

NATIONAL TRANSPORTATION SAFETY BOARD

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



February 2, 2016

MATERIALS LABORATORY FACTUAL REPORT

Report No. 16-006

A. ACCIDENT INFORMATION

Place : Lakeland, Florida
Date : April 20, 2015
Vehicle : Mooney M20TN
NTSB No. : ERA15FA191
Investigator : Shawn Etcher, AS-ERA

B. COMPONENTS EXAMINED

Throttle and mixture control assemblies.

C. DETAILS OF THE EXAMINATION

Overall views of the throttle and mixture control assemblies are shown in figure 1. Both assemblies were discolored and oxidized consistent with exposure to high heat. Remnants of aluminum alloy components on the assemblies were distorted, oxidized, flowed, and missing consistent with having been molten due to exposure to the heat.

The accident airplane reportedly had approximately 15 hours time in service since new at the time of the accident. According to a representative of Mooney International Corporation (Mooney) after referring to manufacturing records, the installed throttle control assembly was Orscheln Products, L.L.C. (Orscheln) part number 660226-027, and the installed mixture control assembly was McFarlane Aviation, Inc. (McFarlane) part number 660226-005. No identifying information was found on the throttle control assembly, but the overall construction was consistent with engineering drawings of the part provided by Orscheln. The manufacturer and part number for the mixture control matching the Mooney manufacturing records was found on the side of the swivel tube at the output end of the mixture control assembly.

During the examination of the throttle control assembly, representatives from Orscheln participated in the examination. A group examination of the throttle control assembly occurred on September 30, 2015.

1. Throttle Control Assembly

Closer views of the input and output ends of the throttle control assembly are shown in figure 2. The position of the input control had been documented on-scene with a line of white paint visible on the release rod and control tube in the upper image

in figure 2 and on the swivel tube and output rod at the output end. The forward portion of the aluminum alloy housing was missing from the input control, exposing the lock coil and cable. The exposed segment of cable had tight wound strands and showed no evidence of “birdcage” deformation¹ that would indicate compression buckling of the cable.

The position of the control was measured at the output end of the assembly and compared to full throttle and idle position descriptions provided by a Mooney representative. As installed on the airplane and measured from the end of the swivel tube to the center of the end fitting attachment hole (see the labeled bracket in figure 2), the full open throttle position measures 4.620 inches, and the full closed throttle position measures 1.3 inches. On the accident control, the throttle position measurement was 3.75 inches, corresponding to a throttle position of 74% of full open.

The throttle control assembly was initially examined visually, and the position of the internal mechanism was documented using x-ray radiography. Once the initial documentation was complete, attempts were made to operate the input control by pressing the release rod, and the release rod moved in and out easily with little resistance.

Additional x-ray radiographs were taken documenting the input control lock mechanism of the throttle control assembly with the release rod in varying positions as shown in figures 3 and 4. With the release button fully extended, the pawl engaged with the lock coil as shown in the upper image in figure 3. As the release rod was pressed in, the pawl disengaged from the lock coil, and the control was able to move relative to the coil as shown in the lower image in figure 3. The radiograph in figure 4 shows the position of the pawl with the release rod pressed in to its forward limit, and the pawl is retracted further into the control tube as compared to the position shown in the lower image in figure 3.

The range of operation of the release rod was measured from the lock position to the full release position. In the lock position (upper image in figure 3), the release rod extended 0.733 inch aft of the aft face of the nut on the aft end of the control tube. With the pawl just disengaged (lower image in figure 3), the release rod extended 0.605 inch from the nut. When the release rod was fully depressed (figure 4 position), the rod extended 0.425 inch from the nut.

Photographs of the lock mechanism in positions comparable to those of figure 3 are shown in figures 5 and 6. In figure 5, the pawl is shown engaged with the lock coil with the release rod fully extended. In figure 6, the pawl is shown disengaged from the lock coil after the release rod was pressed in sufficiently to disengage the lock.

At the output end of the throttle control assembly, the inspection hole in the end fitting was open across the fitting. In figure 7, a wire is shown inserted through the fitting in the inspection hole, demonstrating the inspection hole was open through the

¹ Birdcage deformation is outward splaying of the strands of the cable due to compression buckling.

thickness of the end fitting. Based on an x-ray inspection, the end fitting was threaded onto the end of the output rod such that the end of the rod was just aft of the inspection hole. Upon further inspection, the end of the rod was visible by looking through the inspection hole with an optical microscope.

Next, force required to move the cable through the conduit was measured. First, the conduit at the input end was held fixed, and the output end fitting was pulled with a force gauge. The output rod displaced approximately 0.30 inch with a force of 23 pounds. Next the conduit was held fixed while the control tube was pulled, and a displacement of approximately 0.33 inch was obtained with a force of 25 pounds.

After measuring the force to move the cable as described above, the cable was cut at the input end adjacent to the control tube to facilitate its removal from the conduit. Initial movement of the cable within the conduit occurred again at 23 pounds, but quickly increased to 43 pounds, approaching the capacity of the force gauge. The conduit was straightened by hand, and during the straightening process, wires of the conduit fractured. After straightening, approximately 2 feet of cable were removed with a force of less than 43 pounds. The cable was removed the rest of the way without measuring force.

On the cable, black charred material was observed 13 inches to 21 inches from the output end fitting attachment hole, and the conduit liner was melted and adhered to the cable at 33 inches to 38 inches from the output end fitting attachment hole consistent with heat damage to the liner. Additional cuts were made to inspect the output end of the assembly components between the conduit and the swivel tube. Results of the inspection showed further evidence of heat damage. Debris consistent with the conduit liner was observed near the output end of the conduit and appeared to have been displaced during removal of the cable. The debris was cleaned with acetone and air, and additional debris was removed with tweezers and cotton-tipped swabs. No obstructions were observed once the liner debris was removed.

2. Mixture Control Assembly

Closer views of the input and output ends of the mixture control assembly are shown in figure 8. As with the throttle control assembly, the positions of the mixture control assembly had been documented on-scene with a line of white paint on the release rod, control tube, and lock tube on the input end visible in the upper image in figure 8 and on the swivel tube and output rod on the output end visible in the lower image in figure 8. Remnants of an aluminum alloy housing was present at the aft end of the lock tube.

