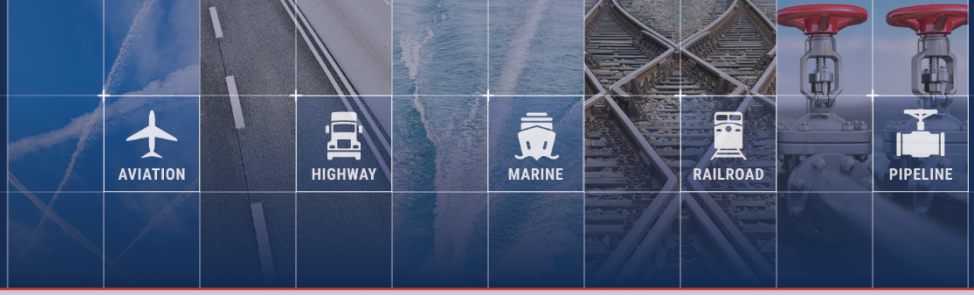

Aviation Investigation Final Report

Location:	CLAREMORE, Oklahoma	**Accident Number:**	FTW99FA132
Date & Time:	May 8, 1999, 08:30 Local	**Registration:**	N4546J
Aircraft:	Grumman American AA-5B	**Aircraft Damage:**	Substantial
Defining Event:		**Injuries:**	1 None
Flight Conducted Under:	Part 91: General aviation - Personal		

Analysis

While in level cruise flight, the propeller separated from the airplane. The pilot made a forced landing at the Claremore Municipal Airport. During the approach, the airplane porpoised, so the pilot elected to touch down in a grassy area between the runway and ramp area. During landing, the nose gear collapsed and the nose wheel separated from the airplane. Examination of the propeller attaching bolts revealed that they failed in fatigue. Examination of the aft spinner bulkhead revealed that crescent shaped arcs had been punched out, elongating the bulkhead's bolt holes. According to FAA service difficulty reports and reports from mechanics, the potential exists for the aft spinner bulkhead to slide off of the crankshaft flange bushings and rest on the propeller bolts during installation. The mechanic will then torque the propeller bolts with the aft spinner bulkhead pinched between the propeller spacer and the bushings. Over time the pinched sections of aft spinner bulkhead fail, leaving the propeller loose.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: The fatigue fracture of the propeller bolts resulting from the improper installation of the propeller assembly.

Findings

Occurrence #1: PROPELLER FAILURE/MALFUNCTION
Phase of Operation: CRUISE

Findings
1. PROPELLER SYSTEM/ACCESSORIES
2. (C) MAINTENANCE,INSTALLATION - IMPROPER - OTHER MAINTENANCE PERSONNEL
3. PROPELLER SYSTEM/ACCESSORIES - LOOSE
4. (C) MISCELLANEOUS,BOLT/NUT/FASTENER/CLAMP/SPRING - FATIGUE
5. PROPELLER SYSTEM/ACCESSORIES - SEPARATION

Occurrence #2: FORCED LANDING
Phase of Operation: DESCENT - EMERGENCY

Occurrence #3: NOSE GEAR COLLAPSED
Phase of Operation: LANDING - FLARE/TOUCHDOWN

Findings
6. PORPOISE/PILOT-INDUCED OSCILLATION - ENCOUNTERED - PILOT IN COMMAND

Factual Information

HISTORY OF FLIGHT

On May 8, 1999, at 0830 central daylight time, a Grumman American AA-5B airplane, N4546J, was substantially damaged during a forced landing following the separation of the propeller while in cruise flight near Claremore, Oklahoma. The commercial rated pilot, sole occupant and owner/operator of the airplane, was not injured. Visual meteorological conditions prevailed, and a flight plan was not filed for the 14 Code of Federal Regulations Part 91 personal flight. The flight originated from the pilot's private grass strip near Ketchum, Oklahoma, at 0815, and was destined for the Oklahoma City Downtown Airport.

During an interview conducted by the NTSB investigator-in-charge (IIC), the pilot stated that the airplane was in cruise flight at 2,500 feet msl, when he noticed a vibration. According to the pilot, the vibration became more violent, and subsequently, the propeller departed the aircraft's engine. The pilot initiated an emergency landing to a field; however, noticing that his glide ratio had improved without the propeller, he decided to land at the Claremore Municipal Airport. The pilot stated that during the approach, the airplane started to porpoise, so he elected to touch down in the grassy area west of runway 35 to absorb some of the landing energy.

