

NATIONAL TRANSPORTATION SAFETY BOARD

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



August 27, 2018

MATERIALS LABORATORY FACTUAL REPORT

Report No. 18-070

A. ACCIDENT INFORMATION

Place : Cleveland, Tennessee
Date : July 26, 2018
Vehicle : Cessna 182P, N1311S
NTSB No. : ERA18LA199
Investigator : Timothy W. Monville, AS-ERA

B. COMPONENTS EXAMINED

Ignition switch assembly and key.

C. DETAILS OF THE EXAMINATION

Overall views of the submitted ignition switch assembly and key are shown in figure 1. The ignition switch had a data tag indicating it was Cessna Aircraft part number C292501-0105 made by Gerdes Products Company and a date stamp indicating it was made in 1976. In the lower image, the switch is shown positioned in the off position. A red line marked on the switch body reportedly indicated the position of the key slot as found after the accident, a position rotated slightly clockwise from the off position shown in figure 1. Prior to receipt in the NTSB Materials Laboratory, the switch had been tested and then disassembled at ACS Products Company, Lake Havasu City, Arizona. According to the test report, the right magneto was hot (not grounded) with the key positioned in line with the red mark.

The key reportedly could be removed from the ignition switch when positioned at any of the 5 switch positions. Starting from the "OFF" position and rotating clockwise, the key positions are "R" for right magneto, "L" for left magneto, "BOTH" for both magnetos, and "START" for start position. After initial photography was completed, the key was inserted in the key slot and rotated to positions other than off, and it was found that the key could be removed with minimal effort from each position including the "OFF" position and positions other than the "OFF" position.

Next the switch assembly was disassembled as shown in figure 2, where the key cylinder and the cylinder housing are shown. In order to operate the switch as designed, the key cylinder rotates within the cylinder housing. Spring-loaded levers in the cylinder (see figure 3) prevent operation of the lock unless a matching key is inserted. In the off position without a key inserted, the levers spring into an axial slot in the cylinder housing wall to prevent rotation of the cylinder within the housing. With the proper key in place,

the levers align with the outer diameter of the cylinder as shown in figure 3, thereby allowing the cylinder to rotate within the cylinder housing. Once the key is rotated from the "OFF" position, the key should be retained within the cylinder since removing the key should cause one of the levers to extend beyond the cylinder diameter (see figure 4). In positions other than "OFF", the lever movement beyond the cylinder diameter is prevented by contact with the inner diameter of the cylinder housing. In the "OFF" position, the levers can extend into an axial slot in the housing, allowing the key to be removed.

In order to test and observe the key and lever movement within the cylinder as they would occur in positions other than "OFF", a wood stick was attached to the lower side of the cylinder as shown in figures 3 through 5. The wood stick prevented movement of the levers beyond the cylinder diameter on the lower side of the cylinder, thereby simulating being inserted in the cylinder housing in positions other than "OFF" while allowing viewing of the lever action on the upper side of the cylinder as the key was inserted and removed from the cylinder.

Next the key was manipulated within the cylinder, and movements of the levers were observed. Figure 3 shows the key fully inserted in the cylinder with all levers flush to the outer diameter of the cylinder. Next, the key was removed by pulling the key axially out of the slot. As the key moved, one of the levers identified as the key retention lever raised up as shown in figure 4. The key retention lever was raised by engagement with a ridge on the key identified as the key retention ridge in figure 6. With the lever engaged on the key retention ridge as shown in figure 4, the lever extended beyond the outer diameter of the cylinder, which would only be possible in the cylinder housing if the cylinder was in the "OFF" position.

In a separate test, the head of the key was raised upward as the key was removed from the key slot. As the key was removed, minimal movement of the key retention lever was observed. The axial displacements of the key in figures 4 and 5 are similar, but in figure 5 the head of the key was raised upward. In the key position shown in figure 5, the key retention lever was nearly flush with the outer diameter of the cylinder.

