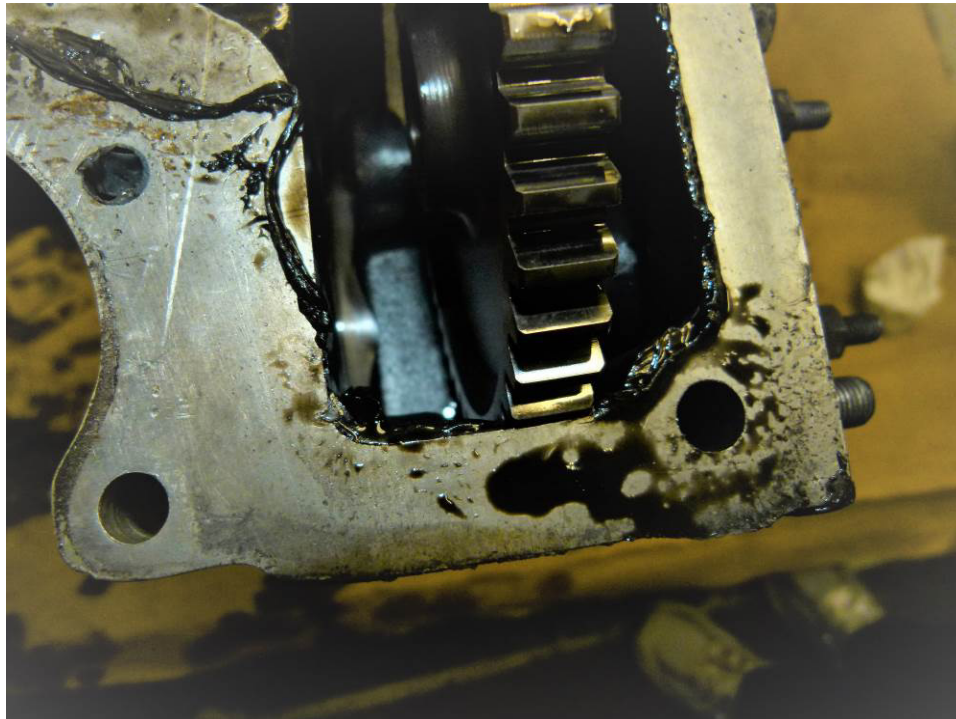


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CRANKCASE ASSEMBLY

CRANKCASE	Casting Number:	1-3-5: 640960	2-4-6: 640961	S/N:4B507
Condition:	Both crankcase halves received damage due to uncontained rotational component issues. Non-CMI sealant was used on case-half parting surfaces.			



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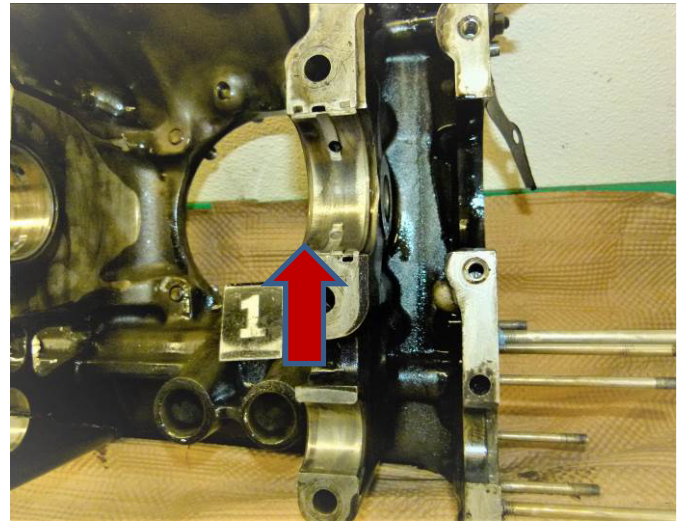
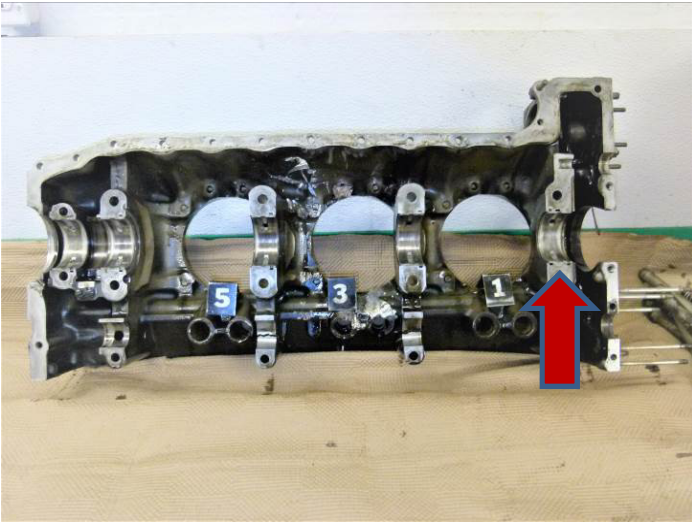
#1 MAIN BEARINGS

