

ERA22FA086

POWERPLANTS

Group Chair's Factual Report - Attachment # 5

Woodward Propeller Governor, Serial Number 746090, Investigation Report and Test
Run Sheet

June 27, 2023

CUSTOMER HONEYWELL ENGINES & SYSTEMS		INVESTIGATION NO 1181231	
CUSTOMER ORDER Crash Investigation		WOODWARD SALES ORDER 3821489	WOODWARD WORK ORDER C106545
CUSTOMER REJECTION DOCUMENT (CAR,QN,RFA,DMR,ETC.) N/A		WARRANTY DISPOSITION N/A	PRODUCT STATUS N/A
PROGRAM/ENGINE TYPE GARRETT SMALL PROP GOVERNOR		ITEM RECEIVED 8210-260	ENGINE MFR MODEL RECEIVED N/A
PROGRAM CODE 83344 SML	SERIAL NUMBER 1746090	ITEM SHIPPED 8210-260	ENGINE MFR MODEL SHIPPED 893615-13
PARENT ITEM NUMBER 8210-260	PARENT ITEM SERIAL NUMBER 1746090	FIRST SHIPPED 04-NOV-1980	LAST SHIPPED 04-NOV-1980
CUSTOMER SERIAL NUMBER N/A	APPLICATION N/A	VESSEL TYPE & VESSEL NUMBER N/A	SITE & LOCATION GRID ID N/A
TIME/CYCLES SINCE NEW, OVERHAUL, OR REPAIR N/A			
DATE REPORT OPENED 01-SEP-2022		DATE PART REMOVED N/A	DATE RECEIVED 23-AUG-2022

TEAM MEMBERS (D1)

Product Engineer: NATHAN BOGDONAS
 Customer QA Engineer: Jean Taylor
 Tech Advisor/Reviewer: David S. Kuchinski
 Customer Account Manager: Charles J. Johnson
 Customer Service Rep: SHANNON L. COTE
 Compliance: Robert A. Feggestad
 Product Integrity Coordinator: James D. Rosplock

REASON FOR INVESTIGATION (D2)

Reported Issue: Event Description: On December 10, 2021, about 2330 eastern standard time, a Swearingen SA-226AT, N54GP, was destroyed when it was involved in an accident near Bedford, New Hampshire. The commercial pilot was fatally injured. The airplane was operated as a Title 14 Code of Federal Regulations Part 135 on demand cargo flight. According to preliminary information from the Federal Aviation Administration, the airplane was on the instrument landing system approach to runway 6 at Manchester Boston Regional Airport (MHT), Manchester, New Hampshire. During the approach, the pilot reported an engine failure at 2330:42 but did not specify which engine. Radio and radar contact were lost at 2330:51, when the airplane was about 1/4 mile from the runway. The wreckage was located on a river sand jetty, oriented north, and a post-crash fire consumed the cockpit, cabin, and both wings. No debris path was observed. A crater about 6 ft long, 3 ft wide, and 2 ft deep was observed at the beginning of the sand jetty. The left aileron was recovered in the water near the crater. The empennage was located just beyond the crater. The empennage remained intact, with the elevator and rudder attached and undamaged except for the right elevator tip. The right wingtip was located near the empennage and an outboard left-wing section was located 60 ft left of the main wreckage. Three landing gear were located near the main wreckage and the radome was located at the end of the sand jetty, in water. Elevator control continuity was confirmed from the elevator to the cockpit area. Rudder control continuity was confirmed from the rudder to the cabin area. No aileron cables were identified. The left engine was located in the main wreckage. The left propeller had separated and was partially embedded in mud to the left of the left engine. All three blades remained attached to the hub and did not exhibit rotational damage. The right engine was located forward and left of the main wreckage. The right propeller remained attached to the right engine and all three propeller blade roots remained attached to the hub and were charred. The right propeller blades appeared to be at or near the feathered position.