During the landing, the nose landing gear collapsed and the nose wheel separated from the aircraft. The airplane slid across the runway and came to rest between two runway lights.

PERSONNEL INFORMATION

The instrument rated commercial pilot had accumulated approximately 8,000 total flight hours. The pilot was rated in single-engine and multiengine land airplanes, single-engine sea airplanes, and was also a certificated flight instructor. The pilot was issued a second class medical certificate with no limitations on December 23, 1998.

AIRCRAFT INFORMATION

The single-engine, low-wing Grumman American AA-5B airplane (serial number AA5B-1283) was manufactured in 1979, by Gulfstream American Corporation. A Lycoming O-360-A4K engine (serial number L-27139-36A) was installed in the airplane during manufacture. According to the aircraft maintenance records, the last annual inspection was completed on May 8, 1998, at an aircraft total time of 1,734.1 hours. The airplane was originally equipped with a McCauley propeller, model 1A170FFA7563. With the McCauley propeller installed, a caution range was placed on engine RPM during descents to prevent hazardous vibrations induced by the harmonic frequencies from the engine and propeller combination. On July 15, 1983, the registered owner purchased a Supplemental Type Certificate (STC-SA1195NW) from

Fletcher Aviation, Inc., of Houston, Texas, to replace the McCauley propeller with a Sensenich propeller and an SK 143-2 Spinner Kit. According to the FAA and the STC owner, with the Sensenich propeller installed, the engine RPM limitation does not apply.

On August 5, 1995, N4546J was involved in an accident, where it received damage to the propeller. On October 27, 1995, a new Sensenich propeller, model 76EM8S10-0-63 (serial number 30328K), with the original SK 143-2 Spinner Kit, was installed by Fletcher Aviation, Inc., at an aircraft total time of 1,583 hours. The STC section titled "Detailed Installation Instructions" states, in part: "2. Install Sensenich, 76EM8S10-0-60 through -65, propeller and SK143-2 spinner assembly IAW installation drawing No. AM130-ID-1 and Gulfstream American service manual."

The Gulfstream American AA-5 Series Maintenance Manual, under the section titled "Propeller Assembly-Maintenance Practices," subsection D, step 3, reads: "Install aft bulkhead assembly (10) on starter ring gear (11) and use a temporary method of securing the bulkhead in place. (One temporary method is to tape the bulkhead to the nose cowl.)." There is also a caution following this step, which states: "THE AFT BULKHEAD CAN BE DAMAGED IF NOT HELD SECURELY IN PLACE DURING PROPELLER INSTALLATION. REMOVE TEMPORARY SECURING MATERIAL AFTER PROPELLER MOUNT BOLTS ARE TORQUED."

There are two STCs available for the installation of the Sensenich propeller on the AA-5B airplanes. STC-SA3326NM, which was not purchased for the accident airplane, under "Detailed Installation Instructions" states, in part:

2. Install Sensenich propeller/spacer assy. using bolts supplied with new propeller (Sensenich bolt kit P/N 76EM8S10) and spinner assembly, in accordance with installation Drawing No. KD110-ID-1. USE EXTREME CAUTION IN PLACING THE BULKHEAD OVER THE PROPELLER DRIVE BUSHINGS (in crankshaft flange) AND WHILE SEATING THE PROPELLER!!

SPECIAL NOTE: It is very easy for the spinner aft bulkhead to slip off the drive bushing shoulders and rest on the propeller bolts when the propeller spacer is seated before tightening the bolts. Should this happen, the bulkhead holes will be deformed and prevent proper center alignment. IF ALL HOLES ARE DAMAGED IT MAY BE UNAIRWORTHY AND SHOULD BE REPLACED! (If re-using an SK143-2 spinner assy. the bulkhead should be inspected for this and replaced if determined to not be airworthy.)

To prevent damage during installation, one person should hold the back plate in position while another seats the propeller spacer over the drive bushing shoulders and installs two of the propeller bolts. When only two bolts have been 'snug-tightened' the propeller should be then pulled through by hand, or spun with the starter WITH MAGS OFF, to see if the spinner is rotating evenly in relation to the front cowling. If there is any doubt the bulkhead is properly centered the propeller should be removed and the aft bulkhead holes inspected.

