



Aviation Investigation Final Report

Location:	Lampasas, Texas	Accident Number:	WPR23LA117
Date & Time:	March 4, 2023, 11:00 Local	Registration:	N6532M
Aircraft:	Stinson 108	Aircraft Damage:	Substantial
Defining Event:	Loss of engine power (partial)	Injuries:	1 None
Flight Conducted Under:	Part 91: General aviation - Personal		

Analysis

While enroute during a cross-country flight, the engine lost total power and the pilot performed a forced landing to a bridge. During the landing, the airplane contacted a cable placed across the bridge and nosed over, which substantially damaged the rudder.

Examination of the engine revealed that three teeth of the crankshaft timing gear had separated, and approximately 60 to 90 percent of the remaining gear teeth had been deformed and flattened, which stopped rotation of the camshaft and resulted in a total loss of power. The liberated teeth exhibited evidence of fatigue cracks and subsequent overstress fractures. The crankshaft timing gear and liberated teeth did not meet the 50 HRC (513 HV) standard for case hardening. No evidence of the engine overheating was found, which eliminated the possibility of an altered case hardening of the crankshaft timing gear via engine heat.

A review of maintenance records revealed that the engine had been overhauled about 58 operating hours before the accident and all ferrous metal parts were non-destructive tested (NDT), including the crankshaft timing gear; the testing did not identify surface or subsurface cracks. An annual inspection of the engine was performed about 8.4 flight hours before the accident and revealed no anomalies. The accident crankshaft timing gear was likely the original gear to the engine.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be:

Improper case hardening of the crankshaft timing gear, which resulted in the fatigue failure of the gear and a total loss of engine power.

Findings

Aircraft	(general) - Fatigue/wear/corrosion
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Factual Information

History of Flight

Enroute	Loss of engine power (partial) (Defining event)
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On March 4, 2023, about 1100 central standard time, a Stinson 108-3 airplane was substantially damaged when it was involved in an accident near Lampasas, Texas. The pilot was not injured. The airplane was operated as a Title 14 *Code of Federal Regulations* Part 91 personal flight.

The pilot reported that he departed the Air Park-Dallas Airport (F69) Dallas, Texas, and was destined for the Kestrel Airpark (1T7) San Antonio, Texas. While enroute, he switched tanks from the right tank to the left tank. About two or three minutes later, the engine lost total power. The pilot switched back to the left tank but power was not restored. The pilot selected a bridge to land on. When the airplane neared the bridge, it contacted a cable that was placed across the threshold of the bridge and the airplane nosed over. The airplane came to rest on the bridge and sustained substantial damage to the rudder.

Postaccident examination of the airframe revealed no mechanical malfunctions or failures that would have precluded normal operation. Examination of the engine revealed no compression or vacuum in some of the cylinders and no rotation of the camshaft when the engine was rotated by hand. Further examination found the crankshaft timing gear exhibited damage to all teeth, with insufficient teeth material remaining to mesh with the camshaft gear. (See Figure 1.) The camshaft gear was not damaged.