INVESTIGATION SUMMARY (D4)

Confirmation Text: DID NOT CONFIRM REASON FOR INVESTIGATION/RETURN
 Discrepant Item Number: NA
 Discrepancy: No Discrepancy Found
 Finding: The unit was received and an as received visual inspection was performed on the unit. Immediately present during the inspection was the charred appearance of the unit. The appearance was consistent with a unit involved in a fire see Figures 1 and 2. The magnetic pick-up coil's wires were not present see Figure 3. When the drive shaft was rotated it had a bit of binding but was capable of rotating. The baseplate packing had evidence of heat damage and had protruded into the inlet and drain ports, however, the packing materials were removed from the ports prior to testing to prevent contaminating the test stand. Lastly, the lockwire was foreign indicating the original had been removed after leaving the Woodward Facility. Even with the findings during the visual inspection it was determined that an as received test could be completed on the unit.



Figure 1 Prop Governor



Figure 2 View of Governor Base



Figure 3 Missing Magnetic Coil Wires

The unit was sent for an as received test. During testing the unit was started up slowly to check for any audible signs of internal damage to the unit. There were no signs of apparent damage to any of the highly rotated components on startup. However, there was a significant amount of leakage and reduced pressure on startup. There was significant external leakage from the unit at the baseplate see Figure 4. The unit was removed from the test stand and the original baseplate packing was replaced in order to reduce the leakage, as this was believed to be the cause of the low pressure on startup. After replacement of the baseplate packing the unit was once again started up slowly. This time the baseplate leakage improved, but as pressure increased additional leakage was observed from the housing base and cover see Figure 5. The leakage originated from locations with packings, so it was expected that the packings had melted due to the post-crash fire causing the leakage observed at test. Additionally, the unit's pressure was still relatively low, but the other packings could not be replaced without disturbing the as received condition of the unit. Therefore, a full test was completed with the reduced pressure. During testing the following test points were out of limits:

- "Total Leak Check" test high at 5.3 qpm (Limits 0.5 qpm max)
- "Relief Valve Check" was low at 230 psig (Limits 465+/-20 psig)
- "Pump Capacity Check" was low at 6.0 qpm (Limits 9.0 qpm minimum)
- "External Leakage" was observed at baseplate, housing base, and cover (Limits none allowed)
- "Maximum RPM" was high at 3786 rpm (Limits 3574+/-10 rpm)
- "Minimum RPM" was high at 3337 rpm (Limits 2815+/-10 rpm)
- "Arm Travel Max to Min" was low at 29 degrees (Limits 60 +/- 5 degrees)
- "Magnetic Pickup Voltage" was skipped since the magnetic pickup coil wires were not present
- "Pickup Indicated RPM" was skipped since the magnetic pickup coil wires were not present.

The unit's external leakage test point can be explained by the post-crash fire which damaged the unit's gaskets allowing oil to leak externally. Test points like min rpm, max rpm, and arm travel, are typically adjusted in the field and the presence of non-Woodward lockwire indicate an adjustment was performed in the field to these settings.

The total leak check, relief valve check, and pump capacity checks are not typical field adjustments. In order to troubleshoot these three test points the relief valve was swapped with a house relief valve. The swap would not have disturbed anything else on the unit as this is an isolated system. Additionally, the relief valve assembly was not disturbed during the swap. After the swap the unit was retested and found that all three test points were within limits confirming that the relief valve was the cause of the three test points checking out of limits on the original run.

