Continental Motors

ENGINE EXAMINATION REPORT

ENGINE MODEL	IO-520-E
ENGINE SERIAL NUMBER	215503-R
AIRCRAFT MAKE & MODEL	Aero Commander 500A
AIRCRAFT SERIAL NUMBER	500A-914-22
AIRCRAFT REGISTRATION	N41AV
FILE NUMBER	14-308

NAME	SIGNATURE	DATE
Phillip Grice	[redacted]	04/14/2015

GENERAL INFORMATION

EXAMINATION		ACCIDENT DATA	
DATE	04/14/2015	**NTSB ACCIDENT #**	CEN15FA056
FACILITY	Continental Motors Inc.	**NTSB INVESTIGATOR**	Jason Aguilera
ADDRESS	2039 S Broad St Mobile, AL 36615	**FAA INVESTIGATOR**	Brian Fricker
		ACCIDENT DATE	11/23/2014
		ACCIDENT LOCATION	McDade, Texas

ENGINE INFORMATION

ENGINE POSITION	Right
TOTAL TIME	Unable to determine with provided logbook
TIME SOH	Unable to determine with provided logbook
TYPE & TIME SLI	The last annual inspection was performed on 10/01/2014 at a hobbs time of 4600.7. The time since the inspection was unable to be determined.
BUILD DATE	09/21/1973
IN SERVICE DATE	Not Reported

Significant logbook information:

The last annual inspection was performed on 10/01/2014 at a hobbs time of 4600.7; the last maintenance item was an oil change on 11/18/2014 at a hobbs time of 4831.6. Only one logbook was provided to the investigators and the first entry was on 4/11/2014 for an oil change.

Report Summary:

Search Code(s):	15-12-40 33-07-35

Inspection of the engine revealed that the engine displayed oil starvation signatures. It was reported that the oil gage housing extension was not installed in the oil gage housing at the accident site. Inspection of the oil gage housing and housing extension revealed the rubber hose was not properly installed when compared to SIL14-6.

Disposition of engine following exam:

Engine was shipped to Air Salvage of Dallas per the NTSB IIC request.

INSPECTION WITNESSES

NAME	Phillip Grice	**NAME**	Kurt Gibson
ADDRESS	Mobile, AL	**ADDRESS**	Mobile, AL
ORGANIZATION	Continental Motors	**ORGANIZATION**	Continental Motors
PHONE	[redacted]	**PHONE**	[redacted]
NAME	Jason Aguilera	**NAME**	Johnnie Little
ADDRESS	NTSB Central Region	**ADDRESS**	Mobile, AL
ORGANIZATION	NTSB	**ORGANIZATION**	Continental Motors
PHONE	[redacted]	**PHONE**	N/A
NAME	Greg Eastburn	**NAME**	
ADDRESS	Mobile, AL	**ADDRESS**	
ORGANIZATION	Continental Motors	**ORGANIZATION**	
PHONE	N/A	**PHONE**	

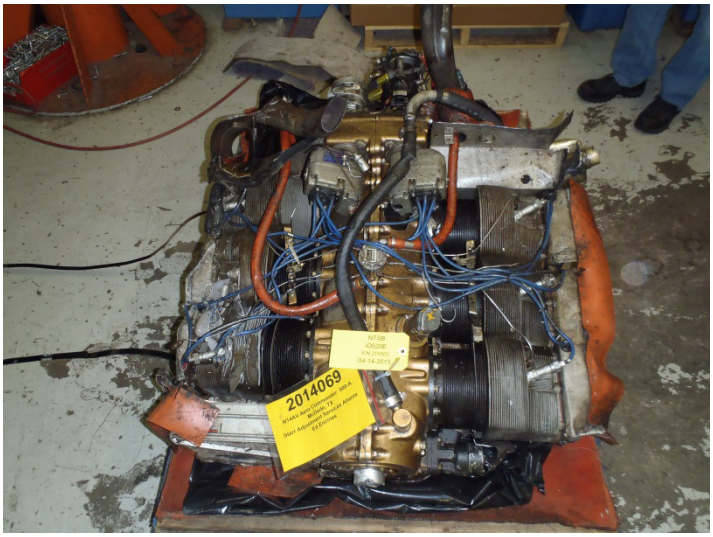
EXTERNAL INSPECTION OF ENGINE

The engine crankcase displayed a large hole near the #2 cylinder bay; the hole was consistent with a connecting rod being released from its respective connecting rod journal. The engine displayed impact damage signatures; the propeller flange had broken free from the crankshaft, the cylinders had varying degrees of impact damage, the oil sump was crushed, and the oil pressure relief valve had broken free from the oil pump housing.

Both of the magnetos remained attached to their respective installation points and sustained minor damage consistent with impact damage. The ignition harness displayed impact damage signatures and was torn and partially severed in several locations. All of the spark plugs remained installed in their respective cylinders; the #3 top spark plug sustained a significant amount of damage and was broken approximately in half, the damage was consistent with impact damage.

The fuel pump remained attached to its respective installation point and sustained damage consistent with impact damage; two of the fuel AN elbows had broken free from the fuel pump. The throttle and fuel metering assembly had partially separated from the engine and displayed damage consistent with impact damage. The fuel manifold valve remained attached to the engine and was undamaged. All of the fuel nozzles remained installed in their respective cylinders and displayed varying degrees of impact damage signatures.

The exhaust system sustained damage consistent with impact damage; the right side exhaust system sustained more damage than the left side. The induction system sustained damage consistent with impact damage. The balance tube was partially crushed and the risers had damage. There were no anomalies noted with the exhaust or the intake system.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FLAMMABLE
KEEP FIRE AWAY
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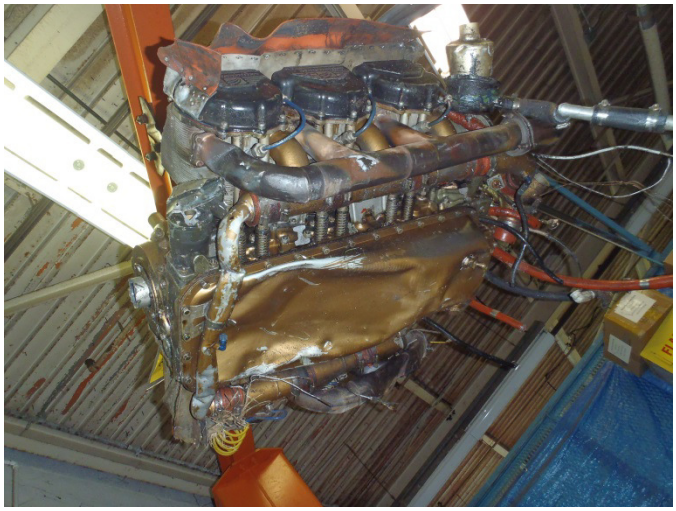
ENGINE TEARDOWN AND COMPONENT EXAMINATION

EXHAUST SYSTEM	
Condition:	The exhaust system displayed damage consistent with impact damage; the damage was more prevalent to the right side exhaust system. There were no anomalies noted with the exhaust system.

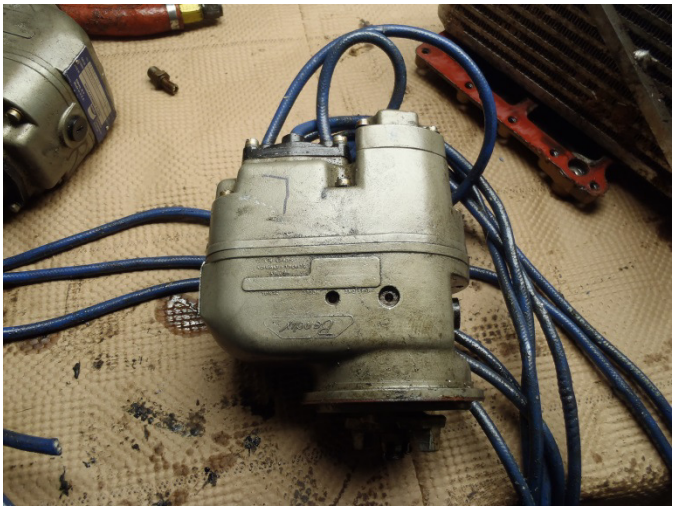
INDUCTION SYSTEM	
Condition:	The induction system displayed damage consistent with impact damage. The balance tube was partially crushed and one of the intake tubes going to the throttle body had broken free from the intake system. There were no signatures of intake leaks noted.

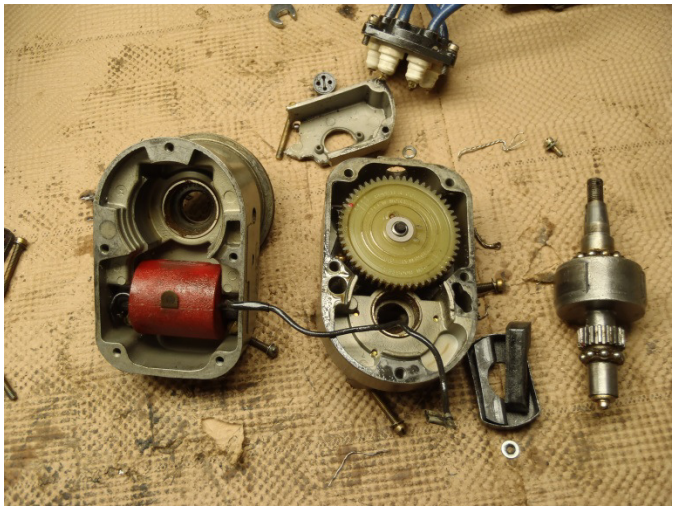


IGNITION SYSTEM

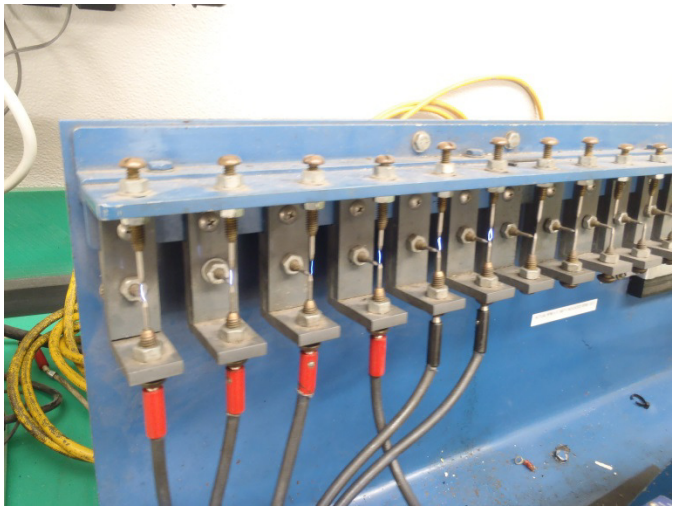
MAGNETO-TO-ENGINE TIMING	Specification: 22° BTDC	L/H: Unable to determine	R/H: Unable to determined

LEFT MAGNETO	Manufacturer: CMI	P/N: 10-600606-1	S/N: 716055
Condition:	The left magneto remained attached to its respective mounting pad and displayed damage consistent with impact and mechanical damage; the top magneto cap was broken. Due to the impact damage the magneto could not be tested on a test bench. The magneto was disassembled and there were no anomalies noted with the internal components.		

