

NATIONAL TRANSPORTATION SAFETY BOARD

Office of Research and Engineering
Materials Laboratory Division
Washington, D.C. 20594



July 9, 2021

MATERIALS LABORATORY FACTUAL REPORT

Report No. 21-051

A. ACCIDENT INFORMATION

Place : Crossville, Tennessee
Date : May 25, 2021
Vehicle : Gulfstream American AA-5A, N26889
NTSB No. : ERA21FA232
Investigator : Brian Rayner, AS-ERA

B. COMPONENTS EXAMINED

Carburetor end of the throttle control cable assembly with attached support bracket, carburetor arm with attached ball screw piece, and carburetor arm attachment nut and cotter pin.

C. DETAILS OF THE EXAMINATION

An overall view of the submitted components as received are shown in figure 1. The airplane had reportedly been mostly consumed by a post-crash fire, and the submitted components were darkened and oxidized consistent with exposure to that fire. The throttle cable had been cut at the location indicated, and the carburetor arm had been disassembled from the carburetor to facilitate shipment to the NTSB Materials Laboratory. The nut and cotter pin for attaching the carburetor arm were also submitted as shown in figure 1.

The ball screw at the carburetor end of the throttle cable assembly was fractured. The ball end of the ball screw remained in the ball joint, and the threaded end of the ball screw remained attached to the carburetor arm. A close view of the ball joint as received is shown in figure 2. The ball end of the ball screw moved freely within the joint. One side of the slot had a curved profile, and the ball screw is shown positioned within the curved profile in figure 2. The edges of the curved side did not appear deformed, indicating the curved profile likely occurred due to wear between the ball screw and the side of the slot. The cap piece at the end of the ball joint was bent such that the slot side was displaced axially away from the joint relative to the opposite side and the edge facing the slot was deformed with a curved impression consistent with contact with the ball screw.

Both sides of the ball screw fracture were examined using an optical stereomicroscope. The oxides and deposits on the threaded end attached to the carburetor arm appeared to be more extensive, so further cleaning and examination

focused on the ball end. The fracture surface on the ball end was initially cleaned using a soft-bristle brush with a solution of Alconox detergent and water to remove loose oxides and deposits. Next, the ball joint was submerged in Evapo-Rust¹ for approximately 30 minutes followed by brushing with a soft-bristle brush to further remove oxides from the surfaces. Following deoxidation, the joint was rinsed sequentially with water and ethanol followed by drying with pressurized air. To facilitate further examination of all the surfaces of the ball end of the ball screw, the ball end was removed from the joint by cutting the cap end from the remainder of the ball joint using a hand-held abrasive cutting tool.

Next, the cleaned and deoxidized ball screw piece was examined using an optical stereomicroscope and a scanning electron microscope (SEM). A series of SEM images stitched together to form a montage image of the fracture surface is shown in figure 3. Most of the fracture surface had rough features with an oxidized intergranular fracture appearance and crevices intersecting the fracture surface, features consistent with high-temperature overstress fracture. Smoother features in planes perpendicular to the outer surface were observed at the edge of the fracture around nearly 2/3 of the circumference (between the 1 o'clock and 8 o'clock positions in figure 3) consistent with overstress fracture of a surface-hardened part. Approximately 1/4 of the fracture surface (maroon and orange-oxidized quadrant shown at the upper left side in figures 2 and 3) had a concave shape, and some areas with dimple features were observed in that quadrant where oxides had been removed from the surface, features consistent with ductile overstress fracture.

An optical image of the ball end of the ball screw is shown in figure 4. The side of the ball screw shown in figure 4 is at the 3 o'clock position in figure 3. Cracks were observed in the shank of the ball screw as indicated in figure 4. The shorter crack closer to the fracture surface was gaped open consistent with overstress fracture.

Matthew R. Fox, Ph.D.
Senior Materials Engineer

¹ Evapo-Rust is manufactured by Harris International Laboratories, Springdale, Arkansas.

