

# NATIONAL TRANSPORTATION SAFETY BOARD

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



October 11, 2002

MATERIALS LABORATORY FACTUAL REPORT

Report No. 02-091

## A. ACCIDENT

Place : Belle Harbor, NY.  
Date : November 12, 2001  
Vehicle : Airbus A300-600, N14053  
NTSB No. : DCA02MA001  
Investigator : Steve Magladry

## B. COMPONENTS EXAMINED

Spring rod (disassembled)

## C. DETAILS OF THE EXAMINATION

The disassembled spring rod components received for examination are illustrated and identified in figure 1. The spring rod is a device, with a contained spring, that imparts a degree of "feel" to a powered control system. The x-ray illustrated in figure 2 was taken prior to disassembly and reveals the components identified in figure 1 in their assembled locations. The yellow arrow in figure 2 indicates the larger diameter of the rod, protruding from the cap, and its misalignment with the remainder of the spring rod. The amount of misalignment between the two diameters on the rod is also discernible in figure 1.

The cap contains 6 vent holes located around the perimeter of the cap. Examination of the cap revealed that it had been impacted on its side, adjacent to one of the vent holes. The yellow arrow in figure 3 indicates the impact mark. The three cracks, numbered and indicated by the red arrows in figure 3, were located on the outer flanged portion of the center hole with the center crack (crack 2) aligned between the impact mark and the cap center. Cracks 1 and 3 were equally spaced on either side of crack 2. The center hole is where the larger diameter of the rod would normally be located. The portion of the inside diameter of the cap that is visible in this illustration contained a circumferential black band, of almost uniform width, indicated by the white arrow. The inside diameter at crack 2 was measured at 0.770 inches and the inside diameter perpendicular to the crack 2 diameter was measured at 0.745 inches.

The inside surface of the cap, at the three cracks, is illustrated in figure 4 with the three cracks numbered as in figure 3. The black areas on the surface consist of particles lodged between the circumferential machining marks. The particles were observed on the full depth of the inside diameter, approximately 0.5 inches, but were more abundant for the first 0.3 inches. The white arrows indicate the start of the black band similarly indicated in figure 3.

A closer view of the impact mark at the vent hole (indicated by the yellow arrow in figure 3) is illustrated in the left view of figure 5. The red dashed line indicates the extent of the deformed surface and the red arrow indicates the edge of the deformed surface at the vent hole. The blue arrow indicates a second slight deformation of the vent hole edge. The right view in figure 5 illustrates the inside surface of the cap, adjacent to the same vent hole. The red dashed line indicates where the inside surface had been deformed inward, and the red arrow indicates the deformed edge of the hole. The green arrow indicates a straight edge to the inward deformation and the blue arrows indicate circumferential score marks that were observed only in the location illustrated.

The two views in figure 6 are at the same magnification and illustrate two of the vent holes looking from above and parallel to the spring rod axis. The left view illustrates an undamaged vent hole and the right view illustrates the damaged vent hole. The yellow dashed line in the right view indicates what would have been the intact surface and the red dashed line indicates the edge of the impacted hole. The blue arrow, as in the left view of figure 5, indicates deformation to the opposite edge of the hole. In both views, the green arrow indicates circumferential machining marks consistent with the hole being drilled.

Examination of the body revealed the hand written identification "A2727114900000" and an American Airlines label displaying a blank line for a serial number. White crystals, deposited in a spiral, were observed down the length of the inside diameter. Energy dispersive spectrometer (EDS) analysis of crystals removed from the body revealed high chlorine and zinc peaks with traces of aluminum, sulfur and oxygen.

Examination of the spring revealed the presence of white crystals on the surface of the coils. EDS analysis of crystals removed from the coils revealed a high zinc peak with traces of sodium, potassium, chlorine and oxygen.

The interacting components, namely the rod, the two retainers, the spring and the cap are illustrated in figure 7, in their relative positions as indicated in figure 2. On the cap, the blue arrow indicates the location of the impact mark, illustrated in figures 3, 5 and 6, and the green arrow indicates location of the cracks, illustrated in figures 3 and 4. The bend in the rod was located at the shoulder between the larger and the smaller diameters and the white, yellow and red arrows indicate the locations of surface features described in the next paragraph. A band of light discoloration was noted around the circumference of the rod at the position indicated by the black arrows in figure 7. A similar band of discoloration, with the addition of corrosion pits, was noted at the position indicated by the gray arrows.