One option may be elected, which involves an added expense but may aid ease of installation and prevent damage to the bulkhead during later re-installation of the propeller, is detailed in the 'Options' section of these installation instructions. If it is to be done, parts should be obtained prior to beginning installation since they are not usually found in stock at most Lycoming Distributors and may be back-ordered.

The "Options" section of STC-SA3326NM states, in part:

A. Replacement of Propeller Drive Bushings: When the propeller is removed, it will be noticed that two of the six drive bushings are shorter than the other four. These may be replaced with Lycoming Part Number 74248 (1ea. Indexing), & 74249 (1ea.) which are longer than the other four originals. This will help hold the aft bulkhead in proper position while the prop is being installed and lessen the chance of it being damaged. If this option is chosen the replacement should be done per Lycoming instructions by qualified personnel only. This change must be recorded in the aircraft engine log.

According to Lycoming Service Instruction No. 1098F dated May 22, 1995, the crankshaft flange is allowed a thickness of 0.38 inches +/-.010 inches. The shank length for the two "shorter bushings" is 0.59 inches (as measured from the forward face to the point corresponding to the aft face of the crankshaft flange). The shank length of the other four bushings is 0.78 inches. With the bushings installed in the crankshaft flange, the two "short bushings" protrude 0.21 inches +/-.010 inches from the front of the flange. The other four bushings protrude from the flange 0.40 inches +/-.010 inches. With the starter ring gear (which measures 0.25 inches thick) installed, approximately 0.150 inches of bushing protrudes from the starter ring gear on four of the six bushings. The two "short bushings" do not protrude from the starter ring gear. Additionally, the forward face of all the bushings are manufactured with break on the outer edge, which decreases the level area by an additional 0.03 inches, leaving 0.120 inches to support the aft spinner bulkhead during installation. The aft spinner bulkhead is 0.0625 inches thick, and has the potential of sliding off the remaining 0.120 inches of protruding bushing during the installation process.

During telephone interviews conducted by the NTSB IIC, both STC owners stated that during installation of the propeller, the aft spinner bulkhead can slip off of the bushings and rest against the propeller bolts. When the bolts are torqued, the aft spinner bulkhead is pinched between the propeller spacer and the bushings. Eventually, half-moon or crescent shaped arcs of aluminum are punched out of the aft spinner bulkhead material, elongating the bolt holes and leaving the propeller loose.

It was reported to the FAA on April 28, 1989, by means of a Service Difficulty Report, that "aircraft using spinner kit SK143-2 are found with elongated mounting holes in rear bulkhead due to crankshaft bushings not long enough to support bulkhead during assembly. Mounting the unit misaligned like this is causing cracking due to vibration. The submitter suggests using longer crankshaft bushing P/N 72-62 (Lycoming) as is suggested by 1 propeller replacement STC."

METEOROLOGICAL INFORMATION

At 0853, the weather observation facility at the Tulsa International Airport (located 20 miles southwest of Claremore) reported the wind as calm, visibility 10 statute miles, sky clear, temperature 11 degrees Celsius, dewpoint 9 degrees Celsius, and altimeter 29.87 inches of Mercury.

WRECKAGE AND IMPACT INFORMATION

The airplane came to rest on a magnetic heading of 347 degrees on the east side of runway 35 with the nose wheel separated. There were three linear ground scars in the grass area west of the runway. The ground scars were equivalent in distance apart to the lateral distance between the airplane's main wheels and the nose wheel. The nose wheel was located in the grass adjacent to the ground scars. The airplane's firewall was buckled, the landing gear-to-fuselage attachment points were structurally damaged, and the wing roots showed evidence of structural damage.

Examination of the engine revealed that the propeller assembly had separated from the crankshaft, and the crankshaft flange bushings contained all six of the threaded sections of the fractured propeller attaching bolts. The starter flywheel was located in the grassy area west of the runway approximately 250 feet north of the ground scars. The airplane was moved to a hangar located on the airport for further examination. When the airplane's nose was lifted for movement, a 3-inch section of propeller blade tip was located beneath the engine cowling.