P/N: SA630464 (Superior Air Parts)

Date Code: 74587600

Condition:

Red arrow points to # 1 main bearing. The bearings were intact and exhibited an insignificant amount of contamination and hard particle passage



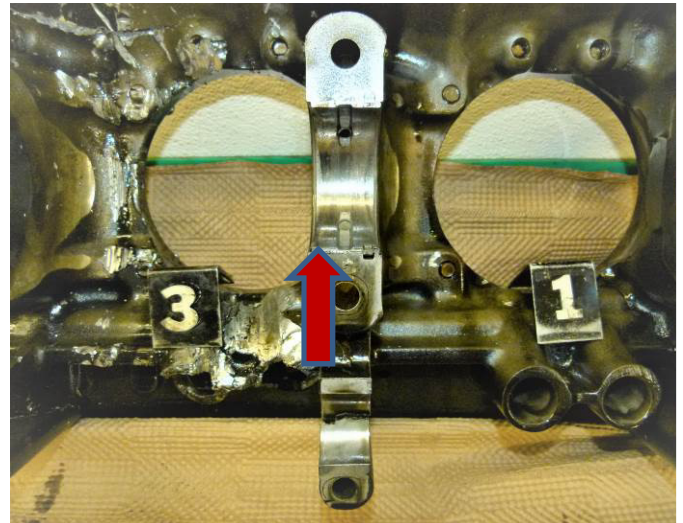
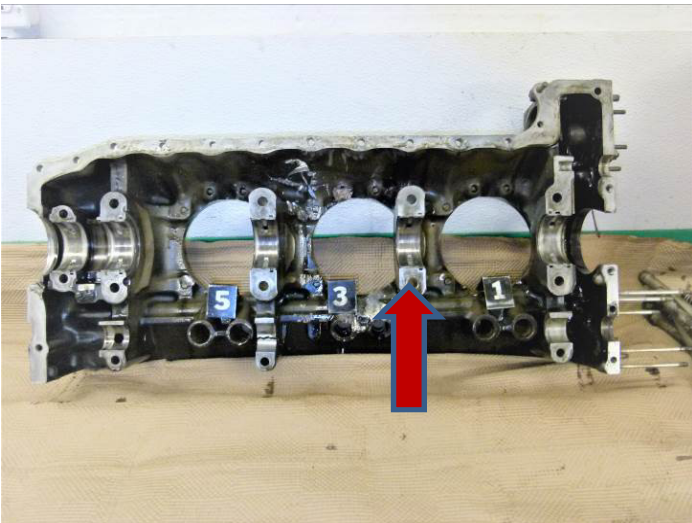
#2 MAIN BEARINGS

P/N: SA630464 (Superior Air Parts)

Date Code: 74587600

Condition:

Red arrow points to # 2 main bearing. The bearings were intact and exhibited an insignificant amount of contamination and hard particle passage



