O T T A W A August 11th, 1943.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1468.

Examination of Plate with Two Welded Door Hinges.

(Copy No. 10.)

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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Origin of Sample and Object of Investigation:

On July 21st, 1943, Prof. J. U. MacEwan, Consultant to Director of Metallurgy, Army Engineering Design Branch, submitted (Reqn. No. 562, A.E.D.B. Lot No. 350, Test No. 1, Report No. 31, Sec. "C"), a sample section of plate with two welded door hinges received by him from Mr. V.G. Morris, Automotive Design Branch. One of the hinges was reported to have been attacked by ball projectiles and the other by armour piercing. Each had been hit several times but both were still intact. The performance of the part was said to be considered satisfactory.

An investigation of the weld, to determine whether or not it was austenitic, and of the bolt, to ascertain its carbon content and heat treatment, was verbally requested.

Chemical Analysis:

The weld metal, when milled from the hinge, was found to contain 14.12 per cent chromium and 8.00 per cent nickel.

The bolt contained 0.31 per cent carbon.

Macro-Examination:

Two views of the hinge, attacked by ball projectiles, are given in Figures 1 and 2. The bolt farthest away from the hinge pin broke in this assembly (ball attacked). The side attacked by A/P projectiles was not cut open but it could be seen that at least one bolt had broken.

Polished cross-sections, from the head and nut ends of one of the bolts, are pictured in Figure 3. It can be seen, in the photograph of the nut end, that welding has pulled the nut away from the bolt. This picture also indicates that the quality of fusion varies from place to place in the same weld. Incomplete fusion in some corners and some undercutting are in evidence.

Physical Examination:

The hardness of the bolt (tested by the Vicker's method with a 10-kilogram load) was 366 Vickers, in locations unaffected by heat. Hardness varied from 199 to 268 Vickers, in the weld metal, and in its heat effected zones from 327 to 542 Vickers, on the bolt head; 299-351 Vickers on the bolt at the nut end; 413 to 530 on the hinge arm; 354 to 437 on the armour plate; 139 to 159 on the nut. In unaffected zones, the hinge arm was 233 Vickers and the armour plate 345 Vickers.

Microstructure:

The bolt had a quenched and tempered structure, as shown at 250 diameters, in Figure 2.

The weld metal was not attacked by a two per cent nital etch or a one per cent picric acid, 5 per cent hydrochloric acid etch. A mixture of 25 c.c. hydrochloric acid and 50 c.c. of 10 per cent chromic acid slightly attacked it after a long exposure. No precipitated constituent was seen.

(Microstructure, cont'd) -

It is understood that before the nut and bolt were welded together the nuts had been pulling off the bolts under the impact of bullets. The fact that welding pulls the nut away from the bolt (Figure 3) explains this occurrence.

Use of a smaller size welding rod might improve weld fusion in corners.

In welding, welding rod material is certainly diluted by the parent metal. The high alloy content of the deposited weld metal then definitely indicates that an austenitic welding rod was used; probably an 18 per cent chromium, 8 per cent nickel (oxidation probably accounts for the fall in the chromium-nickel ratio).

Microstructure and hardness indicate that the bolt has been quenched and drawn.