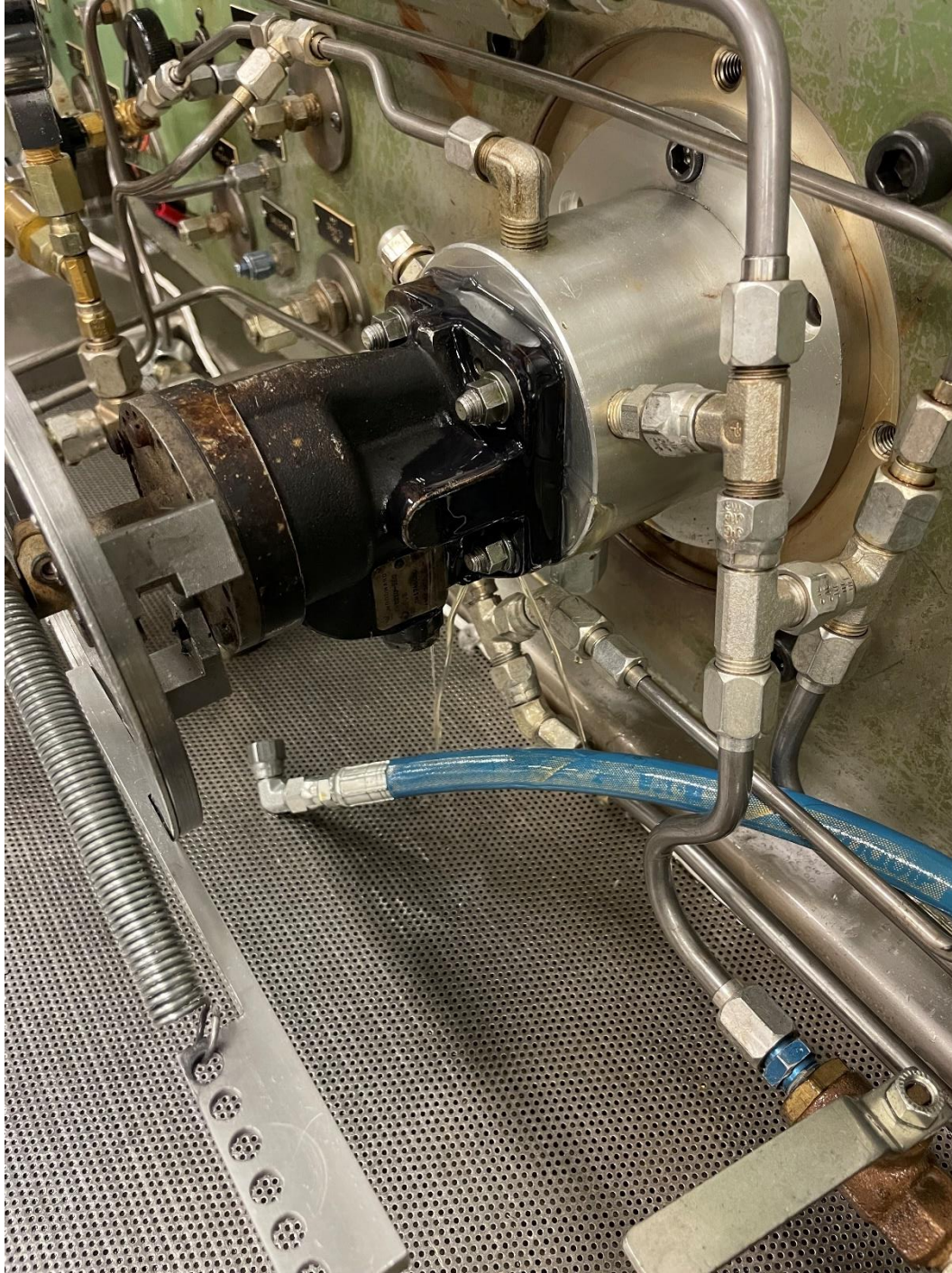


Figure 4 External Leakage from Baseplate

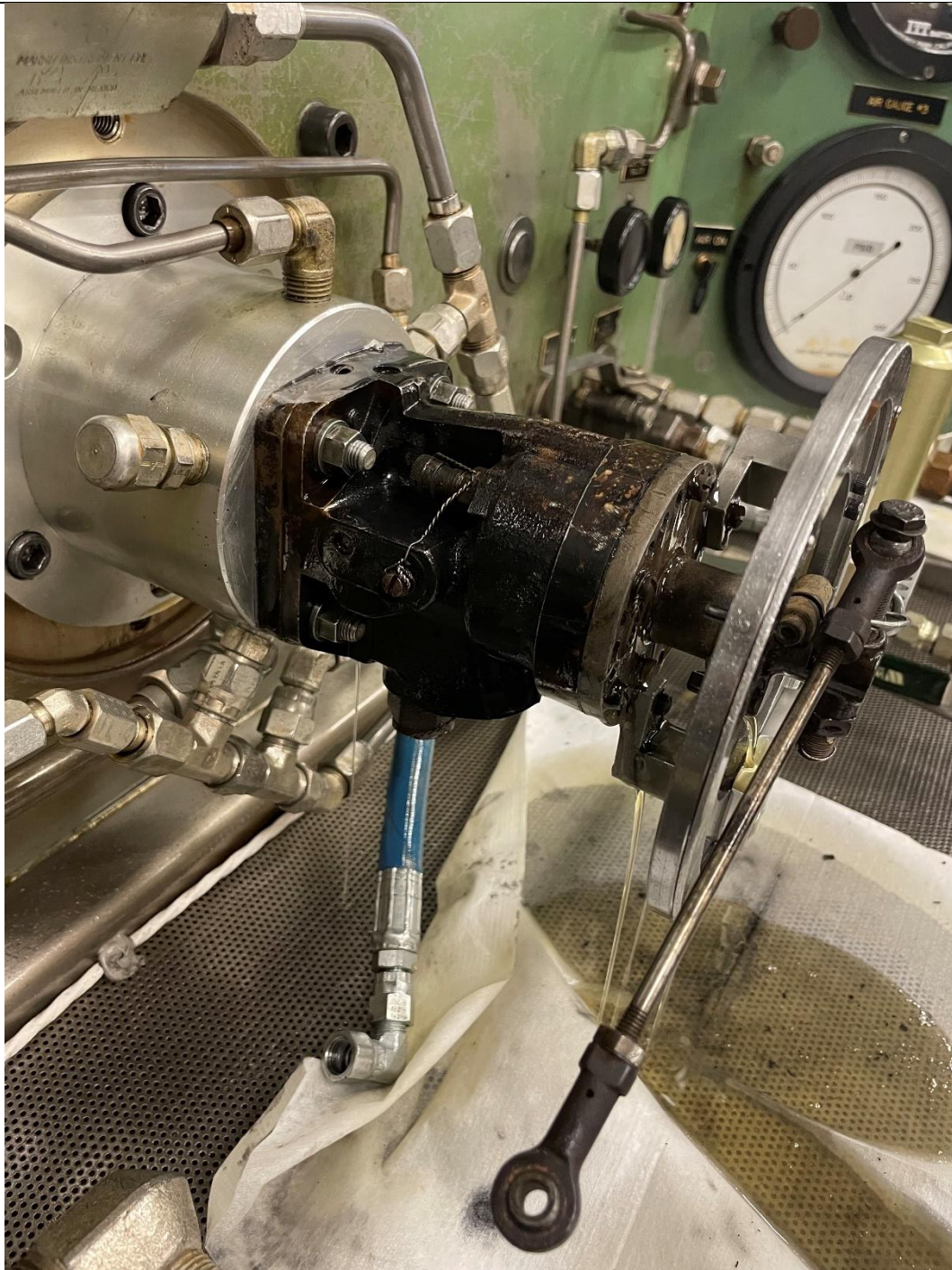


Figure 5 Additional External Leakage While Testing

The cause of all the out of tolerance test points was understood. Therefore, no further testing was necessary. The unit was then disassembled to investigate the cause of the shift in the relief valve performance. Upon disassembly of the relief valve, it was discovered that the relief valve spring (P/N 192370) was shorter than expected. The free length of the spring on new units is approximately 1.760" while the relief valve spring checked 1.495". After the discovery additional dimensions on the spring were checked to confirm that correct spring was used. Dimensions inspected included the number of coils, wire size, inner diameter, and outer diameter all of which were conforming to the spring drawing specification. The relief valve spring is compressed to approximately 1.500" when installed into the unit, therefore its probable that the spring took a set at the

working height due to excessive heat from the post-crash fire. Therefore, when it was tested that spring had a lower preload on it allowing the relief valve to open easier than usual causing the out-tolerance test points observed during testing. It was determined that the observed condition occurred after the crash and would not have been a contributor to the reported event.

During disassembly, the unit's idler bushing (3276-012), was found to be tight to the idler stud (3274-032) and loose to the idler gear (204864). Typically, the idler bushing would be tight to the idler gear and loose to the idler stud. The idler gear, stud and bushing have tight clearances and materials with different coefficients of thermal expansion, so it is probable that the post-crash fire caused the observed condition. Also, this could not have been related to the event as the idler gear was free to rotate in the housing and the unit operated as intended once the relief valve was swapped. During the remainder of the teardown there was more evidence of fire damage, but there was no evidence of any pre-existing conditions that could have contributed to event. See Figures 6 – 11 for disassembly photos.