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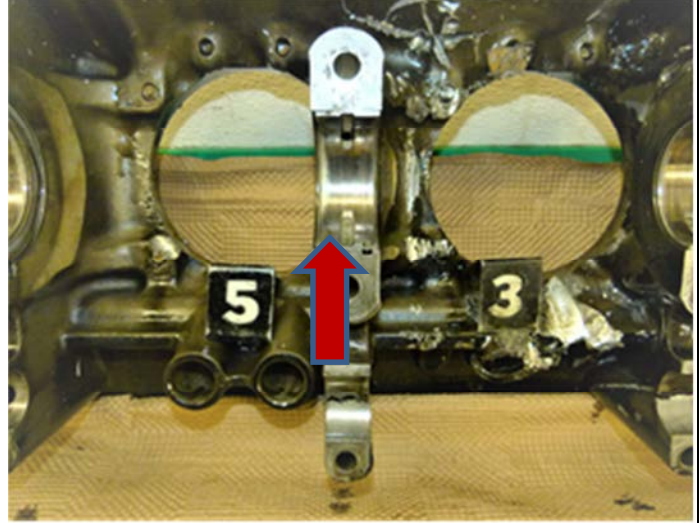
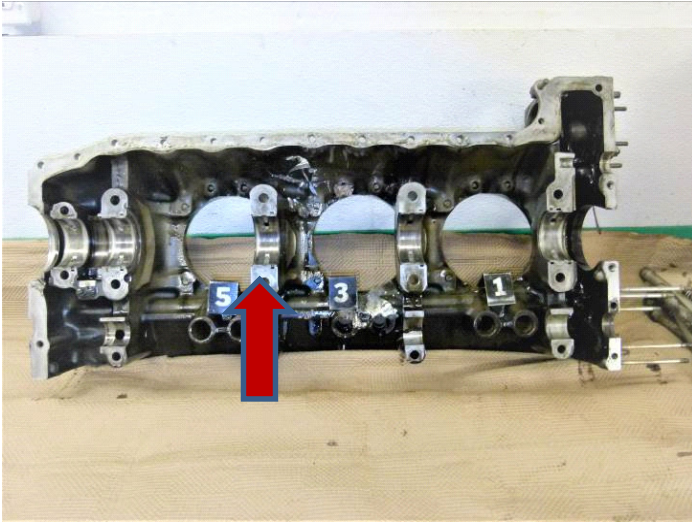
#3 MAIN BEARINGS

P/N: SA630464 (Superior Air Parts)

Date Code: 74587600

Condition:

Red arrow points to # 3 main bearing. The bearings were intact and exhibited an insignificant amount of contamination and hard particle passage



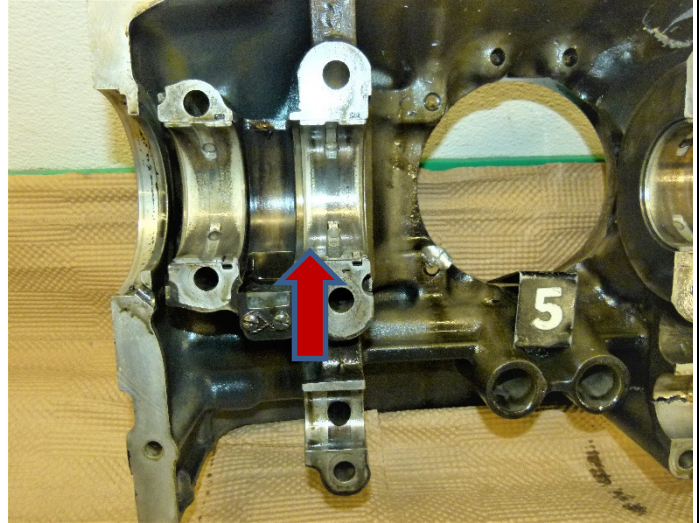
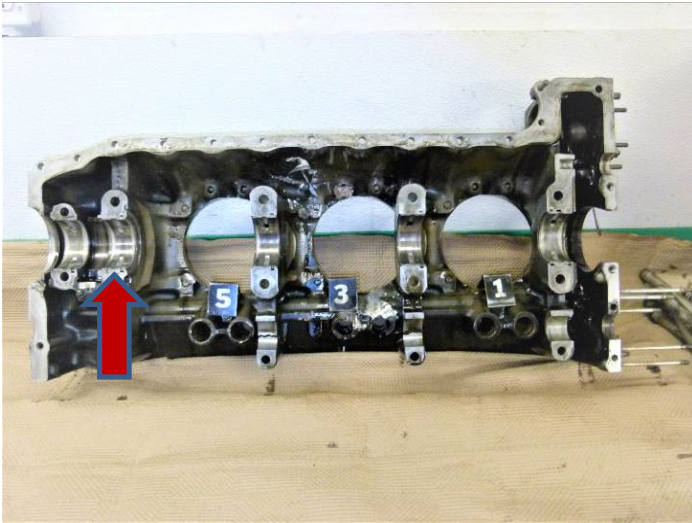
#4 MAIN BEARINGS

P/N: SA630464 (Superior Air Parts)

