File.

OTTAWA February 10th, 1944.

REPORT

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1598.

Examination of Manganese Steel from (1) Symons Cone Crusher Liner, (2) Dipper Tooth for a Shovel Bucket.

(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

O T T A W A   February 10th, 1944.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1598.

Examination of Manganese Steel from
(1) Symons Cone Crusher Liner, (2)
Dipper Tooth for a Shovel Bucket.

Origin of Samples:

On January 24th, 1944, two samples were received at these Laboratories from Mr. J. A. Critchley, Plant Manager, Sorel Steel Foundries Limited, Sorel, Quebec.

In an accompanying letter, dated January 21st, 1944, information regarding these two samples was given as follows: Sample No. 1 was a piece of manganese steel from a Symons cone crusher liner which had failed prematurely in service at the Bell Asbestos Mine, Thetford Mines, Quebec; Sample No. 2 was a piece of manganese steel from a dipper tooth for a shovel bucket which had failed prematurely in service at Algoma Ore Properties Limited, Helen Iron Mine, Ontario.

Object of Investigations:

Chemical analysis and microscopic examination were requested, on both samples, to determine the reason for premature failure.

Macroscopic Examination:

Both pieces appeared sound in the "as received" condition. In both cases the broken surfaces were marked by weathering, but this was to be expected under the circumstances. The working face of the cone crusher liner appeared to be work-hardened.

Chemical Analysis:

Chemical analyses made on drillings from the two samples are shown below. A.S.T.M. Specification A-128-33, for austenitic manganese steel is also shown for the purpose of comparison.

Steel	Per Cent					
	Carbon	Manganese	Silicon	Phosphorus	Sulphur	Chromium
Cone crusher liner	1.11	12.78	0.49	0.037	0.017	0.03
Dipper tooth	1.14	11.72	0.38	0.045	0.008	0.15
A.S.T.M. - A-128-33	1.0-1.4	10.0-14.0	-	0.10 max.	0.05 max.	-

Hardness Determinations:

Hardness was determined on both samples, using the Brinell hardness testing machine with a 3,000-kilogram load. The following results were obtained:

Steel Sample Tested		Brinell Hardness Number
Cone crusher liner	-	201
Dipper tooth	-	201
Crusher liner (work-hardened surface)	-	415

A Brinell hardness number of this order could be expected in a steel of this nature. Also, a Brinell hardness number of 415 for the work-hardened surface of the crusher liner was not out of the ordinary.

-

Microscopic Examination:

One piece was cut from each sample in the "as received" condition, hand polished, and etched in 2 per cent nital.

No free carbides were seen in either sample of steel but considerable porosity was noted in both polished sections.

The grain size of the steel is very large in both cases, as may be observed in Figures 1 and 2, which are photomicrographs, taken at a magnification of 400 diameters, of the polished sections of the crusher liner and the dipper tooth, respectively. Figure 3 is a photomicrograph, taken at a magnification of 30 diameters, of the polished section of the cone crusher liner showing how the porosity follows the grain boundaries. This was particularly prevalent in the cone crusher liner but was also noted in the examination of the polished section of the dipper tooth.

Discussion of Results:

Chemical analysis showed that both samples were well within the A.S.T.M. Specification A-128-33 for austenitic manganese steel, so that it is not likely that the failures can be attributed to the chemical composition of the steels.

The hardness obtained for both samples was in the expected range for this type of manganese steel.

No free carbides were found in either sample. This would indicate that the temperature of quenching was correct and that the period of soaking at this temperature was satisfactory.

The grain size in both polished sections was very large. It is possible to develop better properties in this type of steel by refining the grain. This is accomplished by pouring the molten steel at as low a temperature as possible.

Castings of this type should show very little, if any, (Discussion of Results, cont'd) -

porosity or shrinkage. Both of the samples examined showed considerable shrinkage, along the grain boundaries and throughout the samples generally.

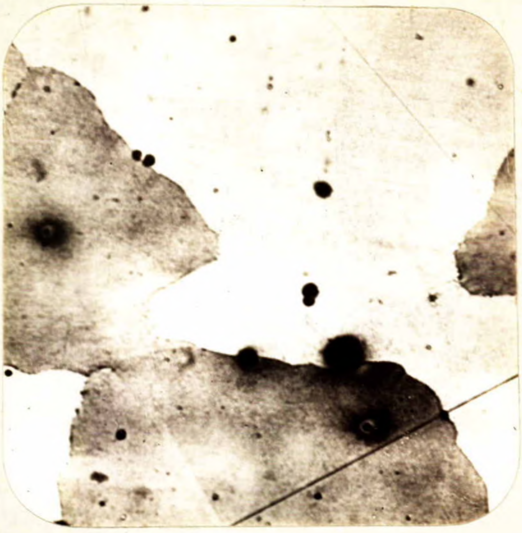
CONCLUSION:

Premature failure in both cases would appear to be due to the very large grain size, and to unsound castings due to shrinkage cavities.

oooooooooooo
oooooo
oo

ELC:GHB.

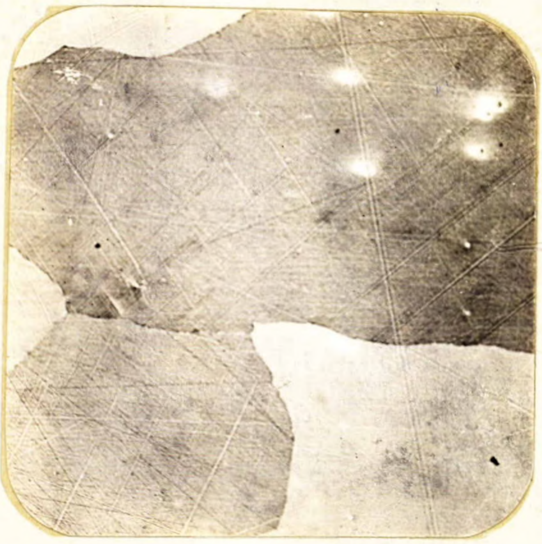
Figure 1.



X100, nital etch.

GENERAL STRUCTURE OF CONE CRUSHER LINER,
SHOWING LARGE GRAIN SIZE.

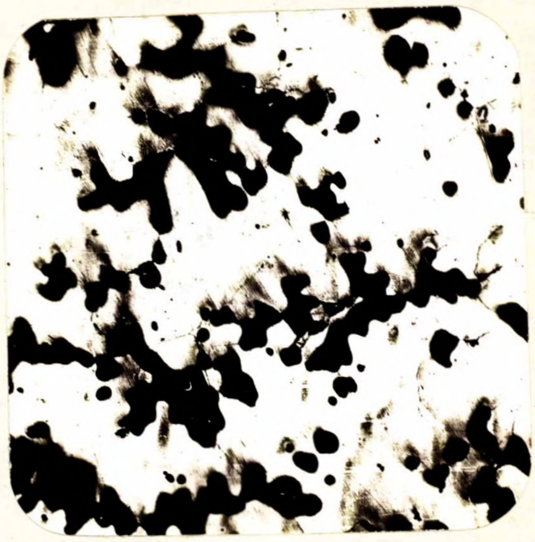
Figure 2.



X100, nital etch.

GENERAL STRUCTURE OF
DIPPER TOOTH, SHOWING
LARGE GRAIN SIZE.

Figure 3.



X30, nital etch.

CONE CRUSHER LINER,
SHOWING POROSITY FOLLOWING
GRAIN BOUNDARIES.

ELC:GHB.