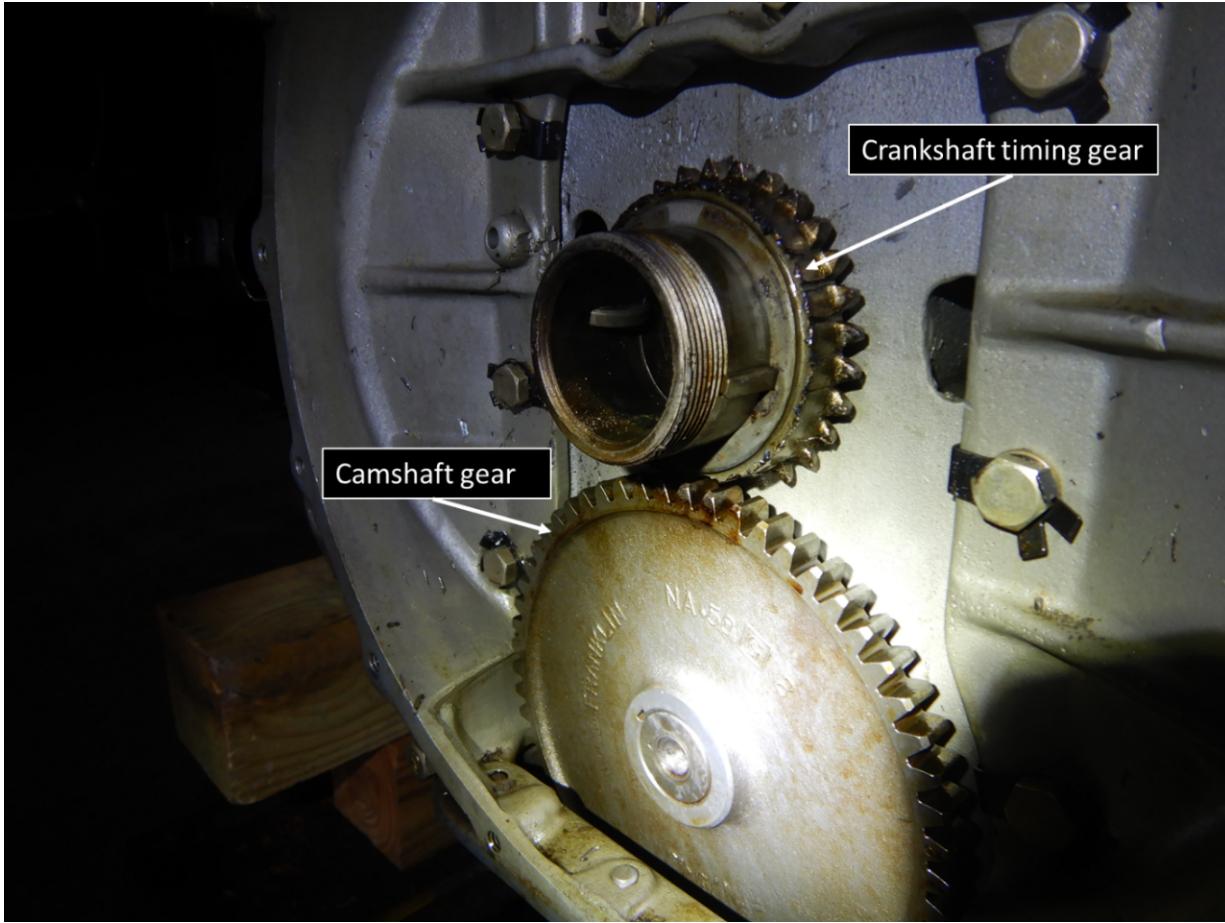


Figure 1. Image of the engine showing the damaged crankshaft timing gear.

The oil was clean and not dark and the engine rotated freely. There was no visual evidence of engine overheating.

Three liberated gear teeth were recovered from the oil sump. The teeth and crankshaft timing gear were sent to the National Transportation Safety Board Materials Laboratory for examination. Figures 1 and 2 show the accident gear alongside an exemplar gear.



Figure 2. The accident gear (left) and an exemplar gear (right).

Besides the three teeth that had fractured and liberated, about 60 to 90 percent of the remaining gear teeth had been deformed and flattened. (See Figure 3.)