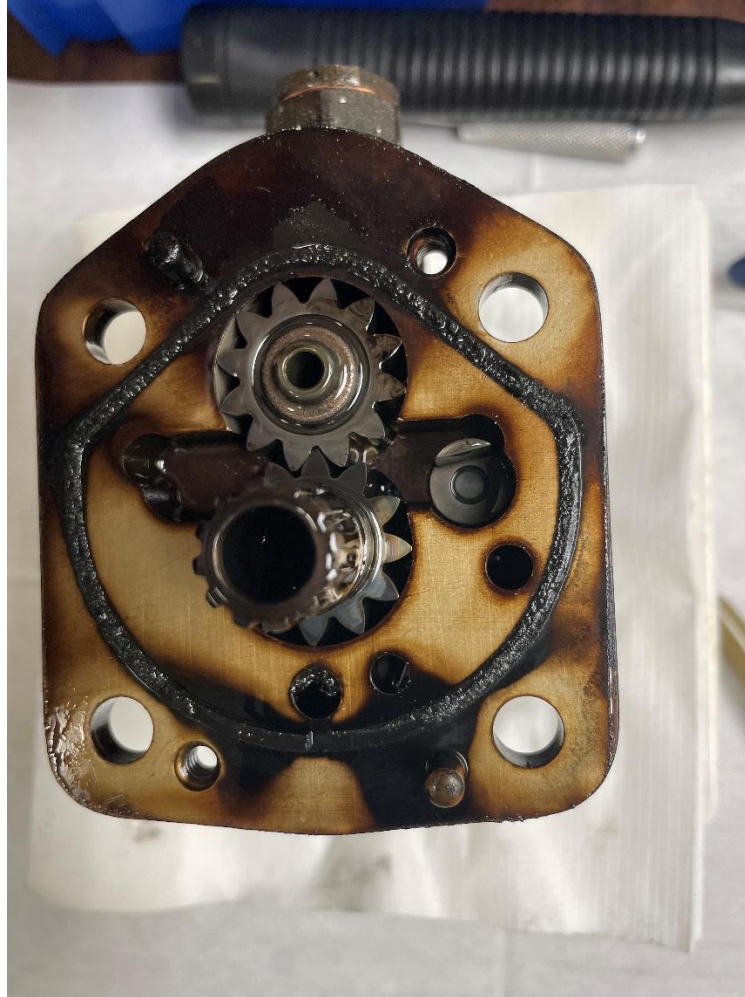


Figure 6 Baseplate Removed

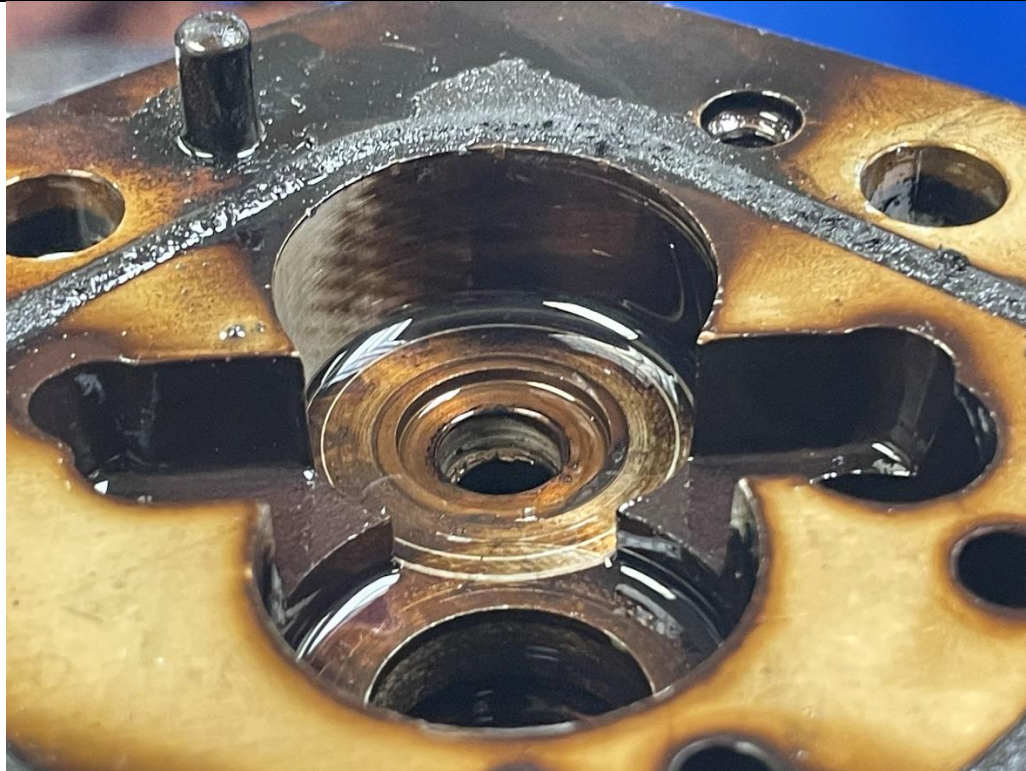


Figure 7 Pump Pocket with Idler Stud Removed



Figure 8 Pressurizing Valve Spring



Figure 9 Pressurizing Valve



Figure 10 Idler Bushing