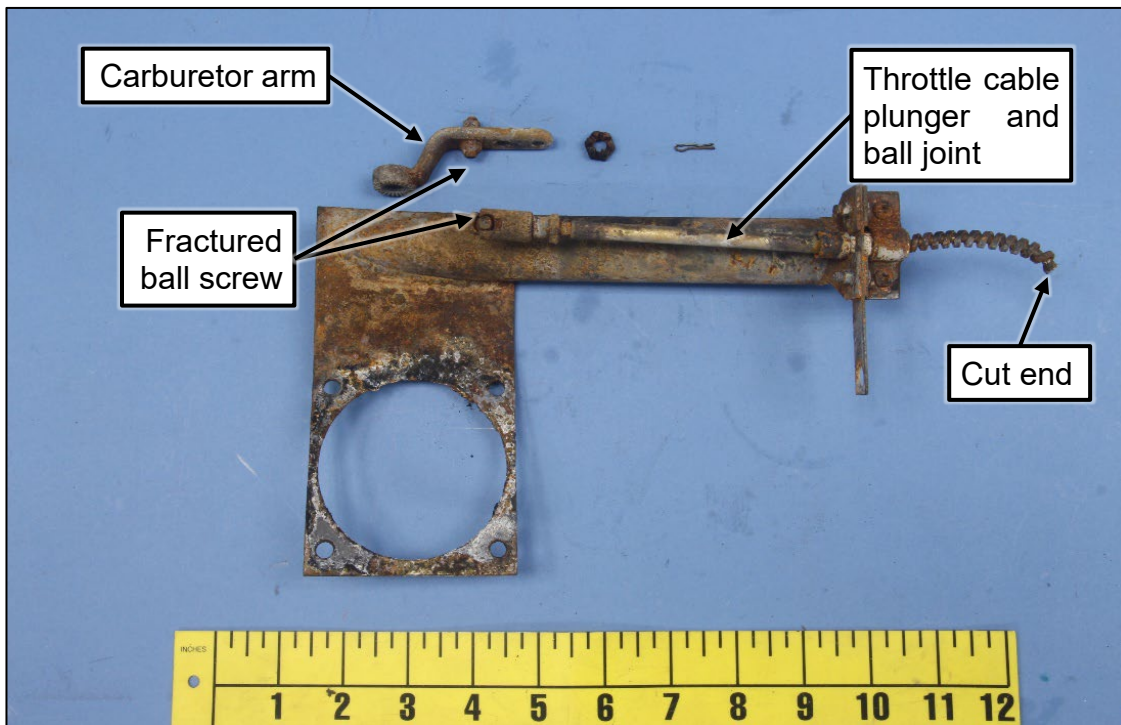


Figure 1. Overall view of the submitted components as received.

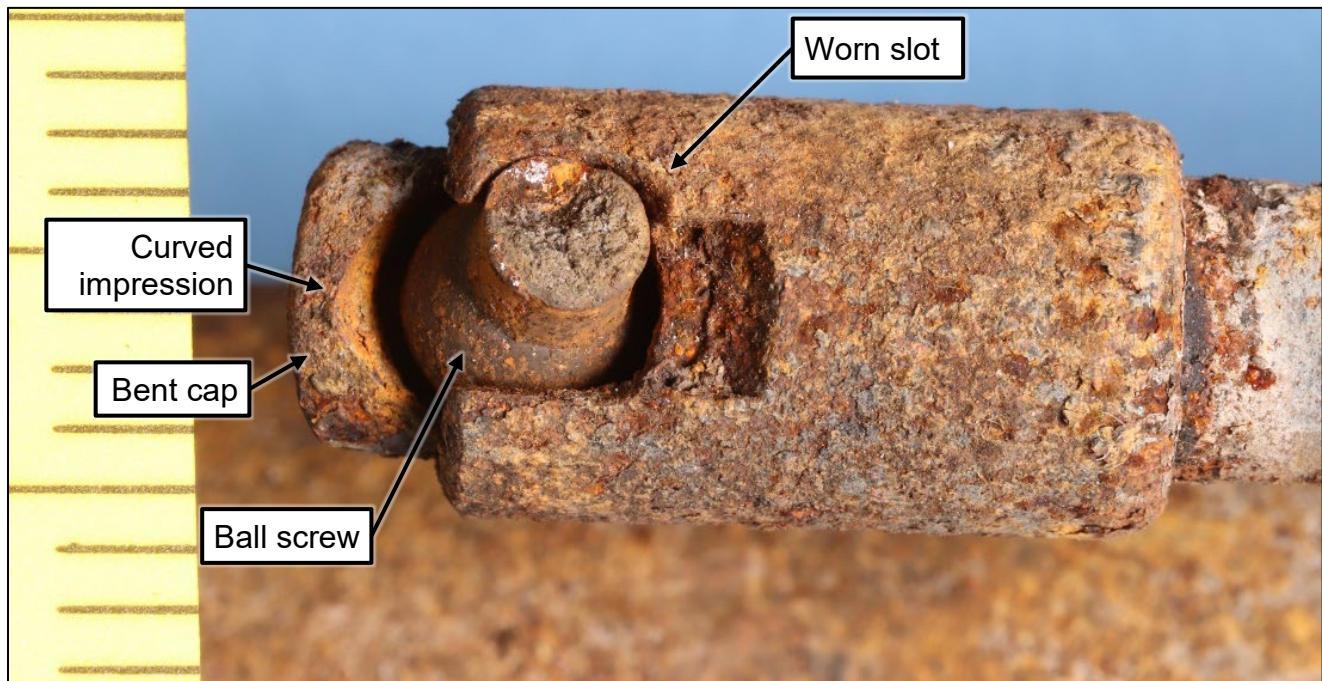


Figure 2. Throttle ball joint with fractured ball screw.