The mixture control position was measured at the output end of the assembly and compared to full rich and idle cut-off position descriptions provided by a Mooney representative. As installed on the airplane and measured from the clamp attach point to the center of the end fitting attachment hole (see the labeled bracket in figure 8), the full rich mixture position measures 7.70 inches, and the idle cut-off position measures

5.35 inches. On the accident control, the mixture position measurement was 6.70 inches, corresponding to a mixture position of 57% of full rich.

The mixture control assembly was initially examined visually, and the position of the internal mechanism in the input control was documented using x-ray radiography as shown in figures 9 and 10. The lock ball was engaged with an internal groove in the lock tube as shown in the upper image in figure 9. Near the middle of the tube, shown in the lower image in figure 9, the release rod was positioned closer to one wall of the control tube leaving a gap on one side and no gap on the other side. At the input end shown in figure 10, the gap between the release rod and the control tube was similar on both sides. Once the initial documentation was complete, attempts were made to operate the input control by pressing the release rod, and the release rod did not move.

To facilitate direct examination of the lock mechanism, the lock tube was sectioned circumferentially using a pipe cutting tool near the forward end and then longitudinally with an small abrasive wheel along sides approximately 90 degrees to the lock ball. During the course of the longitudinal cuts to remove the lock tube, one of the cuts also inadvertently penetrated the wall of the control tube forward of the lock ball location.

A view of the input assembly after sectioning the lock tube is shown in figure 11. The cable segment between control tube and the conduit was tightly wound and showed no evidence of birdcage deformation.

After sectioning, the release rod did not move inward, and the lock ball remained fixed in place. Next, the release rod was pulled outward (aft), resulting in movement and separation of the lock ball from the control tube. Attempts to push the release rod back inward were unsuccessful. A deformation lip associated with the longitudinal cut that penetrated the control tube appeared to interfere with movement of the release rod.

To facilitate separation of the release rod and examination of the control rod interior, the forward end of the control tube was sectioned longitudinally along sides 90 degrees from the lock ball hole and circumferentially just forward of the roll groove (see figure 12). After the cuts were complete, the release rod was pulled out the aft end of the input control.

The release rod was slightly bent consistent with observations from the radiographs. In the view shown in figure 12, the middle portion of the release rod was 0.015 inch higher than the ends.

A close view of the interior of the control tube in the area of the lock mechanism is shown in the lower image in figure 12. On the side opposite from the lock ball hole, corrosion was observed as indicated, and the pattern of the corrosion was consistent with an area of contact between the forward end of the release rod and the control tube interior.

The inside diameter of the control tube adjacent to the circumferential cut was 0.210 inch. The inside diameter of the control tube was reduced in the area of the roll groove (see labeled groove in figure 12). Based on the profile of the roll groove at the edges of the cut, the roll groove deformation penetrated approximately 0.008 inches from the rest of the wall, resulting in an estimated inside diameter of 0.194 inch at the roll groove. The outside diameter of the release rod measured 0.187 inch.

Matthew R. Fox
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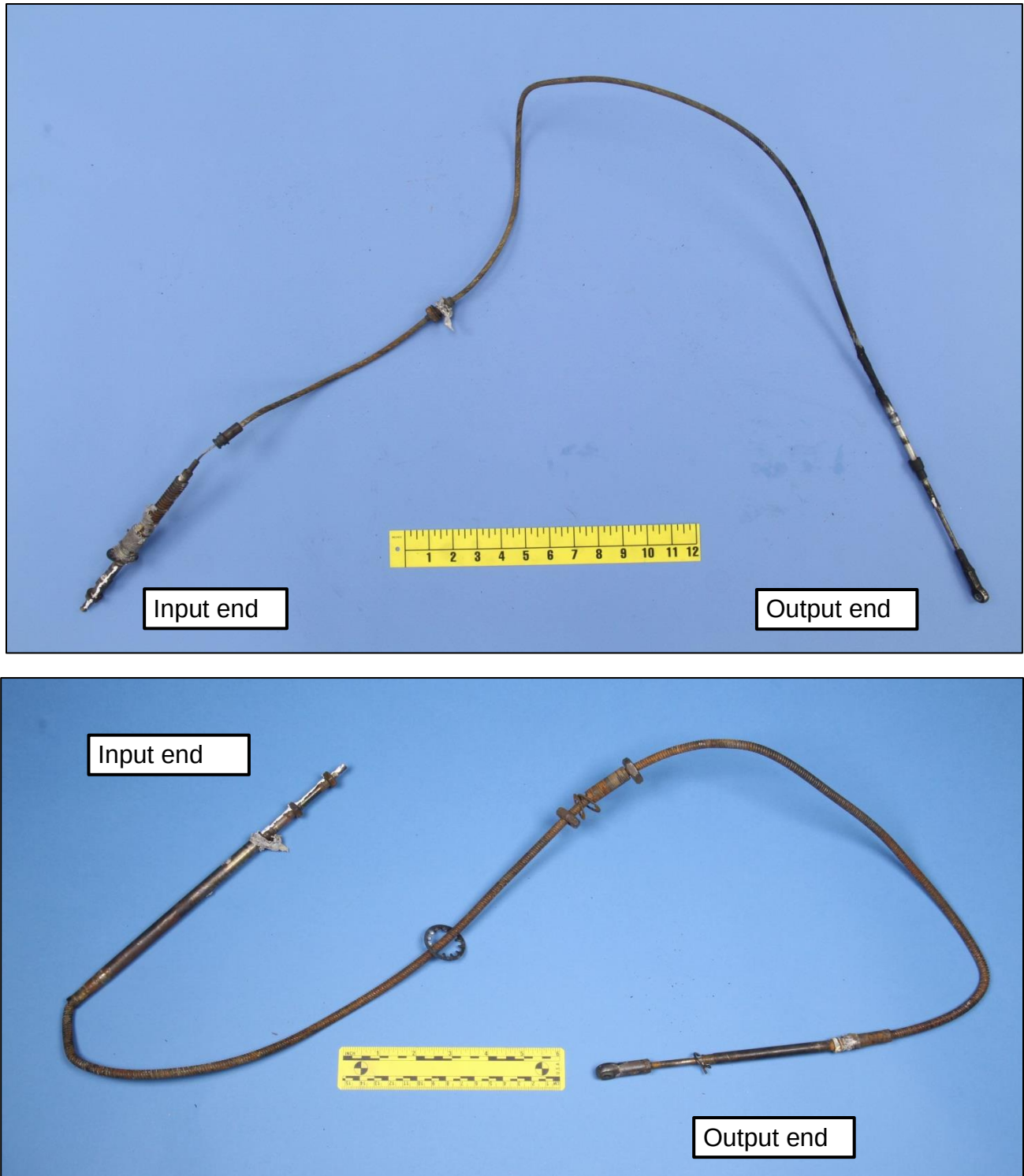


Figure 1. Overall views of the throttle control assembly (upper image) and the mixture control assembly (lower image).