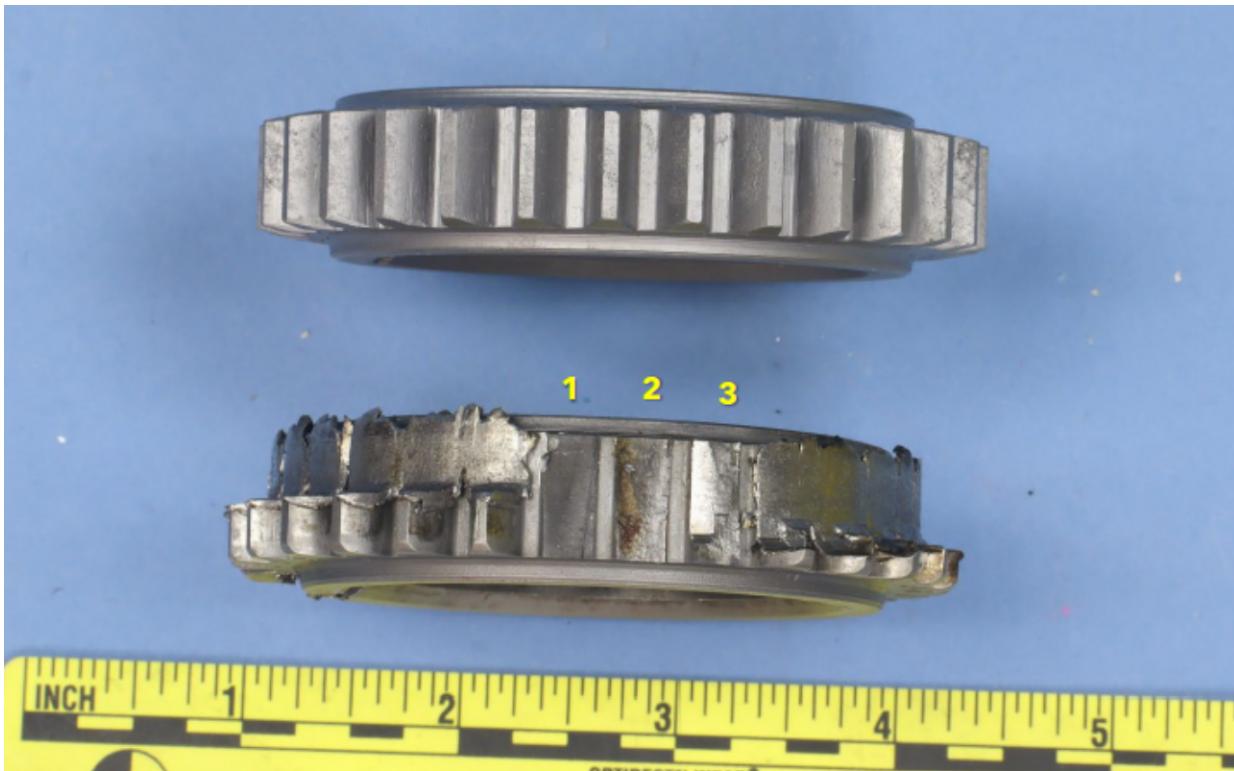


Figure 3. Side view of the accident gear (bottom) and the exemplar gear (top). The location of the three liberated teeth is identified with yellow numbers.

Examination of a fractured tooth using a scanning electron microscope revealed fatigue striations in the undamaged area, consistent with fatigue crack propagation. There were no indications of pits or inclusions at the fatigue initiation site. The opposite long edge of the fractured tooth exhibited ratchet marks, consistent with multiple crack initiation sites. The area just outside these multiple smaller cracks between the main fatigue crack displayed dimpled rupture. This area was consistent with overstress fracture of the final cross-section of the gear tooth at the end of the fatigue crack propagation.

The edge of the primary fatigue crack initiation site of the No. 1 liberated tooth revealed the lower flank and fillet radius of the driven side of the tooth, with the crack initiation site located along the fillet radius on that side. While the area outside the crack initiation site had been smeared, there was relatively little damage on the radius adjacent to the fracture surface edge. No indications of gouging, corrosion, or plastic deformation were located adjacent to the crack initiation site.

Cross-sections of the exemplar gear, worn accident gear teeth, and the No. 2 liberated accident gear tooth were mounted, polished, and etched with a 2% nital solution for metallographic examination. Examination revealed a difference in the case hardening values (HV). (See Figure 4.)

