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August 4th, 1944.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1694.

Examination of Manganese Steel Track Shoe.

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Bureau of Mines
Division of Metallic
Minerals
Physical Metallurgy
Research Laboratories

CANADA
DEPARTMENT
OF
MINES AND RESOURCES
Mines and Geology Branch

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Origin of Request and Object of Investigation:

On July 12th, 1944, a manganese steel track shoe was received from the Inspection Board of the United Kingdom and Canada, Ottawa, Ontario. The covering requisition, O.T. 4251, (July 11th, Ref. No. 12/4/4, Tank File 4/10/D/Ram 9), asked for a complete metallurgical examination. The shoe was to conform to Specification O.A. 219.

Chemical Analysis:

A chemical analysis was made, and compared to Specification O.A. 219 as follows:

	<u>AS FOUND</u>	<u>SPECIFICATION</u>
	<u>- Per Cent -</u>	<u>O.A. 219</u>
Carbon	- 1.15	1.0 - 1.4
Manganese	- 12.54	11.0 - 14.0
Silicon	- 0.79	Less than 1.0.
Phosphorus	- 0.079	Less than 1.0.
Sulphur	- 0.007	Less than 0.05

Hardness:

The Brinell hardness (average of 4 readings) was found to be 183. A hardness of less than 241 Brinell is specified.

Magnetic Test:

The sample was found to be non-magnetic, as required by the specification.

Microscopic Examination:

The steel was examined under the microscope for free carbides. Fine carbides were observed on many of the grain boundaries, as shown in Figure 1. The carbide-free grain boundaries obtained on quenching a piece of the steel from 1900° F. are shown in Figure 2. Figure 3 shows the detail of the carbide grain boundaries.

Discussion:

Carbides on the grain boundaries are detrimental, as they embrittle the steel. The amount of carbides in the sample submitted may not be too serious, but the presence of a condition which needs correction is indicated. These carbides undoubtedly occur as a result of improper quenching, as carbides present as a result of heating to too low a

(Discussion, cont'd) -

temperature or for too short a time probably would be more massive, and would certainly not be confined to the grain boundaries.

Conclusions:

1. The track shoe submitted conforms to Specification O.A. 219, with the exception of some fine carbides observed on the grain boundaries.

2. The carbides on the grain boundaries are undoubtedly caused by improper quenching.

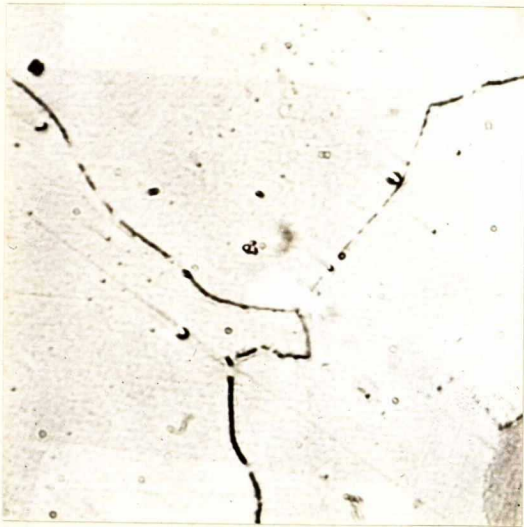
Recommendation:

Consideration should be given to improvement of quenching practice.

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AEM:GHB.

Figure 1.

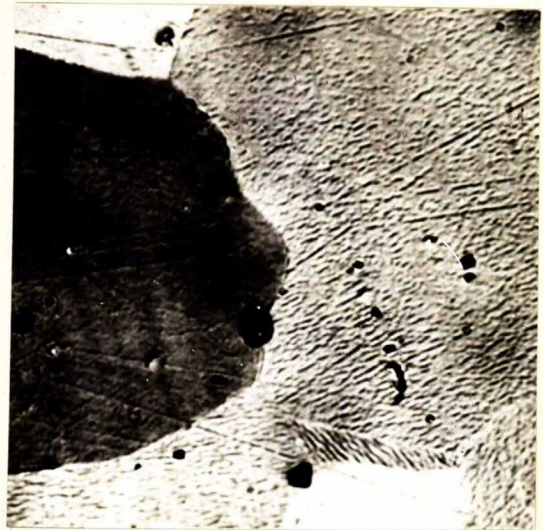


X1000, nital etch.

As Received.

CARBIDES ON
GRAIN BOUNDARIES.

Figure 2.



X1000, nital etch.

After Water Quenching from 1900° F.

CARBIDE-FREE
GRAIN BOUNDARIES.

Figure 3.



X2000, nital etch.

As Received.

DETAIL OF GRAIN
BOUNDARY CARBIDES.