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O T T A W A   August 12, 1943.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1474.

Examination of Defective Canadian
Dry Pin Track Shoes.

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(Copy No. 6.)

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 August 12, 1943.

REPORT

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ORE DRESSING AND METALLURGICAL LABORATORIES

Investigation No. 1474.

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Dry Pin Track Shoes.

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Origin of Material and Object of Investigation:

On July 29th, 1943, Professor J. U. MacEwan, Consultant to Director of Metallurgy, Army Engineering Design Branch, Department of Munitions & Supply, submitted five Canadian Dry Pin Track shoes for examination. These were representative of a number of austenitic manganese steel shoes, produced by Electric Steels Limited, Cap de la Madeleine, Quebec, which had failed within the first 200 miles of a field test. Requisition 569, A.E.D.B., Lot No. 357 requests that the possible causes for failure be determined.

Macro Examination:

Failure occurred in the ribbed sections of all the links close to the grouser. Figures 1,2,3, and 4 illustrate the cracks in each of the five links. Figure 5 shows a crack which has opened up considerably in the outside rib of one of the links. A link which had cracks in all the ribs but one was subjected to a pull test. Figure 6 shows the fractured surfaces of the ribs after this test. The ribs having the cracks in them prior to the test show the metal to be dendritic at the point of fracture. The one which was not cracked has a uniform structure. The pictures are approximately 1/3 the normal size of the links.

Figure 1.

Figure 2.

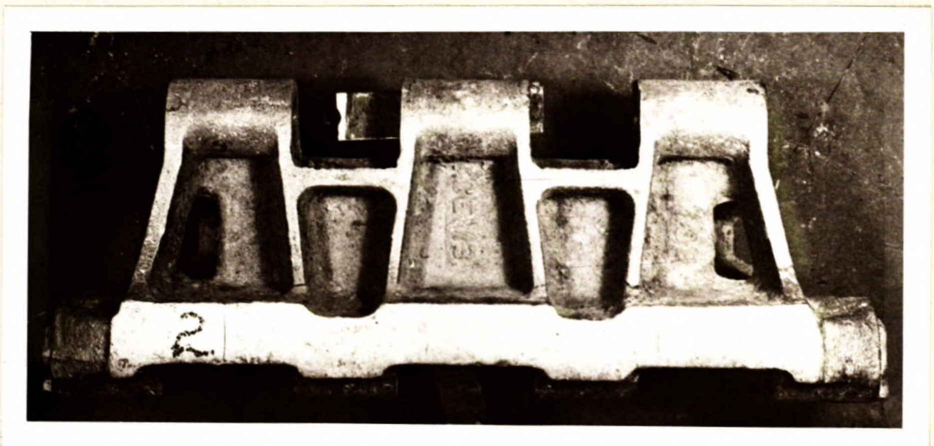


Figure 3.

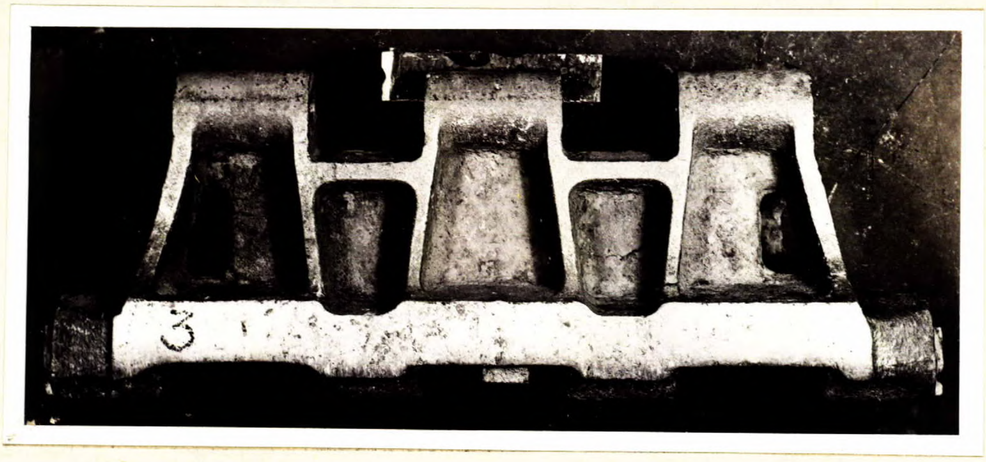


Figure 4.

