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O T T A W A December 12th, 1944.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1760.

Metallurgical Examination of Broken Left Hand Idler Wheel Bracket.

(Copy No. 10.)

Bureau of Mines
Division of Metallic
Minerals
-
Physical Metallurgy
Research Laboratories

CANADA

DEPARTMENT
OF
MINES AND RESOURCES

Mines and Geology Branch

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Origin of Material and Object of Investigation:

On October 18th, 1944, one broken left hand idler wheel bracket, D-37919B, was received from the Division of Metallurgy, Army Engineering Design Branch, Department of Munitions and Supply, Ottawa, Ontario. The covering requisition, No. 675 (A.E.D.B. Lot No. 568, Report No. 13, Test No. 66), called for a metallurgical examination to determine the quality of the material.

A general view of a bracket is shown in Figure 1.

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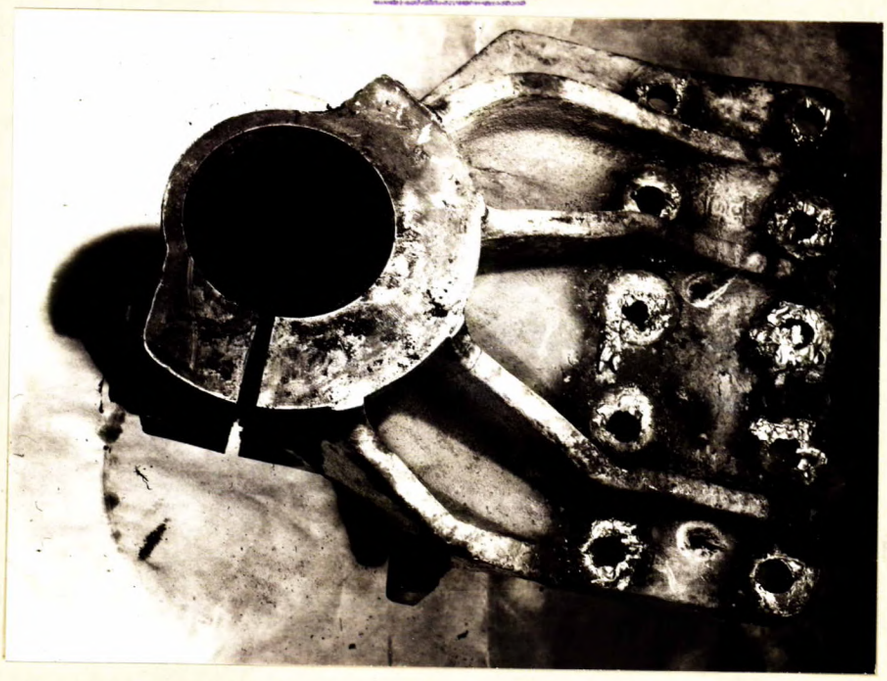
1760
1200
J.C.H.

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

Figure 1.



GENERAL VIEW OF AN IDLER WHEEL BRACKET.

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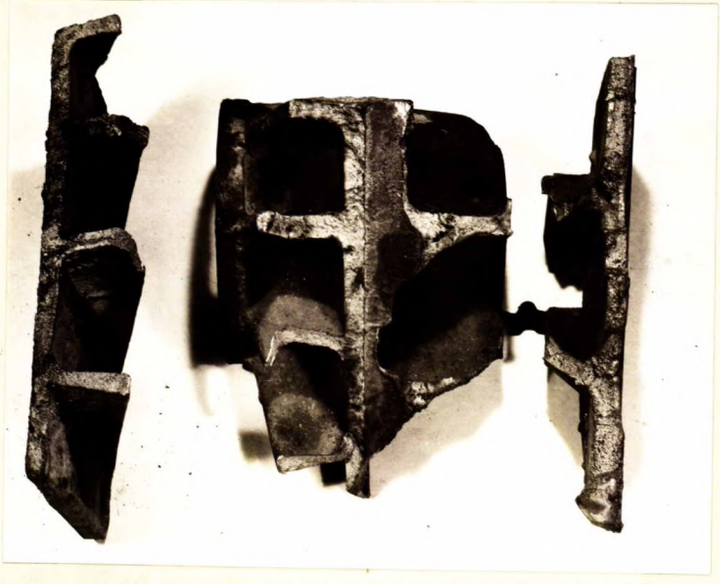
Preliminary Examination:

The bracket had broken in two places, the two plates having broken away from the hub. A view of the broken bracket is shown in Figure 2.

Figure 2.



PHOTOGRAPH OF BROKEN BRACKET.

(Approximately 1/6 full size).