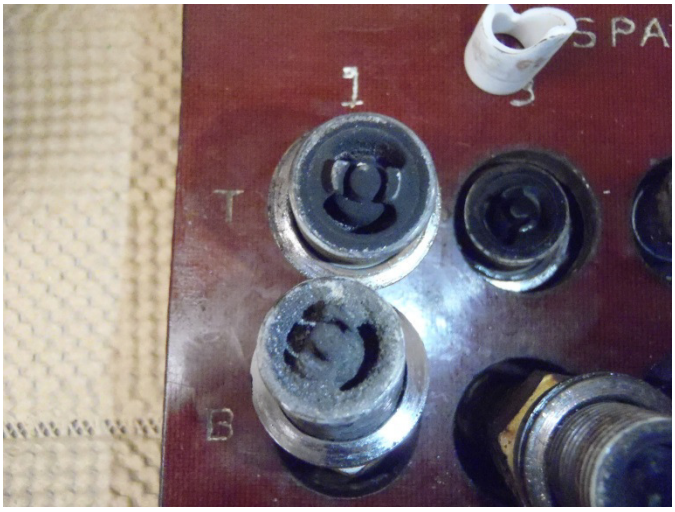




RIGHT MAGNETO	Manufacturer: CMI	P/N: 10-600656-1	S/N: 1023292
Condition:	The right magneto remained attached to its respective mounting pad and displayed minor damage consistent with impact damage. The magneto was mounting on a test bench and it was noted that the magneto was capable of producing a spark across a 7mm gap at all tested RPM settings. There were no anomalies noted with the magneto.		



IGNITION HARNESS	Manufacturer: Aerolite by Skytronics	P/N: Not Marked	S/N: Not Marked
Condition:	The ignition harness displayed damage consistent with impact damage; several of the ignition leads were torn and severed. There were no anomalies noted with the ignition harness.		
SPARK PLUGS	Manufacturer: Champion	P/N: RHB32E	
Condition:	All of the spark plugs remained installed in their respective cylinders and had varying degrees of impact damage. The #3 top spark plug sustained the most damage and was broken approximately in half. The #2 spark plug electrodes displayed normal wear signatures and were grey in color. The remaining spark plugs displayed normal wear signatures and displayed a black sooty appearance consistent with a rich mixture.		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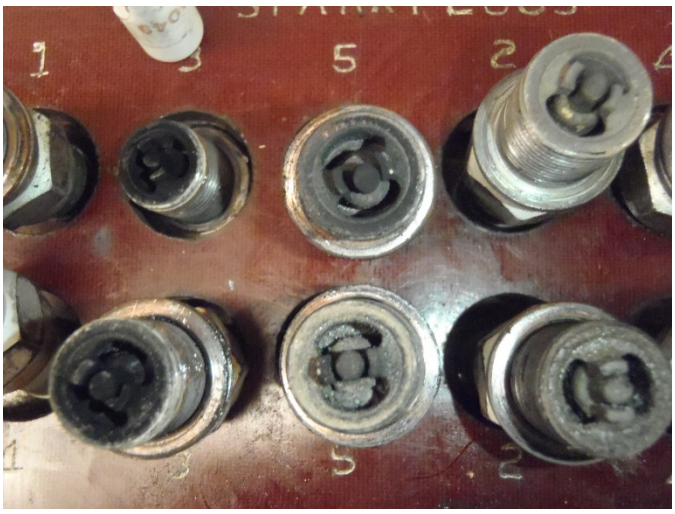
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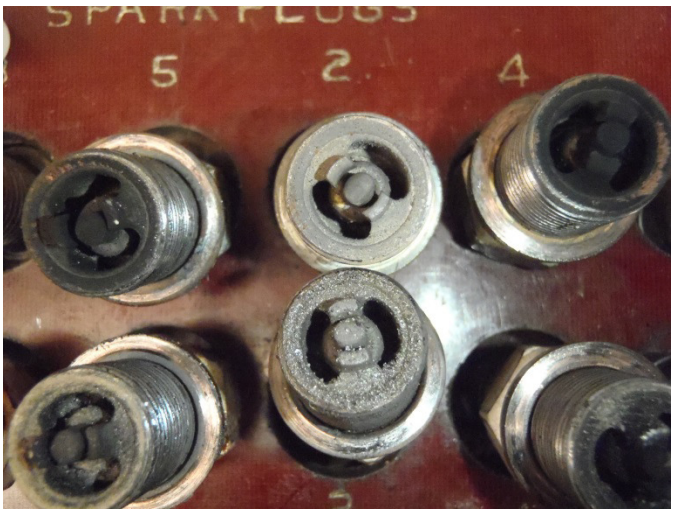
SPARK PLUGS
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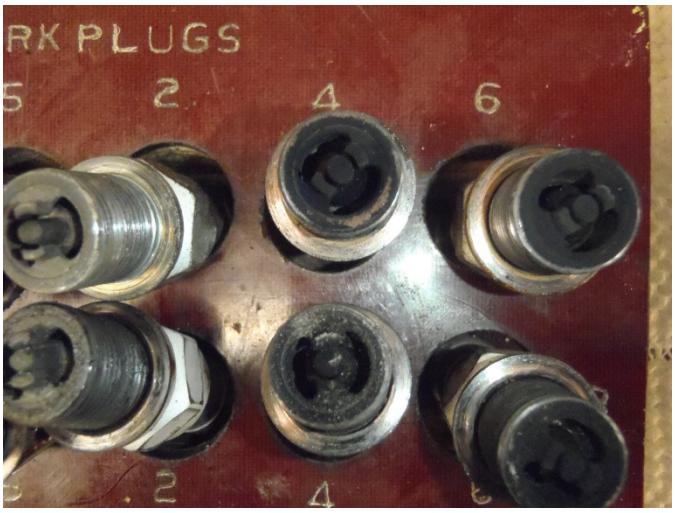
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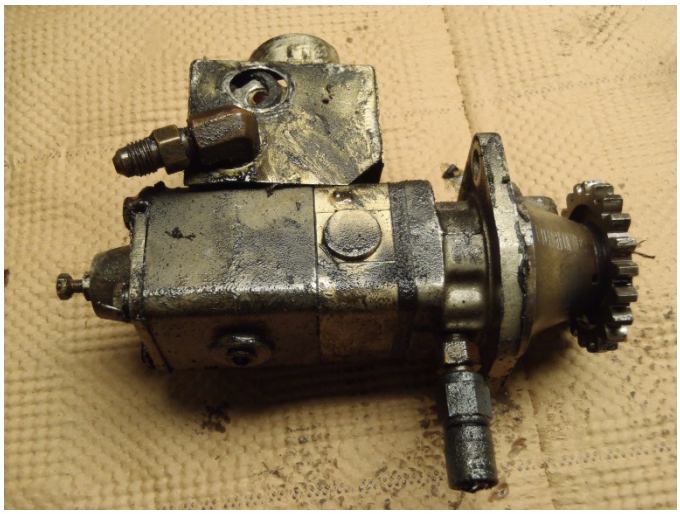
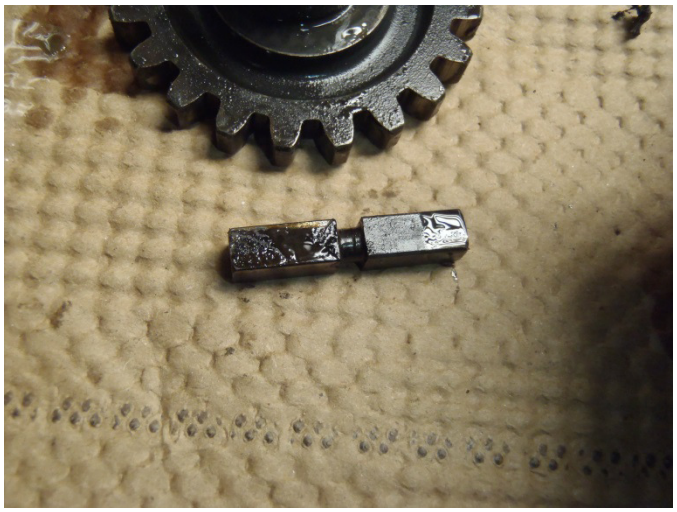
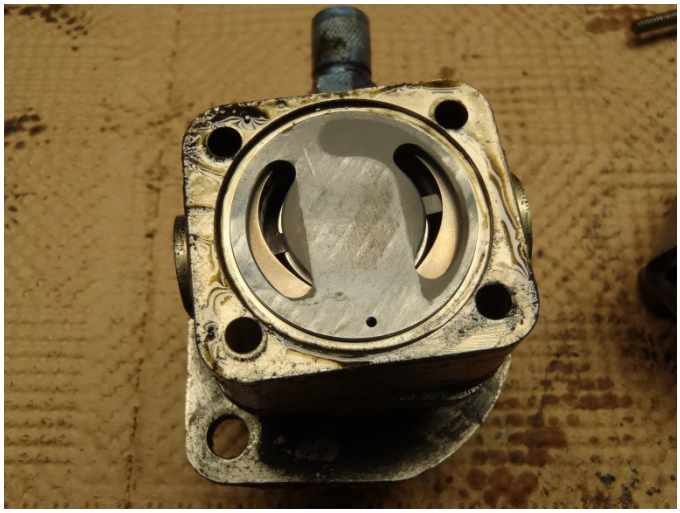
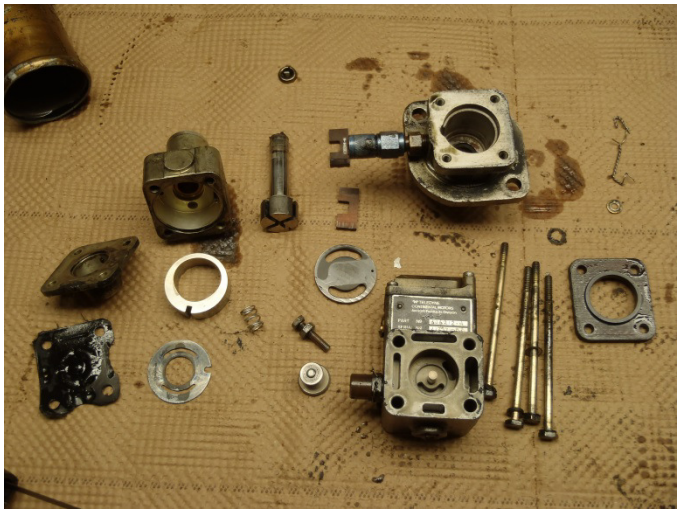
FUEL SYSTEM

FUEL PUMP	Manufacturer: CMI	P/N: 646212-4	S/N: L129710BR
Condition:	The fuel pump remained attached to its respective installation point and displayed damage consistent with impact damage; two of the fuel AN elbows had broken free from the fuel pump. The fuel pump was removed and disassembled; it was noted that the fuel pump drive shaft was intact. The internal components displayed normal operating signatures. There were no anomalies noted with the fuel pump.		

