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O T T A W A August 2nd, 1943.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1465.

Examination of Aluminum Alloy Screws.

(Copy No. 10.)

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Origin of Problem:

In a letter dated July 22nd, 1943 (File No. 902-38-1 (AMAE DAI) , A/C A. L. Johnson, for Chief of the Air Staff, Department of National Defence Air Service, Ottawa, Ontario, requested the examination of several batches of aluminium alloy screws suspected of having been overheated (burned).

The screws were made from aluminium alloy 2430 wire (batch CMXR), delivered by the Aluminum Company of Canada, Shawinigan, Quebec. They were cold-headed and the threads rolled on by the Stowell Screw Company, Montreal, Quebec. The heat treatment was performed by the Precision Heat Treatment Company, Montreal, and the anodizing by Warren Industries Limited.

A part of the samples (Boxes 1 and 2) were submitted

(Origin of Problem, cont'd) -

after heat treatment but before anodizing. These samples included whole, but defective, screws and also broken parts of screws in the condition as released from Precision Heat Treatment Company. Figure 1 shows some of these samples.

The remaining part of the samples (Boxes 3 to 10) were submitted after anodizing and as received at Canadian Vickers Limited, as released by the Stowell Screw Company. Many of these screws showed evidence of overheating and were badly corroded in the course of anodizing. Figure 2 shows some of the anodized

It was requested that the cause of the failure be determined and metallurgical evidence of the defects be obtained.

Figure 1.

HEAT-TREATED SCREWS - AS RECEIVED
(Boxes Nos. 1 and 2)

(Approximately actual size)

(Continued on next page)

(Origin of Problem, cont'd) -

Figure 2.

HEAT TREATED AND ANODIZED SCREWS - AS RECEIVED.
(Box No. 3)

(Approximately actual size)

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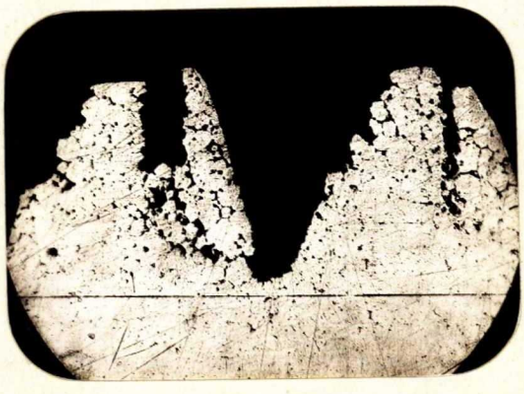
Metallographic Examination:

Figures 3 and 4 show the intercrystalline corrosion on the surface of the threads of overheated screws (Box No. 2).

Figure 3.



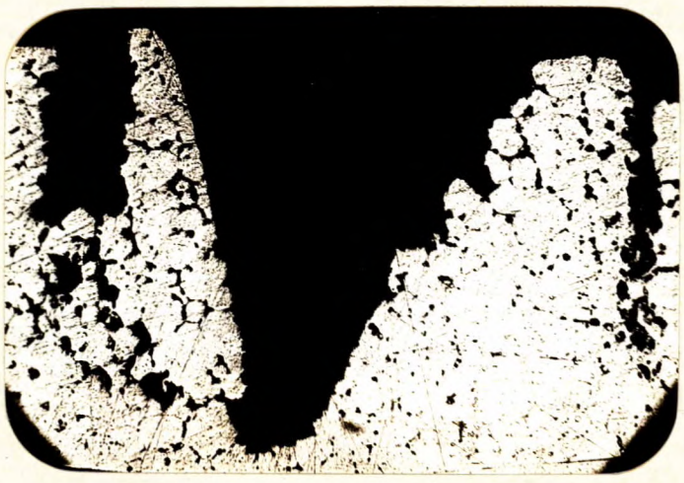
X50, unetched.

OVERHEATED SCREW.
(Box No. 2)

(Continued on next page)

(Metallographic Examination, cont'd) -

Figure 4.



X100, unetched.

THREADS OF OVERHEATED SCREW.
(Box No. 2)

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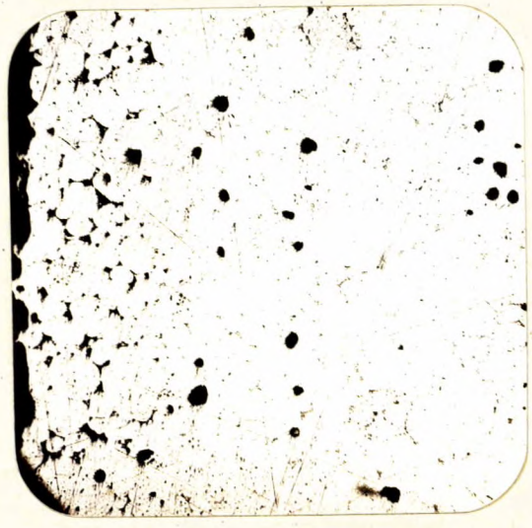
Figures 5 and 6 show the typical structure of overheated ("burned") material of the duralumin type, as found on screws from Box No. 2.

Figure 5.



X100, unetched.