A close view of the key for the ignition switch is shown in figure 6. The ridge associated with movement of the key retention lever as the key was removed from the cylinder is indicated. The cut surfaces of the key notches were examined. Relatively smooth and reflective surface features consistent with a worn surface were observed on the flank of the notch adjacent to the key retention ridge as indicated in the middle image in figure 6. A smooth and reflective surface consistent with wear was also observed on the tip end of the shank opposite the notched side as indicated in the lower image in figure 6. No unused key was available for comparison to determine the extent of wear associated with the worn surfaces.

Views of the upper side of the key cylinder are shown in figure 7. A quadrilateral-shaped area with a smooth and reflective surface consistent with wear was observed on the lower side of the key slot as shown in the lower image in figure 7. The location and

shape of the worn area was consistent with wear contact with the tip of the key as it was inserted and removed. With the key inserted fully to the shoulder, the position of the tip of the key was as indicated in the lower image in figure 7.

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

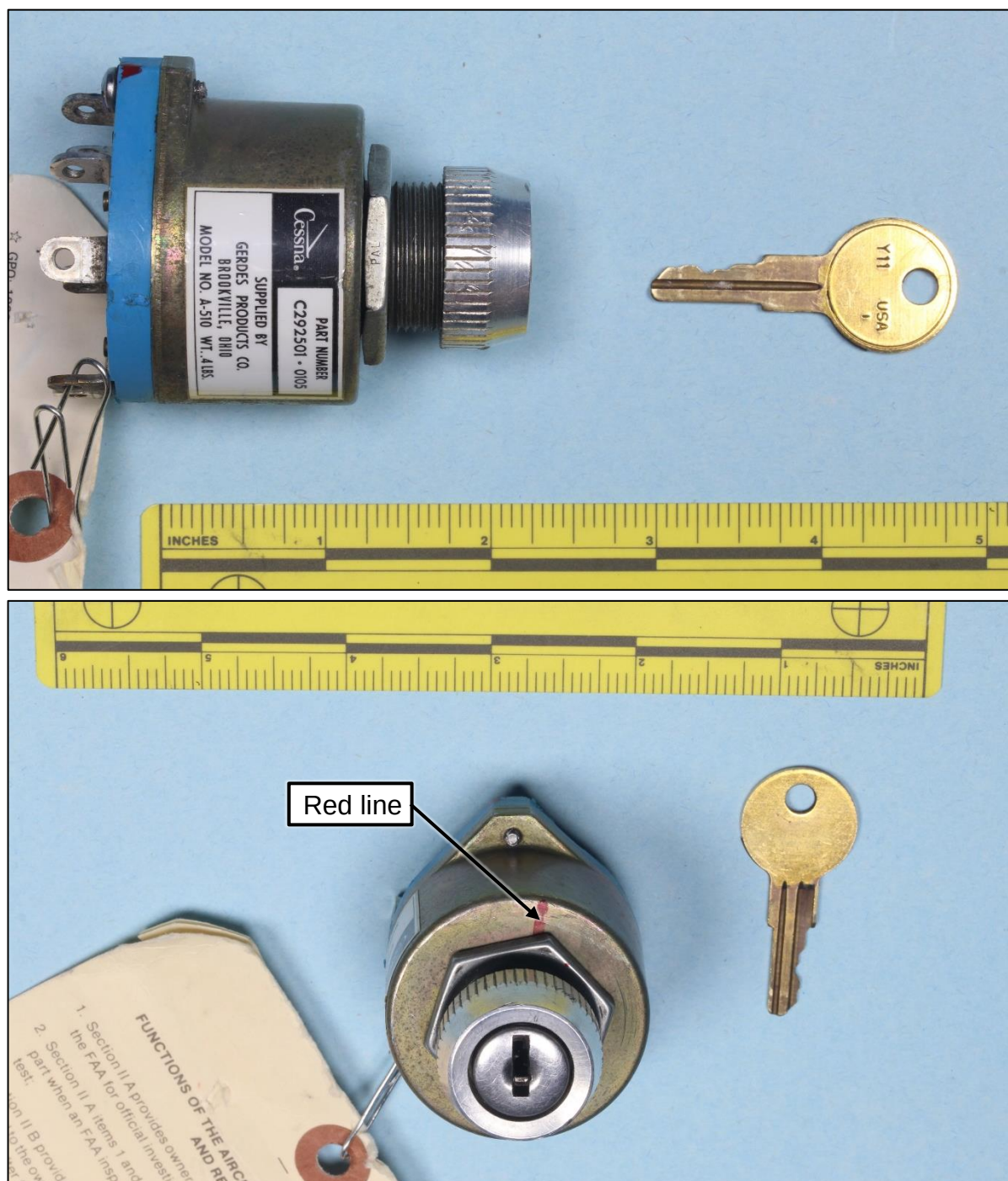


Figure 1. Overall views of the submitted ignition switch and key. The switch in the lower image is positioned in the "OFF" position. The red line indicated in the lower image reportedly marked the switch position as found after the accident.