The surface feature on the rod at the location indicated by the white arrow in figure 7 is illustrated in the left view of figure 8. The feature consisted of a black deposit on 3 sides of a shiny surface. The feature was 0.55 inches long, as indicated by the green arrows and the shiny surface was 0.37 inches long, as indicated by the red arrows. The black deposit consisted of particles lodged between the circumferential machining marks and the shiny surface consisted of flattened machining marks. The right view of figure 8 illustrates typical machining marks at this feature. The machining marks to the left of the red dashed line were outside of the shiny surface area and have not been disturbed. The marks to the right

of the red dashed line were located in the shiny surface area and have had their peaks slightly compressed.

The surface feature at the location indicated by the yellow arrow in figure 7 is illustrated in figure 9. This feature, located directly opposite to the center of the feature illustrated in the left view of figure 8, displayed a slight compression to the machining marks and more of the black particles lodged between the circumferential machining marks.

The surface feature at the location indicated by the red arrow in figure 7 is illustrated in figure 10. The yellow arrows in figure 10 indicate a circumferential band containing a black surface deposit, the green arrows indicate black corrosion pits, the red arrows indicate green crystalline deposits, and the blue arrows indicate white crystalline deposits. EDS analysis of the green crystalline deposits revealed elements consistent with an aluminum alloy with distinctive peaks of copper, oxygen and chlorine. Analysis of the white crystalline deposit revealed similar elements with a large chlorine peak.

The discolored band with corrosion pits, indicated by the gray arrows in figure 7, is illustrated in the left view in figure 11. The band was approximately 1.06 inches wide from the end adjacent to the thread to the yellow dashed line, with the majority of the corrosion pits located within 0.25 inch-wide bands at each end and indicated by the yellow and white arrows. Visual examination of the surface revealed that the pitting was predominantly black in color and consisted of pits with curved edges and pits that had developed from surface scratches oriented on the longitudinal axis of the rod. The variation in the pits adjacent to the yellow dashed line is illustrated in the right view of figure 11. When the surfaces of some pits were scraped off a majority of them contained white crystals and others contained both white and green crystals, similar in appearance to those illustrated in figure 10.

The components identified as retainer 1 and retainer 2 in figures 1 and 7 are illustrated in figure 12. The retainers consist of a brown colored body with a steel washer, identified by the white arrow, located at the outer (as installed) end. The retainers were measured at 1.06 inch long and had an internal shoulder at each end that was 0.25 inch wide. The yellow arrow indicates the outer shoulder on each retainer. The surface of the steel washer on retainer 1, normally in contact with the rod face indicated by the white arrow in figure 10, displayed the same white crystalline deposit. The shoulder, indicated by the yellow arrow, displayed the same white crystalline deposit with light indications of the green crystals. The deposits on retainer 2 appeared similar but were of a much smaller quantity. EDS analysis of the brown colored body revealed that it was a copper alloy.

Derek Nash  
Mechanical Engineer

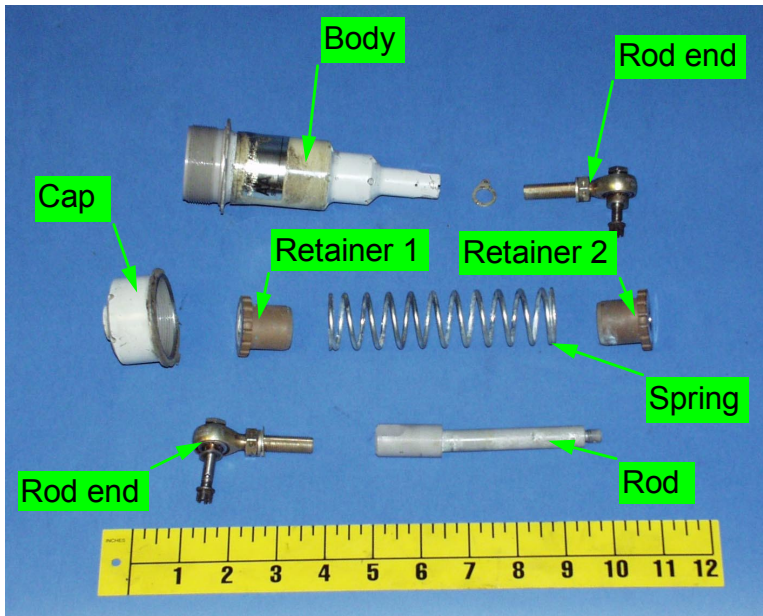


Figure 1. The spring rod components as received for examination.