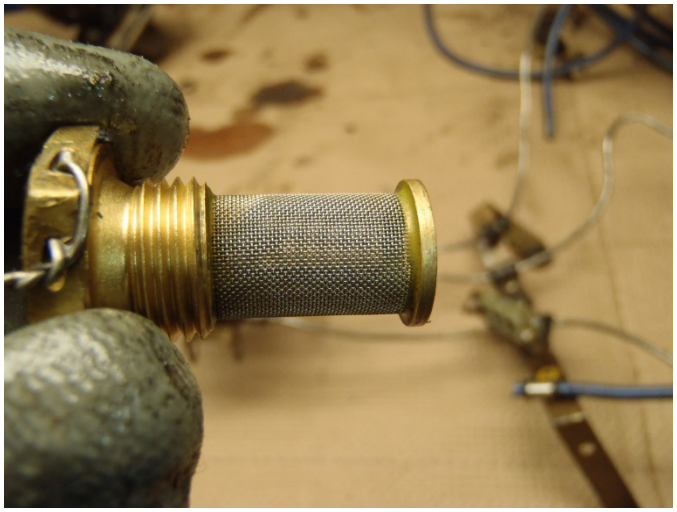






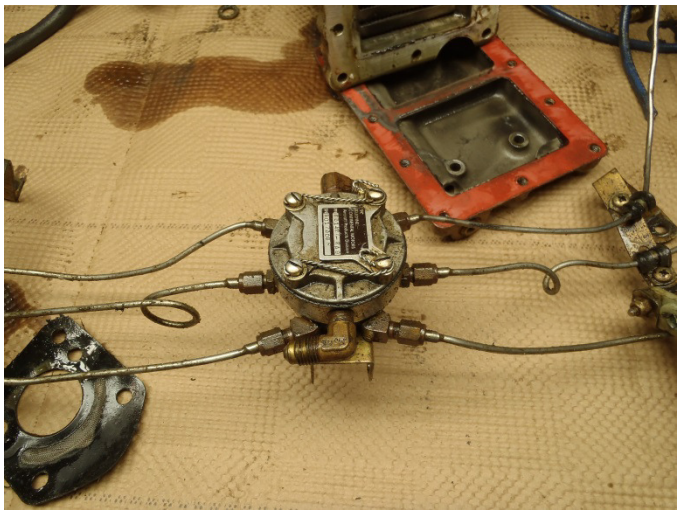


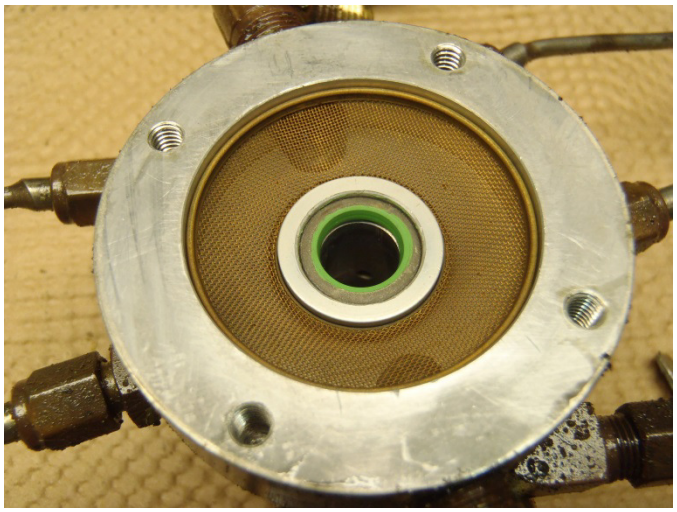
THROTTLE BODY METERING UNIT	Manufacturer: Aircraft Accessories of Oklahoma	P/N: 625219-2	S/N: A00IA270
Condition:	The throttle and fuel metering assembly sustained damage consistent with impact damage and had partially broken free from the engine. The throttle and fuel metering assembly was removed and the fuel metering unit was disassembled. The internal components displayed normal operating signatures and the fuel screen was clear of any contaminates.		

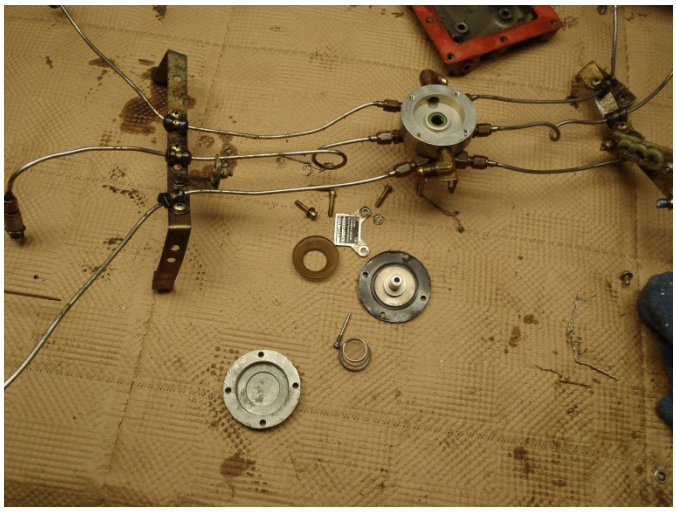


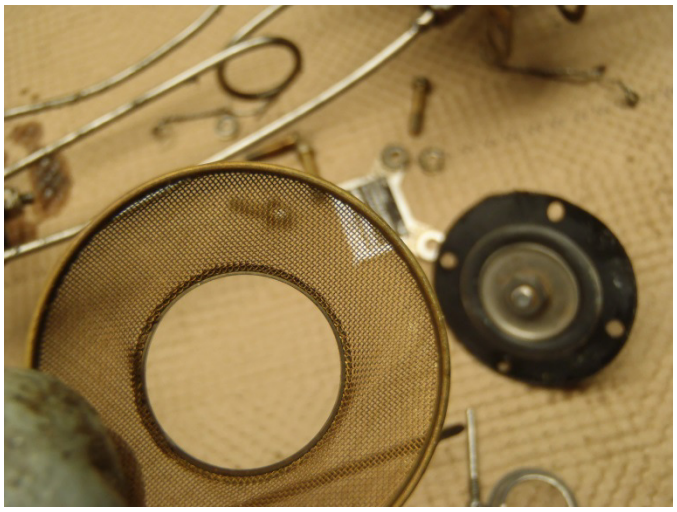
FUEL MANIFOLD VALVE	Manufacturer: CMI	P/N: 631427-2A9	S/N: B017308R

Condition:	The fuel manifold valve remained attached to its respective installation point and was undamaged. The manifold valve was disassembled and the internal components were inspected. There were no anomalies noted with the internal components and the screen was clear of contaminates.









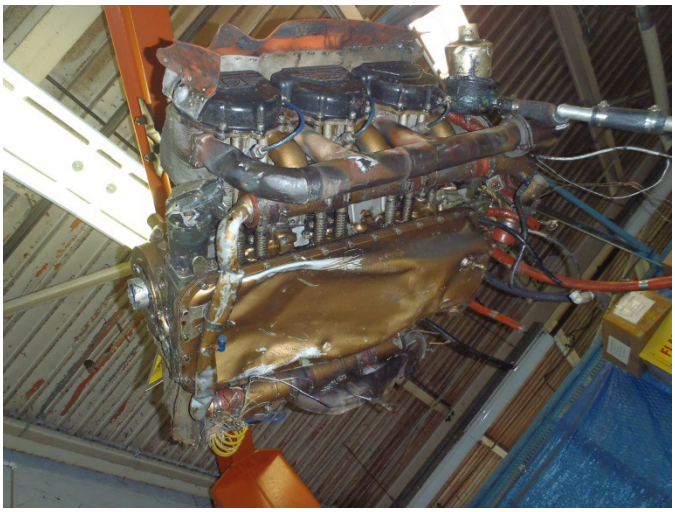
FUEL NOZZLES AND LINES	Manufacturer: CMI

Position	#1	#3	#5	#2	#4	#6
Size	D13AA	D13AA	D13AA	D13AA	D13AA	D13AA

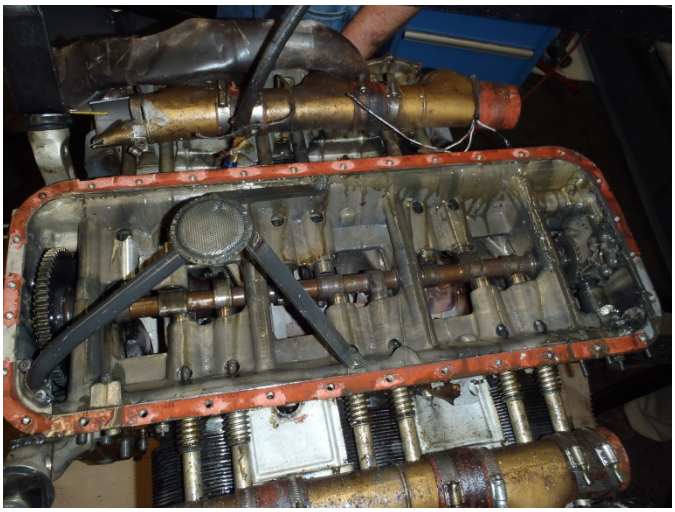
Condition:	The fuel nozzles displayed damage consistent with impact damage; the #3 and the #5 fuel nozzles displayed significant impact damage signatures and were broken approximately in half. The #3 nozzle could not be removed due to the impact damage; the remaining nozzles were removed and check for blockages; there were no blockages noted with any of the removed fuel nozzles.