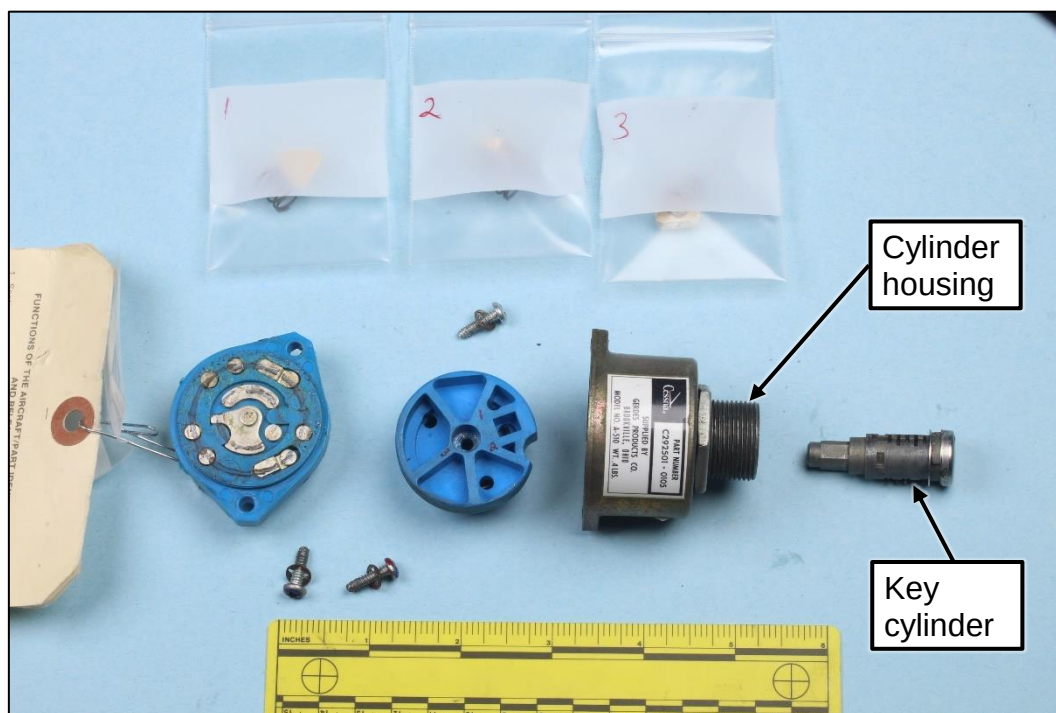


Figure 2. Components of the ignition switch after disassembly. The key cylinder and cylinder housing components are indicated.

