File.

FILE COPY

OTTAWA September 27th, 1943.

# REPORT

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1501.

## Examination of Austenitic Manganese Steel Track Shoes Containing Cracks in Various Sections.

=========

(Copy No. 10.)

Bureau of Mines
Division of Metallic
Minerals
-
Ore Dressing
and Metallurgical
Laboratories

CANADA

DEPARTMENT
OF
MINES AND RESOURCES

Mines and Geology Branch

OTTAWA September 27th, 1943.

# REPORT

of the

## ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1501.

### Examination of Austenitic Manganese Steel Track Shoes Containing Cracks in Various Sections.

==========

Origin of Material and Object of Investigation:

On August 25th, 1943, Professor J. U. MacEwan, Consultant to the Director of Metallurgy, Army Engineering Design Branch, Department of Munitions and Supply, Ottawa, Ontario, submitted seven austenitic manganese steel Canadian Dry Pin track shoes for examination. This request is covered by Requisition No. 584, AEDB Lot No. 372, dated August 27th, 1943.

The shoes had been produced by Electric Steels Limited, Cap-de-la-Madeleine, Quebec, and showed cracks in various sections, reported to have occurred at some point in the production cycle. It was requested that a complete metallurgical examination be carried out to determine the cause of cracking.

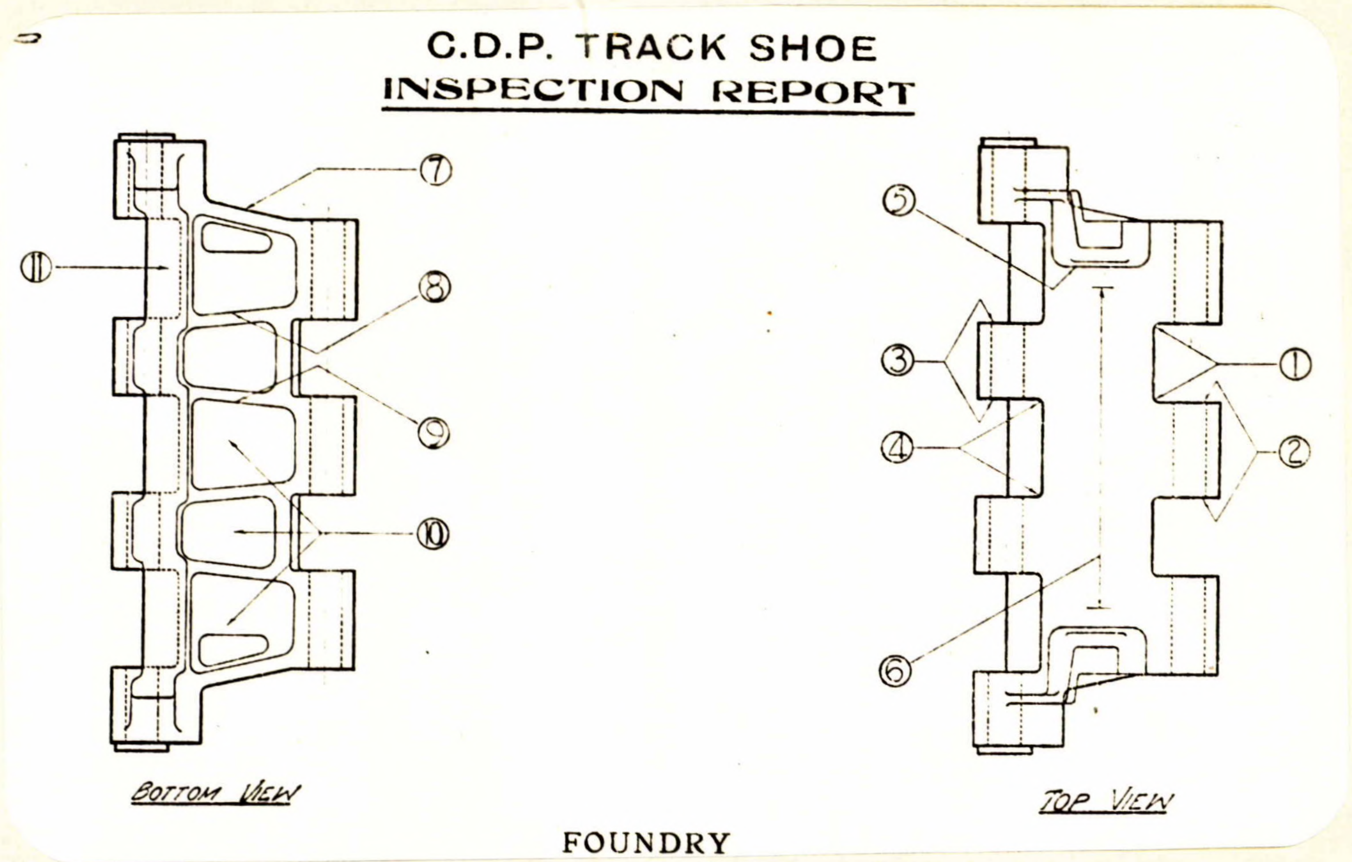
Macro-Examination:

