OTTAWA July 3rd, 1942.

REPORT

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1258.

Examination of Two Attachment Nuts
from a Kittyhawk Oleo Leg.

(Copy No. 7.)

BUREAU OF MINES
DIVISION OF METALLIC MINERALS

ORE DRESSING AND
METALLURGICAL LABORATORIES

CANADA
DEPARTMENT
OF
MINES AND RESOURCES
MINES AND GEOLOGY BRANCH

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from a Kittyhawk Oleo Leg.

Origin of Request and Object of Investigation:

On June 6th, 1942, Squadron Leader A. L. Smith, of the Department of National Defence (Air Service), Ottawa, Ontario, delivered to our laboratories two attachment nuts from a Kittyhawk Oleo leg. One nut was split and the threads were badly mutilated. This is illustrated in Figures 1 and 2.

In the accompanying letter, File No. 938HE-1-14 (AMAE DAI IM), written by Wing Commander J. A. Easton for Group Captain A. L. Johnson, it was stated that the failure might have been due to overstressing incident to the manner in which the plane landed, i.e. that it did not come down flat on the three landing points.

Microscopic Examination:

The microstructure, as shown in Figure 3 (at 100 diameters), is normal for a medium carbon steel that has been air-cooled from some temperature not far above the upper critical.

Physical Tests:

The Vickers hardness value was found to be 191, which corresponds to a tensile strength of 92,000 p.s.i.

The unbroken nut was taken to the National Research Council gauge laboratory. There it was machined into a ring and slit as shown in Figure 4.

The internal diameter was very accurately determined at five different locations on three diameters of the ring, both before and after slitting. The external diameter was likewise very accurately determined at three different points on each of three diameters. The average inside and outside diameters are reported below:

	Before slitting	After slitting
Average inside diameter, inches	1.0721	1.0740
Average outside diameter, inches	1.5047	1.5069

On Page 181, Chapter VI, of the book entitled "Practical Metallurgy" (written by George Sacks, Dipl. Ing., D. Eng., of the Case School of Applied Science, and Kent R. Van Horn, B.S., M.S., Ph.D., of the Aluminum Company of America), which is published by the American Society for Metals, Cleveland, Ohio, the following equation is developed for the determination of residual stresses in rings from measurements made before and after slitting.

(Continued on next page)

(Physical Tests, cont'd) -

$$t_b = E\, d \left(\frac{D_1 - D_o}{D_1 D_o} \right)$$

t_b	=	Residual tensile stresses.
E	=	Modulus of elasticity.
d	=	Wall thickness.
Do	=	Mean diameter before slitting.
D_1	=	Mean diameter after slitting.

In this case,	E	=	30,000,000 p.s.i.
	d	=	0.2163 inch.
	Do	=	1.2884 inches.
	D_1	=	1.2905 inches.

By substituting these values in the above equation, it is found that the residual tensile stresses in the ring machined from the nut are in the order of 8,200 pounds per square inch.

Chemical Analysis:

A carbon determination was made. The carbon content was found to be 0.27 per cent.

Discussion of Results; Conclusions:

The nut that failed appeared to have been fabricated in the normal manner from steel of a good quality. The structure is characteristic of that obtained by air cooling from above the critical temperature, which is a normal structure for hot rolled steel.

The intensity of the residual stresses found in the other nut is not too high. Stresses of this order may be considered normal.

It would therefore appear that the condition of

(Discussion of Results; Conclusions, cont'd) -

these nuts is quite normal in every respect and that the failure was caused by conditions that applied external stresses in excess of those normally anticipated in service.

It is quite possible that these high stresses could arise from conditions brought about by excessively rough landing, aggravated by over-tightening the nuts. To minimize this source of trouble a torsion wrench could be used so that all nuts would be tightened uniformly.

The wide spread of the split in the fractured nut could only be explained by assuming that the nut had been forced open after actual fracture, very likely by the same forces that caused the failure.

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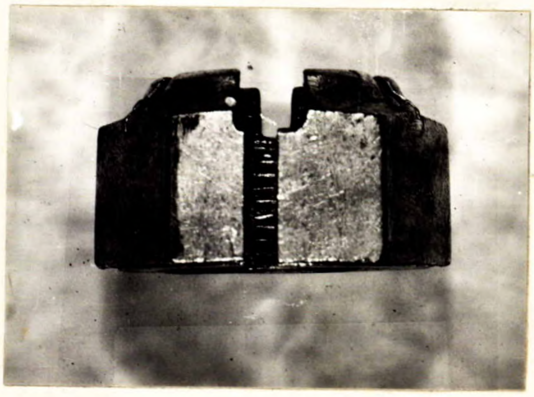
Figure 1.



Photograph of broken Oleo nut, showing split.

Actual size.

Figure 2.

Photograph of broken Oleo nut, showing mutilated threads.

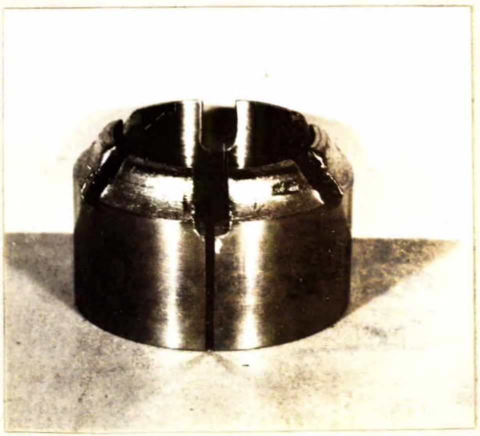
Actual size.

Figure 3.

X100, picral etch.

Photomicrograph showing structure of steel in broken nut.

Figure 4.



Photograph of ring machined out of the unbroken nut and slit for determination of residual stresses.

Actual size.

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