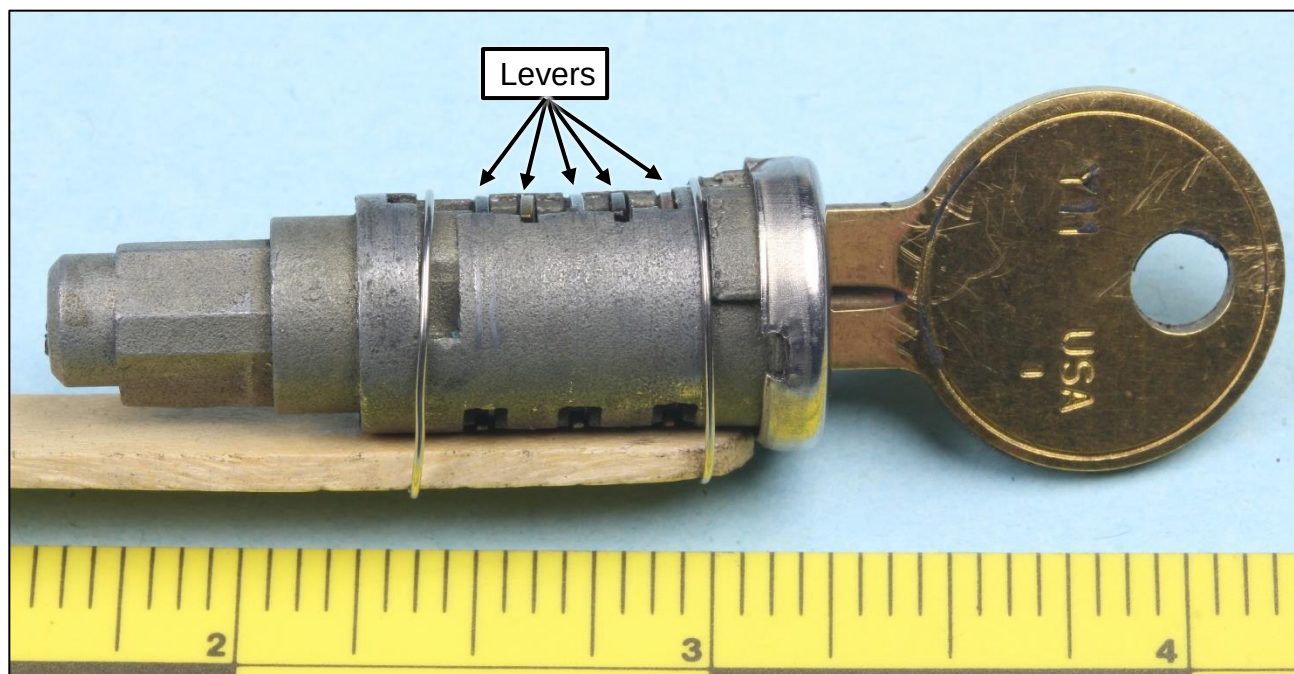


Figure 3. View of the key inserted in the cylinder. A wood stick was attached to the cylinder as shown to constrain downward lever movement, thereby simulating the interior of the cylinder housing with the key in positions other than "OFF" during testing of the lever action.