Date Code: 74587600

Condition:

Red arrow points to # 4 main bearing. The bearings were intact and exhibited an insignificant amount of contamination and hard particle passage



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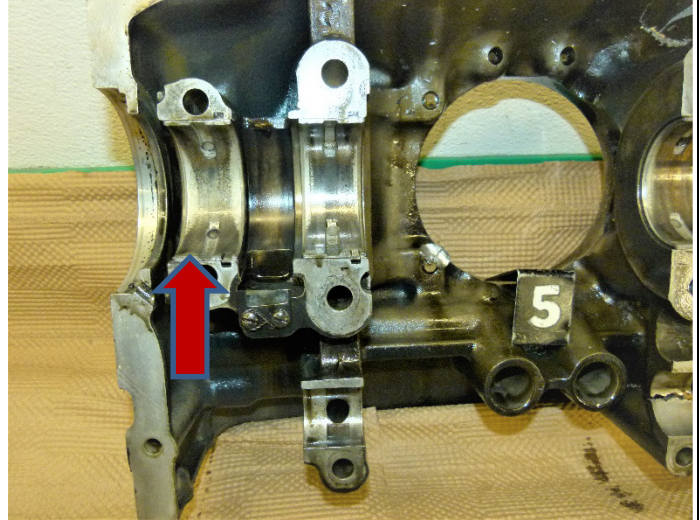
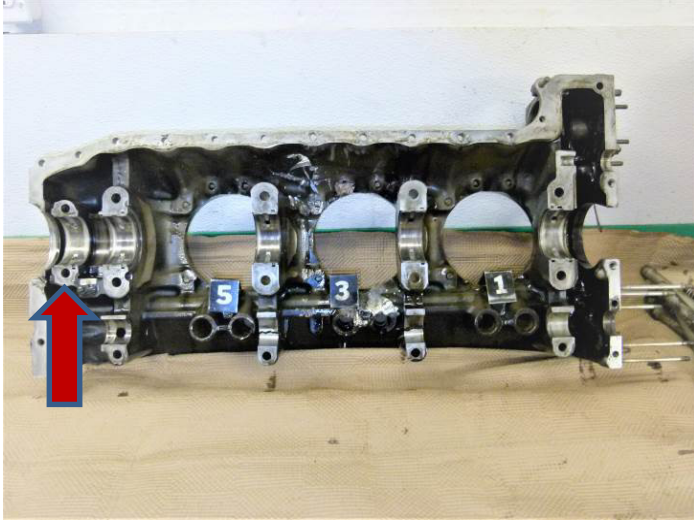
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#5 MAIN BEARINGS

P/N: SA630464 (Superior Air Parts)

Date Code: 74587600

Condition: Red arrow points to # 5 main bearing. The bearings were intact and exhibited an insignificant amount of contamination and hard particle passage



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CRANKSHAFT ASSEMBLY

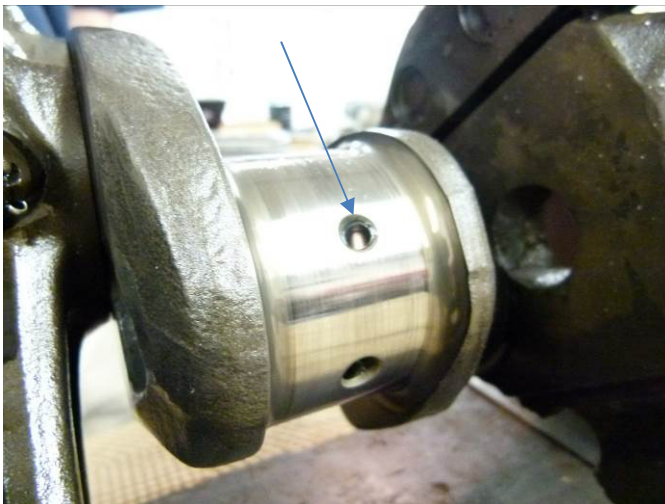
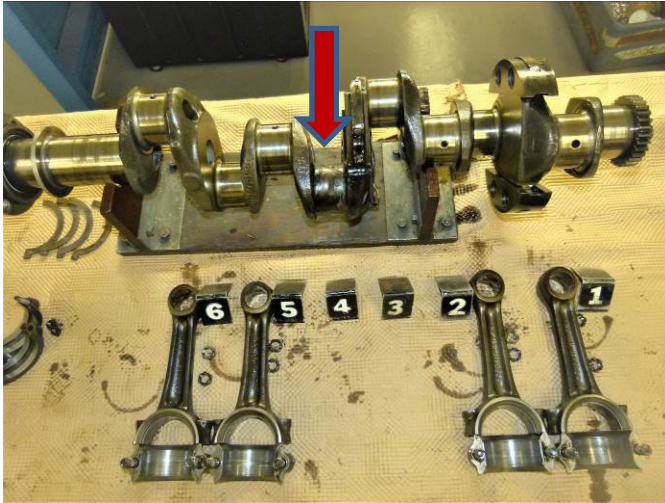
CRANKSHAFT

