NATIONAL TRANSPORTATION SAFETY BOARD
Office of Research and Engineering
Materials Laboratory Division
Washington, D.C. 20594

March 12, 2001

MATERIALS LABORATORY FACTUAL REPORT Report No. 01-030

A. ACCIDENT

Place	: Montello, Nevada
Date	: August 3, 2000
Vehicle	: Bell 206L, N10864
NTSB No.	: LAX00-G-A286
Investigator	: Richard Parker

B. COMPONENTS EXAMINED

Control servo's, cyclic control rods, swashplate and pitch links.

C. DETAILS OF THE EXAMINATION

The components received for examination are illustrated in figure 1. Identifications written on the servo's and matching of fracture faces located the supplied components as illustrated.

Fractures in the lateral cyclic system are encircled and identified as "L1" to "L4". Fractures and bending in the fore and aft cyclic system are encircled and identified as "F1" to "F3". Fractures and bends in the collective system are encircled and identified as "C1" and "C2". Damage and a fracture to the swashplate are encircled and identified as "S1" and "S2" respectively. Fracturing of the mast is encircled and identified as "M". Fractures and bends in the pitch link to the main rotor blade, color-coded yellow, are encircled and identified as "Y1" and "Y2". A fracture and a bend in the pitch link to the main rotor blade, color-coded red, are encircled and identified as "R1" and "R2".

Figure 2 illustrates a portion of the lateral cyclic servo indicated by "L1" in figure 1. The fracture faces arrowed "a" and "b" displayed a bright sparkling appearance with minimal deformation of the adjacent material, typical of an overstress brittle failure. The fracture indicated by arrow "c" displayed a dull fibrous surface and a shear lip, consistent with a ductile overstress separation. Significant bending and twisting was observed in the vicinity of fracture "c".

Examination of the fractures identified as "L2" and "L3" in figure 1 revealed a mixture of bending and 45 degree shear lips consistent with an overstress separation. At fracture "L4" a cup and cone feature was found, consistent with an overstress separation, and a barely visible deformation was noted on the few threads that were exposed.

Figure 3 illustrates a portion of the fore and aft cyclic servo indicated by "F1" in figure 1. The dashed lines indicate adjoining fracture faces. The fracture face arrowed "d" displayed the same features as those indicated by arrows "a" and "b" in figure 2, indicative of a brittle overstress fracture. Fracture faces "e" and "f" displayed the same features as the one indicated by arrow "c" in figure 2, indicative of ductile overstress separations.

The fracture face indicated by arrow "g" in figure 3 is illustrated in figure 4. The small white arrows on the fracture face indicate radial lines emanating from the fracture origin. The black on white arrows indicates shear lips. This fracture was typical of a ductile overstress fracture emanating from one side of the component.

Bending of the rod adjacent to the clevis was observed at location "F2" in figure 1. Features observed at "F3" in figure 1 were similar to those at "L4".

Figure 5 illustrates a portion of the collective servo indicated by "C1" in figure 1. The sections indicated by the unmarked arrows had been bent and twisted, similar to those of servo "L1" illustrated in figure 2, but had not fractured.

The fracture at the collective lever and support assembly, encircled and identified as "C2" in figure 1, is illustrated in figure 6. The dashed lines indicate matching fracture locations on the support assembly, arrowed "h". The collective lever is arrowed "j" and the lower end of the swashplate pivot sleeve is arrowed "k". All of the fracture faces on the support assembly displayed 45-degree shear lips and mechanical deformation consistent with bending overstress fractures.

Figure 7 illustrates the upper surface of the swashplate. Arrow "h" indicates the upper end of the support assembly and arrow "k" indicates the upper end of the pivot sleeve. The unmarked arrows indicate mechanical damage to the upper ends of the support assembly and the pivot sleeve. The unmarked circle in the lower left corner of figure 7 indicates the swashplate portion of the fracture identified as "S2" in figure 1.

The fracture identified as "S2" in figure 1 is illustrated in figure 8. Individual fracture faces are arrowed "m", "n", "p" and "q" and the black dashed lines indicate matching fracture faces. Arrow "r" indicates a crack appearing to emanate from fracture face "q". The swashplate arm is indicated by arrow "s" and the clevis end of the yellow pitch link is indicated by arrow "t". The red dashed line on the swashplate arm indicates where the fractured portion was removed for ultrasonic cleaning in acetone for further examination.

