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O T T A W A

August 6th, 1943.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1467.

Examination of United States Manufactured Specimen
of Manganese Steel from a Pulverizer Ring.

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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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Origin of Request and Object of Investigation:

On July 19th, 1943, one sample of manganese steel was submitted to these Laboratories for examination. In an accompanying letter from Mr. J.R. Blais, Sales Department, Sorel Steel Foundries Limited, Sorel, Quebec, it was stated that this material was manufactured in the United States and had given an exceptionally long life. It was also mentioned that the specimen was broken from a ring which was used in an "American Pulverizer Company" for grinding bauxite. It was requested that the chemical analysis and physical properties be determined and that comments be made on the manufacturing process.

Macroscopic Examination:

The "as received" material was a broken piece from a cylindrical ring. The fracture was very coarse indicating presence of dendrites and columnar grains which grew from the mold walls toward the axis. This condition is shown in Figure 1.

Chemical Analysis:

The chemical analysis of the material is given below, in comparison with the A.S.T.M. Specification A-128-33, for austenitic manganese steel:

	Sample	A.S.T.M.
	"As Received"	A-128-33
	-Per cent-	
Carbon	- 1.24	1.0-1.4
Manganese	- 13.13	10.0-14.0
Silicon	- 0.26	-
Phosphorus	- 0.042	0.10 max.
Sulphur	- 0.006	0.05 max.
Chromium	- 0.27	-

Hardness Determination:

The Hardness of the material was found to be 234 V.H.N.

Microscopic Examination:

The microscopic examination of the material revealed that the steel was coarse grained, that the carbides inside and on the grain boundaries were not completely removed, and that shrinkage holes were also present. Figures 2, 3 and 4 show the presence of these conditions.

Discussion of Results:

The coarse fracture of the specimen indicated that a large grain size in the steel was to be expected. The microscopic examination has confirmed this prediction.

Such a large grain size is an indication of a very high pouring temperature.

The chemical analysis of the material shows the content of each element is within the limits of the A.S.T.M. specification.

(Discussion of Results, cont'd) -

However, it must be pointed out that both the carbon and manganese are kept on the high side of the range. Attention should be drawn to this condition which gives to the steel a better ability to harden by martensitization due to cold working. The wearing properties, in turn, are greatly improved by the hardness thus developed in the material. Chromium content (0.27) has also a slight hardness effect.

Due to the size and form of the material "as received", it was practically impossible to determine the tensile and impact properties of the steel. However, these properties are expected to be low on account of the large grain and the presence of carbides, which are objectionable especially when present at these grain boundaries.

The microscopic examination revealed that the steel was not manufactured with special care. The large grain size, the presence of carbides, and shrinkage holes are all usually considered as defects in such a type of steel. However, in this particular case, it seems that the presence of such defects is not as detrimental as it would be expected, since the material has had an extremely long life. This might be explained, on account of the fact that certain types of service do not require a high tensile or impact strength. For example, the main requirement of a pulverizer is good wearing properties. The long life of the pulverizer parts is chiefly dependent on this feature.

The wearing properties of a material are proportional to its hardness. In an austenitic manganese steel, cold working brings in martensitization which develops better hardness and wearing properties. The hardness by martensitization is in turn, proportional to both the manganese and carbon content.

It seems that, for such a type of service, the main factor

would be to keep the carbon and manganese on the high side of the range.

CONCLUSIONS:

1. The material submitted has a large grain size and contains carbides on the grain boundaries and shrinkage holes.
2. These defects, which would be mostly objectionable as a general rule, seem to be of minor importance due to a special type of service.
3. The long life of the steel is attributed to the good wearing properties developed by a high carbon and manganese content.