The engine cowling was removed once the airplane was in the hangar. The lower engine cowling had a gash originating outboard of the landing light, extending laterally to just forward of the engine exhaust pipe. A second 3-inch section of propeller blade tip was found laying in the lower cowling next to the air outlet on the left side. Both pieces of blade tip displayed red paint transfers and had a torn appearance.

The propeller assembly, consisting of the propeller, propeller spacer, the aft spinner bulkhead, and the spinner cone was located 3 miles west of the airport. Approximately 6 inches of one blade tip was missing outboard of the white tip stripes. The fractured propeller blade displayed red (similar in color to the paint transfers on the tip pieces) and blue paint transfers on its leading edge and face near the fracture area. The airplane was painted white, with blue and red stripes running longitudinally on the sides of the airplane from the engine cowling to the tail.

The spinner cone had a hole, about equal in size and shape to a propeller attaching bolt head, punched out near its apex. The spinner cone was removed to view the propeller attaching bolt heads. The forward sections of four of the six propeller bolts were in place and the forward section of one bolt was laying in the spinner cone. The forward section of the sixth bolt was not located during the investigation. Two of the propeller bolts were still safety wired together

and were in their pre-accident position. Two other bolts, located opposite each other and in their pre-accident position, had remnants of broken safety wire installed in their heads.

The engine's number 1 cylinder rocker arm cover had a hole punched out of it. Removal of the rocker arm cover revealed that the intake valve was destroyed and pieces of it could be seen in the cylinder. The valve keepers were also destroyed. The valve pieces were removed for examination at the NTSB Materials Laboratory in Washington, D.C., along with the propeller assembly.

TESTS AND RESEARCH INFORMATION

On July 14, 1999, the NTSB IIC examined the Lycoming O-360-A4K engine at the manufacturer's facility. Pieces of the fractured number 1 intake valve were located in the intake manifold of the number 4 cylinder. The number 1 and 4 piston tops were "heavily damaged by debris." The number 2 and 3 piston tops were also damaged by debris. All four cylinder heads had corresponding damage. The crankshaft runout was checked and found to be within new limits. The camshaft and bearings displayed even wear. The crankshaft, with the propeller bushings and the aft sections of the bolts installed, was taken to the NTSB Materials Laboratory in Washington D.C.

The crankshaft, propeller, propeller spinner, aft spinner bulkhead, and propeller bolts were examined on July 15, 1999 by the NTSB, FAA, and a representative of the propeller manufacturer. Examination of the fracture faces on the longer bolt pieces (forward pieces) revealed "crescent-shape crack arrest positions and ratchet marks, indicative of fatigue cracking." Examination of the aft bolt pieces, which were installed in the propeller bushings, revealed that "all bolts separated as a result of fatigue that was caused by reverse bending loads. In each bolt, the fatigue cracking stemmed from multiple origins located in the thread roots, on opposite sides of the bolt."

Hardness values of the bolts were measured at the shank portions of the bolts. All the bolts were found to be within the manufacturer's engineering drawing specifications. The fractured safety wire found on two of the bolts was also examined. Magnification of the fracture surfaces did not reveal any shear lips or plastic deformation, as would be typical of a stretching, overload failure. The safety wire was removed and examined under a scanning electron microscope (SEM). Fine striations, typical of fatigue fracture propagation, could be seen on the fracture surface.

The crankshaft flange, aft face on the propeller spacer, and both the forward and aft faces on the aft spinner bulkhead and starter ring gear, contained "severe peening damage, indicating that these surfaces were subjected to considerable relative motion." Four of the six starter ring gear bolt holes were elongated in the circumferential direction.

The aft spinner bulkhead bolt holes were examined. Four of the six bolt holes displayed a sheared off arc of about 60 degrees. These sheared arcs were similar to those described by

the STC owners. There were two bolt holes, opposite each other, that did not display the sheared arcs. The two bolt holes that were not elongated were positioned over the two shortest crankshaft flange bushings, which do not protrude from the starter ring gear.

Examination of the outboard end of the fractured propeller blade revealed a "bending deformation in the blade." The fracture features on the two separated propeller tip pieces were "consistent with an overstress that resulted from impact." Examination of the number 1 intake valve and valve keepers revealed that they "failed in overload." See the enclosed Materials Laboratory Factual Report for more information.