Figure 9 is an end view of the clevis, arrowed "t as in figure 8, illustrating the fracture faces arrowed "n" and "q" as in figure 8. The figure also illustrates the dislocation

of the spherical bearing outer race, arrowed "u", from its normal location between the two fracture faces. The clevis was removed and the bearing was pressed out. The fractured portion was ultrasonically cleaned in acetone for further examination.

The fracture face arrowed "m" in figure 8 is illustrated in figure 10. Examination revealed that severe mechanical damage had obliterated any fracture features with the exception of the area within the dashed lines. Scanning electron microscope (SEM) examination of the area within the dashed lines revealed that it was also mechanically damaged although isolated pockets contained the ductile dimples consistent with a tensile overload.

The fracture face arrowed "n" in figures 8 and 9 is illustrated in figure 11. SEM examination revealed ductile dimples over all portions of the fracture, including isolated pockets within the damaged area enclosed by the dashed line.

Figure 12 illustrates the fracture face arrowed "p" in figure 8. A slight twist was observed adjacent to the fracture face. The direction of this twist was consistent with rotation, at the fracture face, in the direction indicated by arrow "v" compared to the matching fracture piece in figure 13. The unmarked arrows indicate crack arrest positions where the fracturing process had a momentary halt. SEM examination of fracture "p" revealed the presence of ductile dimples over all portions of the fracture, including isolated pockets within the damaged areas indicated by the dashed lines.

The fracture face arrowed "q" in figures 8 and 9 is illustrated in figure 13. SEM examination revealed ductile dimples on the fracture face with the exception of the mechanically damaged areas within the red dashed lines. A slight twist was observed adjacent to the fracture face. The direction of this twist was consistent with this piece being rotated in the direction indicated by arrow "w" compared to the matching fracture piece in figure 12. The crack, arrowed "r' is similarly identified in figure 8 and was observed on this portion only.

Severe bending of the mast portion supplied can be seen identified as "M" in figure 1. The fracture face displayed a 45-degree lip, with a little twisting, consistent with a rotating bending overstress event.

As can be seen in figure 1, the yellow pitch link was subjected to severe bending at the fracture indicated as "Y1". Examination of the fractured tube revealed a 45–degree lip consistent with an overstress separation.

Examination of the pitch link rod fracture identified as "Y2" in figure 1 revealed faces with a shear lip around the complete circumference and with little or no bending deformation consistent with an overstress tensile separation.

The fracture on the red pitch link rod end, identified as "R1" in figure 1, revealed cup and cone features and approximately 20 degrees of bending deformation consistent with an overstress bending separation.

At the location identified as "R2" in figure 1 the red pitch link had been bent approximately 10 degrees starting approximately 9 inches from the center of the clevis attachment hole.