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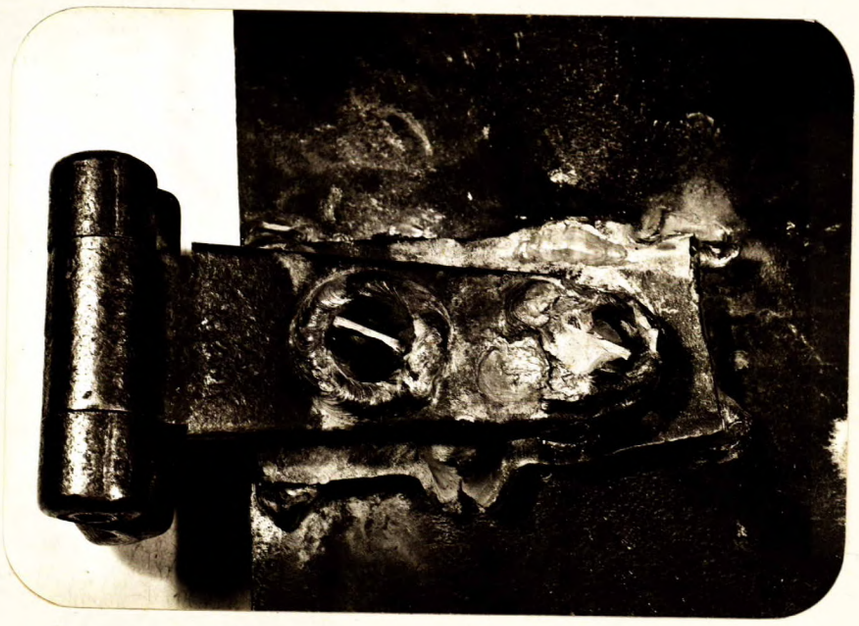
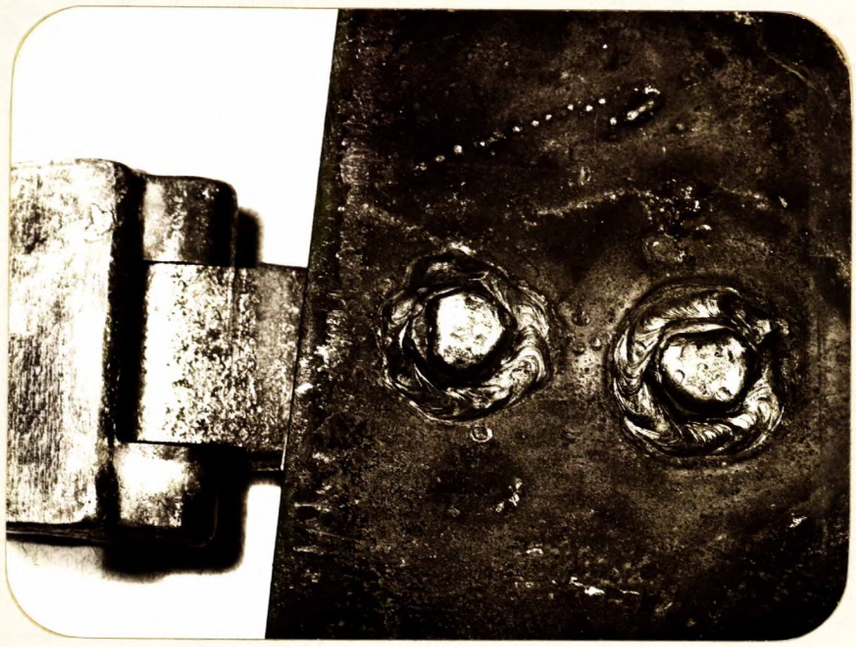
Figure 1.



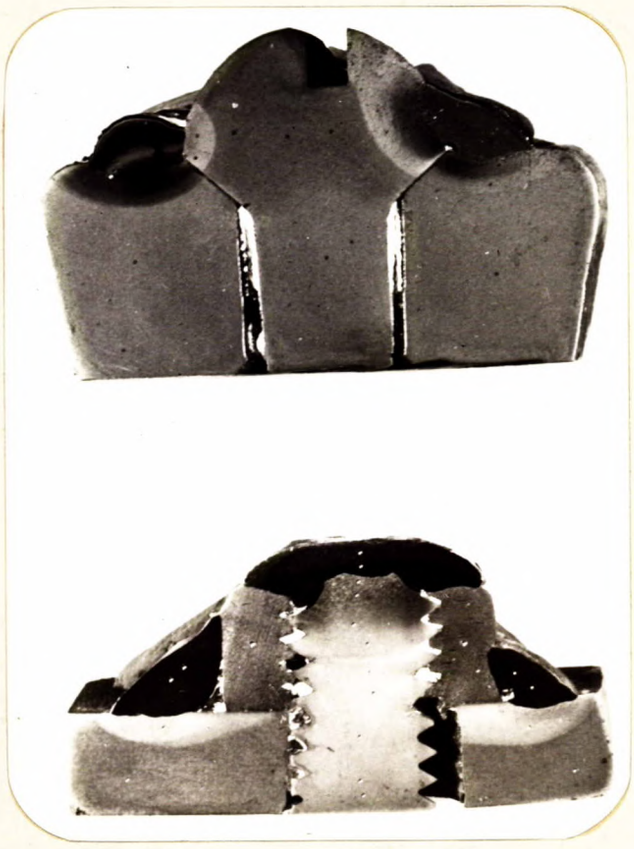
(Approximately $\frac{5}{4}$ size).

Figure 2.



(Approximately $\frac{5}{4}$ size).

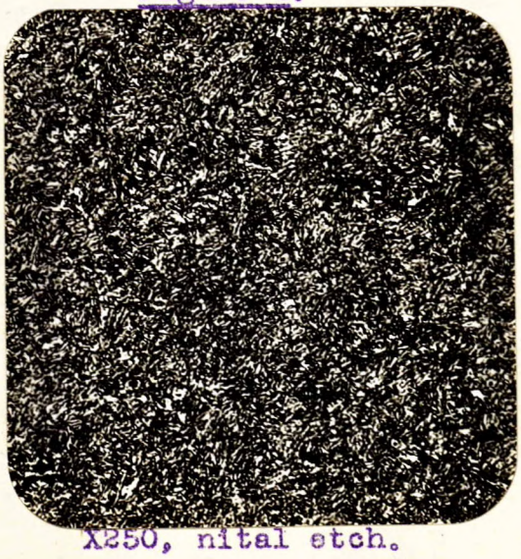
Figure 3.



(Approximately twice actual size)

CROSS-SECTIONS OF BOLT AND NUT ENDS.

Figure 4.



X250, nital etch.

STRUCTURE OF STEEL IN BOLT.

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