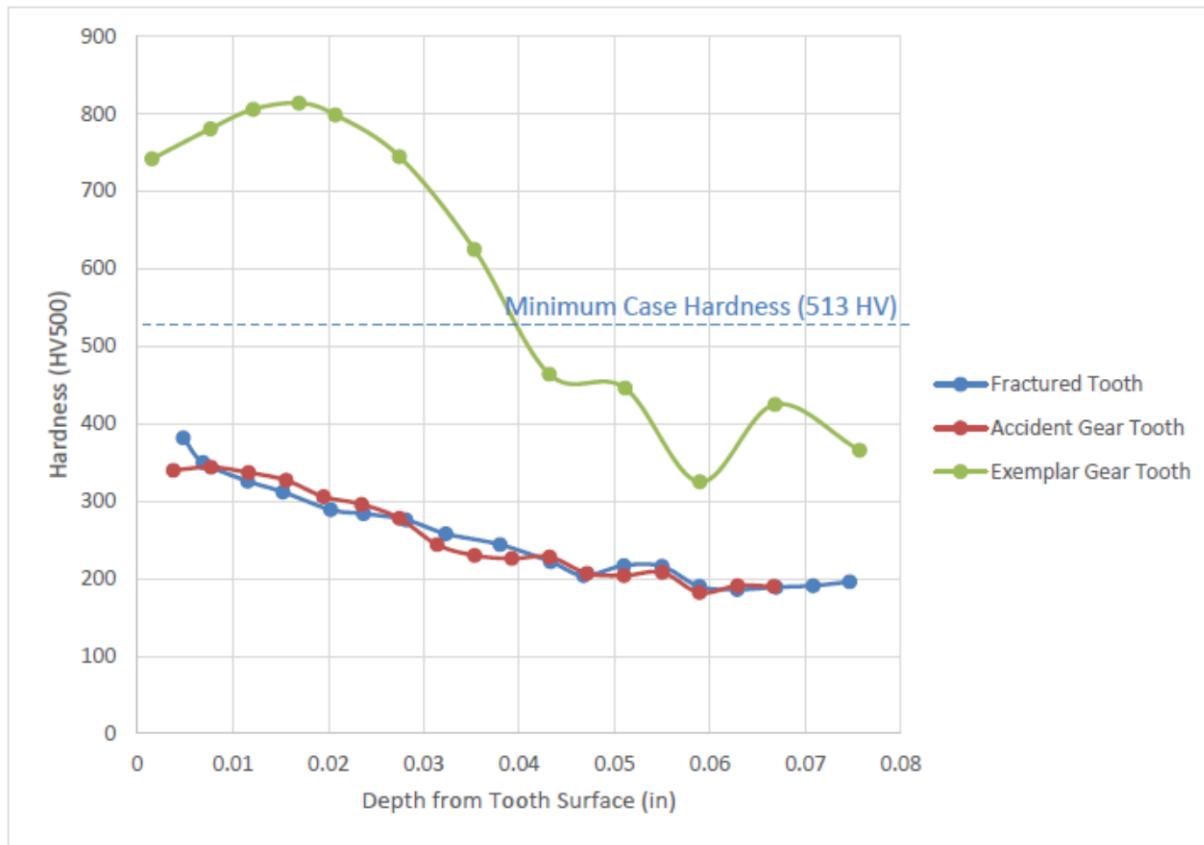


Figure 4. Chart of hardness (in HV₅₀₀) changes based on depth from the surface of the accident gear, a liberated tooth from the accident gear, and the exemplar gear.

For all three, the surface exhibited a higher hardness than the core—however, this was most pronounced in the exemplar gear. The exemplar tooth exhibited a high hardness above 513 HV₅₀₀ (50 HRC) for a depth of 0.04 inches—these hardness data were consistent with and typical of a case hardening surface treatment. In contrast, both the accident gear and liberated tooth exhibited hardnesses of 340 HV₅₀₀ (35 HRC) near the surface. Neither of these hardness levels met the minimum value for case hardening. The core hardness of both accident teeth averaged around 195 HV₅₀₀ (92.5 HRB), whereas the core hardness of the exemplar gear averaged 390 HV₅₀₀ (40 HRC).

A review of the maintenance records revealed that the engine underwent an overhaul on September 1, 2020, at a tachometer time of 2316.89 hours. During the overhaul, all ferrous parts, which would have included the crankshaft timing gear, were non-destructive tested (NDT) with a wet-method magnetic particle testing machine by a level II NDT technician. The crankshaft timing gear was not replaced at that time. According to the accountable manager for the overhaul facility, the wet-method magnetic particle test identifies indications of surface and subsurface cracks. He further stated that crankshaft timing gears are included in the ferrous parts inspected. The last annual inspection of the engine occurred on November 10, 2022, at a tachometer time of 2366.53 hours. The tachometer time at the time of the accident

was 2374.89, or 58 hours since overhaul. A review of the engine maintenance logbook going back to 1963 did not show a replacement of the crankshaft timing gear, consistent with the accident gear being the original gear for the engine.