Derek Nash
Mechanical Engineer

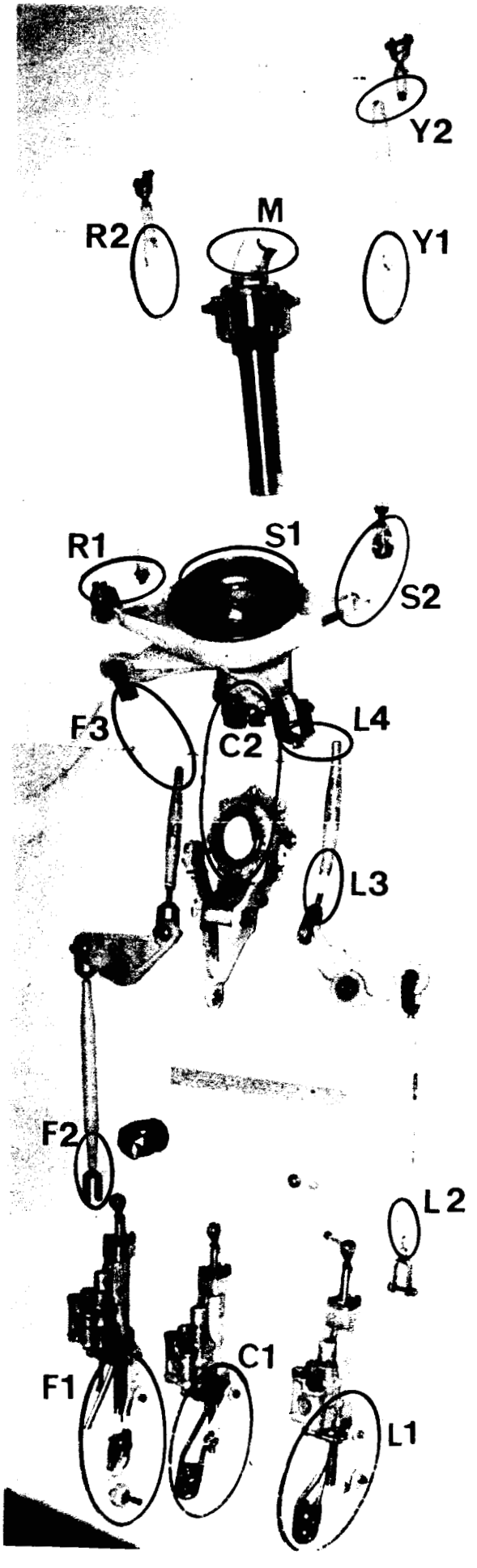

Figure 1. The components received for examination.

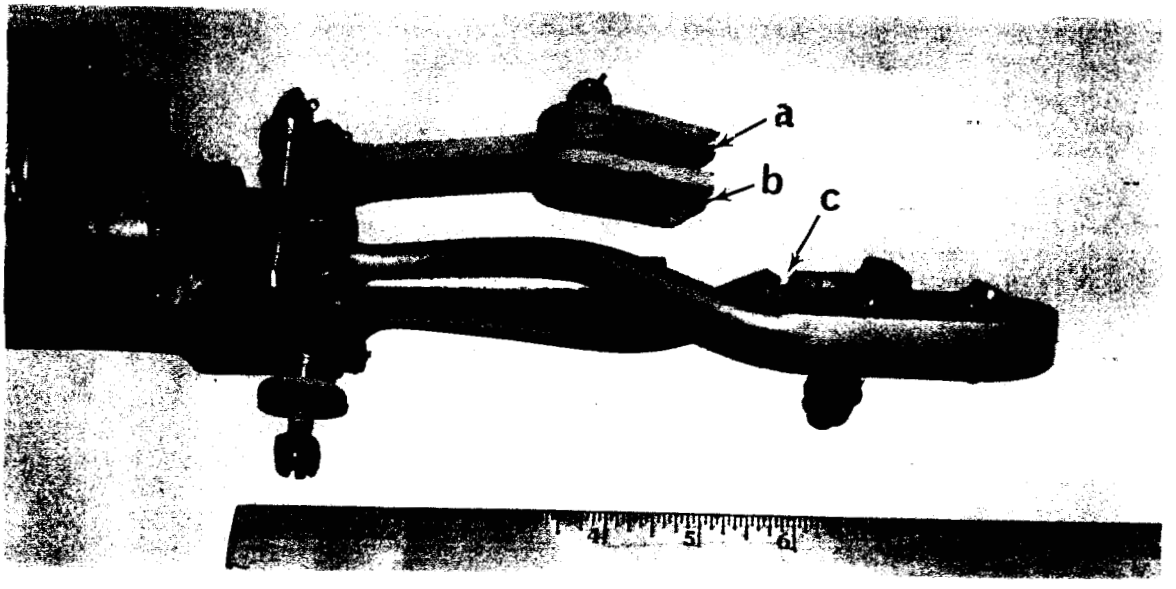

Figure 2. The portion of the lateral cyclic servo indicated as "L1" in figure 1.