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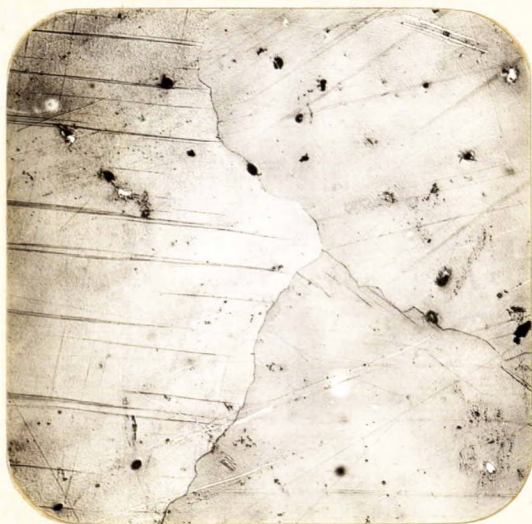
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Figure 1.



ILLUSTRATING COARSE DENDRITIC FRACTURE
OF THE "AS RECEIVED" SAMPLE.

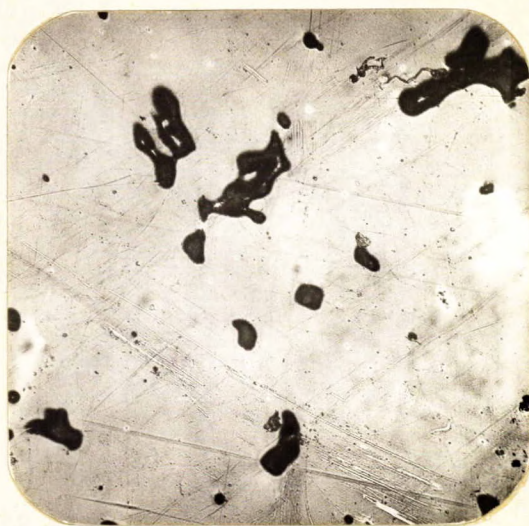
Figure 2.



X100, nital etch.

SHOWING THE LARGE GRAIN
SIZE OF THE MATERIAL.

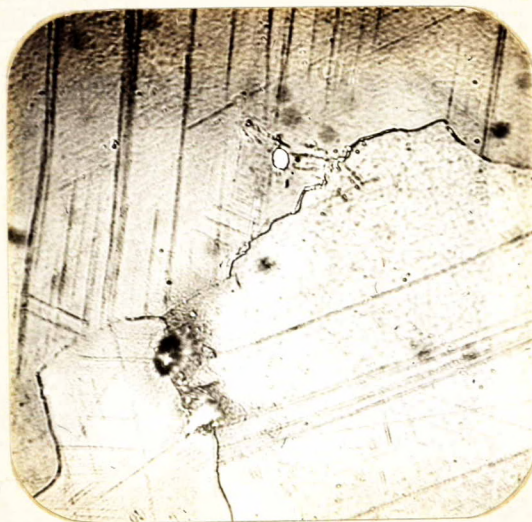
Figure 3.



X100, nital etch.

SHOWING SHRINKAGE HOLES
IN THE MATERIAL.

Figure 4.



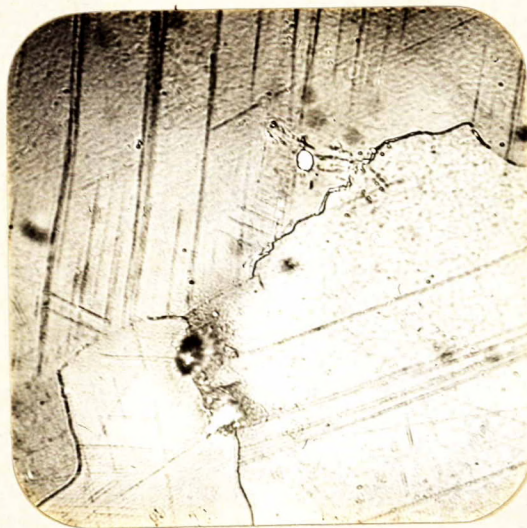
X1000, nital etch.

SHOWING CARBIDES ON THE GRAIN BOUNDARIES.

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Figure 4.



X1000, nital etch.

SHOWING CARBIDES ON THE GRAIN BOUNDARIES.

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