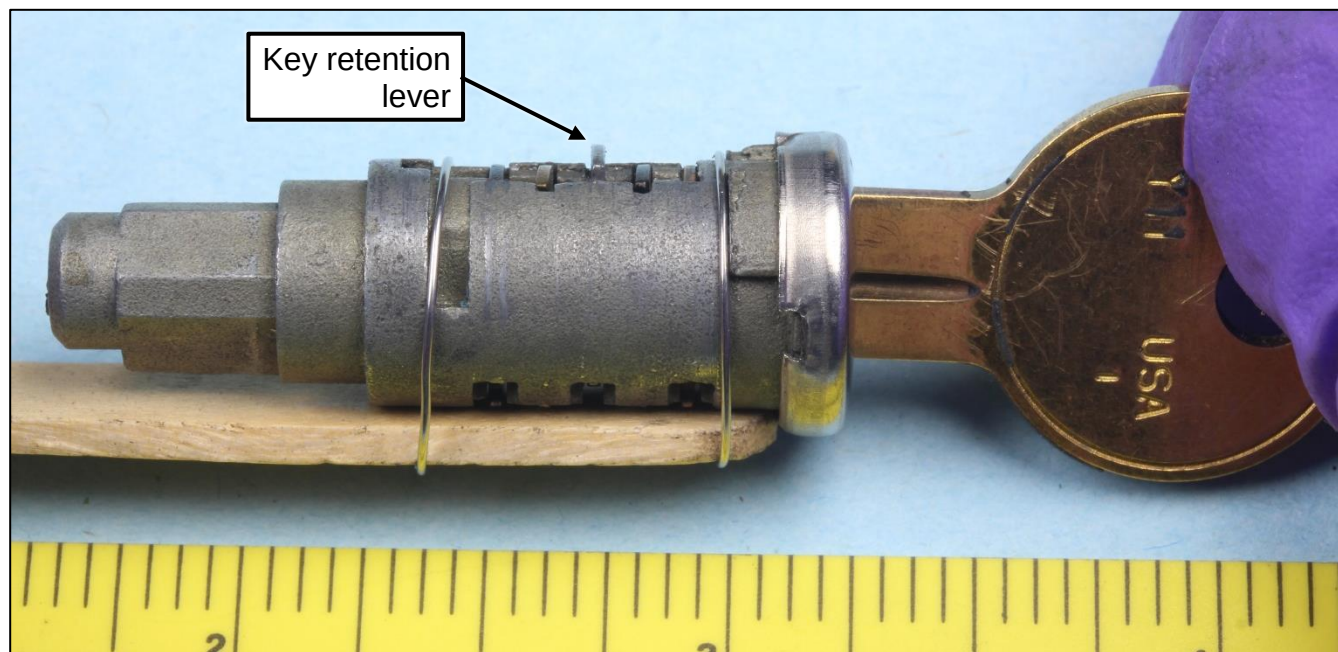


Figure 4. View of the cylinder with the key partially removed axially. The key retention lever raised due to engagement with the retention ridge on the key (see figure 6).

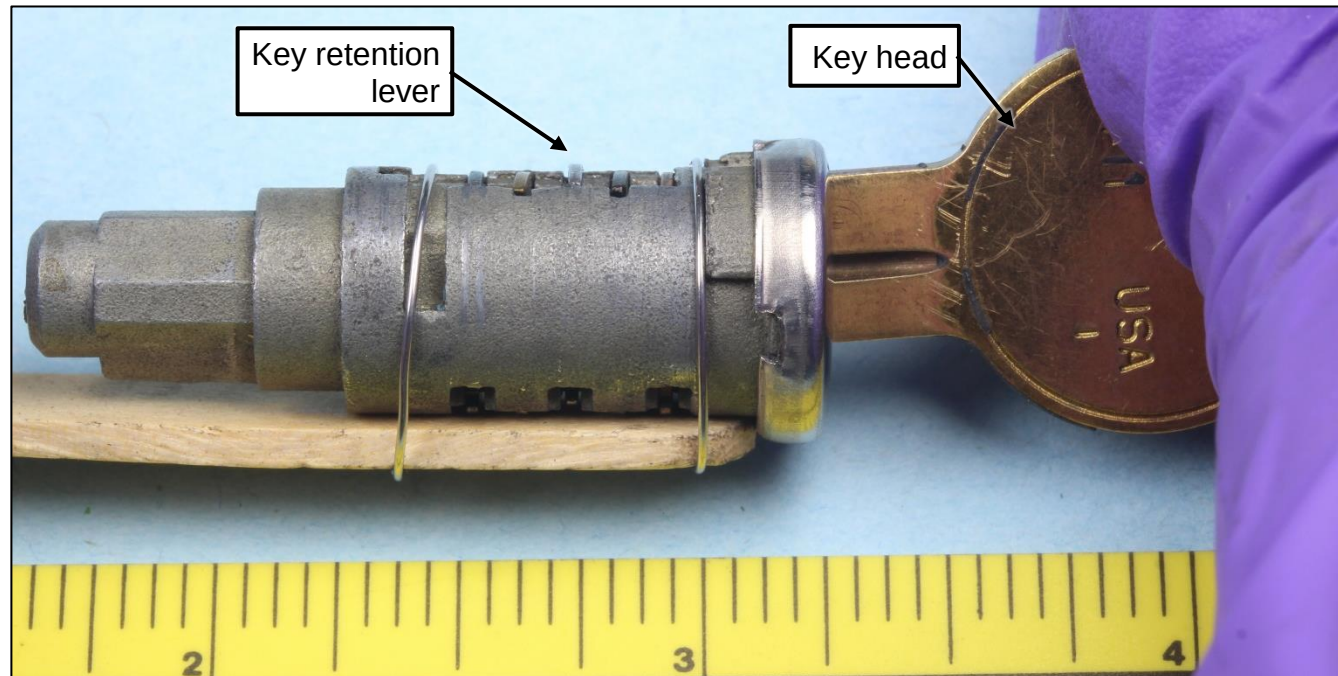


Figure 5. View of the cylinder with the key partially removed as in the prior figure but with the head of the key lifted upward. The key could be removed with limited movement of the key retention lever.