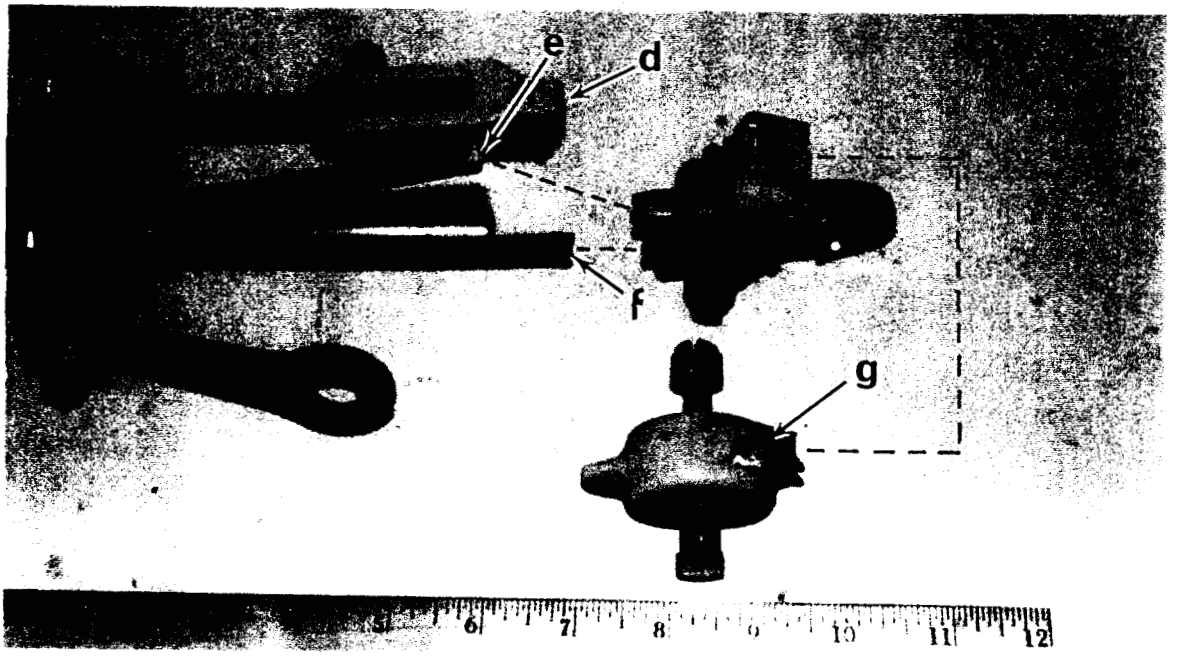

Figure 3. The portion of the fore and aft cyclic servo indicated as "F1" in figure 1.

Figure 4. The fracture face indicated by arrow "g" in figure 3. (3.7X)

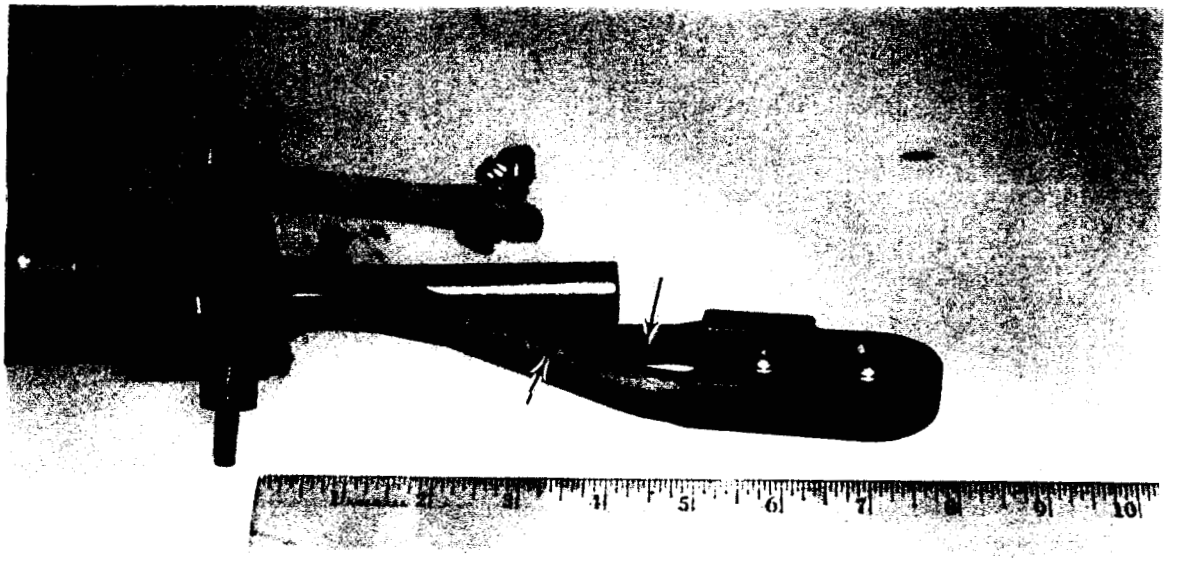

Figure 5. The portion of the collective servo indicated as "C1" in figure 1.