EDGE OF SCREW HEAD.
(Box No. 2)

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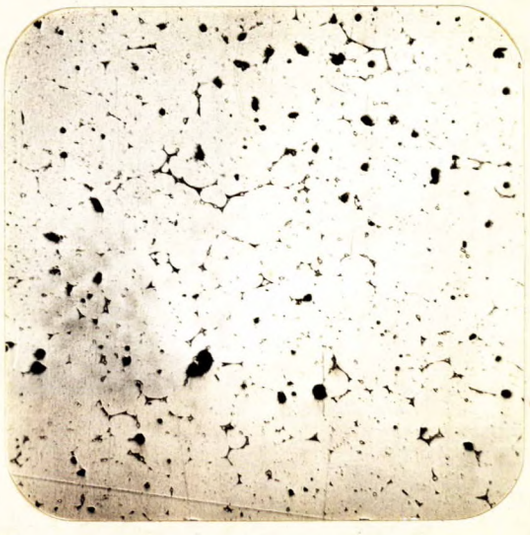
Figure 6.



X100, unetched.

INSIDE STRUCTURE OF OVERHEATED SCREW.
(Box No. 2)

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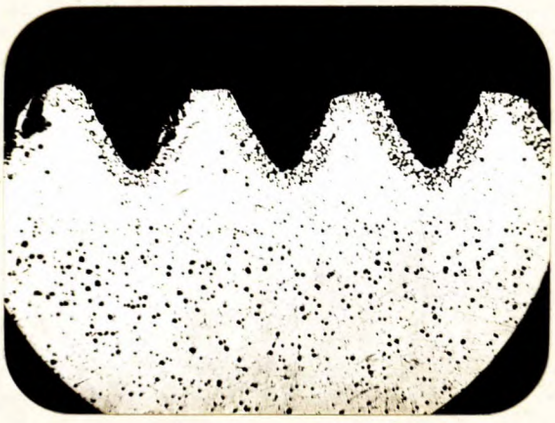
(Metallographic Examination, cont'd) -

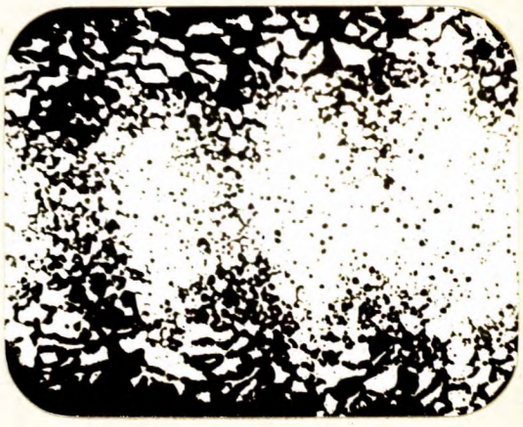
Figures 7 and 8 show cross-sections of overheated and subsequently anodized screws.

Figure 7.



X25, unetched.

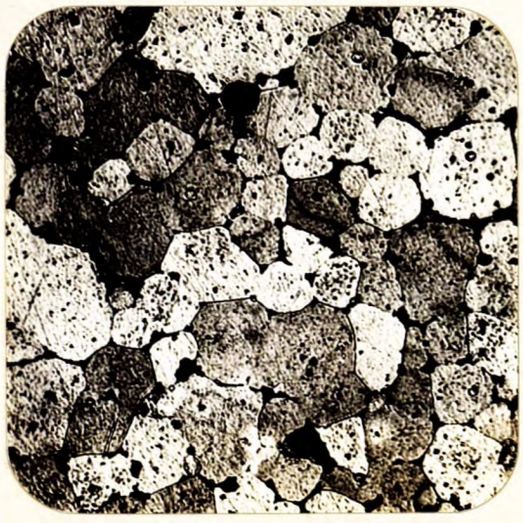
Figure 8.



X25, unetched.

Figure 9 shows the microstructure of an overheated screw from Box No. 2, Figure 10 the microstructure of overheated and anodized material (near the edge).

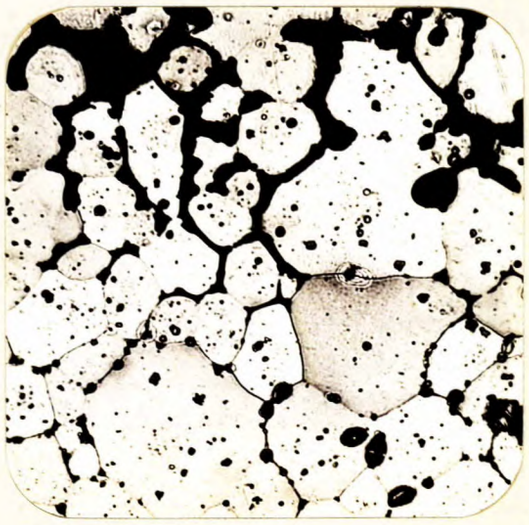
Figure 9.



X250, Keller's etch.

OVERHEATED SCREW HEAD.

Figure 10.



X250, Keller's etch.

OVERHEATED ANODIZED SCREW.

Discussion of Results:

The examination shows that all submitted samples were badly overheated.

Overheating (or burning) of duralumin type aluminium alloys occurs due to solution-heat treatment at too high temperatures and causes localized melting of intercrystalline copper-rich eutectic mixtures. These complex intermetallic compounds, formed by coring and local segregation, melt at appreciably lower temperatures than the homogenized alloys. Overheating forms molten layers between the crystals, resulting in cracking due to hot shortness, and generally destroys the material, rendering it utterly useless.

Figures 3 to 10 show that all examined screws were destroyed due to overheating and subsequent intercrystalline corrosion. This type of corrosion consists in gradual loosening of the grains on dissolution of the intercrystalline matter and causes fistular granulation of the attached material below the surface.

Overheating of the examined screws caused loosening of their grain boundaries, which facilitated intercrystalline corrosive attack, aggravated subsequently in the annodizing operation.

Overheated (burnt) material is useless and can be used only a s scrap for remelting purposes.

CONCLUSIONS:

The examined screws are definitely useless due to overheating and subsequent corrosion.

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