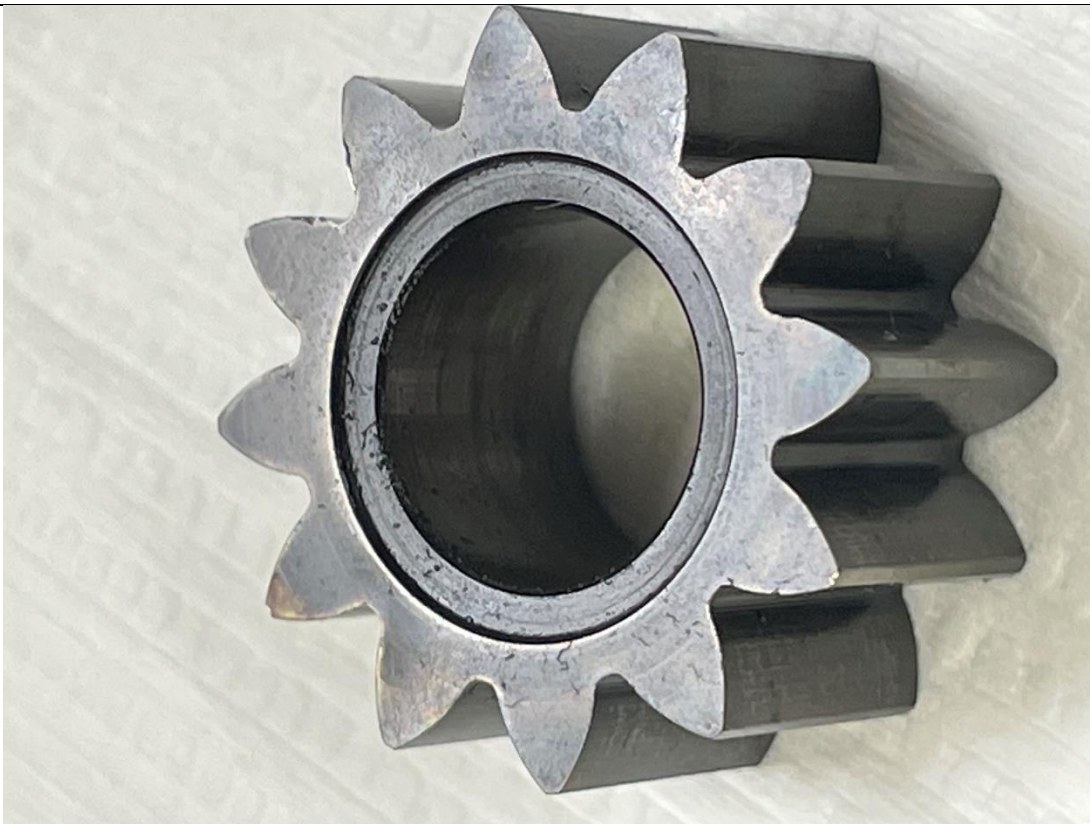


Figure 11 Idler Gear

In summary, all the out tolerances observed at test were the result of normal field adjustments and the post-crash fire. There was no evidence of a pre-existing condition that would have caused the reported event.

