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

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1640.

Examination of Broken Austenitic Manganese Steel Cone Crusher Mantle.

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Foreword:

On April 14th, 1944, a broken piece of a cast manganese steel cone crusher mantle was received from the Joliette Steel Limited, Joliette, Quebec. This was accompanied by correspondence signed by Mr. R. Rivest, of the Sales Engineering Department, requesting a metallurgical examination.

The sample submitted was about 2 inches thick. It had been flame-cut from the broken casting.

Chemical Analysis:

The chemical analysis of this sample of manganese steel was found to be as follows:

		Per Cent
Carbon	-	1.45
Manganese	-	11.85
Silicon	-	0.84
Nickel	-	Nil.
Chromium	-	0.03

Microscopic Examination:

A specimen cut from the sample submitted was prepared for the microscope. A 4 per cent picral etch was used to show the structure. Figures 1 and 2 show the steel structure at X100 and X500 magnifications respectively. Note that there is a continuous carbide film around the grains.

Heat Treatment Test:

A piece, 2" x 2" x ½" in size, was cut from the sample. This piece was heated at 1940° F. for 3 hours and then water-quenched. The resultant structure is shown in Figure 3, a photomicrograph taken at a magnification of 100 diameters. Note that the grain boundaries appear to be rather heavy. Figure 4, at 250 diameters, shows that this heavy grain boundary is not continuous in all places. Figure 5, at 2000 diameters, shows in detail the structure of the grain boundary.

Discussion of Results:

The structure shown in Figures 1 and 2 indicates that the quenching during heat treatment has not been severe enough to prevent carbides from forming.

The sample heat-treated in these Laboratories showed some material precipitated on the grain boundaries. This material is undoubtedly carbide. The conditions of this heat treatment were known to be good and the quench was more severe than that commonly encountered in industrial practice.

It is therefore concluded that the chemical analysis is at fault. The carbon is higher than that recommended. A carbon content of 1.4 per cent is usually considered to be the absolute maximum, and usually a range of from 1.0 per cent to 1.3 per cent carbon is considered desirable. The manganese, at 11.85 per cent, would be satisfactory if the carbon were lower.

Conclusions:

1. The cone crusher mantle failed because of the presence of carbides on the grain boundaries.

2. The carbides are present on the grain boundaries because the carbon content is too high.

Recommendations:

1. It is recommended that the carbon content of these castings be reduced to 1.0 to 1.3 per cent and that the manganese be kept within the range of 11 per cent to 14 per cent.

2. It is not recommended that the heat-treatment practice be changed at this time.

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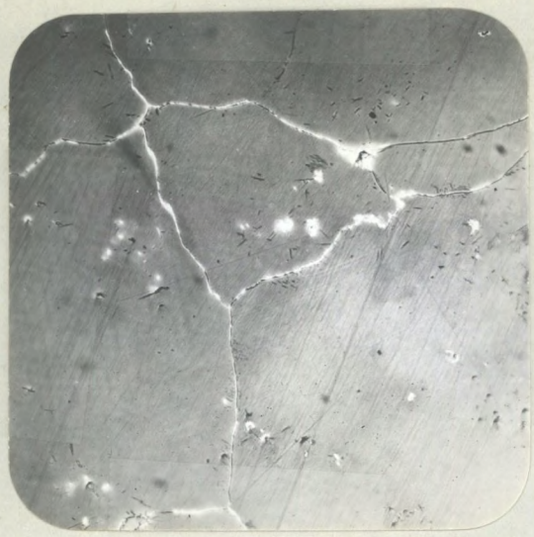
Figure 1.



X100, picral etch.

PHOTOMICROGRAPH SHOWING GRAIN BOUNDARY CARBIDES AND ALSO A FEW CARBIDES THROUGHOUT THE GRAINS.

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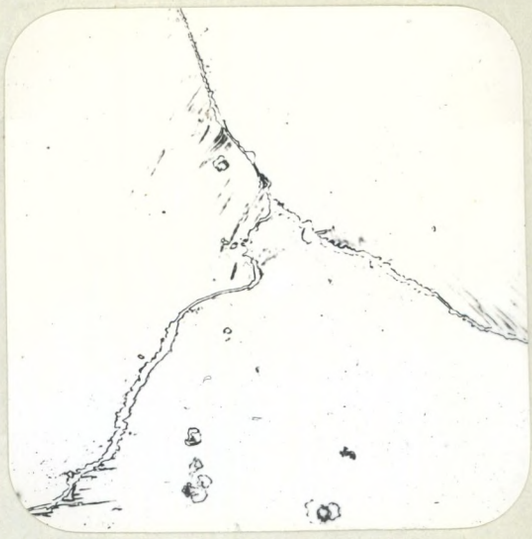
Figure 2.



X500, picral etch.

PHOTOMICROGRAPH SHOWING DETAIL OF GRAIN BOUNDARY CARBIDES.

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Figure 3.

X100, picral etch.

PHOTOMICROGRAPH SHOWING STRUCTURE AFTER WATER-QUENCHING PIECE 2" x 2" x $\frac{1}{2}$" FROM 1940° F.

Note heavy grain boundaries.

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Figure 4.

X200, picral etch.

SAME AS FIGURE 3.
SHOWS DISCONTINUOUS, HEAVY GRAIN BOUNDARIES.

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Figure 5.

X2000, picral etch.
SAME AS FIGURE 3.
SHOWS DETAILS OF GRAIN BOUNDARY STRUCTURE.

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