O T T A W A September 28th, 1942.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1308.

Metallurgical Examination of Aircraft Oleo Leg Steel Forging 22666.

(Copy No. 10.)

BUREAU OF MINES
DIVISION OF METALLIC MINERALS
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ORE DRESSING AND
METALLURGICAL LABORATORIES

CANADA
DEPARTMENT
OF
MINES AND RESOURCES
MINES AND GEOLOGY BRANCH

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Origin of Sample:

An aircraft oleo leg forging, marked "22666," was submitted on September 10th, 1942, by A. S. Lane, Inspector-in-Charge, Canadian Aircraft Group, BRITISH AIR COMMISSION, 1050 Beaver Hall Hill, Montreal, Quebec.

Object of Study:

The forging showed a peculiar surface condition. Request was made for study of the properties of the forging in general and a determination of the nature of the surface condition.

Analysis:

Drillings from the forging were chemically analysed. The results follow:

		Per cent
Carbon	=	0.31
Manganese	=	0.64
Silicon	=	0.24
Phosphorus	=	0.019
Nickel	=	3.11
Chromium	=	0.81
Vanadium	=	0.03
Molybdenum	=	0.35
Tungsten	=	Not detected.

Macro-Examination:

A general view of the forging and a close-up of the surface are shown in Figures 1 and 2. A disc about 1 inch thick was cut from the large end of the forging at a point where surface roughness was severe. This was then immersed for 1 hour in a 50 per cent solution of nitric acid in water at 180° F.

After this treatment it was noted that some of the defects which were closed at the surface opened up again about 1/8 inch below it, while others were open their entire length. The deepest defect discovered measured about 13/32 inch. The etch revealed that none of these laps had its origin in the interior of the forging. A small defect, which appeared to be a pipe, was discovered in the centre of the etched section.

Physical Examination:

Test bars of 0.505-inch diameter and 2-inch gauge length, as well as izod bars, were machined from the large and small ends of the forging. The results are as follows:

	Small End	Large End
Ultimate stress, p.s.i. -	134,000	136,000
Yield stress, p.s.i. -	122,000	118,000
Elongation in 2 inches, per cent	22.0	21.0
Reduction in area, per cent -	58.0	60.4
Average izod value, in foot pounds	75	73
Brinell hardness number -	280	280

Microstructure:

A cross-section of one of the surface laps was polished and etched in a 4 per cent solution of picric acid in alcohol. The structure thus revealed showed that the steel had been quenched and tempered. The defect was found to be, at its origin, full of oxide inclusion which decreased until near the surface it was negligible. Photomicrographs of the lap are shown in Figures 3 and 4. A sulphur print taken from the surface of the forging revealed an absence of sulphur segregation.

Discussion of Results:

Macro- and micro-examinations definitely prove that the surface defects are laps formed as a result of folding-in of surface metal (with its covering oxide layer) in the forging operation. Such folding occurs when too few steps are used in the forging operation. The most probable cause of some laps' joining at the surface but opening up again inside is found in the fact that the oxide scale decreases toward the exterior, thus allowing the outer edges to be effectively

(Discussion of Results, cont'd) -

joined by a process analogous to forge welding.

The microstructure of the forging is satisfactory. The small pipe discovered is considered unimportant because these forgings are used hollow. All the results of the chemical analysis and physical tests meet the specifications.

From these data it is evident that the worth of the forging is decided by how much machining is to be done upon it. If it is machined below the depth of its most severe lap, then it should be entirely satisfactory; otherwise, its use is inadvisable.

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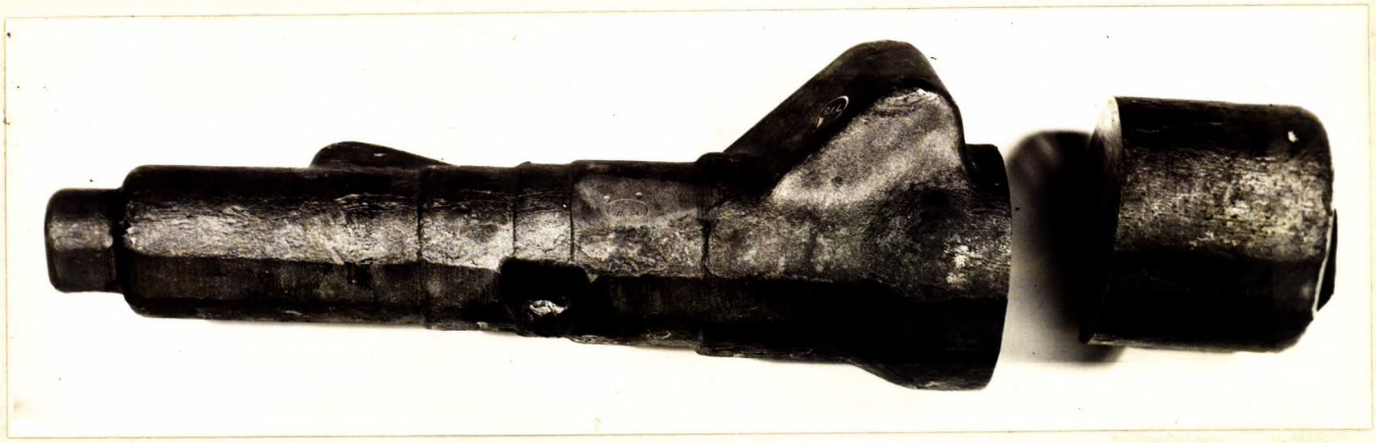
Figure 1.



GENERAL VIEW OF FORGING.

Figure 2.

CLOSE-UP OF DEFECTIVE SURFACE.

Figure 3.

X100, picric acid etch.

ORIGIN OF LAP.

Figure 4.

X100, picric acid etch.

NEARER TO SURFACE OF FORGING.

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