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O T T A W A

August 5th, 1944.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1696.

Examination of Three Manganese Steel Track Shoes.

~~CONFIDENTIAL~~

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Origin of Request and Object of Investigation:

On July 27th, 1944, three manganese steel track shoes were submitted by Prof. J. U. MacEwan, Division of Metallurgy, Army Engineering Design Branch, Department of Munitions and Supply, Ottawa, Ontario. Requisition No. 661 (A.E.D.B. Lot No. 554, Report No. R23/5C/D2, Test No. 32) requested a metallographic examination of the shoes to determine the amount and distribution of free carbides.

It was stated that the shoes had been manufactured by Electric Steels Limited, Cap de la Madeleine, Quebec, and that the manufacturer wished to check on the efficiency of a shorter heat-treating cycle.

Chemical Analysis:

The chemical analyses, as supplied by Electric Steels Limited, were as follows:

<u>Heat No.</u>	<u>Code No.</u>	<u>Date</u>	<u>Car- bon</u> - P e r -	<u>Sili- con</u> C e n t	<u>Sul¹/₂ phur</u> C e n t	<u>Phos- phorus</u> -	<u>Mangan- ese</u>	<u>Molyb- denum</u>	<u>Cop- per</u>
A-5820	6-13	July 22	1.13	0.75	0.012	0.066	12.0	-	-
D-920	6-14	July 22	1.23	0.90	0.012	0.062	12.4	-	-
A-5821	1-1	July 24	1.15	0.64	0.012	0.065	12.1	-	-

Microscopic Examination:

Two of the track shoes were found to contain free carbides on the grain boundaries. The other sample was found to be free of carbides. Photomicrographs of these structures are shown in Figures 1 to 3. The detail of the carbide grain boundary is shown in Figure 4.

Discussion:

Grain boundary carbides, if at all continuous, embrittle austenitic manganese steel. Their presence in two of the samples submitted indicates, at best, a condition that should be corrected. As all the carbides present are at the grain boundaries and there is a complete absence of massive carbides, a cooling before quench, or a slack quench, rather than incorrect soaking temperature or time of soak, must be responsible for the two-phase condition. This defect in quenching is of the haphazard type and not associated with the process, as one of the steels was in a satisfactory condition.

Conclusion:

1. Free carbides observed on the grain boundaries are the result of the quenching practice.

2. The two-hour-plus cycle used in treating these shoes is apparently sufficient to give complete solution of the carbides.

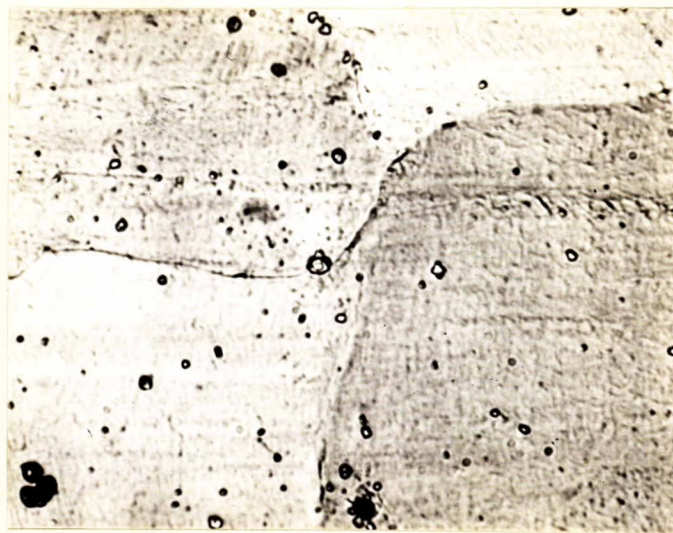
Recommendation:

Consideration should be given to improving the quenching operation.

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AEM:GHB.

Figure 1.



X1000, nital etch.

Heat No. A-5850.

CARBIDE-FREE GRAIN BOUNDARIES.

Figure 2.

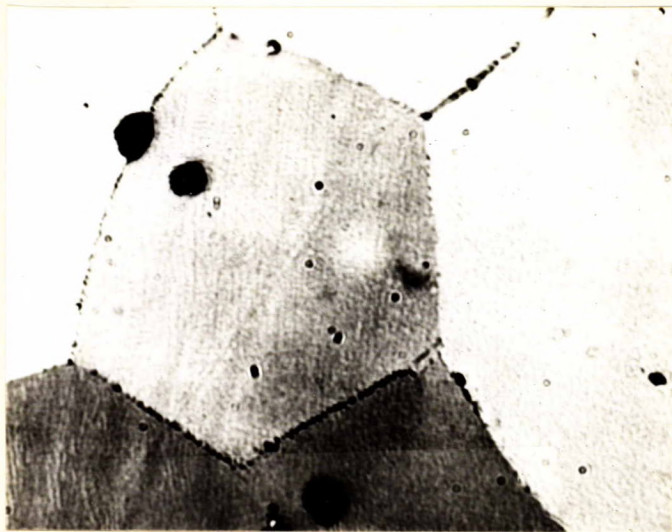


X1000, nital etch.

Heat No. D-920.

CARBIDES AT GRAIN BOUNDARIES.

Figure 3.

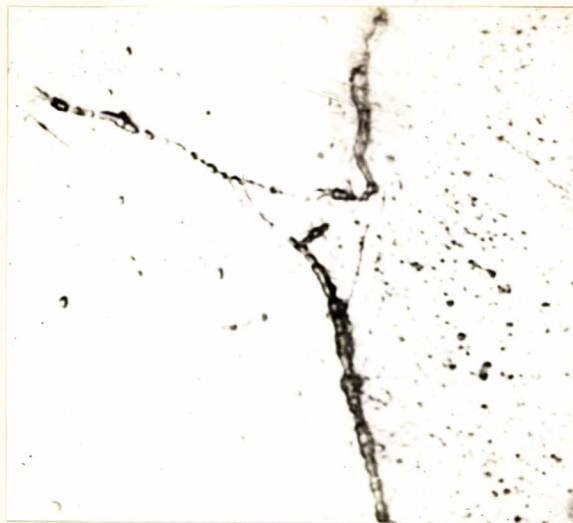


X1000, nital etch.

Heat No. A-5821.

CARBIDES AT GRAIN BOUNDARIES.

Figure 4.



X2000, nital etch.

Heat No. D-920.

DETAIL OF CARBIDE GRAIN BOUNDARIES.