The owner of STC-SA3326NM sent the NTSB IIC three damaged exemplar aft spinner bulkheads for examination and comparison. One aft spinner bulkhead was less damaged than the other two. Four of the six propeller bolt holes on this bulkhead displayed crescent shape sheared areas similar to the accident aircraft aft spinner bulkhead. Two of the aft spinner bulkhead bolt holes were relatively undamaged and were positioned opposite each other, and were likely matched up with the "short bushings," which caused little damage to the two holes. The two other aft spinner bulkheads displayed multiple crescent shape sheared areas on all the holes. According to the STC owner, it did not matter which propeller was installed (McCauley or Sensenich), "the potential for the aft spinner bulkhead sliding off of the bushings during installation still exists because of the short bushings." The STC owner added that he has replaced hundreds of aft spinner bulkheads over the years and estimates that approximately 40 percent of all AA-5B propellers are loose due to this installation error.

ADDITIONAL INFORMATION

The airplane, with the exception of the engine and propeller assembly, was released to the owner's representative upon completion of the field portion of the investigation. The engine and propeller assembly were released to the owner's representatives on September 13, 1999, and September 23, 1999, respectively.

Pilot Information

Certificate:	Commercial	**Age:**	66,Male
Airplane Rating(s):	Single-engine land; Single-engine sea; Multi-engine land	**Seat Occupied:**	Left
Other Aircraft Rating(s):	None	**Restraint Used:**	
Instrument Rating(s):	Airplane	**Second Pilot Present:**	No
Instructor Rating(s):	Airplane multi-engine; Airplane single-engine; Instrument airplane	**Toxicology Performed:**	No
Medical Certification:	Class 2 Valid Medical--no waivers/lim.	**Last FAA Medical Exam:**	December 23, 1998
Occupational Pilot:	UNK	**Last Flight Review or Equivalent:**	
Flight Time:	8000 hours (Total, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	Grumman American	**Registration:**	N4546J
Model/Series:	AA-5B AA-5B	**Aircraft Category:**	Airplane
Year of Manufacture:		**Amateur Built:**	
Airworthiness Certificate:	Normal	**Serial Number:**	AA5B-1283
Landing Gear Type:	Tricycle	**Seats:**	4
Date/Type of Last Inspection:	May 8, 1998 Annual	**Certified Max Gross Wt.:**	2400 lbs
Time Since Last Inspection:	57 Hrs	**Engines:**	1 Reciprocating
Airframe Total Time:	1791 Hrs	**Engine Manufacturer:**	Lycoming
ELT:	Installed, not activated	**Engine Model/Series:**	IO-360-A4K
Registered Owner:	JAMES M. INHOFE	**Rated Power:**	180 Horsepower
Operator:		**Operating Certificate(s) Held:**	None
Operator Does Business As:		**Operator Designator Code:**	

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	TUL ,725 ft msl	**Distance from Accident Site:**	20 Nautical Miles
Observation Time:	08:53 Local	**Direction from Accident Site:**	220°
Lowest Cloud Condition:	Clear	**Visibility**	10 miles
Lowest Ceiling:	None	**Visibility (RVR):**	
Wind Speed/Gusts:	/	**Turbulence Type Forecast/Actual:**	/
Wind Direction:	0°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	29 inches Hg	**Temperature/Dew Point:**	11°C / 9°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	KETCHUM , OK (NONE)	**Type of Flight Plan Filed:**	None
Destination:	OKLAHOMA CITY , OK (2DT)	**Type of Clearance:**	None
Departure Time:	08:15 Local	**Type of Airspace:**	Class G

Airport Information

Airport:	CLAREMORE MUNICIPAL 107	**Runway Surface Type:**	Grass/turf
Airport Elevation:	725 ft msl	**Runway Surface Condition:**	Dry
Runway Used:	0	**IFR Approach:**	None
Runway Length/Width:		**VFR Approach/Landing:**	Forced landing

Wreckage and Impact Information

Crew Injuries:	1 None	**Aircraft Damage:**	Substantial
Passenger Injuries:		**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	1 None	**Latitude, Longitude:**	36.309448,-95.609741(est)

Administrative Information

Investigator In Charge (IIC):	Lupino, Nicole
Additional Participating Persons:	BYRON WALTON; OKLAHOMA CITY , OK
Original Publish Date:	August 10, 2000
Last Revision Date:	
Investigation Class:	Class
Note:	
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=46252