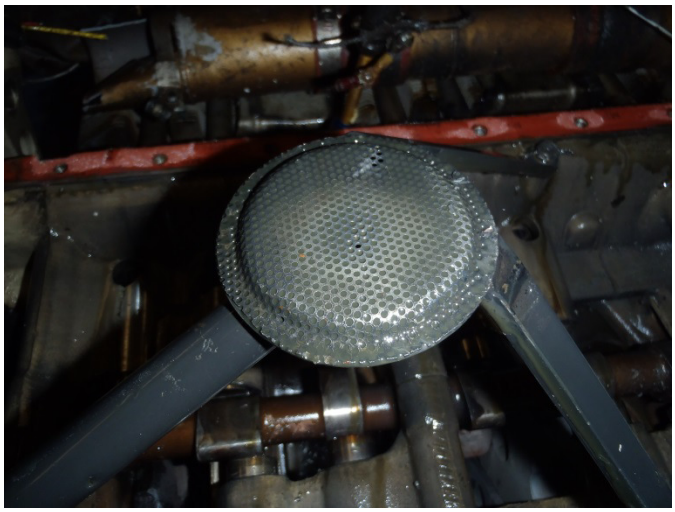
LUBRICATION SYSTEM

OIL SUMP	
Condition:	The oil sump sustained damage consistent with impact damage. The oil sump was removed and it was noted only residual oil remained within the oil sump. The oil sump also contained a significant amount of metallic material consistent with connecting rods, bearings, crankcase material, and other unidentifiable metallic debris.

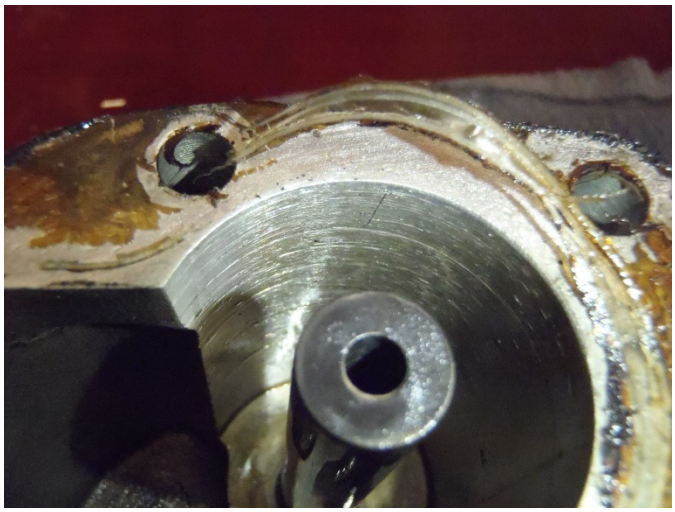


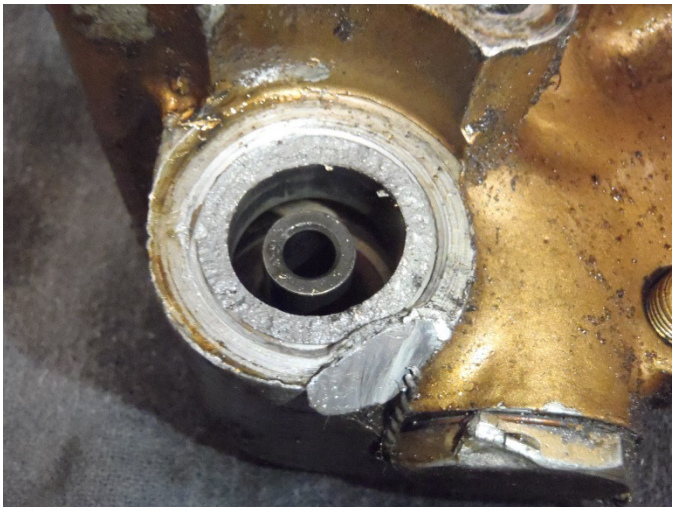
OIL PICK-UP TUBE & SCREEN	
Condition:	The oil pickup tube and screen was undamaged and displayed normal operating signatures. The oil pickup screen contained a small amount of metallic material; however, the screen was not blocked.





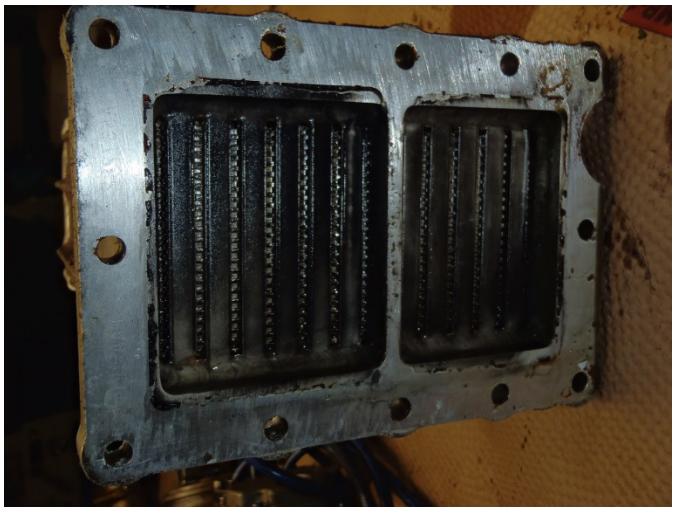
OIL PUMP	
Condition:	The oil pump sustained damage consistent with impact damage; the oil pressure relief valve housing had broken free from the rest of the oil pump. The oil pump was disassembled and visually inspected. The oil pump housing displayed scoring consistent with hard particle passage and there was metallic material present on the oil pump gears. The oil pressure relief valve could not be removed due to the impact damage.



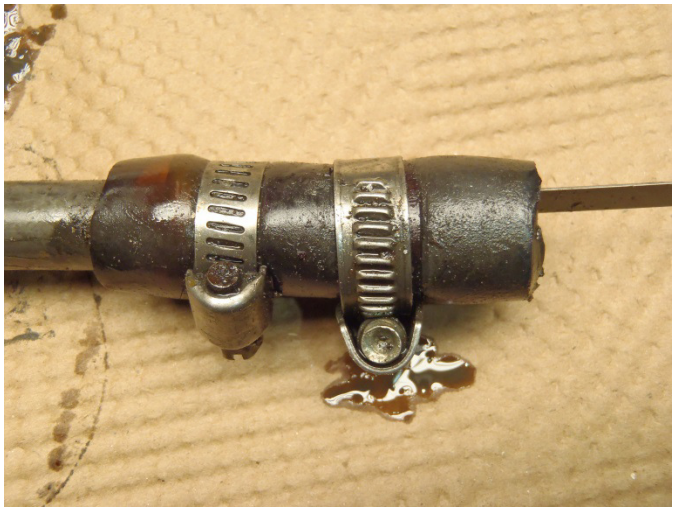


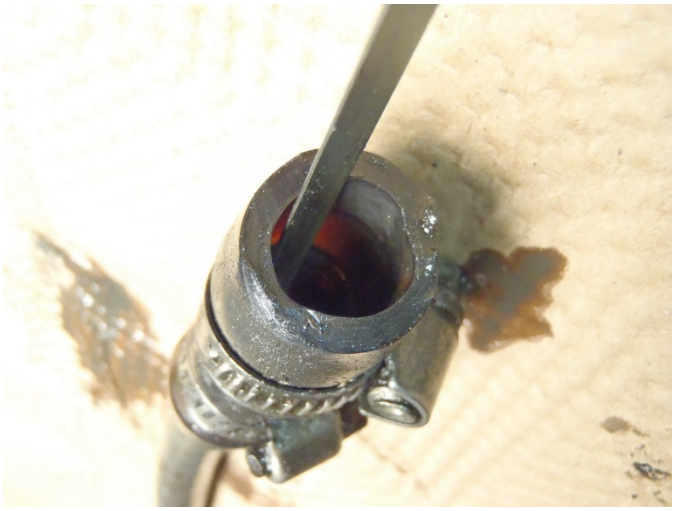
OIL SCREEN		
Condition:	The oil screen remained secure in its respective installation point and was undamaged. The screen was removed and it was noted there was a significant amount of metallic material present in the oil screen.	

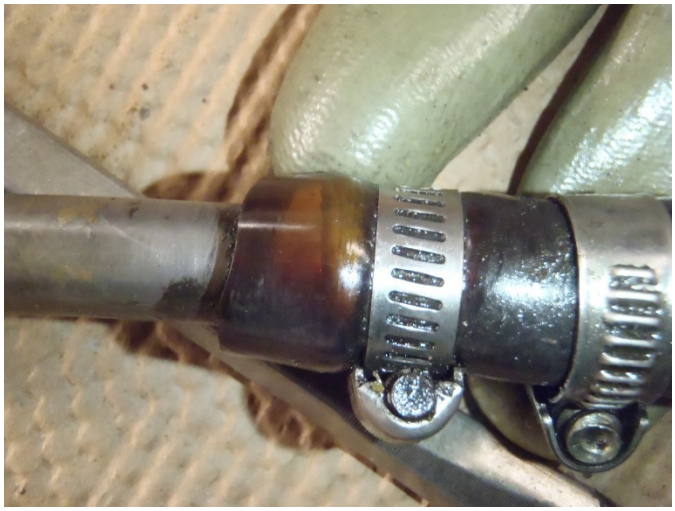
OIL COOLER	Manufacturer: Illegible	P/N: Illegible	S/N: Illegible
Condition:	The oil cooler remained attached to the oil cooler adapters and displayed minor impact damage signatures and normal operating signatures. There were no anomalies noted with the oil cooler		



OIL GAGE	
Condition:	According to the on scene investigator the oil gage housing extension was found detached from its oil gage housing in the engine crankcase. The oil gage housing extension was inspected and there were no signs of impact damage. The oil gage hose was not positioned in such a way to place the oil gage housing extension joint in the middle of the hose; according to SIL14-6 the hose should be centered over the connection joint. It was also noted that the top hose clamp was placed below the oil gage housing extension bead; the bead on the oil gage housing extension is designed to fit securely against the oil gage housing. The hose material was not as specified in CMI parts manual.