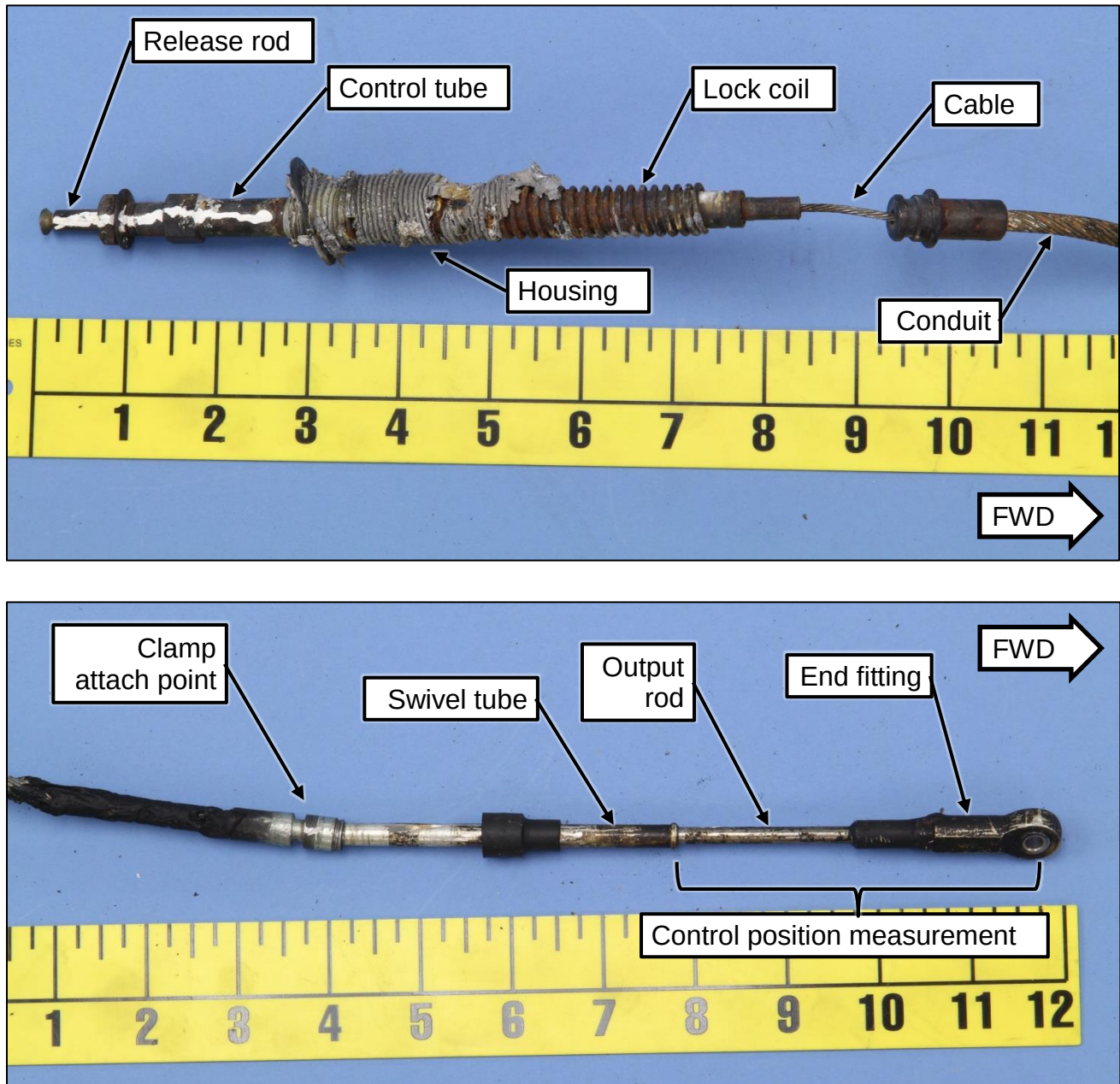


Figure 2. Closer view of the throttle control assembly at the input end (upper image) and output end (lower image).