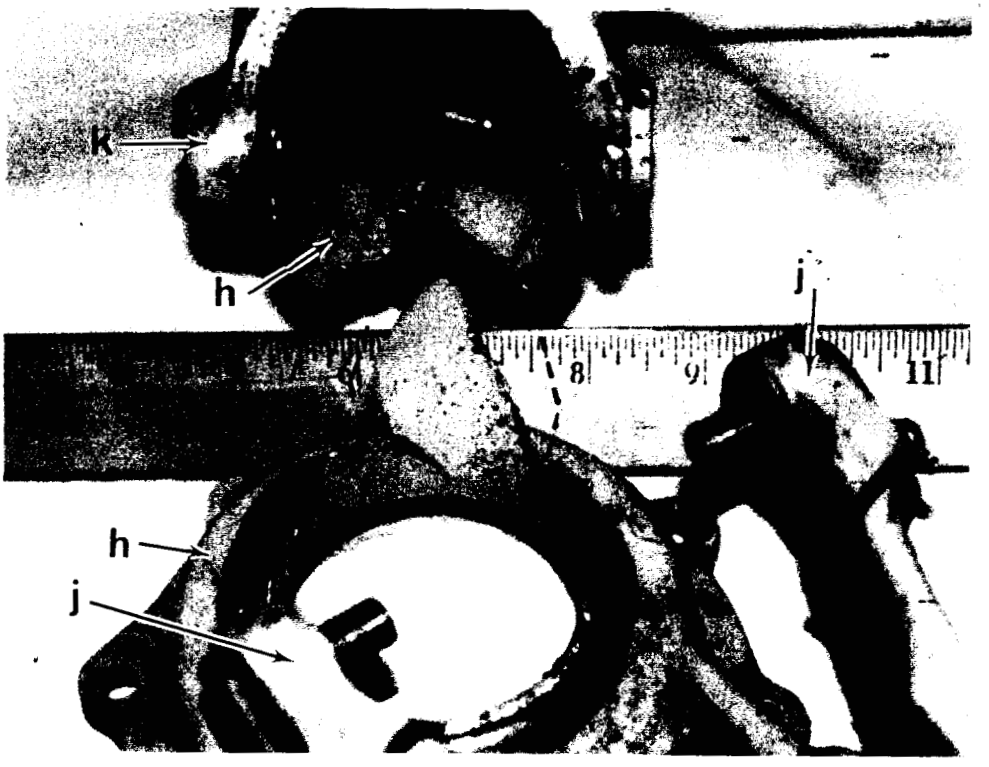

Figure 6. The fracture at the collective lever and support assembly identified as "C2" in figure 1.

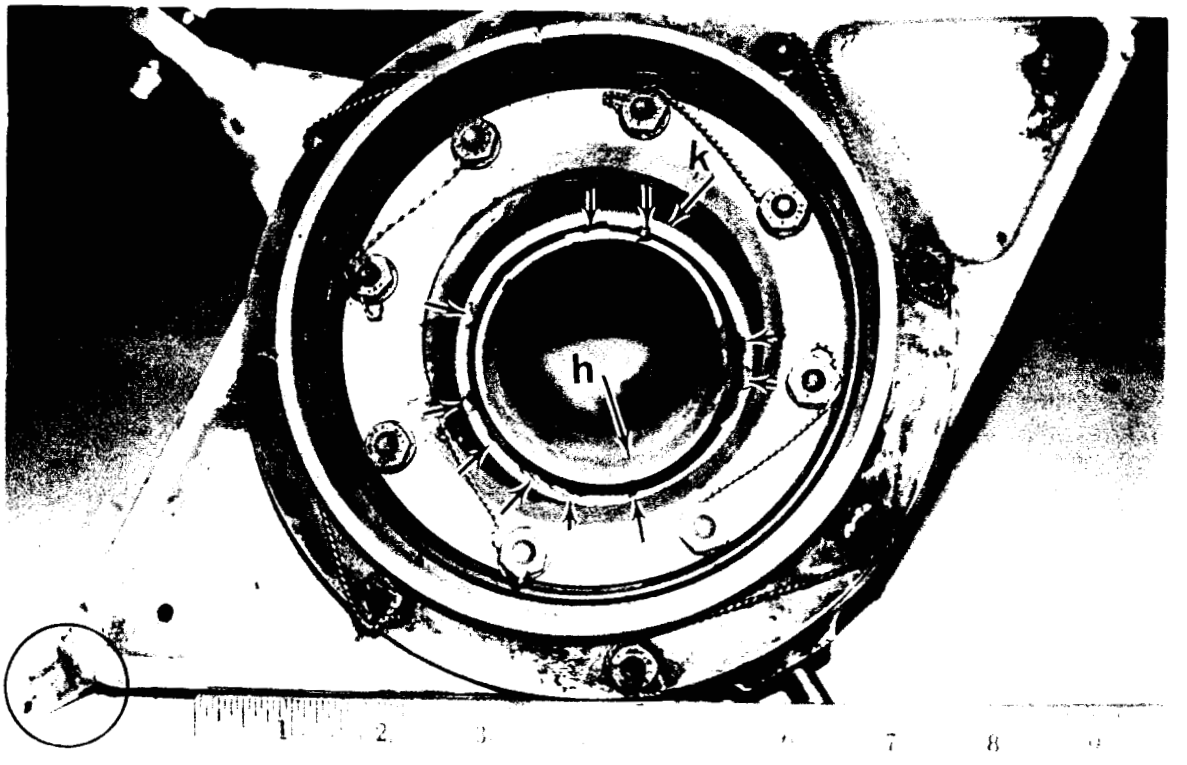

Figure 7. The upper surface of the swashplate identified as "S1" in figure 1.

