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

# R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1268.

## Examination of Two Failed Austenitic Manganese Steel Castings.

(Copy No. 5.)

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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Source of Material and Object of Investigation:

On July 9th, 1942, Mr. J. A. Sutherland, Sales Department, JOLIETTE STEEL LIMITED, Joliette, Quebec, submitted sections of two manganese steel castings for examination. It was stated, in a letter dated June 27th, 1942, that these castings, a jaw plate and a dipper tooth, had failed in service at the plant of the International Nickel Company of Canada Limited, Copper Cliff, Ontario. It was also stated

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

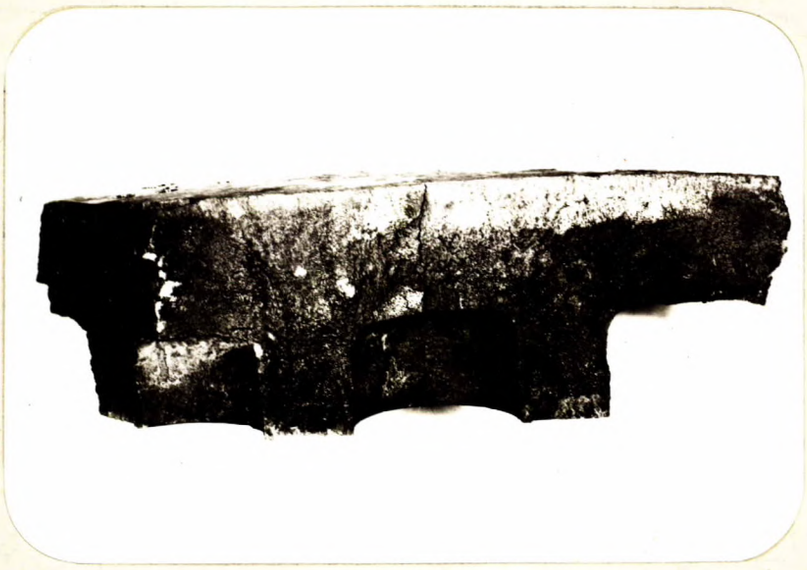
that chemical, physical and microscopic tests carried out by different laboratories were not conclusive. A complete examination by our laboratories was therefore desired in order to clear up, if possible, the cause of these failures.

In this report, the jaw plate and dipper tooth castings will be referred to as Steel No. 1 and Steel No. 2, respectively.

Macro-Examination:

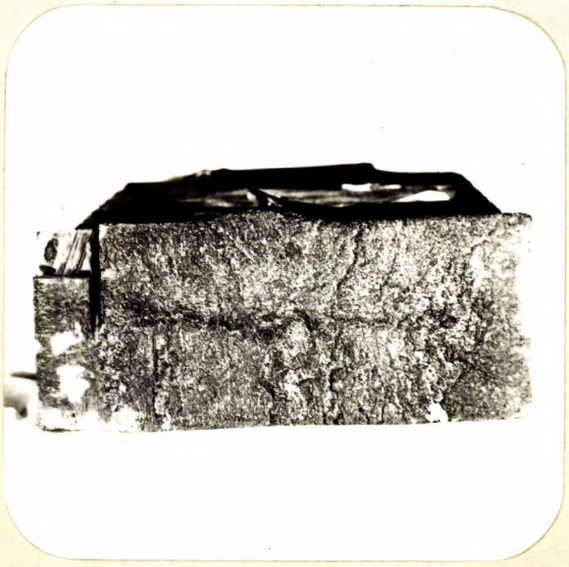
Figures 1 and 2 show the fractures of the two castings.

Figure 1.



JAW PLATE FRACTURE. (Approx. 1/3 size).

Figure 2.



DIPPER TOOTH FRACTURE. (Approx. 1/3 size).

Chemical Analysis:

-(Per cent)-

| | A.S.T.M. Spec. A 128-33. | Steel No. 1. | Steel No. 2. |
|---|---|---|---|
| Carbon - | 1.00-1.40 | 1.32 | 1.23 |
| Manganese - | 10.00-14.00 | 15.22 | 11.34 |
| Silicon - | 0.25-1.00 | 0.55 | 0.22 |
| Phosphorus - | 0.10 max. | 0.071 | 0.074 |
| Sulphur - | 0.05 max. | 0.010 | 0.010 |
| Chromium - | -- | 0.13 | 0.13 |

Microscopic Examination:

Both steels were found to be fairly clean. Figures 3 and 4 are photomicrographs at X100 magnification of Steels Nos. 1 and 2 respectively, after an etch in a solution of 4 per cent picric acid in alcohol. Figures 5 and 6 are photomicrographs of the same steels at X1000 magnification, also etched in picral. Figure 7 shows, at X100 magnification, the structure of Steel No. 1. Both steels contain massive free carbides (the white etching constituent) along the grain boundaries and also within the grains.