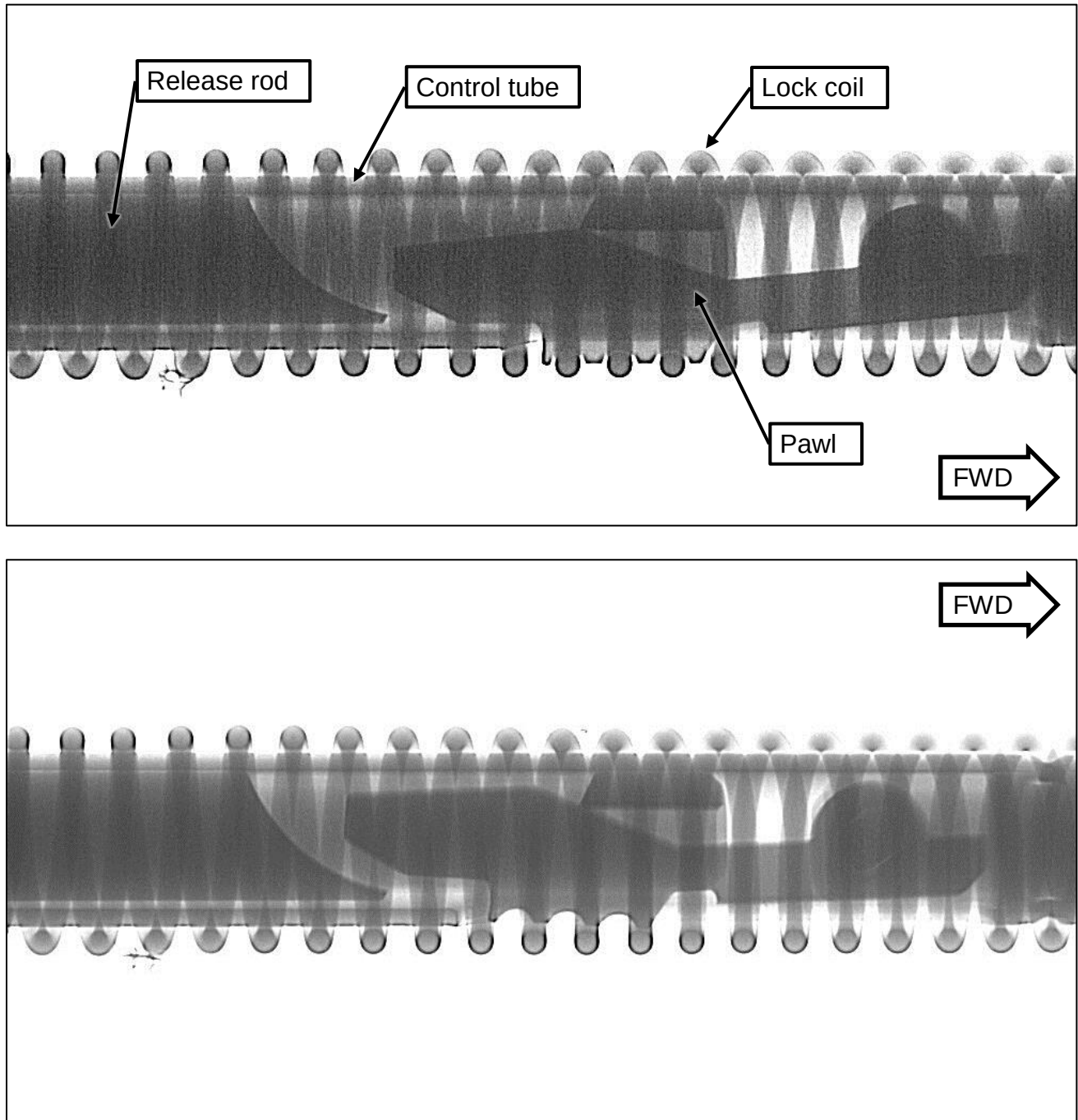


Figure 3. Radiographs of the input control lock mechanism in the throttle control assembly in the locked position (upper image) and in the just unlocked position (lower image).

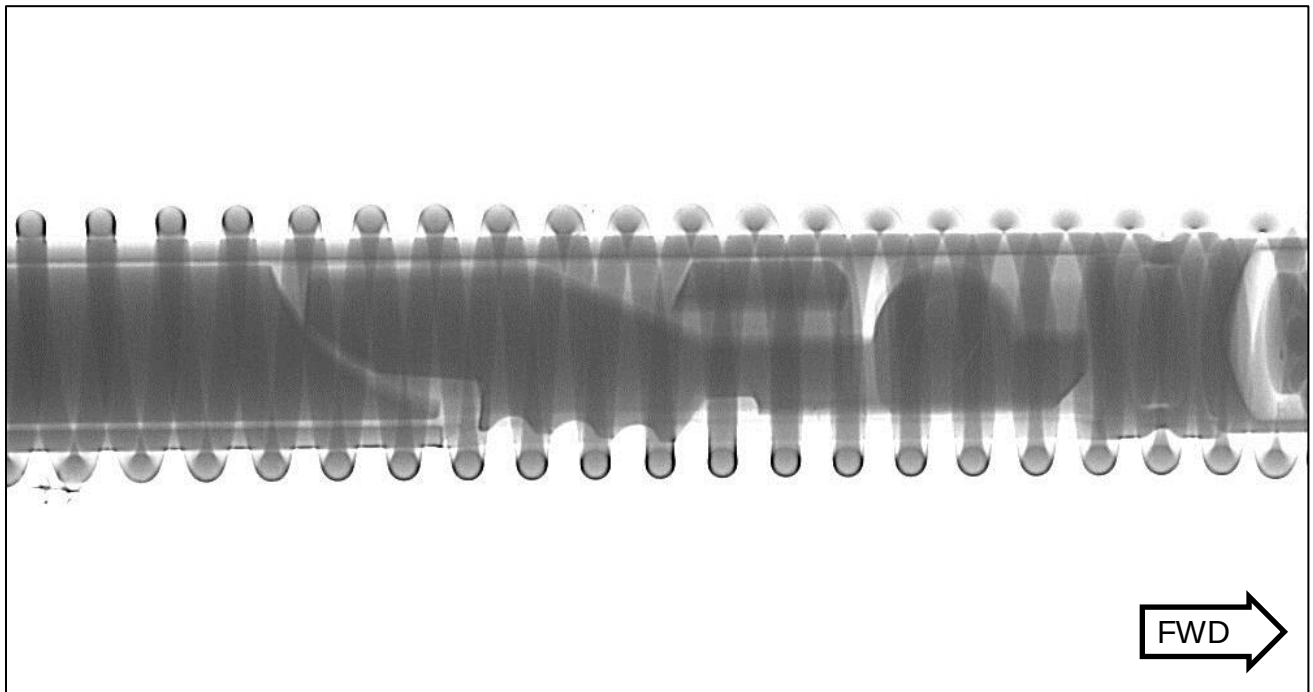


Figure 4. Radiograph of the input control lock mechanism in the throttle control assembly with the lock mechanism fully retracted.

