O T T A W A December 23rd, 1942.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1337.

Examination of a Lancaster Spar Aluminium-Alloy Extrusion.

(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 Request and Object of Investigation:

In a letter dated November 16th, 1942, File CANAID/M.244/12126, Mr. A. S. Lane, Inspector-in-Charge, British Air Commission, Canadian Aircraft Group, 1050 Beaver Hall Hill, Montreal, Quebec, requested the examination of a half-section of a Lancaster Spar aluminium-alloy extrusion showing non-uniformity of macrostructure.

In an enclosed copy of a letter from Mr. H. W. Clark, Inspector-in-Charge, B.A.C., Victory Aircraft Limited (formerly National Steel Car Corp. Ltd.), Malton, Ontario, it was stated that the submitted half-section was cut out

(Origin of Request and Object of Investigation, cont'd) -

9 inches from the stamped (marked for identification purposes) end of a 31-foot-long extrusion. This half-section was received here on November 18th.

The etched section showed, on the corners, "bright" spots (Figure 1), and an explanation of the origin of these apparent defects was requested. It was also stated that on a similarly etched specimen the wavy line at 45 degrees across the corner was shown to be a hair crack, but that it was obtained by heavier etching. Mr. Russell of the Aluminum Company of Canada, Toronto, found that in this case the specimen was overetched.

In a second letter, dated December 14th, 1942, File No. CANAID/M.244/12213, Mr. A. S. Lane gave additional information on the manufacture of these extrudings. The material used conforms to B.S.I. Specification 2L40. The shape was extruded, straightened, de-twisted, and age-hardened. It was stated that the other half-section showed the same phenomena on the corners.

It was also stated that "the affected area of apparent defects would be removed at the aircraft factory when cutting the extrusion to length."

Macroscopic Examination:

Figure 1 shows the etched half-section as received. After repolishing and etching with Keller's reagent*, the same macrostructure was obtained.

Figure 2 shows the macrostructure of a cross-section cut through the "bright" spot (perpendicular to the surface shown in Figure 1) and etched with Keller's reagent. This

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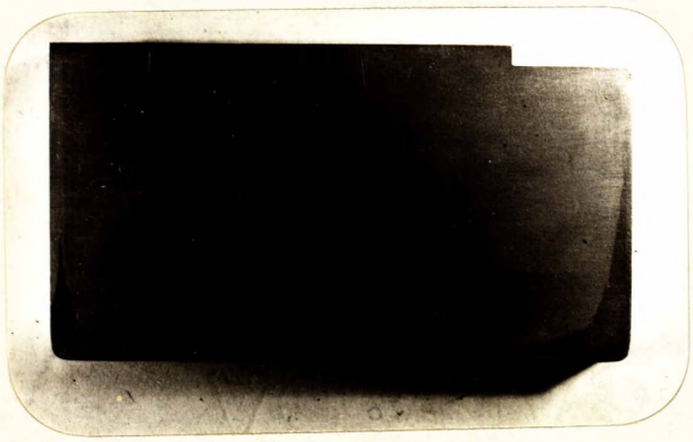
* Keller's reagent: 1% HF, 1.5% HCl, 2.5% HNO_3, and 95% H_2O.

(Macroscopic Examination, cont'd) -

surface shows that the "bright" areas run parallel to the direction of extrusion.

No hair cracks were found.

Figure 1.



SECTION PERPENDICULAR TO THE EXTRUSION, AS RECEIVED.

(Approx. nat. size).

Figure 2.

SECTION LONGITUDINAL TO THE EXTRUSION, (etched with Keller's reagent).

(Approx, nat. size).

Microscopic Examination:

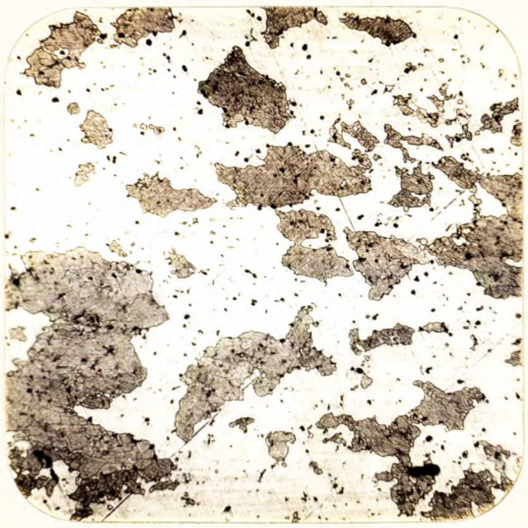
Figure 3 shows the typical microstructure of the inside part of the extrusion. Figure 4 shows the microstructure of the "bright" area. Both microphotographs are representative of the section perpendicular to the direction of extrusion.

No cracks on the "bright" area were detected.

(Continued on next page)

(Microscopic Examination, cont'd) -

Figure 3.



X100, etched with Keller's reagent.

AVERAGE STRUCTURE.

Figure 4.

X100, etched with Keller's reagent.

"BRIGHT" SPOT.

Hardness Tests:

Hardness was determined by the Vickers method, using a 10-kilogram load.

Average (inside)	-	150 V.H.N.
"Bright" areas in the corners	-	160 V.H.N.

Discussion of Results:

The metallographic examination shows that the "bright" spots are areas of very fine grain structure, located symmetrically on the corners of the cross-section of the extrusion.

The hardness tests indicate that these areas are slightly harder than the rest of the material.

It is known that the structure of an aluminium-alloy extrusion varies not only on the beginning and the end

(Discussion of Results, cont'd) -

of the extrusion, but also on the inside and outside of its cross-sections.

These differences in grain size, which are due to pressure and temperature effects in the process, are especially marked in the last part of the extrusion. Various workers have investigated these phenomena but none has been able to eliminate the heterogeneity. It was demonstrated, however, that the different structures produce no marked variations in mechanical properties of the extrusion.

In this particular case the peculiar formation of the fine-grained areas is due to the rectangular shape of the extrusion. In view of the fact that the "bright" areas are not included in the actual spar structure, their effect is of no great concern.

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