ROOT CAUSE (D4)

Origin of Cause: FIELD / END CUSTOMER (OWNER)
 General Cause: No Problem Found
 Cause: No Problem Found or Identified

CORRECTIVE ACTION PLAN (D5)

General Corrective Action: No Action without Additional Customer Input
 Specific Corrective Action: No Direct Action, Continue to Monitor

CORRECTIVE ACTION IMPLEMENTATION (D6)

Corrective Action Status: NO ACTION

WOODWARD GOVERNOR COMPANY
Rockford, Illinois
CAGE 66503
VENDOR CODE 23245

AS RECEIVED

TSP-325
Page 9 of 15
Rev. AH

CONSTANT SPEED PROP GOVERNOR - TEST REPORT
Use with Governors 210560 (869120-1), 210563 (893615-3) (See Below)

OIL INLET TEMP. 140 ± 5 DEG. F. OIL INLET PRESSURE 95 ± 10 PSIG

S/N 1746090

P/N 8210-260

PT.	TSP	PARAGRAPH NUMBER	SPEED (RPM)		OIL PRESSURE (PSIG)		OIL FLOW (QTS./MIN)	
			REQUIRED	ACTUAL	REQUIRED	ACTUAL	REQUIRED	ACTUAL
1	C1	CHECK VALVE PRESS. CHECK	0	0	15 Max.	10	START FLOW	START FLOW
2	C2	TOTAL LEAK CHECK	0	0	200 $\pm$ 10	200	.5 MAX.	5.3
3	C3	RELIEF VALVE CHECK a.	3500 $\pm$ 15	3500	465 $\pm$ 20	230	0	0
4	C4	PUMP CASE PRESSURE b.	3500 $\pm$ 15	3500	525 PSI MAX.	245		
5	C4	PUMP CAPACITY CHECK	3500 $\pm$ 15	3500	150 $\pm$ 5	150	9.0 MINIMUM	6.0
6	C5	EXTERNAL LEAK	3500 $\pm$ 15	3500	RELIEF VALVE	-----	0	Leaks near control lever and base
7	C6	OVERSPEED SETTING	3942 $\pm$ 10	N/A	150 $\pm$ 5	N/A		
8	C7	MAXIMUM RPM	3754 $\pm$ 10	3786	150 $\pm$ 5	150		
9	C8	MINIMUM RPM	2815 $\pm$ 10	3337	150 $\pm$ 5	150	USE	
10	C9	ARM TRAVEL - MAX. TO MIN.	55 DEG. -65 DEG.	*	-----	-----	BLEED	
11	C10	INCREASE SPEED TO OBTAIN		3777	200 $\pm$ 5		ORIFICE	
12	C10	INCREASE SPEED TO OBTAIN		3825	50 $\pm$ 5			
13	C10	PRESSURE GAIN = PT12-PT11 20-40 RPM		48				
14	C11	DECREASE SPEED TO OBTAIN	3783	3883	200 $\pm$ 5 PSI	200		
15	C11	SPEED HYSTERESIS = PT11-PT 14 -15 TO +40 RPM		-6				
16	C12	INTERNAL LEAK	AS REQUIRED	3795	150 $\pm$ 5	150	NEW 1.40 MAX. O'HAUL 1.7 MAX.	N/A .8
17	C13	MAGNETIC PICKUP VOLTAGE	3700 $\pm$ 10	N/A	Adjust pickup to 4.5V $\pm$.2 peak-to-peak			No wires from pickup
18	C13	PICKUP INDICATED RPM	925 $\pm$ 3*	N/A				
19	C16	ELECTRICAL SPEED CHANGE	50 $\pm$ 5	N/A	28 VDC APPLIED TO COIL			

Use with Governors:

210736 (869120-6, -7, -8, -9) 8210-260 (893615-13)

210738 (893615-7, -12) 8210-100 (893615-17)

210743 (897382-1) 8210-266 (893615-18)

REMARKS: If governor is shipped without a lever, test with P/N 210039

*Applied to 210743 prior to "D" change only.
Indicated pickup RPM (62)

TECHNICIAN	SIGNATURE	DATE
	Matt Jeffers	08/24/2022
GARRETT PURCHASE ORDER # <u>N/A</u>		
W.G. SALES ORDER # <u>3821784</u>		

* max screw is at 86 degrees
min screw is at 57 degrees
29

with HOUSE Relief Valve

Relief valve = 485 psi

Pump case = 495 psi

Pump Capacity = 9.7 gpm

Total leak = .3 gpm