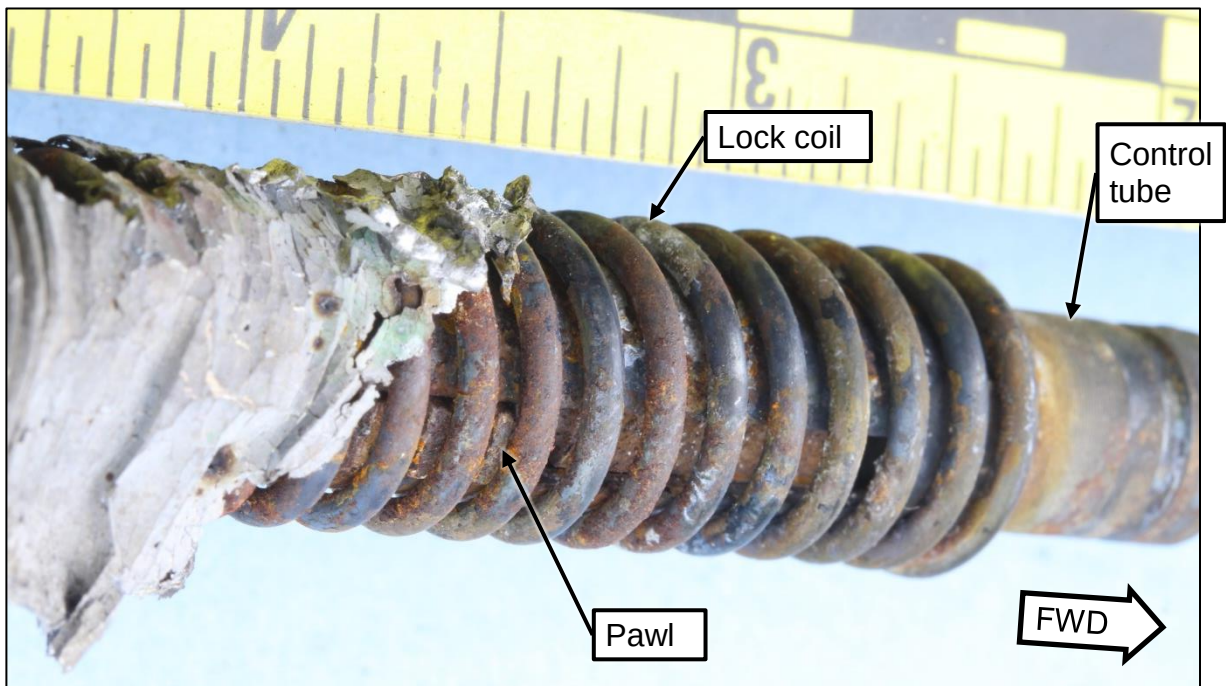


Figure 5. View of the input control lock mechanism for the throttle control assembly with the pawl engaged with the lock coil.

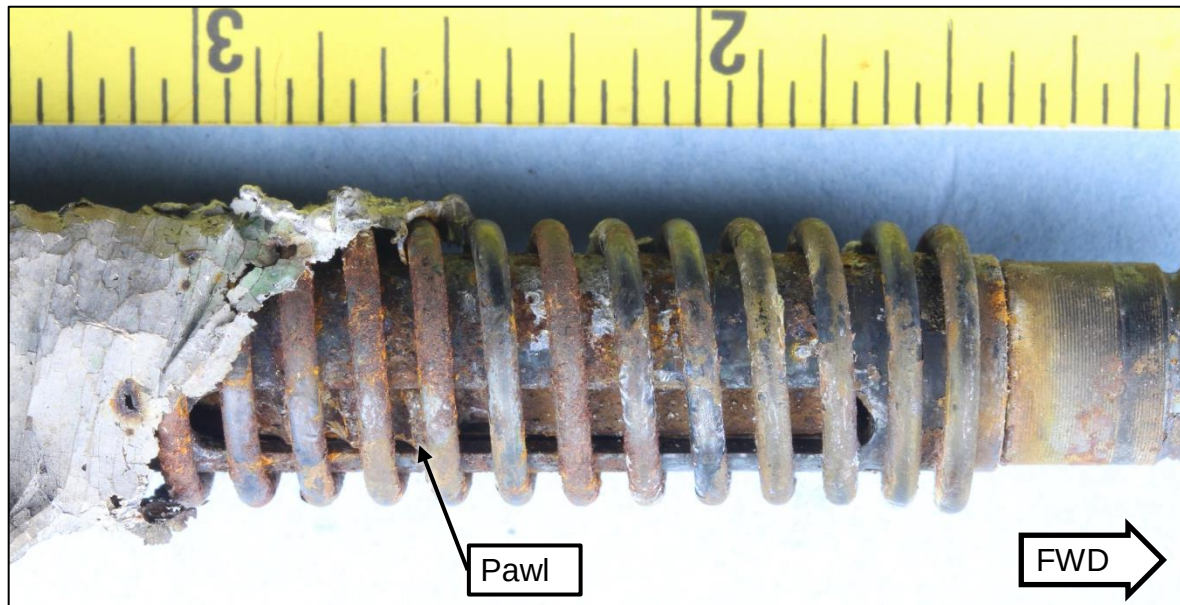


Figure 6. View of the input control lock mechanism for the throttle control assembly with the pawl disengaged from the lock coil.