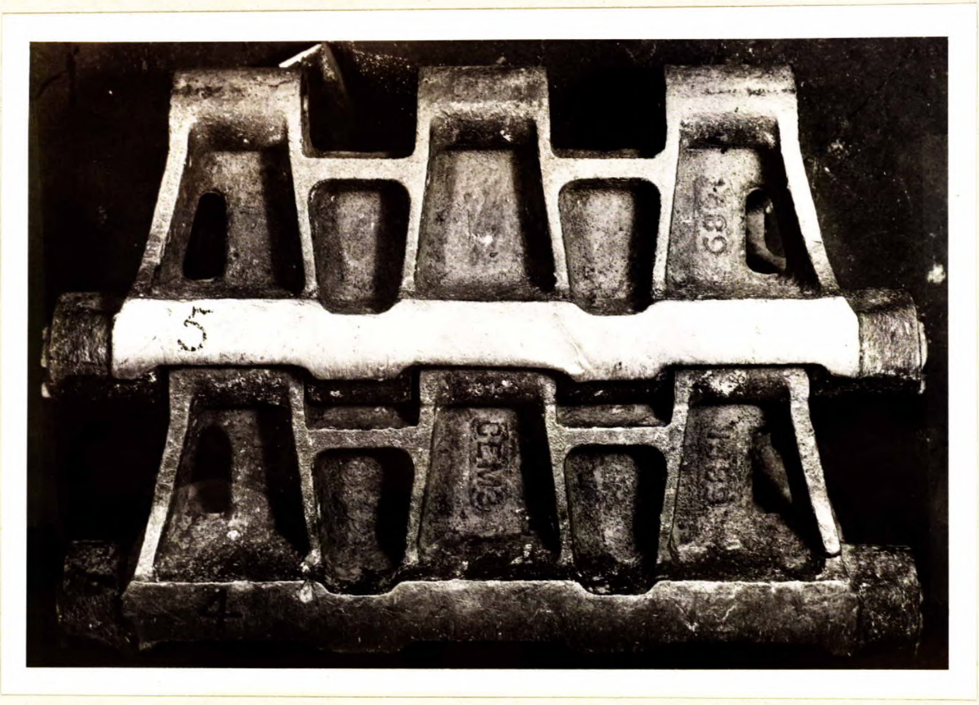
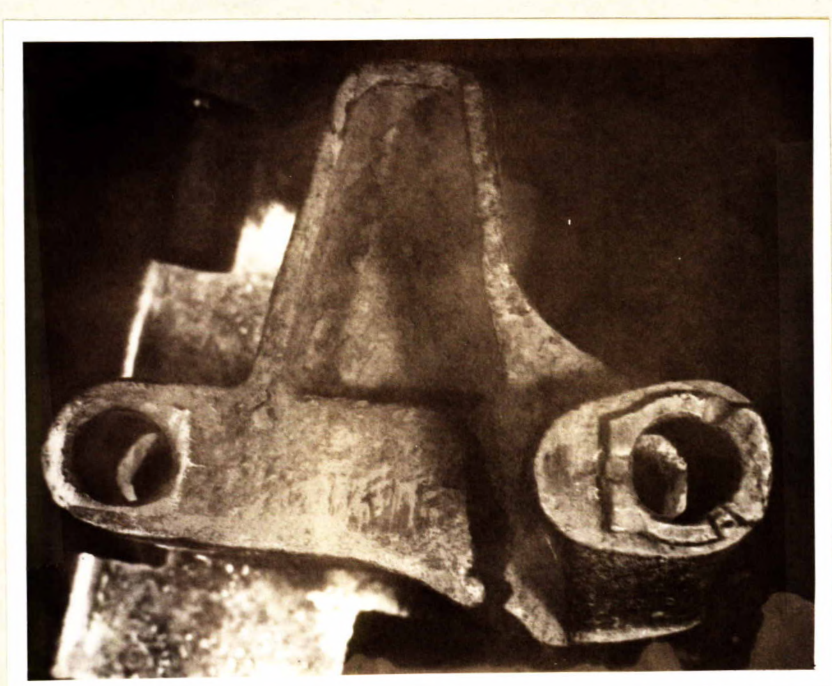