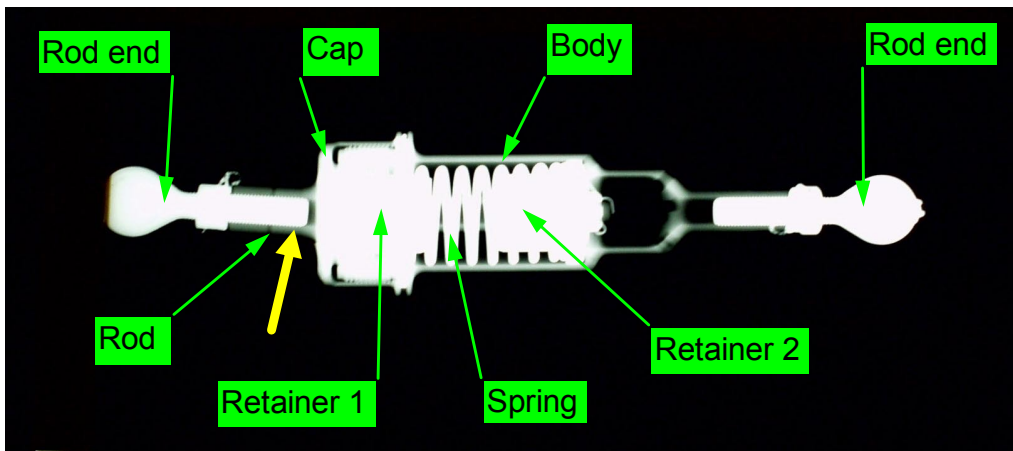


Figure 2. X-ray of the spring rod before disassembly

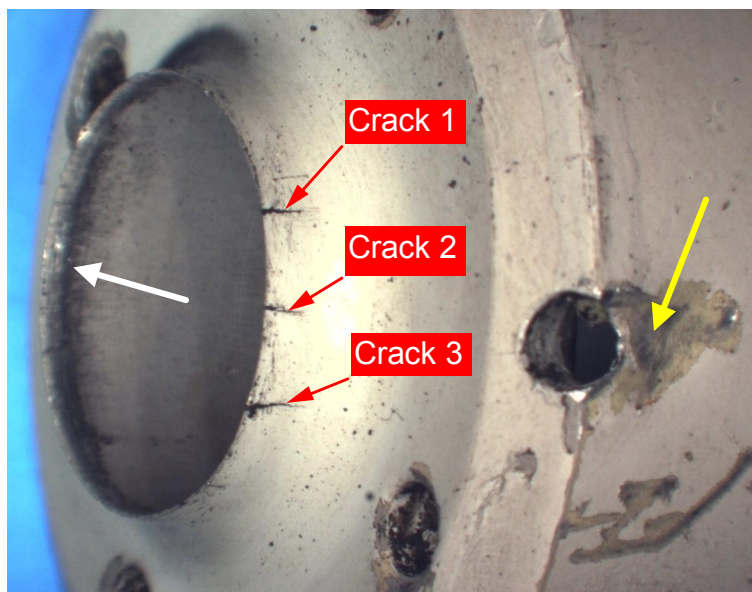
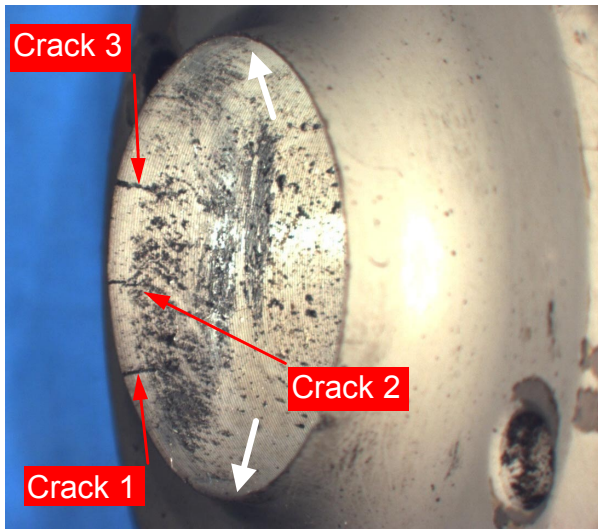
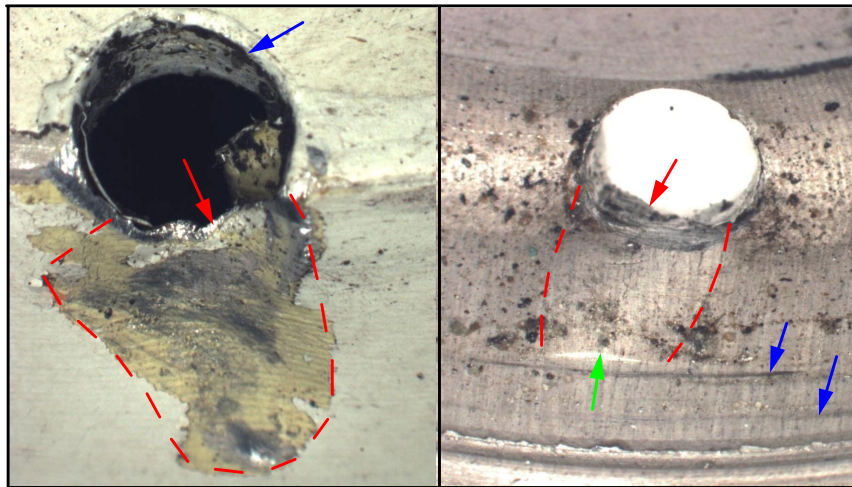