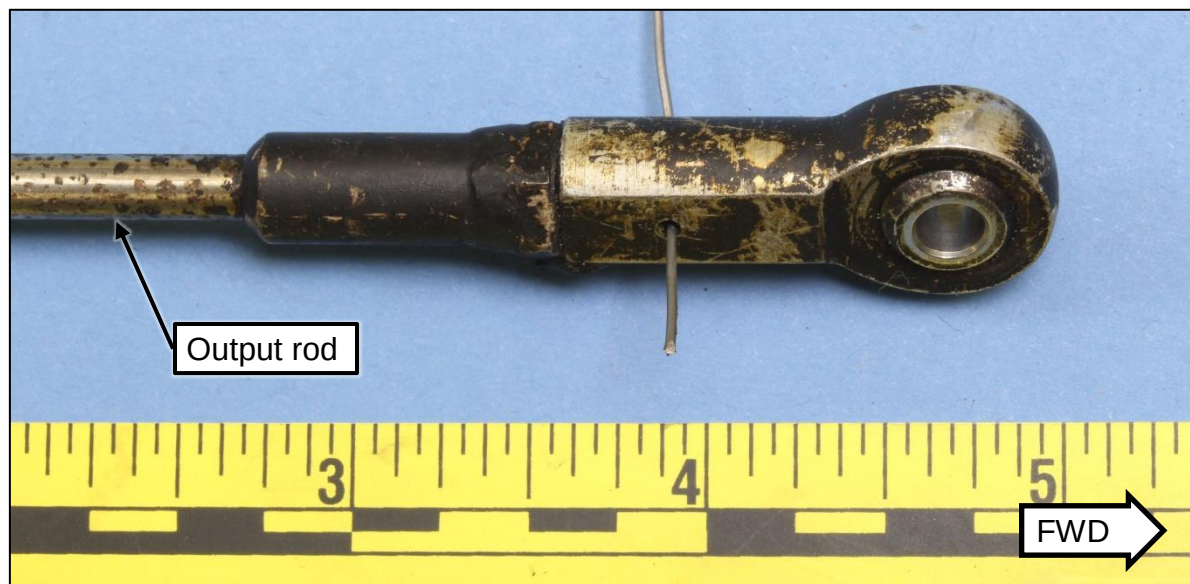


Figure 7. View of the end fitting at the output end of the throttle control assembly with a wire inserted through the inspection hole.

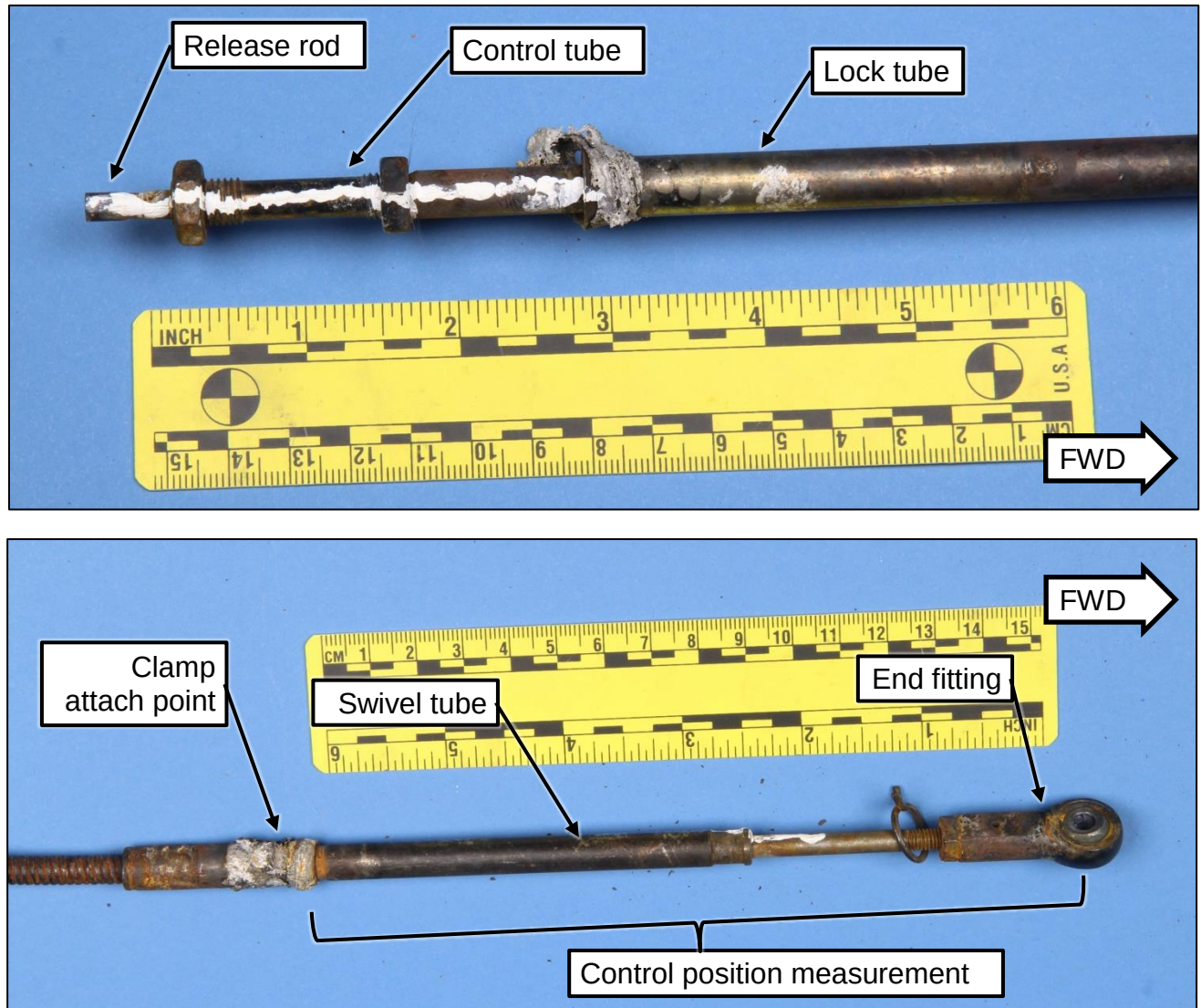


Figure 8. Close views of the input end (upper image) and output end (lower image) of the mixture control assembly.