Forging Number:
631649F

S/N: Undetermined

Heat code: K68

Condition: Crankshaft # 4 connecting-rod journal suffered catastrophic oil starvation damage. The red arrow points to light visible through the oil transfer tube to the journal oil orifice in #4 rod journal. No oil blockage was discovered in the oil galleys or transfer tubes. The nose seal assembly was protruding from the crankcase. The oil seal retainer plates and attaching hardware were not installed as received.



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TRANSFER COLLAR

Condition:

The transfer collar exhibited normal wear patterns.



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COUNTER WEIGHTS

Condition:

The rear counter weights were intact and free to move on pins. One of the forward counter weights released for undetermined reasons. The opposing forward counterweight remained attached to pins but was damaged.



INTERNAL TIMING

Condition:

The internal timing marks aligned when piston 1 was positioned at top dead center



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#1 CONNECTING ROD

P/N: 632041F

Forging or Serial Number: Undetermined

Condition: The connecting rod did not exhibit damage.

#1 CONNECTING ROD BEARING

P/N: SA630826 Superior Air Parts Date Code: 3-9

Condition: The bearing exhibited hard particle passage and contamination embedded in the Babbitt layer.



#3 CONNECTING ROD

P/N: 632041F

Forging or Serial Number: Undetermined

Condition: #3 rod was damaged and the rod cap separated.

#3 CONNECTING ROD BEARING

P/N: SA630826 Superior Air Parts Date Code: 3-9

Condition: #3 rod bearing was extruded and destroyed from mechanical damage.



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#5 CONNECTING ROD

P/N: 632041F

Forging or Serial Number: Undetermined

Condition: The connecting rod did not exhibit damage.

#5 CONNECTING ROD BEARING

P/N: SA630826 Superior Air Parts Date Code: 3-9

Condition: The bearing exhibited hard particle passage and contamination embedded in the Babbitt layer.



#2 CONNECTING ROD

P/N: 632041F

Forging or Serial Number: Undetermined

Condition: The connecting rod did not exhibit damage.

#2 CONNECTING ROD BEARING

P/N: SA630826 Superior Air Parts Date Code: 3-9

Condition: The bearing exhibited hard particle passage and contamination embedded in the Babbitt layer.



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#4 CONNECTING ROD

P/N: 632041F

Forging or Serial Number: Undetermined

Condition: #4 rod was damaged and the rod cap separated.

#4 CONNECTING ROD BEARING

P/N: SA630826 Superior Air Parts Date Code: 3-9

Condition: #4 rod separated at the rod cap due to oil starvation.



#6 CONNECTING ROD

P/N: 632041F

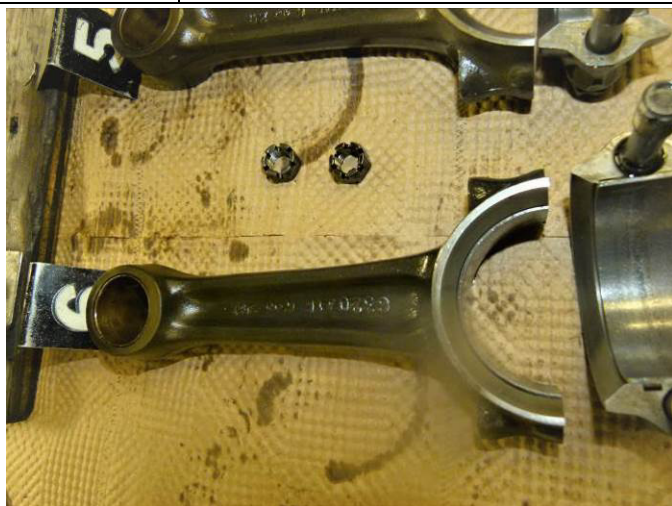
Forging or Serial Number: Undetermined

Condition: The connecting rod did not exhibit damage.