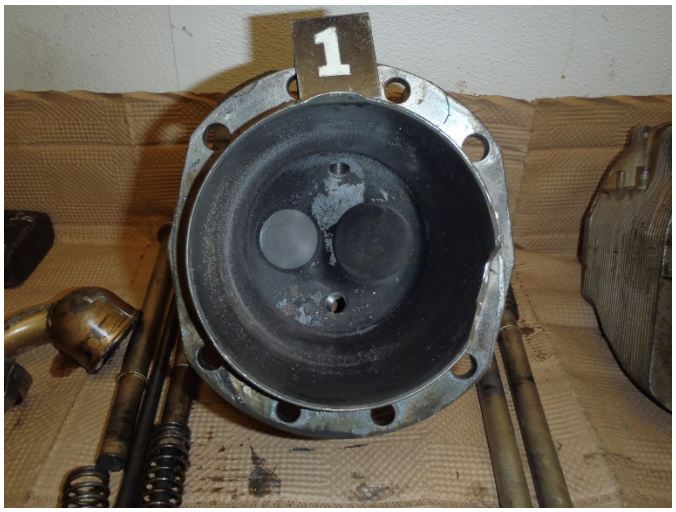




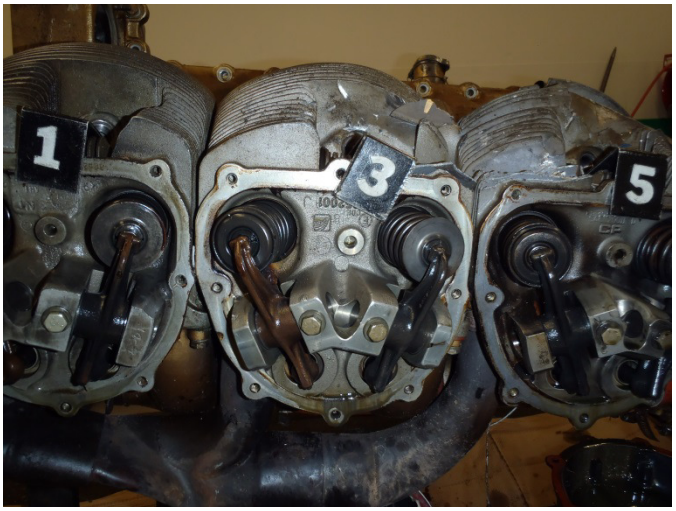


CYLINDERS

CYLINDER #1	P/N: Illegible	S/N: ECC712ST	
Condition:	The cylinder remained attached to its respective cylinder bay and displayed damage consistent with impact damage. The cylinder was removed and it was noted that the valve heads, cylinder bore, and combustion chamber displayed normal operating and combustion signatures. The cylinder skirt displayed damage consistent with mechanical damage. The overhead components displayed normal operating signatures.		

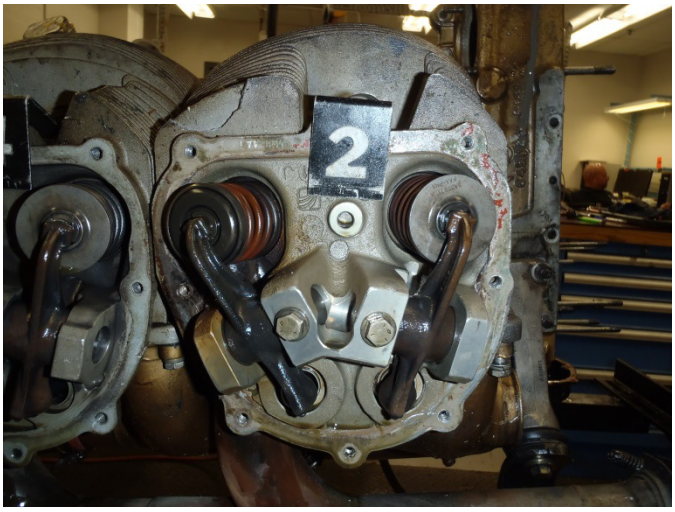


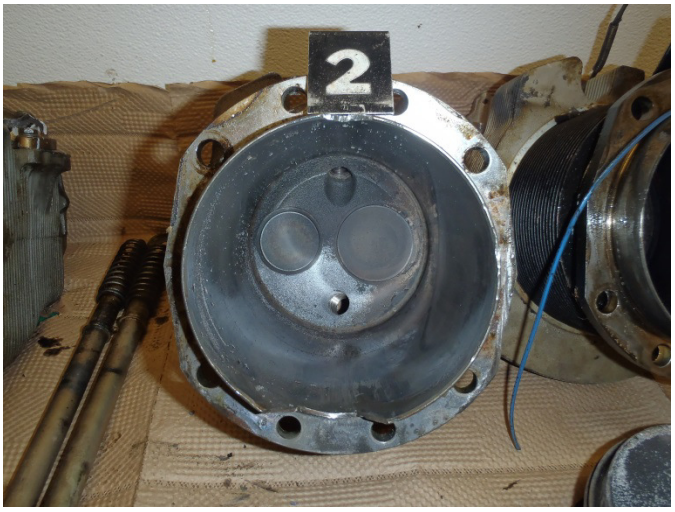
CYLINDER #3	P/N: SA52006-A1	S/N: 526-113-12630	
Condition:	The cylinder remained attached to its respective cylinder bay and displayed damage consistent with impact damage. The cylinder was removed and it was noted that the valve heads, cylinder bore, and combustion chamber displayed normal operating and combustion signatures. The cylinder skirt displayed damage consistent with mechanical damage. The overhead components displayed normal operating signatures.		



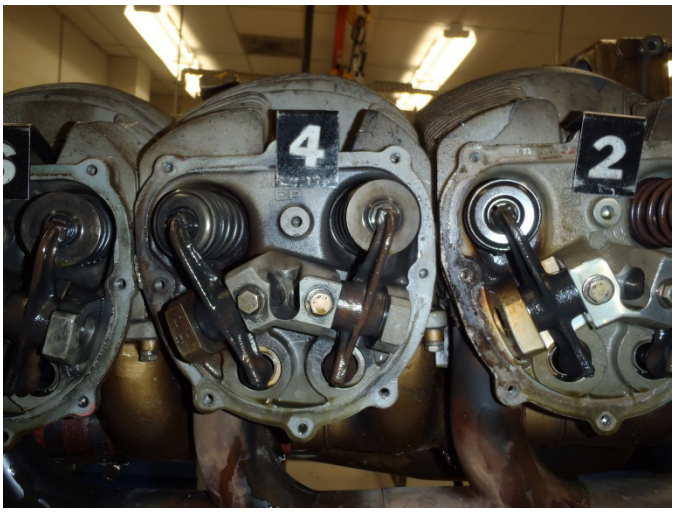
CYLINDER #5	P/N: Illegible	S/N: Illegible	
Condition:	The cylinder remained attached to its respective cylinder bay and displayed damage consistent with impact damage. The cylinder was removed and it was noted that the valve heads, cylinder bore, and combustion chamber displayed some corrosion and normal operating and combustion signatures. The cylinder skirt was undamaged. The overhead components displayed normal operating signatures.		

CYLINDER #2	P/N: SA52006A16	S/N: 528-G11-9300	
Condition:	The cylinder remained attached to its respective cylinder bay and displayed damage consistent with impact damage. The cylinder was removed and it was noted that the valve heads, cylinder bore, and combustion chamber displayed normal operating and combustion signatures. The cylinder skirt displayed damage consistent with mechanical damage. The overhead components displayed normal operating signatures.		





CYLINDER #4	P/N: Illegible	S/N: Illegible	
Condition:	The cylinder remained attached to its respective cylinder bay and displayed damage consistent with impact damage. The cylinder was removed and it was noted that the valve heads, cylinder bore, and combustion chamber displayed normal operating and combustion signatures; the cylinder also displayed minor corrosion. The cylinder skirt displayed damage consistent with mechanical damage. The overhead components displayed normal operating signatures.		



CYLINDER #6	P/N: SA52000-A1	S/N: 52-J02-25097	
Condition:	The cylinder remained attached to its respective cylinder bay and displayed damage consistent with impact damage. The cylinder was removed and it was noted that the valve heads, cylinder bore, and combustion chamber displayed normal operating and combustion signatures. The cylinder skirt was undamaged. The overhead components displayed normal operating signatures.		

VALVES AND GUIDES	
Condition:	All of the valves and guides displayed normal operating signatures and normal combustion signatures. There were no anomalies noted with any of the valves.
ROCKER ARMS AND SHAFTS	
Condition:	All of the rocker arms displayed normal operating signatures. There were no anomalies noted with the rocker arms.

#1 PISTON, RINGS AND PIN	Piston P/N: Illegible
Condition:	The piston head displayed normal combustion deposits and had two semicircular indentions consistent with valve strikes. The piston skirt displayed normal operating signatures and the back of the piston displayed damage consistent with mechanical damage. All of the piston rings were intact and free to move in their respective grooves.

#3 PISTON, RINGS AND PIN	Piston P/N: AEC648045/AC
Condition:	The piston head displayed normal combustion deposits. The piston skirt displayed normal operating signatures and the back of the piston displayed damage consistent with mechanical damage. All of the piston rings were intact and free to move in their respective grooves.

#5 PISTON, RINGS AND PIN	Piston P/N: 654850
Condition:	The piston head displayed normal combustion deposits. The piston skirt displayed normal operating signatures and the back of the piston displayed damage consistent with mechanical damage. All of the piston rings were intact and free to move in their respective grooves.

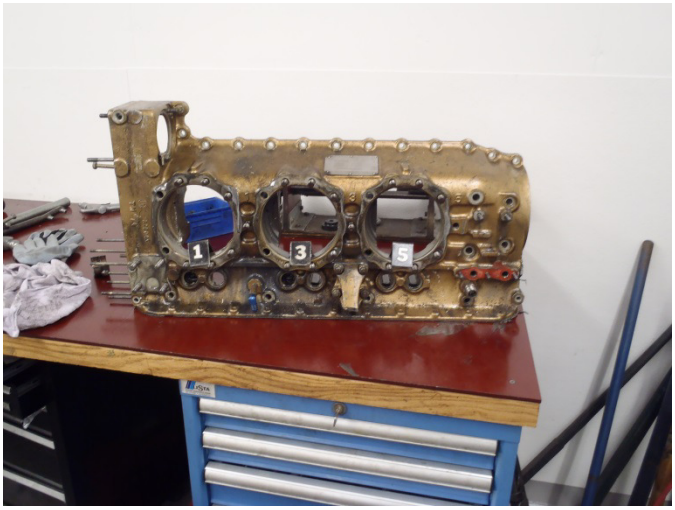
#2 PISTON, RINGS AND PIN	Piston P/N: 2654850
Condition:	The piston head displayed normal combustion deposits and had two semicircular indentions consistent with valve strikes. The piston skirt displayed normal operating signatures and the back of the piston displayed damage consistent with mechanical damage; a portion of the piston had broken free from the rest of the piston. The rear piston ring had broken which was consistent with the mechanical damage to the piston. The remaining piston rings were intact and free in their respective grooves.