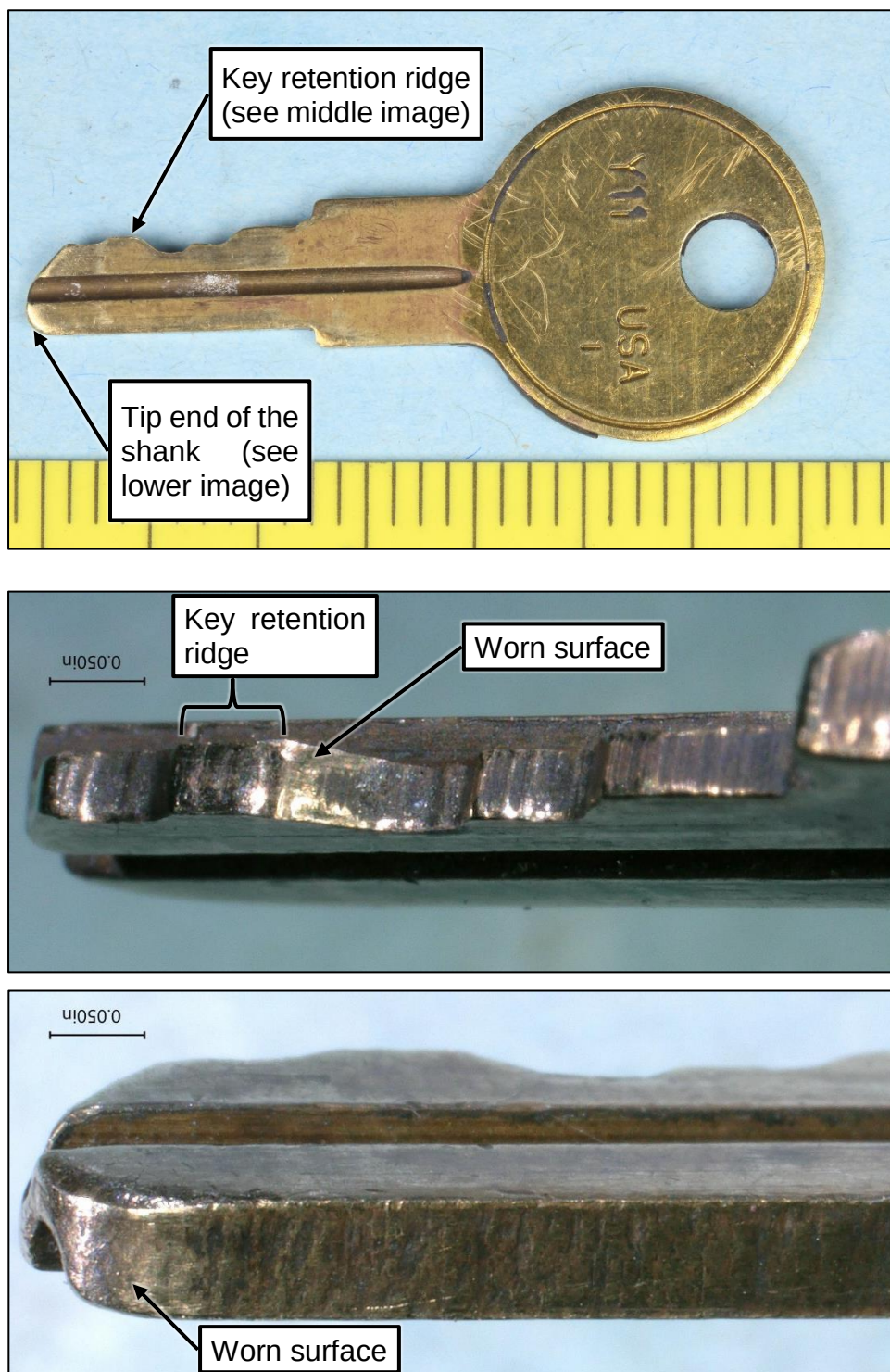


Figure 6. Views of the key. Worn surfaces on the side of the notch adjacent to the key retention ridge (middle image) and on the lower surface at the tip end of the shank (lower image) are shown.