#6 CONNECTING ROD BEARING

P/N: SA630826 Superior Air Parts Date Code: 3-9

Condition: The bearing exhibited hard particle passage and contamination embedded in the Babbitt layer.



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CAMSHAFT

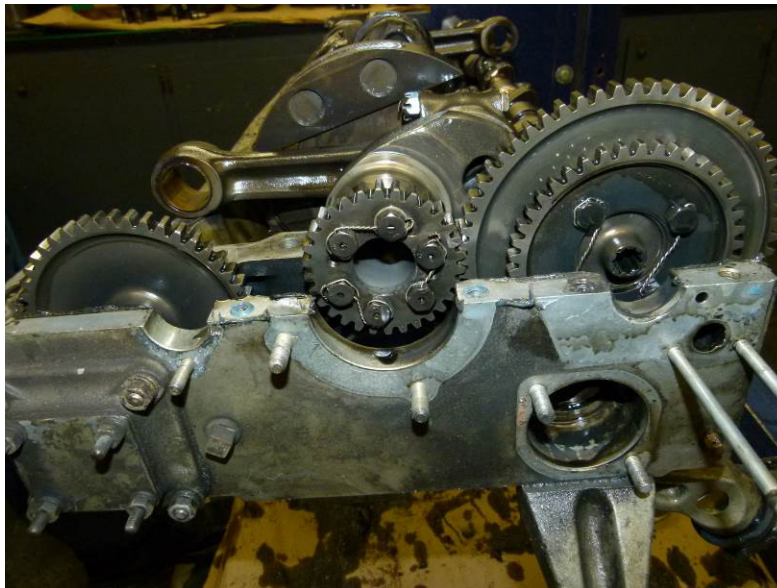
CAMSHAFT	P/N: 535661-V	S/N: Undetermined
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Condition:	The camshaft received impact damage from released counter weight.
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ACCESSORY GEARS

Condition:	Normal wear patterns were exhibited. Assembly bolts were secured correctly.
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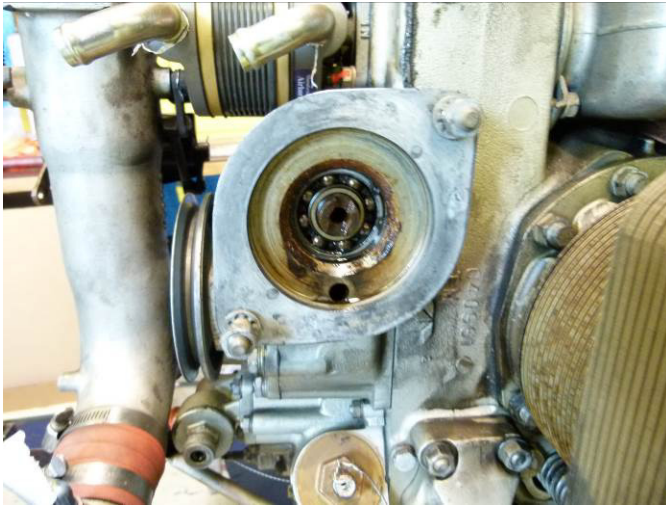
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STARTER	Manufacturer: Undetermined	P/N: Undetermined	S/N: Undetermined
Condition:	Not shipped with engine		
STARTER ADAPTER	P/N: Undetermined		
Condition:	No damage was exhibited. The pulley was turned freely when the starter adapter was rotated manually. Note: starter motor missing as received.		



ALT/GEN #1	Manufacturer: Undetermined	P/N: Undetermined	S/N: Undetermined
Condition:	Not shipped with engine		
VACUUM PUMP	Manufacturer: Airborne	P/N: 216CW	S/N: 1555402
Condition:	The vacuum pump rotated freely and appeared to be undamaged.		



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PROPELLER GOVERNOR	Manufacturer: Edo-Aire	P/N: 34-82801-2	S/N: 9??5 (data plate damaged)
Condition:	The propeller governor did not exhibit damage. The installation gasket was incorrect. A shipping gasket was installed instead of the required gasket with an integral screen.		