Figure 3. The impact mark and the cracks observed on the cap.



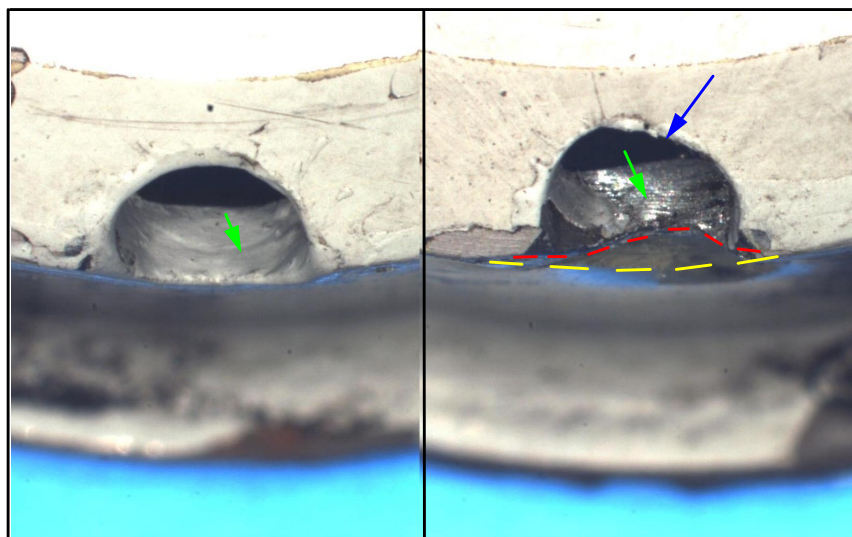
ImageNo:210A0163, Project No:A00329 | 5 mm |

Figure 4. The inside diameter of the cap adjacent to the three cracks identified as in figure 3.