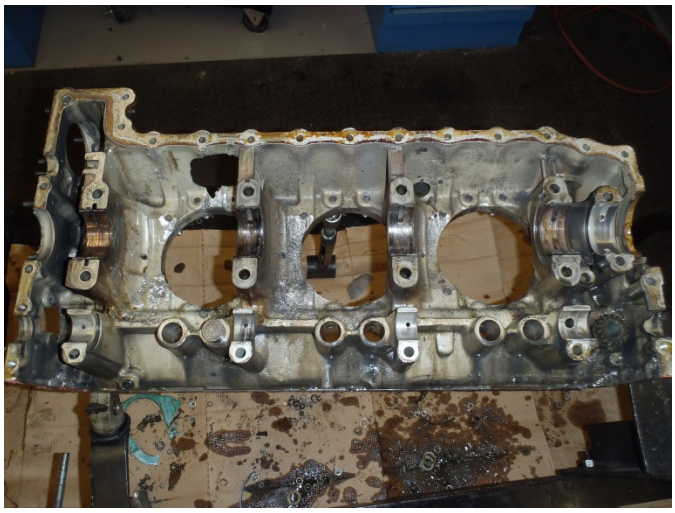
#4 PISTON, RINGS AND PIN	Piston P/N: SA648013
Condition:	The piston head displayed normal combustion deposits. The piston skirt displayed normal operating signatures and the back of the piston displayed damage consistent with mechanical damage; a portion of the piston had broken free from the rest of the piston. The rear piston ring had broken which was consistent with the mechanical damage to the piston. The remaining piston rings were intact and free in their respective grooves.

#6 PISTON, RINGS AND PIN	Piston P/N: SA648013
Condition:	The piston head displayed normal combustion deposits. The piston skirt displayed normal operating signatures and the back of the piston displayed damage consistent with mechanical damage. All of the piston rings were intact and free to move in their respective grooves.

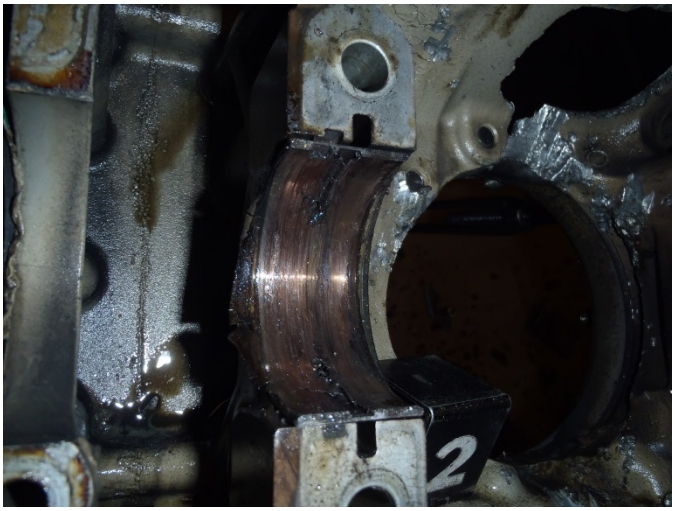
CRANKCASE ASSEMBLY

CRANKCASE	Casting Number:	1-3-5: 649043	2-4-6: 649042	S/N: A9 96 05 R
Condition:	The crankcase displayed damage in a form of a large hole at the #2 cylinder bay; the damage was consistent with mechanical damage from a released connecting rod. The internal portion of the crankcase displayed mechanical damage to the #1, #2, and the #4 cylinder bays. There were no signs of bearing movement or blockages of the oil galleys.			

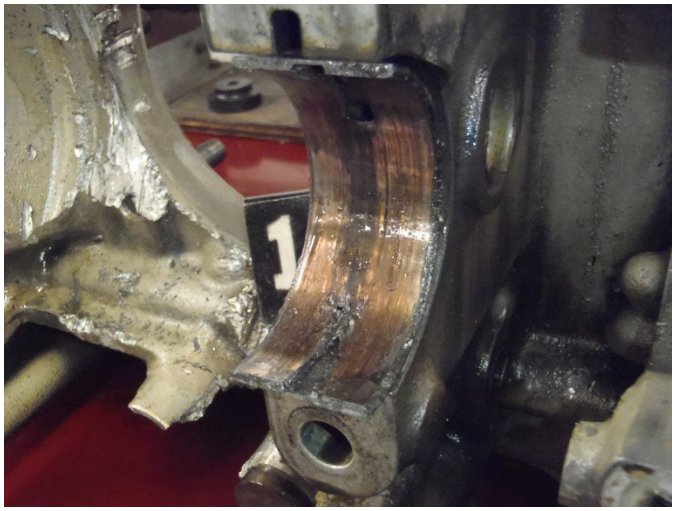




#1 MAIN BEARINGS	P/N: SA642720	Date Code: 2-07
Condition:	The bearing was in place in the bearing saddle and displayed damage consistent with lubrication distress. The bearing displayed scoring and thermal smearing of the surface babbit. The bearing displayed damage from being extruded.	

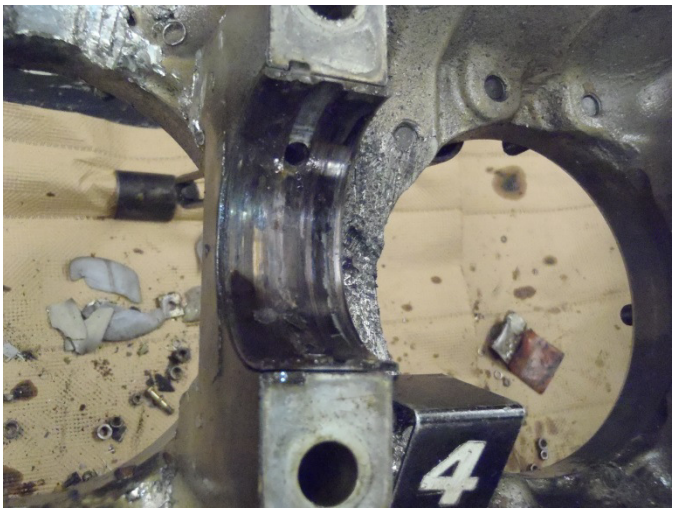


Left

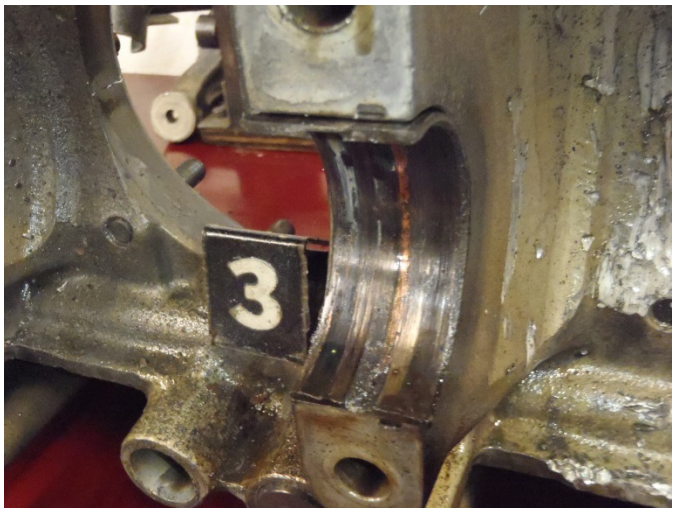


Right

#2 MAIN BEARINGS	P/N: SA642720	Date Code: 2-07
Condition:	The bearing was in place in the bearing saddle and displayed damage consistent with lubrication distress. The bearing displayed scoring and thermal smearing of the surface babbit.	



Left



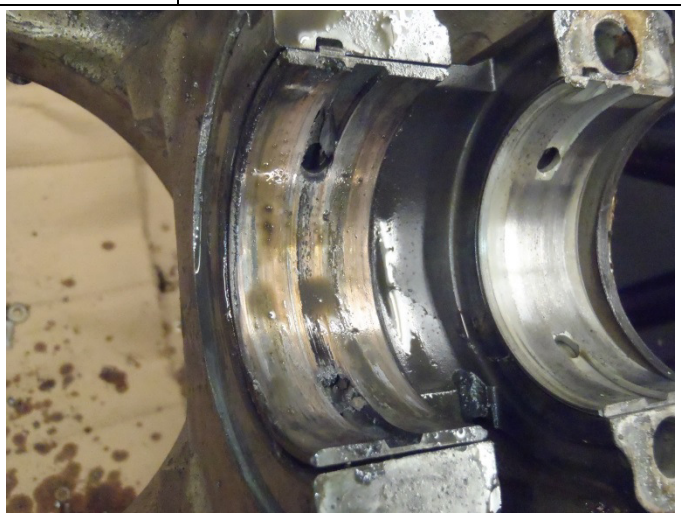
Right

#3 MAIN BEARINGS	P/N: SA642720	Date Code: 2-07
Condition:	The bearing was in place in the bearing saddle and displayed damage consistent with lubrication distress. The bearing displayed scoring and thermal smearing of the surface babbit.	

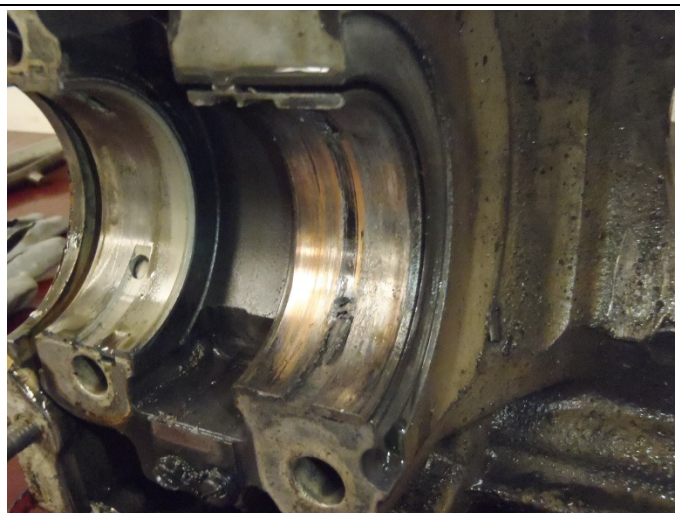
Left

Right

#4 MAIN BEARINGS	P/N: SA642720	Date Code: 2-07
Condition:	The bearing was in place in the bearing saddle and displayed damage consistent with lubrication distress. The bearing displayed scoring and thermal smearing of the surface babbit.	

