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DEPARTMENT OF MINES AND RESOURCES

BUREAU OF MINES

CANADA

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Ottawa, February 12, 1947.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 2179.

Investigation of the Cause of Brittleness in a Steel Casting.

(Copy No. 4)

CANADA

Bureau of Mines

Mineral Dressing and
Metallurgy Division

Physical Metallurgy
Research Laboratories

DEPARTMENT
OF
MINES AND RESOURCES

Mines and Geology Branch

O T T A W A

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Origin of Material and Object of Investigation:

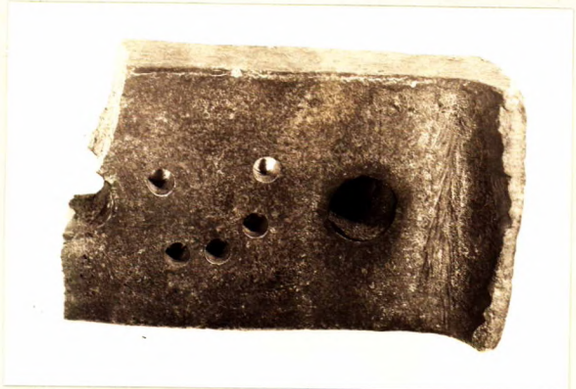
On January 29, 1947, Mr. L. Last, of Lynn MacLeod Metallurgy Limited, Thetford Mines, Quebec, submitted a broken piece of steel casting for examination (see Figure 1). In an accompanying letter, Mr. Last stated:

> "I am sending a broken casting which I broke with a sledge hammer. This casting is used in a "Jumbo" machine which is used by the mines for breaking the ore.
>
> "This casting is ordinary carbon steel and is supposed to be full annealed. However, after checking the analysis, I am under the impression that the casting has not been at the proper temperature for sufficient time or else is in the normalized state and has dangerous stresses.
>
> "As this may be an indication that our heat treatment is not good, I would greatly appreciate any criticism and help which your department can give us."

(Continued on next page)

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

Figure 1.



SAMPLE CASTING
"AS RECEIVED".

(Approximately 1/2 actual size.)

Chemical Analysis:

Drilling were taken for chemical analysis. The results were as follows:

		Per Cent
Carbon	-	0.19
Manganese	-	0.53
Silicon	-	0.28
Sulphur	-	0.030
Phosphorus	-	0.027
Chromium	-	Trace.
Nickel	-	Trace.
Molybdenum	-	Nil.
Vanadium	-	Nil.

Hardness Tests:

The Brinell hardness of the casting was 137.

Microscopic Examination:

A specimen was cut from the casting for microscopic examination. In the unetched condition a uniform distribution of inclusions was observed. No grain boundary eutectoid inclusions were present. The specimen was etched in 2 per cent nital and again examined under the microscope. Figure 2 (X100) illustrates the pearlite-ferrite structure arranged in a

(Microscopic Examination, cont'd) -

Widmanstätten pattern. This is characteristic of the "as cast" condition of steel.

Figure 2.

X100, etched in
2 per cent nital.

"AS CAST" STRUCTURE.

Discussion:

The chemical analysis shows that the casting was poured from a low-carbon steel having practically no residual alloys.

The structure of the casting is similar to the normal "as cast" structure of a low-carbon steel. This may be the result of either of the following:

(a) The casting was not heat-treated,
or
(b) The casting while being heat-treated did not reach the critical point of the steel (approximately 1585° F. (848° C.)

A casting in this condition is brittle. The following steps are suggested:

1. The furnace pyrometers should be checked carefully.
2. The distribution of heat in the furnace should be studied by placing chromel-alumel thermocouples in the actual load of castings and taking

(Discussion, cont'd) -

temperature readings with a portable potentiometer.

3. After (2) above has been carried out, care should be taken in the arrangement of castings on the furnace car to ensure proper circulation.

Conclusions:

1. The casting was poured from a low-carbon heat of steel.

2. The Brinell hardness is 137.

3. The structure of the casting corresponds to the "as cast" or unheat-treated type.

4. The casting is relatively brittle, due either to lack of heat treatment or to improper heat treatment.

Recommendation:

A thorough check should be made of the entire heat treatment process, since faulty heat treatment can cause premature service failures.

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