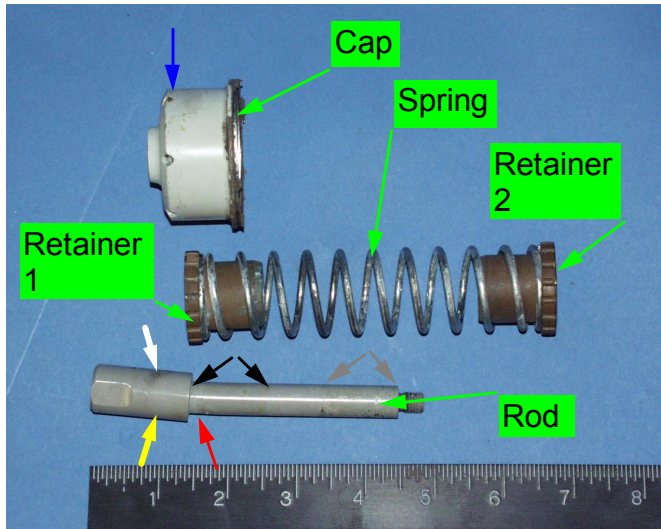
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Figure 5. The exterior (left view) and the interior (right view) of the vent hole with the impact mark.



ImageNo: 210A0239, Project No:A00329

Figure 6. Comparison of an undamaged vent hole (left view) and the damaged vent hole (right view) from above.



ImageNo:210A0273, Project No:A00329 | 200 mm |

Figure 7. The rod, the spring/retainer assembly and the cap in their relative, assembled, positions.

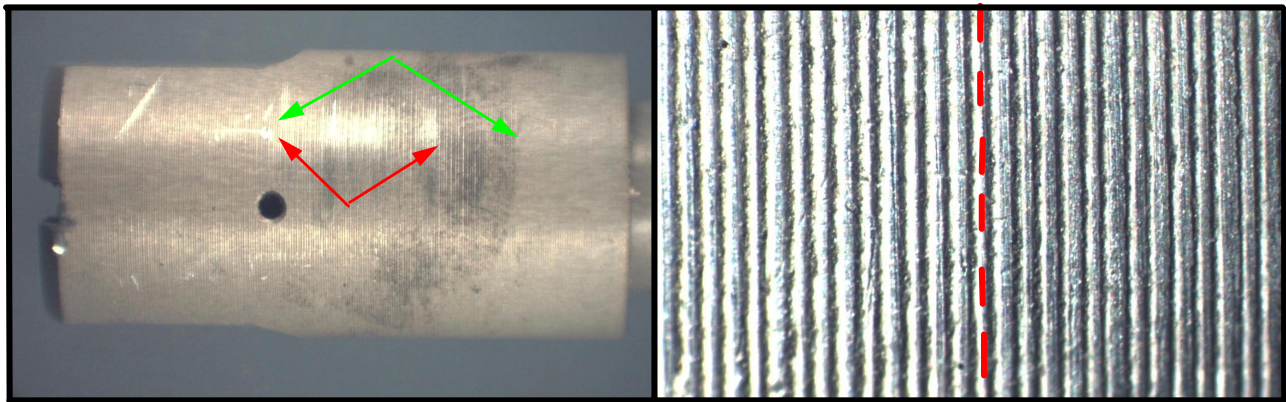
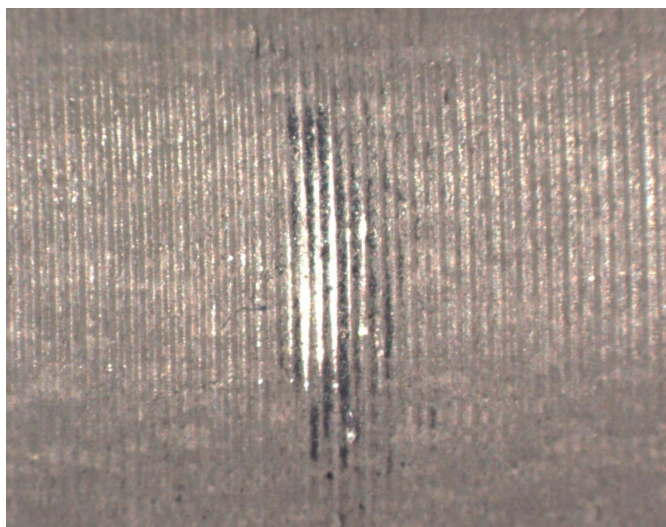
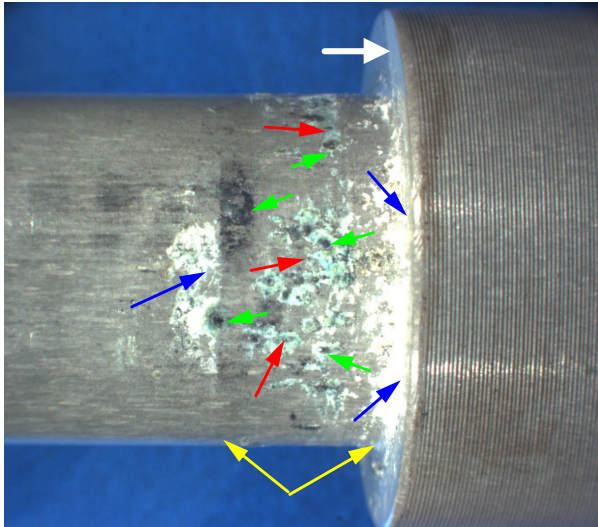