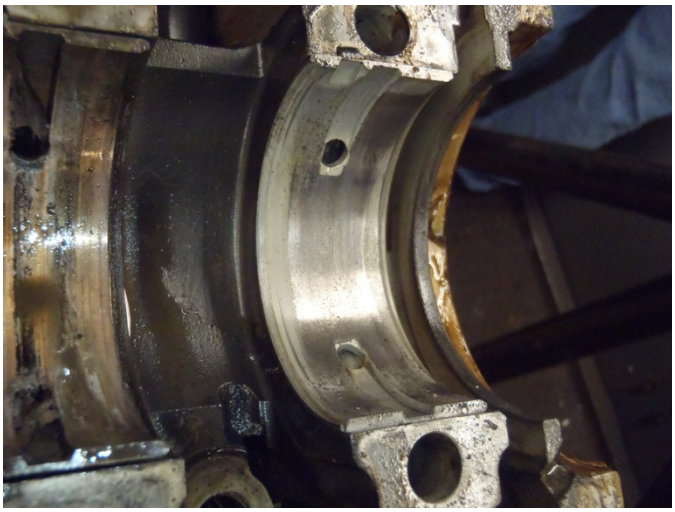


Left

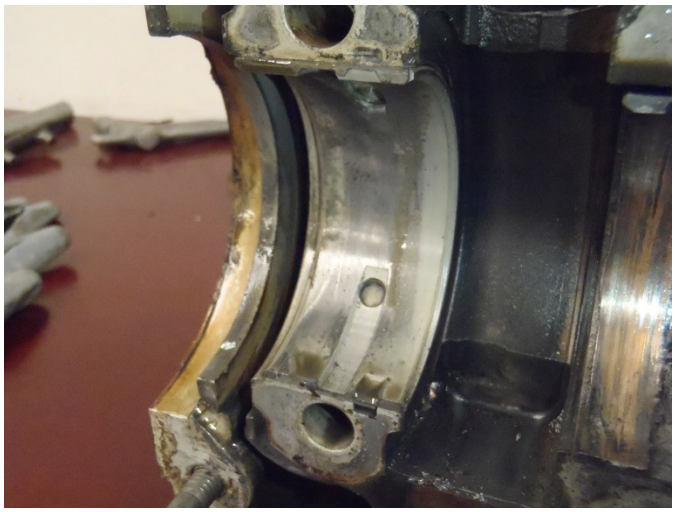


Right

#5 MAIN BEARINGS	P/N: SA642720	Date Code: 2-07
Condition:	The bearing was in place in the bearing saddle and displayed normal operating signatures. There were no signs of bearing movement or distress with the bearing.	



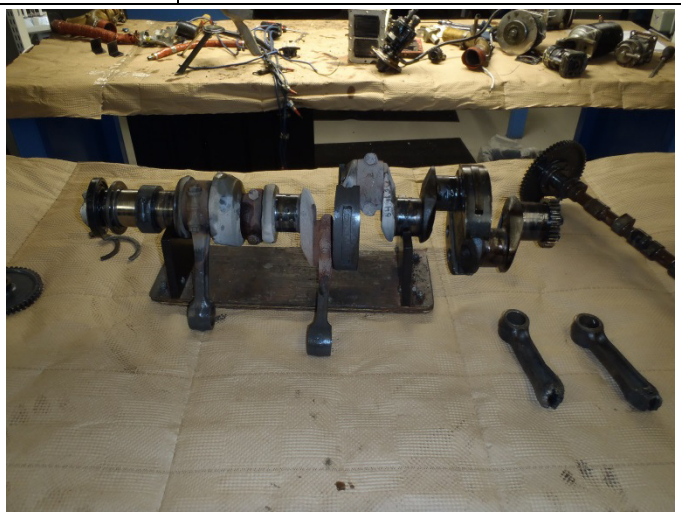
2-4-6

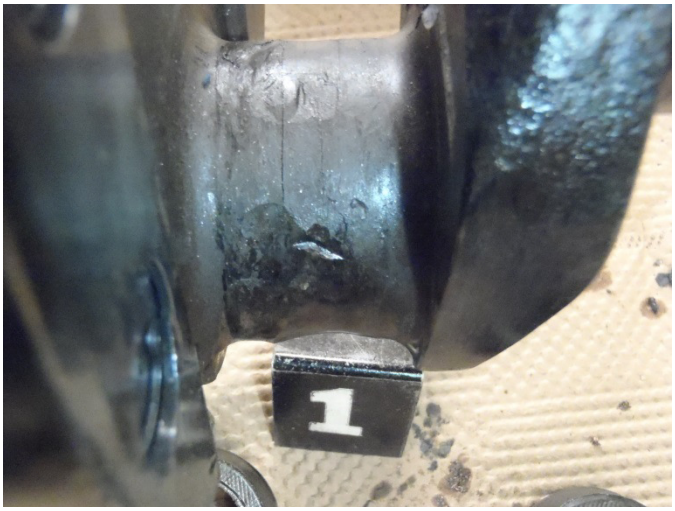


1-3-5

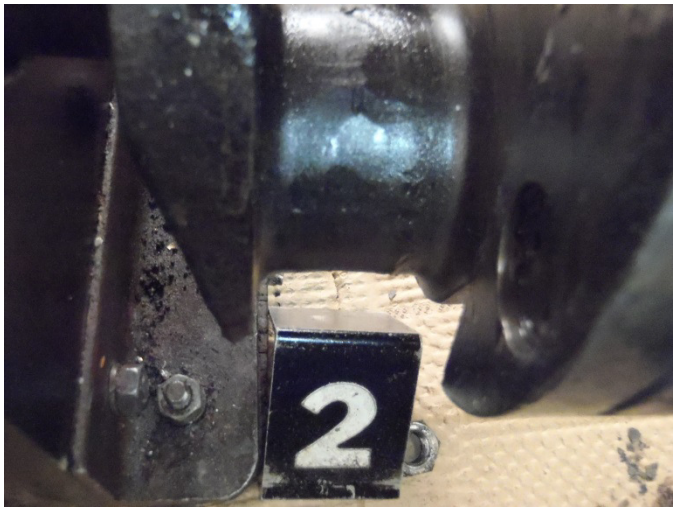
CRANKSHAFT ASSEMBLY

CRANKSHAFT	Forging Number: 649130	S/N: Propeller Flange Not returned	Heat code: HAO
Condition:	The propeller flange had broken free from the rest of the crankshaft and was not returned with the rest of the engine. The rest of the crankshaft was intact and the crankshaft gear was intact, secure, and the bolts were safety wired. The crankshaft main bearing displayed varying amount of lubrication distress; all of the connecting rod journal displayed lubrication distress signatures. The #1 and the #2 connecting rod bearings displayed the most thermal damage and also displayed some mechanical damage. The #1 and the #2 connecting rod journal oil galleys could not be inspected due to displaced journal material. The remaining oil galleys were intact and clear of any obstruction.		



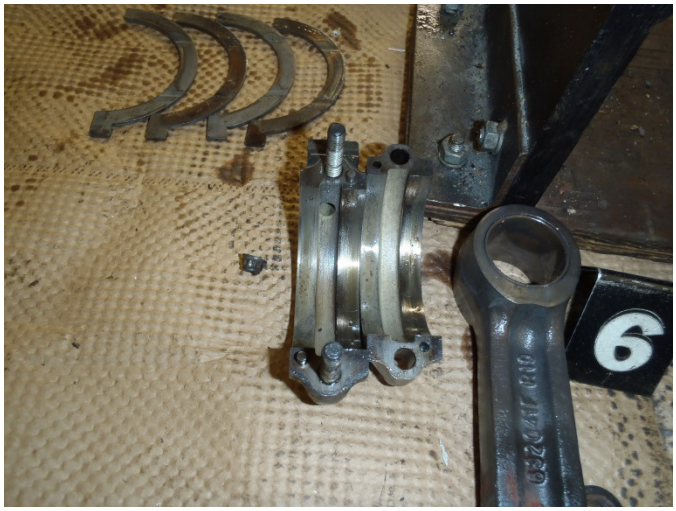


#1 Connecting Rod Journal



#2 Connecting Rod Journal

TRANSFER COLLAR	
Condition:	The transfer collar remained intact and was undamaged. There were no anomalies noted with the transfer collar.



COUNTER WEIGHTS	
Condition:	The counterweights remained attached to their respective hangers, were undamaged, and capable of normal movement. There were no anomalies noted with the counterweights.
INTERNAL TIMING	
Condition:	The internal timing was verified by counting the teeth between the crankshaft gear and the camshaft gear timing marks.

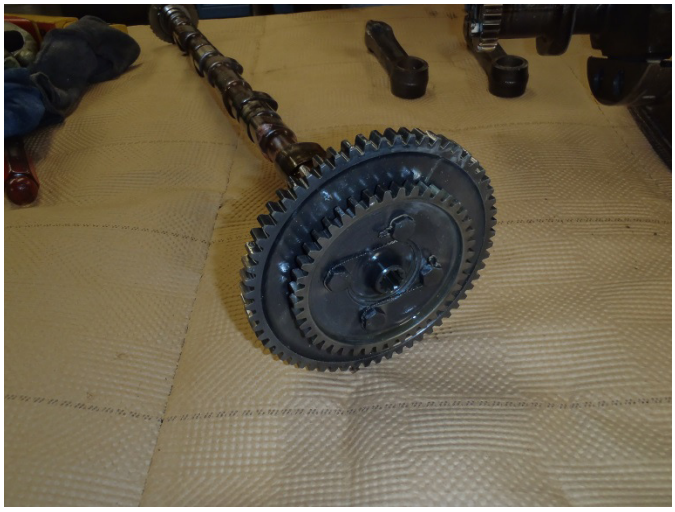
#1 CONNECTING ROD	P/N: Illegible	Forging: 632041
Condition:	The connecting rod had released from its respective journal and displayed damage consistent with thermal and mechanical damage. The connecting rod cap and the connecting rod bolts and nuts were located in the oil sump. The connecting rod cap displayed thermal and mechanical damage.	
#1 CONNECTING ROD BEARING	P/N: Illegible	Date Code: Illegible
Condition:	Fragments of the connecting rod bearing were located in the oil sump. The bearing fragments displayed thermal damage consistent with lubrication distress as well as mechanical damage.	
#2 CONNECTING ROD	P/N: Illegible	Forging: 632041
Condition:	The connecting rod had released from its respective journal and displayed damage consistent with thermal and mechanical damage. The connecting rod cap and the connecting rod bolts and nuts were located in the oil sump. The connecting rod cap displayed thermal and mechanical damage.	
#2 CONNECTING ROD BEARING	P/N: Illegible	Date Code: Illegible
Condition:	Fragments of the connecting rod bearing were located in the oil sump. The bearing fragments displayed thermal damage consistent with lubrication distress as well as mechanical damage.	