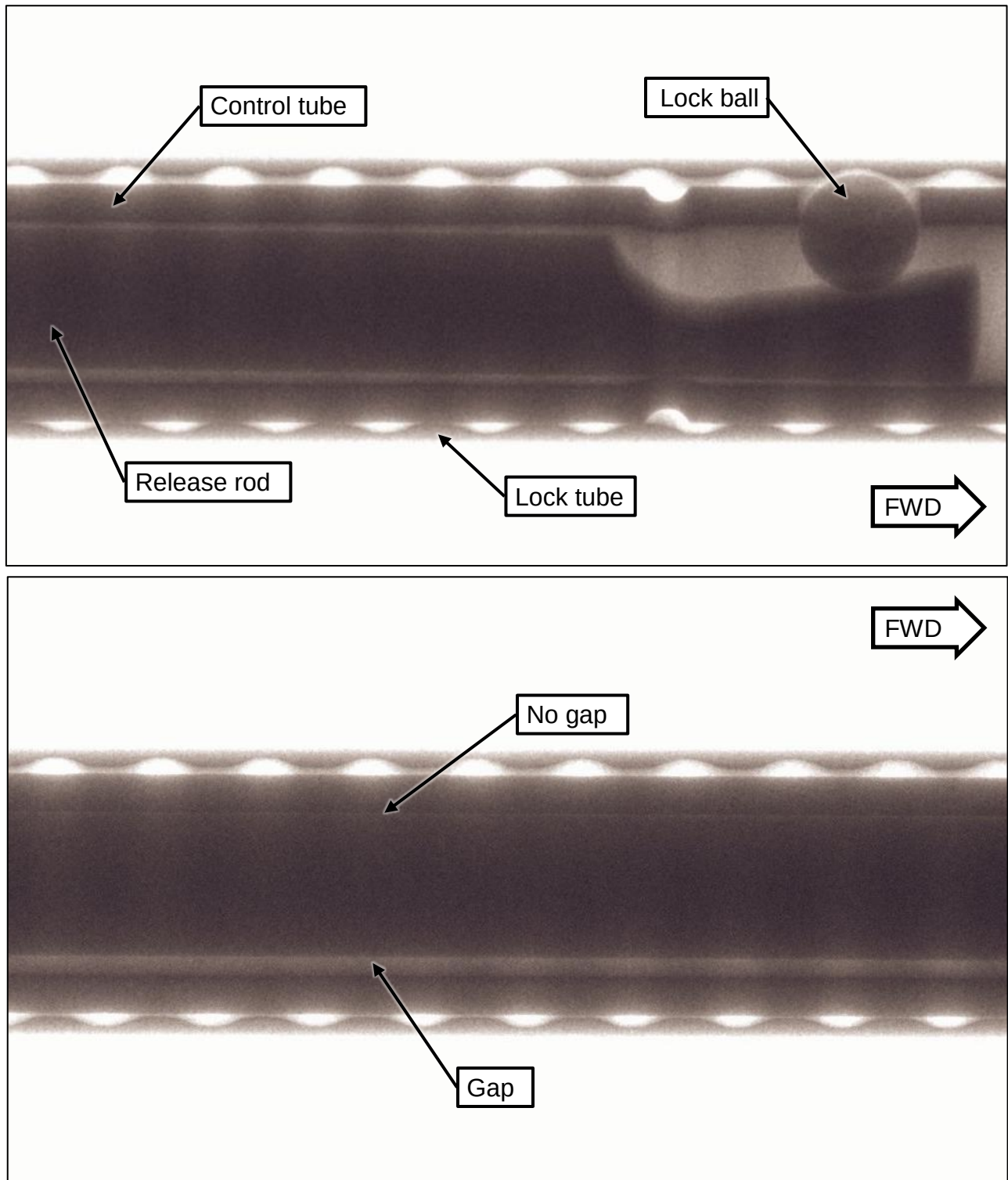


Figure 9. Radiographs of the lock mechanism (upper image) and the middle portion (lower image) of the mixture input control.

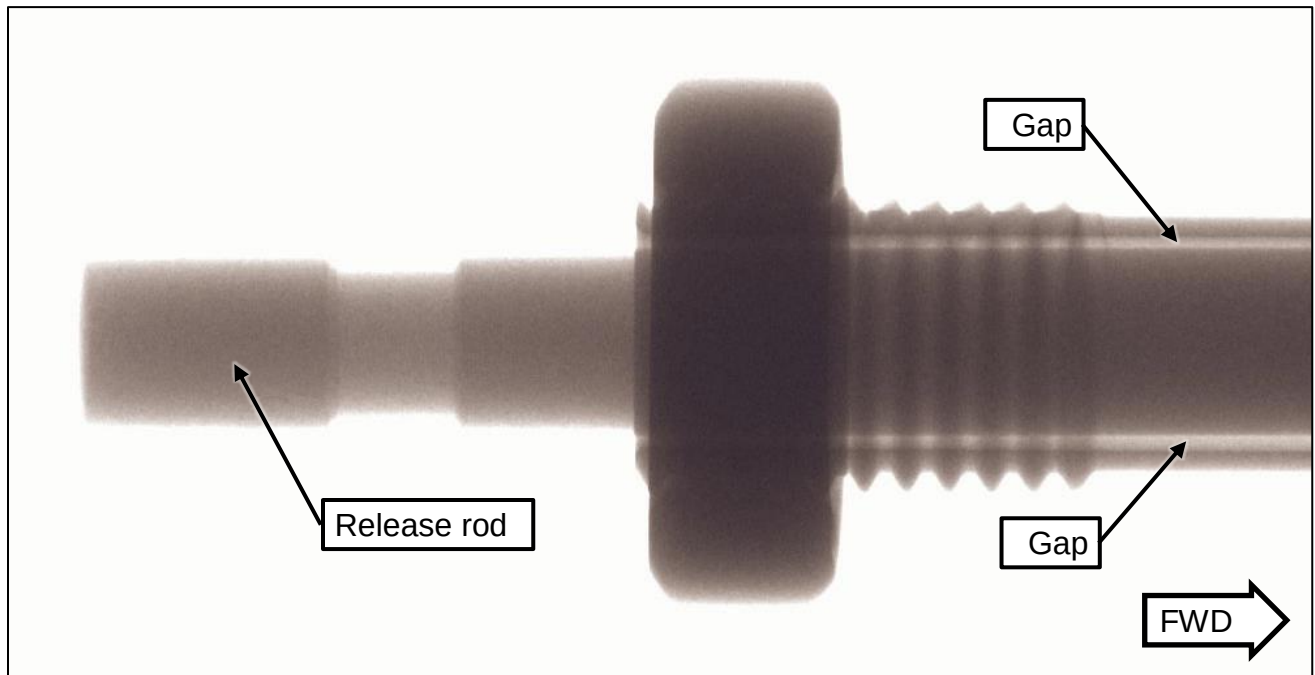


Figure 10. Radiograph of the input end of the mixture control assembly.