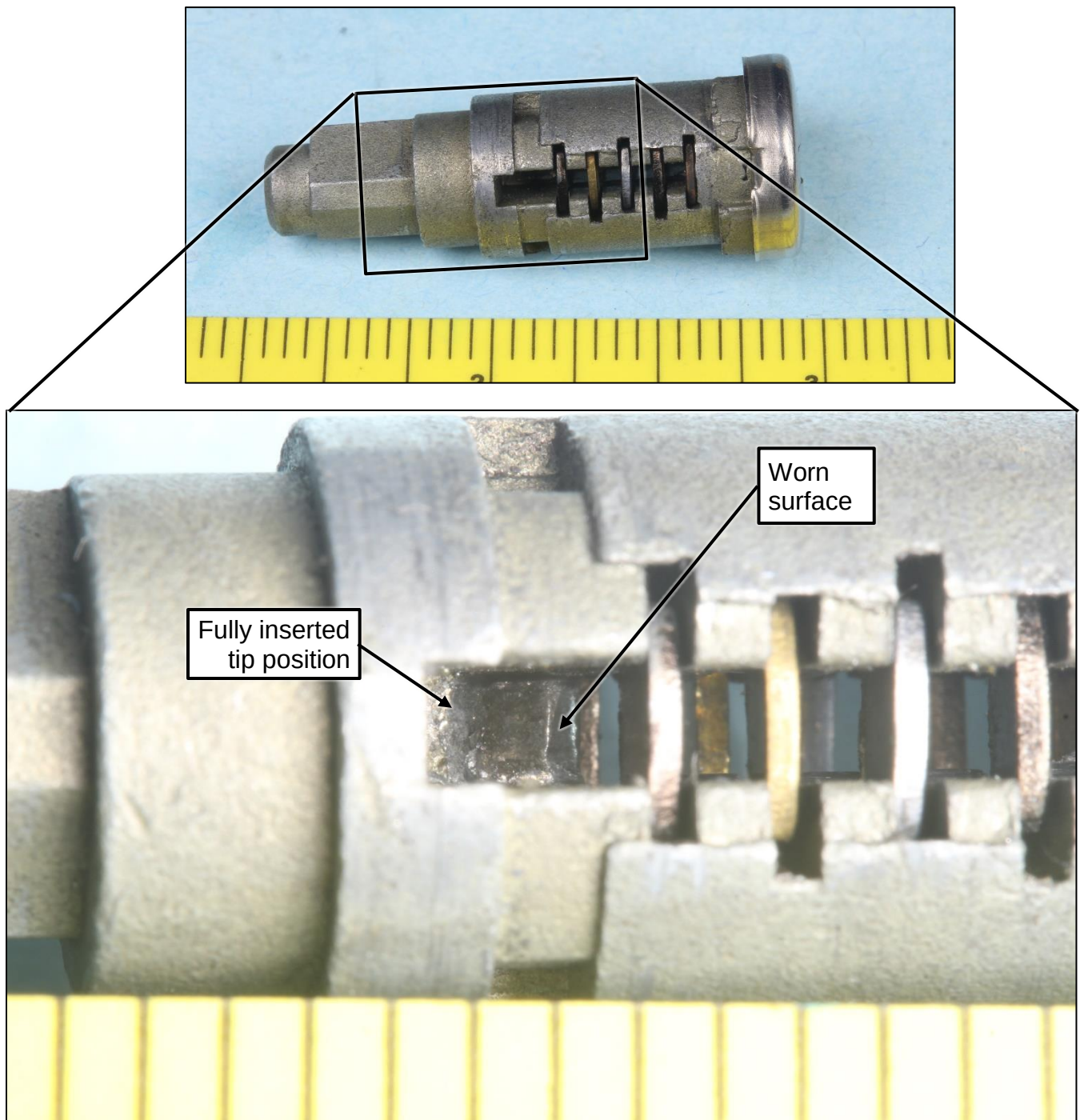


Figure 7. View of the keyway slot in the cylinder. A worn surface on the lower side of the keyway slot is indicated.