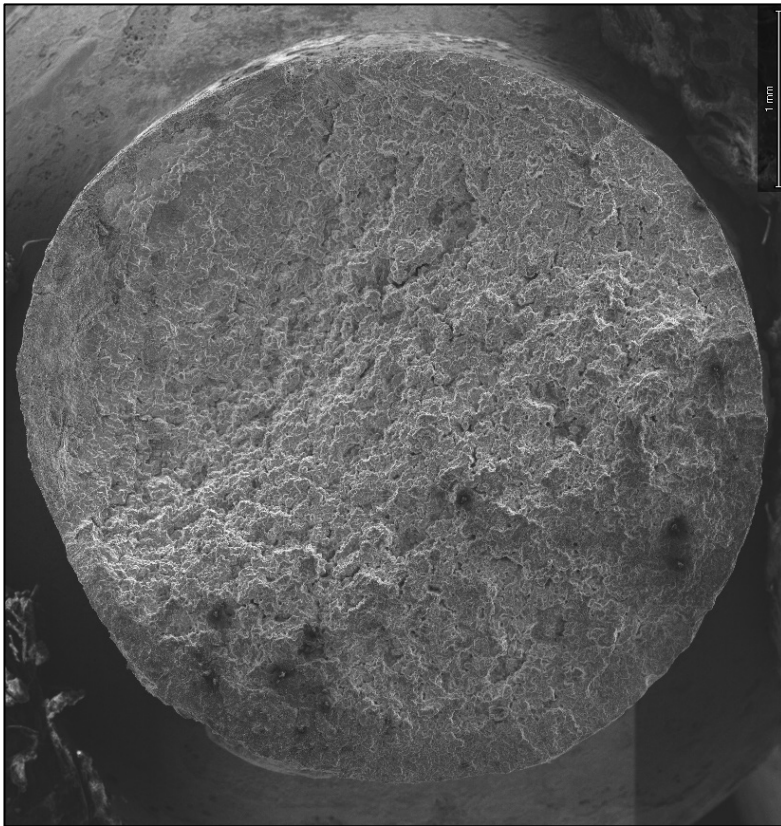


Figure 3. Montage of SEM images showing the cleaned and deoxidized ball screw fracture surface.

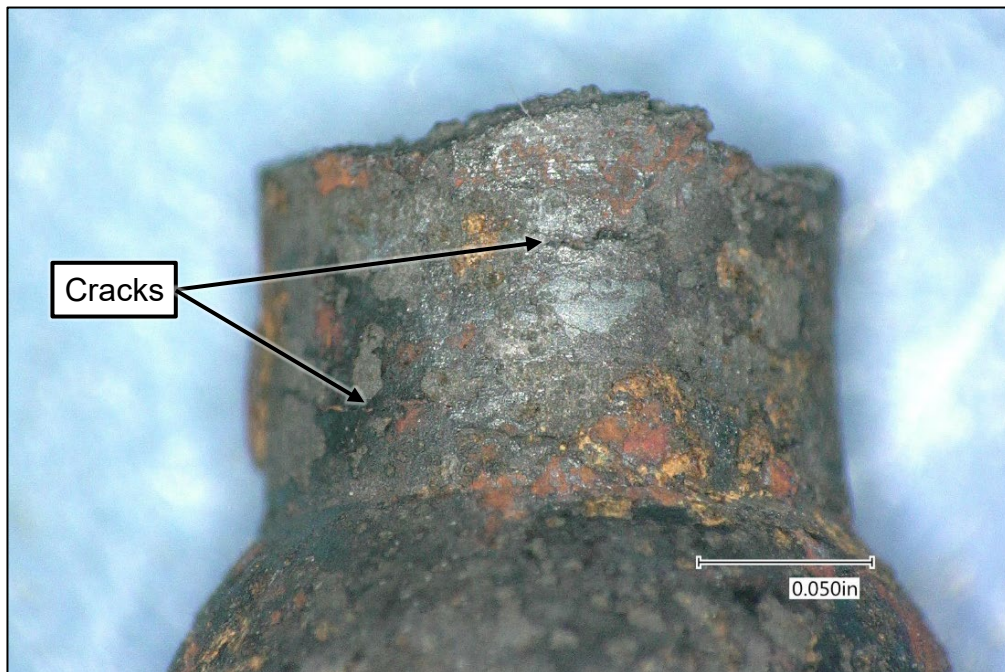


Figure 4. Side of the ball screw at the 3 o'clock position in figure 3 after disassembly, cleaning, and deoxidation showing secondary cracks in the shank.