Figure 8. The surface feature at the location indicated by the white arrow in figure 7.



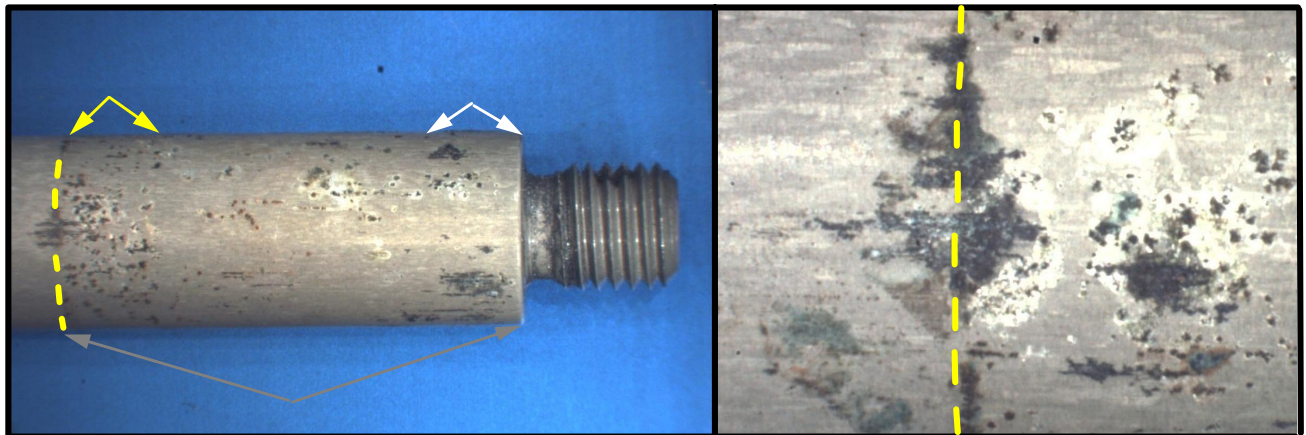
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Figure 9. The surface feature at the location indicated by the yellow arrow in figure 7.

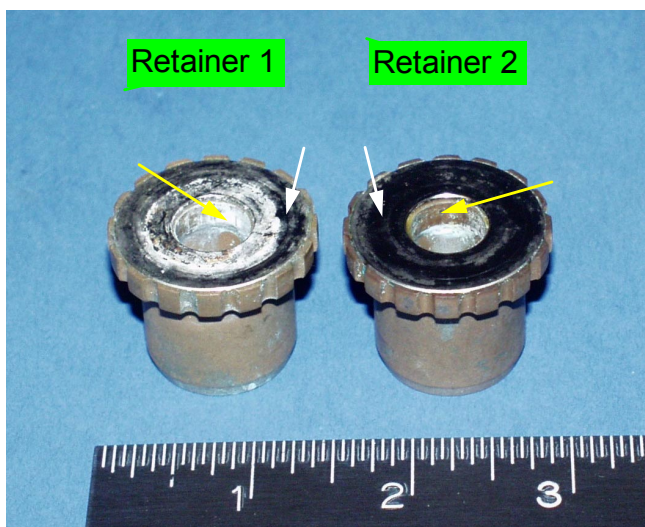


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Figure 10. The surface features at the location indicated by the red arrow in figure 7.



The surface features at the end of the rod indicated by the gray arrows in figure 7.



ImageNo:201A0259, Project No:A00329 | 100 mm |

Figure 12. Retainers 1 and 2 illustrating their outer faces, as assembled and illustrated in figure 7.