(Figures 3 to 7 are at back of this report)

Discussion of Results:

The compositions of the two steels were found to be within the limits of the S.S.T.M. specification for austenitic manganese steel, except for the manganese content of Steel No. 1. Both steels were fairly clean and, apart from the high manganese content in Steel No. 1, appeared to have been properly made. The small grain size of the steels indicates

(Discussion of Results, cont'd) -

that the steel was not poured from too high a temperature.

The presence of free carbides in these castings, especially along the grain boundaries, would have an embrittling effect and consequently would lower their impact physical properties.

In order to get these carbides in solution the casting must be heated to the proper solution temperature and to retain them in solution the casting must be quenched rapidly in cold water. It may be that the quenching temperature was too low or that the quenching rate was not fast enough.

Conclusions:

The failure of the castings can be attributed to the embrittling effect of the free carbides at the grain boundaries.

The presence of these carbides in the steel was due to a faulty heat treatment.

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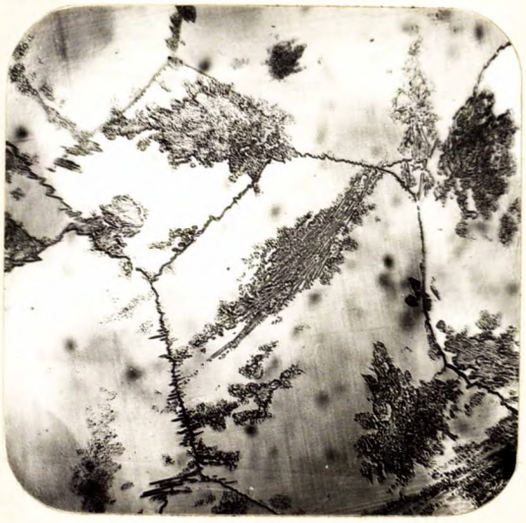
(Photomicrographs)

Figure 3.