Figure 5.

(Approximately ½ size)

Figure 6.



X-ray Examination.

Links numbers 4 and 5 (Figure 4) were X-rayed at the National Research Council. No abnormalities were observed in the ribs which could not be seen visually.

Chemical Analysis:

Drillings were taken from two links and analysed separately. The results were:

		Link No. 2	Link No. 3
Carbon	-	1.25	1.24
Manganese	-	12.8	12.8
Phosphorus	-	0.058	0.060

Hardness.

The Brinell hardness values of the links were 217-223.

Microscopic Examination.

Samples for microscopic examination were cut from several links. Sections were cut transversely across the grouser and also through the ribs. Free carbides were evident in all the nital etched specimens examined. Figure 7, taken at X100, of a section through the grouser shows carbides both in the grains and at the grain boundaries. Figure 8 (X500) shows carbides in a section taken from a rib.

Figure 7.

X100. Nital Etched.
Grouser Section.
(Note free carbides-white constituent)

(Continued on next page)

Figure 8.

X500. Nital Etched.
Rib Section.
(Note showing of free carbides at two points)

Discussion

The chemical analysis shows that these links were cast in austenitic manganese steel of satisfactory composition. The dendritic structure at the point of fracture illustrated in Figure 6 suggests that an unsatisfactory foundry condition exists, since the abnormal portion of the fracture exhibited a dendritic structure. This would be caused by either shrinks or hot tears. Due to the position at which these occur it is felt that hot tears are the most likely cause. Hot tears are usually produced by cores with insufficient collapsability.

Hot tears may not be the only cause for failure in service. Other failed links, not examined, may have cracks due to too severe quenching or improper time temperature cycle in the heat-treat furnace. Careful observation should be made at the foundry to check the above-mentioned possibilities.

The heat treatment given to the links which were examined was not satisfactory. Free carbides were evident both around the grain boundaries and in the grains themselves. These were more prevalent in the thicker section (e.g. grouser, Figure 7). This precipitation of free carbides may be due to:

(1) Insufficient soaking time at the proper temperature, 1830° F-1940° F.

(2) Too low a temperature in the heat-treat furnace.

(3) Improper quench.

(4) Links being allowed to cool prior to the quench.

Elimination of free carbides (especially at the grain boundaries) is essential in order to produce a satisfactory link. It is well known that free carbides produce brittleness.

Conclusions

1. Austenitic manganese steel of a satisfactory composition was used in casting the links.

2. A dendritic structure is present in the ribs where failure occurred. This indicates that the rib fractures may be hot tears.

3. Cores which have too great strength at high temperatures cause hot tears.

4. Possibility of cracks produced by severe quenching or improper time temperature cycle in the furnace must not be ruled out as only a few links were investigated.

5. The links received an unsatisfactory heat treatment as free carbides were present.

Recommendations.

1. Close inspection in the foundry should be initiated to determine whether rib cracks occur in casting   in heat treatment.

2. Elimination of the hot tears should be effected by control of core manufacture.

3. The heat treatment should be checked in order to eliminate the precipitation of free carbides.

4. If shoes free from cracks prior to heat treatment develop cracks after the heat treatment, then either the quenching medium temperature is too cool or the time temperature heat-treat cycle is too severe and should be lengthened somewhat to include a preheat time.

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