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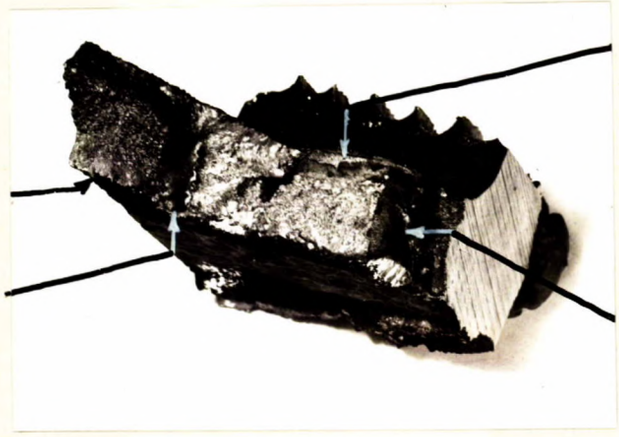
(Preliminary Examination, cont'd) -

A visual examination of the fracture revealed the presence of internal chills, fatigue fracture, and cold shuts. Temper colours and smooth areas on the fracture surface indicated that the broken portions had rubbed together after fracture. Figure 3 illustrates these various details.

Figure 3.



(Approximately 2/3 full size).

Chemical Analysis:

The specification covering the material, QQ-S-681B class 4C2, does not state any definite chemical composition, apart from setting limits of 0.06 per cent and 0.05 per cent for sulphur and phosphorus respectively. Analysis showed the composition to be as follows:

		Per Cent
Carbon	-	0.38
Manganese	-	0.70
Silicon	-	0.46
Sulphur	-	0.047
Phosphorus	-	0.020
Chromium	-	0.08
Nickel	-	2.38
Molybdenum	-	0.25

This is approximately the composition of SAE 4640 steel, with the exception that SAE 4640 gives a range of

(Chemical Analysis, cont'd) -

1.65-2.00 per cent for nickel.

Mechanical Tests:

Two tensile test bars, 0.282 inch in diameter, were machined from the bracket. The following results were obtained:

Maximum stress, p.s.i.	-	124,600	121,000
0.2 per cent proof stress, p.s.i.	-	114,000	112,000
Elongation in 1 inch, per cent	-	6	3.5
Reduction in area, per cent	-	6.25	7.75

Specification QQ-S-681B calls for the following mechanical properties:

Maximum stress, p.s.i.	-	105,000
Yield strength, p.s.i.	-	85,000
Elongation in 2 inches, per cent	-	18
Reduction in area, per cent	-	40

Several checks, or "crow's feet", showed up in the tensile specimens and the fracture was brittle and granular (see Figure 4).

(Continued on next page)

(Mechanical Tests, cont'd) -

Figure 4.

(Slightly less than full size).

Note "crow's feet".

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Micro-Examination:

On macro-etching a section through the fracture, the wire used as chills showed up (Figure 5). Proper fusion had not taken place, leaving planes of weakness.

(Continued on next page)

(Micro-Examination, cont'd) -

Figure 5.

(Approximately 4 times full size).

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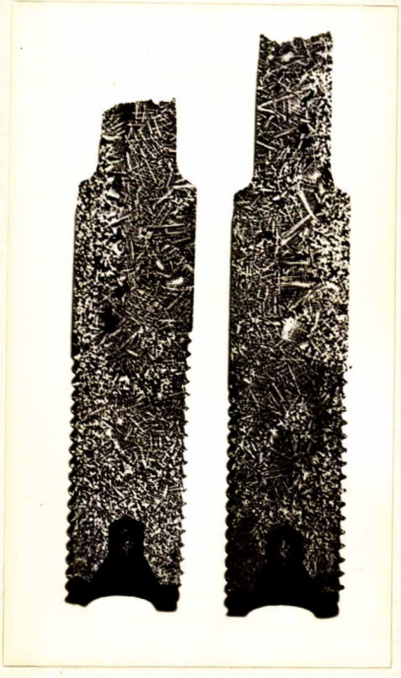
The tensile bars were sectioned and deep-etched, and the dendritic structure of the casting was revealed. Severe porosity was also revealed (see Figure 6).

Figure 6.



1:1 HCl etch.

DENDRITIC STRUCTURE AND POROSITY.

(Approximately 1½ times full size).

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(Micro-Examination, cont'd) -

Under the microscope, alloy segregation known as Widmanstätten structure was seen. An attempt was made to eliminate this to find out its effect on the ductility of the metal. Two bars were cut from the bracket. One was given a homogenizing treatment, 2000° F. for 24 hours. This bar was then quenched and drawn back to its original hardness of Rockwell 'C' 28. Izod test specimens were then machined from both these bars and the notch impact properties were determined. No significant difference was observed, 13-14 foot-pounds being required to break both bars.

The steel was clean, the few inclusions present being manganese sulphide.

CONCLUSIONS:

The metal used in the bracket is satisfactory.

The low elongation and reduction in area are due to foundry defects, i.e. chills (presence of unfused material), cold shuts, and porosity, predominantly porosity. The Widmanstätten structure, or alloy segregation, might be eliminated by faster cooling in the mould but this would have much less effect on mechanical properties than would improving casting soundness.

The material does not meet the specifications for elongation and reduction in area.

The use of internal chills, a practice resorted to to pass X-ray tests, seldom produces fusion in steel castings.

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