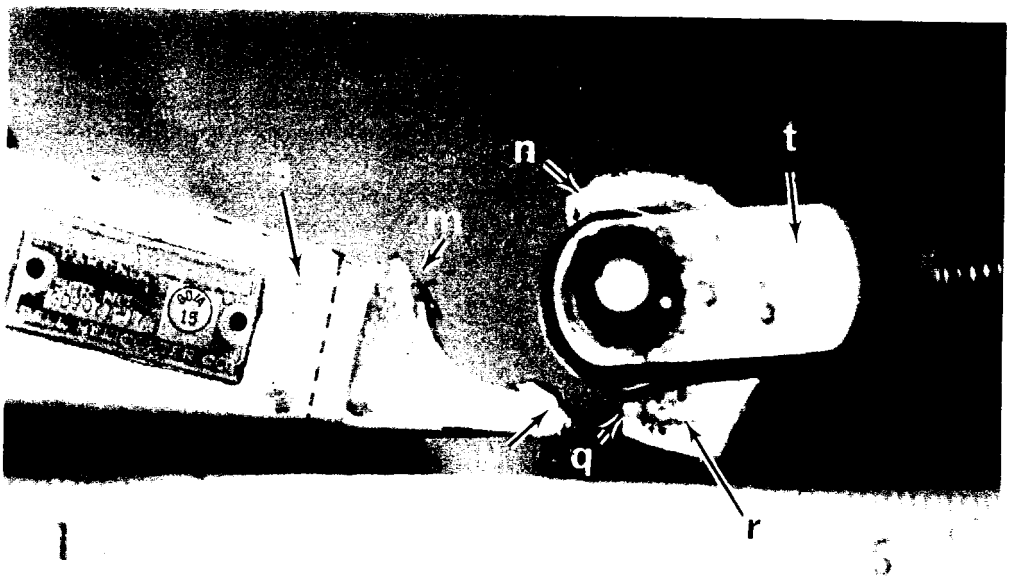

Figure 8. The fracture at the connection of the yellow pitch link to the swashplate identified as "S2" in figure 1.

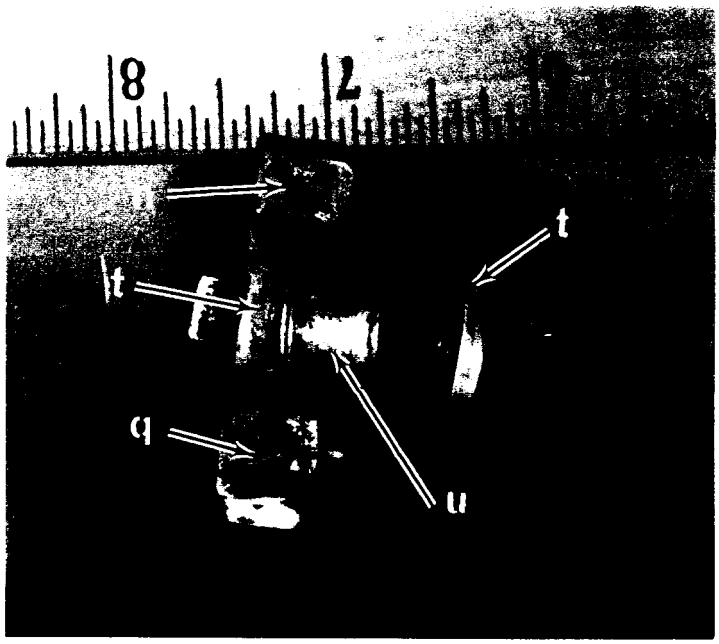

Figure 9. An end view of the fracture faces identified as "n" and "q" in figure 9.

Figure 10. The fracture face arrowed "m" in figure 8. (5X)

Figure 11. The fracture face arrowed "n" in figures 8 and 9. (5X)

Figure 12. The fracture face arrowed "p" in figure 8. (5X)

Figure 13. The fracture face arrowed "q" in figures 8 and 9. (5X)