Pilot Information

Certificate:	Private	Age:	71,Male
Airplane Rating(s):	Single-engine land	Seat Occupied:	Left
Other Aircraft Rating(s):	None	Restraint Used:	4-point
Instrument Rating(s):	None	Second Pilot Present:	No
Instructor Rating(s):	None	Toxicology Performed:	
Medical Certification:	Class 3 With waivers/limitations	Last FAA Medical Exam:	September 30, 2022
Occupational Pilot:	No	Last Flight Review or Equivalent:	October 17, 2022
Flight Time:	1537 hours (Total, all aircraft), 1475 hours (Total, this make and model), 1474 hours (Pilot In Command, all aircraft), 6 hours (Last 90 days, all aircraft), 2 hours (Last 30 days, all aircraft), 0 hours (Last 24 hours, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	Stinson	Registration:	N6532M
Model/Series:	108	Aircraft Category:	Airplane
Year of Manufacture:	1948	Amateur Built:	
Airworthiness Certificate:	Normal	Serial Number:	108-4532
Landing Gear Type:	Tailwheel	Seats:	4
Date/Type of Last Inspection:	October 17, 2022 Annual	Certified Max Gross Wt.:	
Time Since Last Inspection:		Engines:	1 Reciprocating
Airframe Total Time:	3044.76 Hrs	Engine Manufacturer:	FRANKLIN
ELT:	C91 installed, activated, did not aid in locating accident	Engine Model/Series:	6A4165 SERIES
Registered Owner:	On file	Rated Power:	165 Horsepower
Operator:	On file	Operating Certificate(s) Held:	None
Operator Does Business As:	On file	Operator Designator Code:	None

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	Condition of Light:	Day
Observation Facility, Elevation:		Distance from Accident Site:	
Observation Time:		Direction from Accident Site:	
Lowest Cloud Condition:	Clear	Visibility	10 miles
Lowest Ceiling:			Visibility (RVR):
Wind Speed/Gusts:	9 knots / 15 knots	Turbulence Type Forecast/Actual:	None / None
Wind Direction:	240°	Turbulence Severity Forecast/Actual:	N/A / N/A
Altimeter Setting:	29.95 inches Hg	Temperature/Dew Point:	20°C / 0°C
Precipitation and Obscuration:			
Departure Point:	Plano, TX (F69)	Type of Flight Plan Filed:	None
Destination:	San Antonio, TX (17T)	Type of Clearance:	Unknown
Departure Time:	09:30 Local	Type of Airspace:	Class G

Wreckage and Impact Information

Crew Injuries:	1 None	Aircraft Damage:	Substantial
Passenger Injuries:	N/A	Aircraft Fire:	None
Ground Injuries:	N/A	Aircraft Explosion:	None
Total Injuries:	1 None	Latitude, Longitude:	31.06328,-98.181897(est)

Administrative Information

Investigator In Charge (IIC):	Salazar, Fabian
Additional Participating Persons:	Carl Newton; FAA San Antonio FSDO; San Antonio, TX
Original Publish Date:	June 20, 2024
Last Revision Date:	
Investigation Class:	Class 3
Note:	The NTSB did not travel to the scene of this accident.
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=106830

The National Transportation Safety Board (NTSB) is an independent federal agency charged by Congress with investigating every civil aviation accident in the United States and significant events in other modes of transportation—railroad, transit, highway, marine, pipeline, and commercial space. We determine the probable causes of the accidents and events we investigate, and issue safety recommendations aimed at preventing future occurrences. In addition, we conduct transportation safety research studies and offer information and other assistance to family members and survivors for each accident or event we investigate. We also serve as the appellate authority for enforcement actions involving aviation and mariner certificates issued by the Federal Aviation Administration (FAA) and US Coast Guard, and we adjudicate appeals of civil penalty actions taken by the FAA.

The NTSB does not assign fault or blame for an accident or incident; rather, as specified by NTSB regulation, "accident/incident investigations are fact-finding proceedings with no formal issues and no adverse parties ... and are not conducted for the purpose of determining the rights or liabilities of any person" (Title 49 *Code of Federal Regulations* section 831.4). Assignment of fault or legal liability is not relevant to the NTSB's statutory mission to improve transportation safety by investigating accidents and incidents and issuing safety recommendations. In addition, statutory language prohibits the admission into evidence or use of any part of an NTSB report related to an accident in a civil action for damages resulting from a matter mentioned in the report (Title 49 *United States Code* section 1154(b)). A factual report that may be admissible under 49 *United States Code* section 1154(b) is available [here](#).