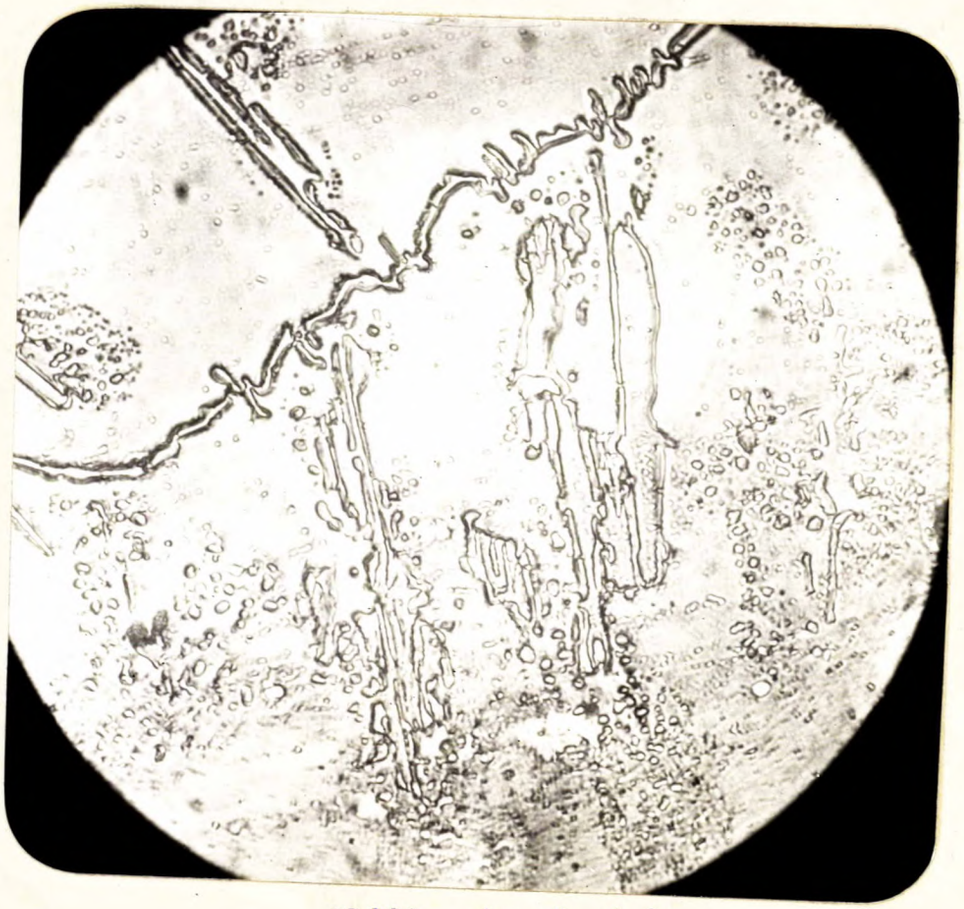


X100, picral etch.
STEEL NO. 1.

Figure 4.

X100, picral etch.
STEEL NO. 2.

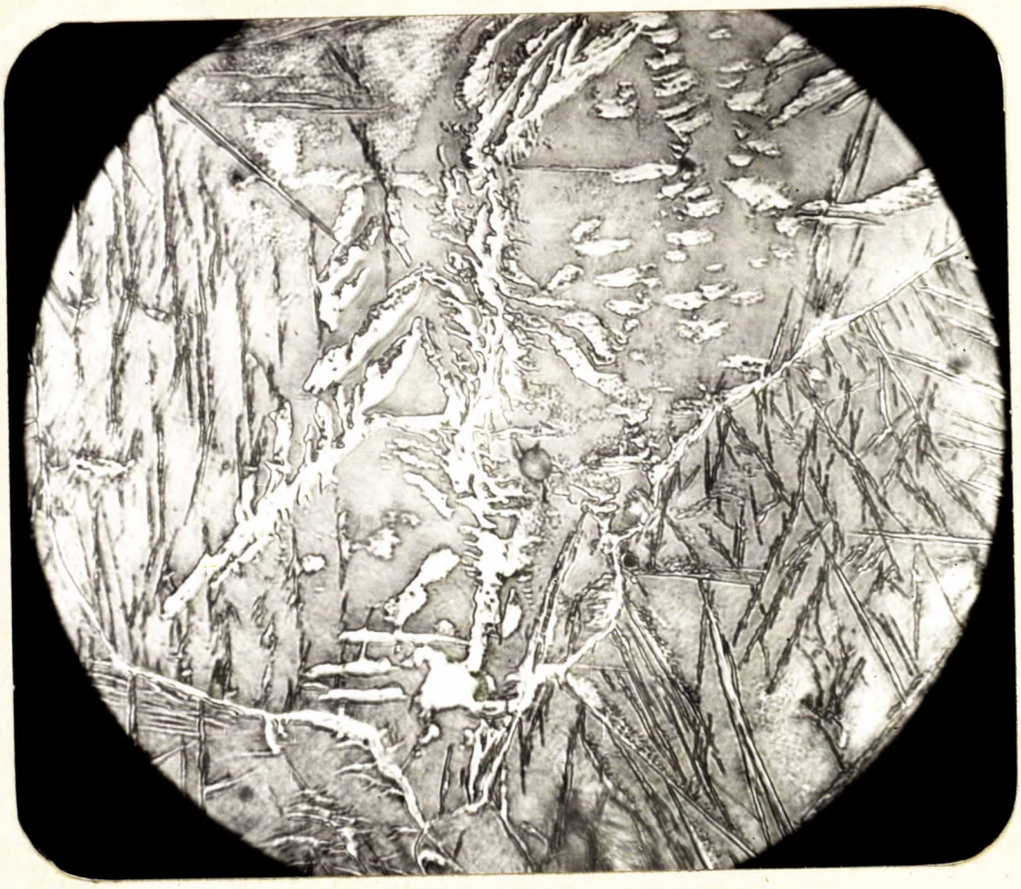
Figure 5.



X1000, picral etch.
STEEL NO. 1.

(Photomicrographs, cont'd) -

Figure 6.



X1000, picral etch.
STEEL NO. 2.

Figure 7.

X100, picral etch.
MICROSTRUCTURE OF STEEL NO. 1.

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