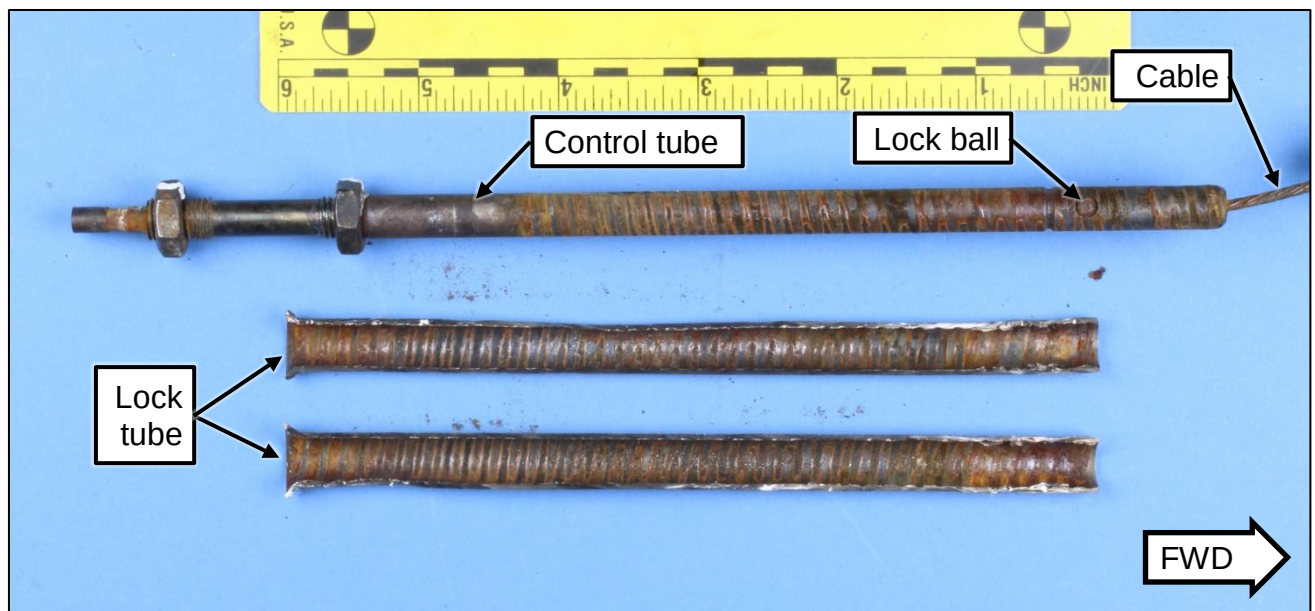


Figure 11. View of the input end of the mixture control assembly after sectioning the lock tube.

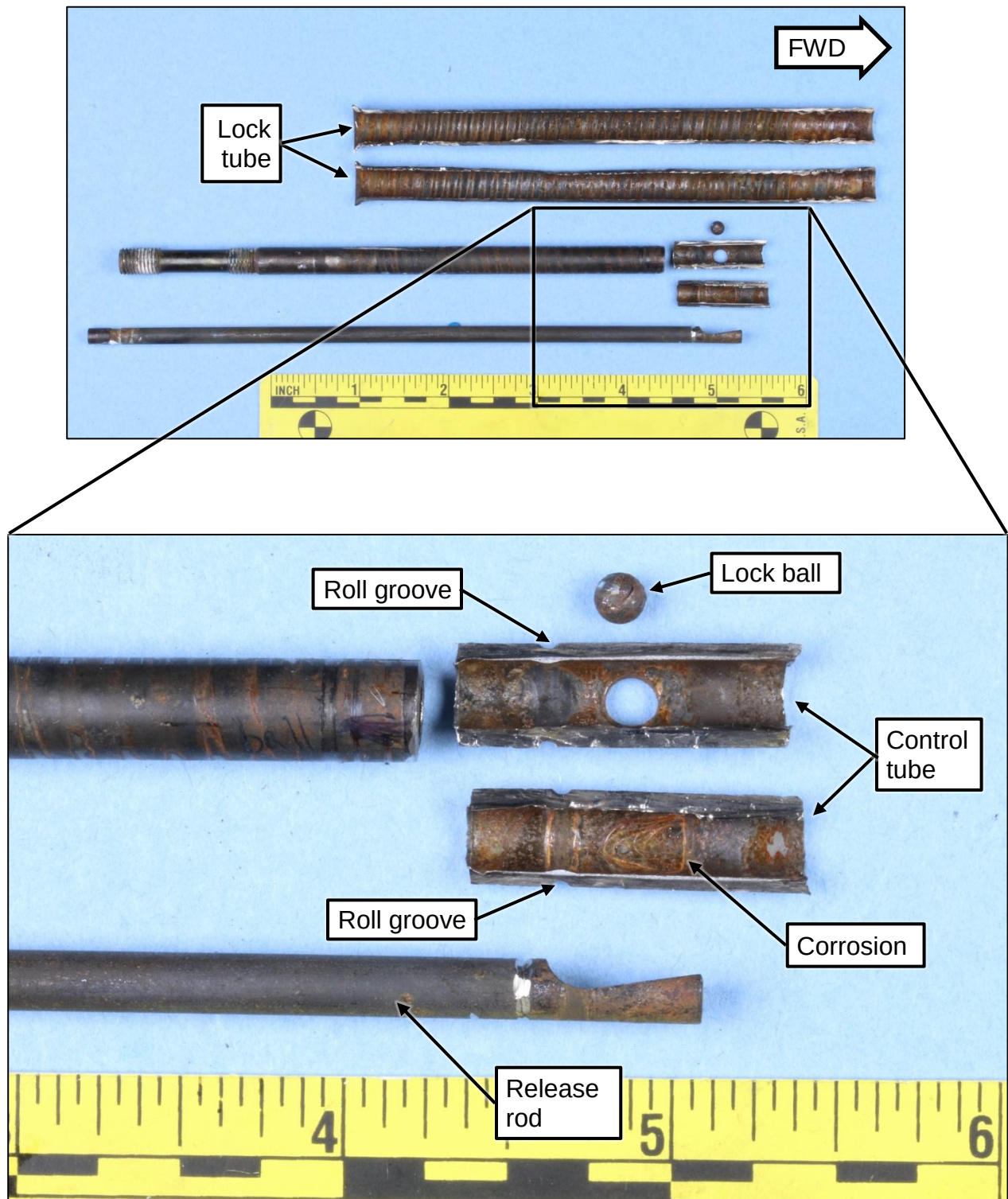


Figure 12. Views of the mixture input control lock mechanism after sectioning the control tube and removing the release rod from the control tube.