#3 CONNECTING ROD	P/N: Illegible	Forging: 632041
Condition:	The connecting rod assembly remained attached to its respective journal and displayed thermal discoloration consistent with lubrication distress of the rod bearing.	
#3 CONNECTING ROD BEARING	P/N: SA630826	Date Code: 11-06
Condition:	The connecting rod bearing displayed lubrication distress and thermal damage of the surface babbit; the copper layer of the bearing was partially exposed. The bearing had partially extruded from the bearing saddle.	
#4 CONNECTING ROD	P/N: Illegible	Forging: 632041
Condition:	The connecting rod assembly remained attached to its respective journal and displayed thermal discoloration consistent with lubrication distress of the rod bearing.	
#4 CONNECTING ROD BEARING	P/N: SA630826	Date Code: 11-06
Condition:	The connecting rod bearing displayed lubrication distress and thermal damage of the surface babbit; the copper layer of the bearing was partially exposed.	

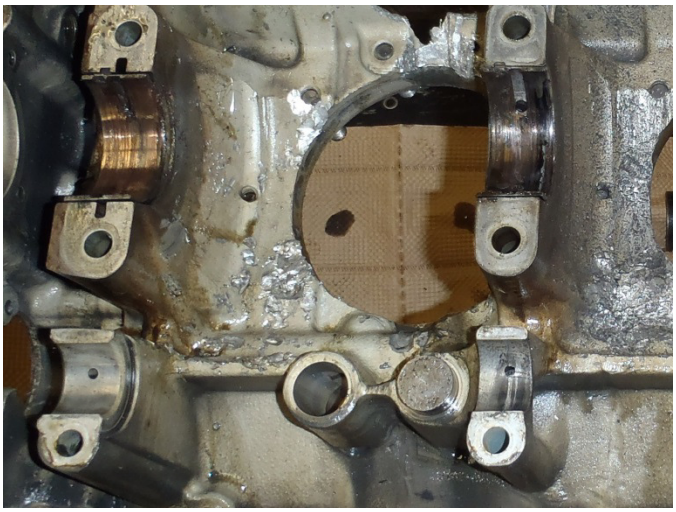
#5 CONNECTING ROD	P/N: Illegible	Forging: 632041
Condition:	The connecting rod assembly remained attached to its respective journal and displayed thermal discoloration consistent with lubrication distress of the rod bearing.	
#5 CONNECTING ROD BEARING	P/N: SA630826	Date Code: 11-06
Condition:	The connecting rod bearing displayed lubrication distress and thermal damage of the surface babbit; the copper layer of the bearing was partially exposed. The bearing had partially extruded from the bearing saddle.	
#6 CONNECTING ROD	P/N: Illegible	Forging: 632041
Condition:	The connecting rod assembly remained attached to its respective journal and displayed thermal discoloration consistent with lubrication distress of the rod bearing.	
#6 CONNECTING ROD BEARING	P/N: SA630826	Date Code: 11-06
Condition:	The connecting rod bearing displayed lubrication distress and thermal damage of the surface babbit; the copper layer of the bearing was partially exposed. The bearing had partially extruded from the bearing saddle.	

CAMSHAFT

CAMSHAFT	P/N: 655384	S/N: N/A
Condition:	The camshaft remained intact and displayed normal operating signatures. The camshaft gear cluster remained secure and the bolts were safety wired. There were no anomalies noted with the camshaft.	



LIFTERS	#1	#3	#5	#2	#4	#6
INTAKE	653888	653888	653888	653888	653888	653888
EXHAUST	SA642277	SA642277	SA642277	SA642277	SA642277	SA642277
Condition:	The #2 and the #6 lifters displayed spalling of the lifter faces. The remaining lifters displayed normal operating signatures. There were no anomalies noted that would have prevented normal operation.					



#2 exhaust lifter displaying spalling

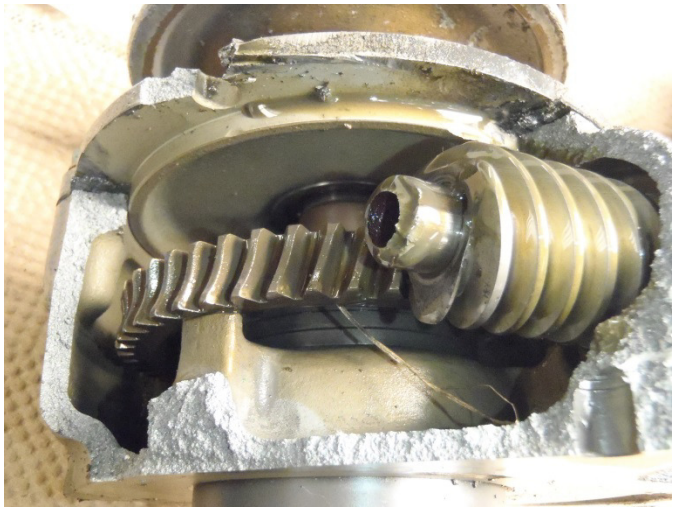
#6 lifters displaying spalling

ACCESSORY GEARS	
Condition:	The accessory gears displayed normal operating signatures. There were no anomalies noted with the accessory gears.

ACCESSORIES

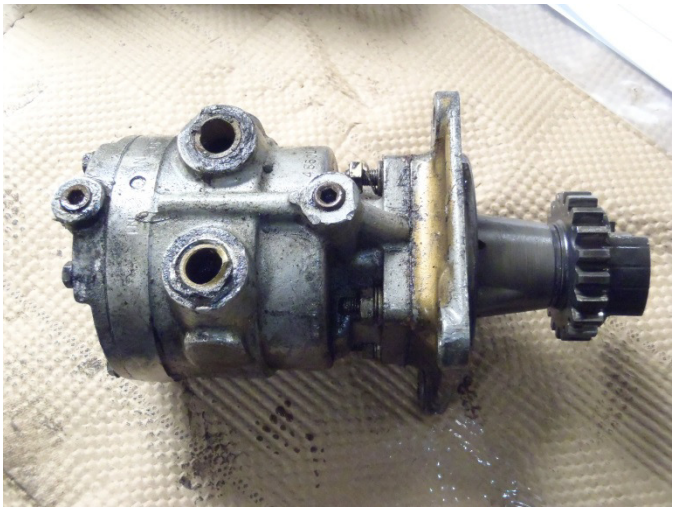
STARTER	Manufacturer: Dataplate Missing	P/N: Dataplate Missing	S/N: Dataplate Missing
Condition:	The starter remained attached to the starter adapter mounting pad; however, the mounting pad had broken free from the rest of the starter adapter. There were no anomalies noted with the starter.		

STARTER ADAPTER	P/N: Illegible
Condition:	The starter adapter remained attached to the engine and sustained a significant amount of damage consistent with impact damage. The starter adapter housing was broken and portions of the internal components were exposed. There were no anomalies noted with the starter adapter.

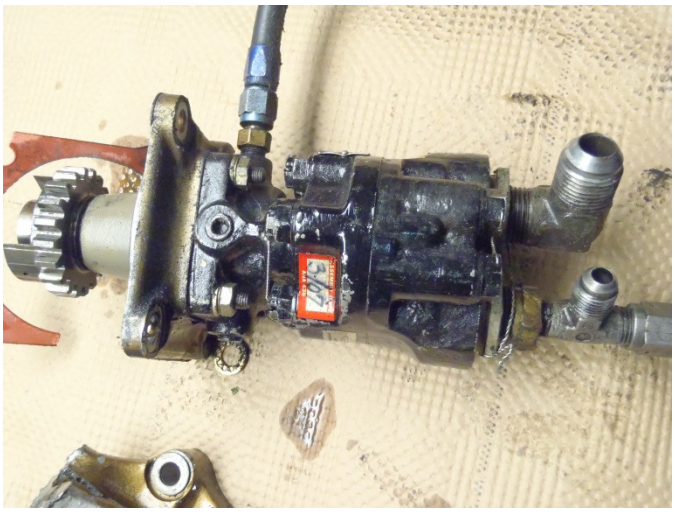


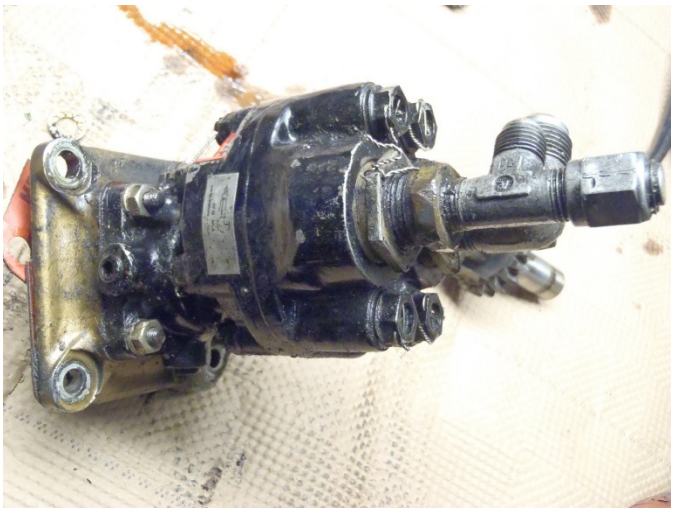
ALT/GEN #1	Manufacturer: Hartzell	P/N: ALU-8521R	S/N: H-N060094
Condition:	The alternator remained attached to its respective installation point and displayed minor damage consistent with impact damage. There were no anomalies noted with the alternator.		

VACUUM PUMP	Manufacturer: Garwin	P/N: Illegible	S/N: Illegible
Condition:	The vacuum pump remained attached to its mounting pad and sustained damage consistent with impact damage. There were no anomalies noted with the vacuum pump.		



HYDRAULIC PUMP	Manufacturer: Not Recorded	P/N: Not Recorded	S/N: Not Recorded
Condition:	The hydraulic pump remained attached to its respective mounting pad and displayed minor impact damage signatures. There were no anomalies noted with the hydraulic pump.		





PROPELLER GOVERNOR	Manufacturer: Woodward	P/N: 210467	S/N: 987879 J
Condition:	The propeller governor remained attached to its respective mounting pad and displayed damage consistent with impact damage; a portion of the propeller governor control had broken free from the rest of the governor. There were no anomalies noted with the governor. The governor gasket screen had a small amount of metallic material present; however, the screen was not blocked.