Figure 1 is a chart showing the system of referring to various parts of the shoe by number. With reference to it, the shoes were cracked as follows:

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | shoe | cracked | at | Station | No. | 1. |
| 1 | " | " | " | " | " | 4. |
| 2 | " | " | " | " | " | 5. |
| 1 | " | " | " | " | " | 6. |
| 1 | " | " | " | " | " | 7. |
| 1 | " | " | " | " | " | 11. |

The cracks were quite deep, extending almost through the section in every instance.

Figure 1.




REFERENCE CHART FOR NUMBERING THE VARIOUS PARTS OF THE SHOES.

-

Chemical Analysis:

Drillings for chemical analysis were taken from the surface layer, and from the metal underneath after the surface layer had been removed by grinding, to check for any decarburization.

The results of the analyses were as follows:

| | SHOE NO. 1 | | SHOE NO. 2 | |
|---|---|---|---|---|
| | Surface | Core | Surface | Core |
| | - Per cent - | | | |
| Carbon - | 0.94 | 1.13 | 1.03 | 1.10 |
| Manganese - | | 13.7 | | 14.3 |
| Sulphur - | | 0.008 | | 0.012 |
| Phosphorus - | | 0.066 | | 0.048 |
| Chromium - | | 0.42 | | 0.23 |
| Silicon - | | 0.55 | | 0.91 |

Hardness:

The hardness of the metal varied from 201 to 217 Brinell (with the 3,000-kilogram load and 30-second applications).

Heat Treatment:

A section of one of the shoes (approximately half of shoe) was reheated to 1900° F. for 2½ hours and quenched in boiling water. A crack was observed in one of the web sections after quenching.

Micro-Examination:

Microspecimens were cut from a shoe through the cracked specimen and away from the cracked section. A microspecimen was also cut from the piece of the shoe which had been reheat-treated. All specimens were polished, etched in nital, and examined under the microscope.

In the two specimens from the shoe before reheat treatment, very few free carbides were observed. However, there were a large number of microshrinks present, particularly at the grain boundaries. Figure 2, at 100 diameters, shows

(Micro-Examination, cont'd) -

such a shrink on the section near the crack.

Figure 2.

X100, nital etch.

SECTION NEAR CRACK.

Note shrinkage at the grain boundaries.

Discussion:

The chemical analyses show that there is slight decarburization, but it is felt that there is not enough to be considered serious. They also indicate the presence of chromium in the steel. According to the literature, chromium has the following effects when present in austenitic manganese steel:

(1) It renders the steel less critical to heat treatment.

(2) It causes the steel to work-harden more readily.

(3) It induces a higher hardness in the unworked steel. However, it is felt that the small amount of chromium present would have very little effect on the properties of the steel.

The chromium either may have been added purposely during the steelmaking or may have been introduced in the

(Discussion, cont'd) -

scrap. If the latter is the case, insufficient deoxidation in the steelmaking is indicated, as all but a small percentage of the chromium should be oxidized off and go to the slag during the period when the steel is "boiled" to oxidize the carbon down to the desired value.

A section of one of the shoes cracked on being quenched in boiling water from 1900° F. Austenitic manganese steel shoes from other producers have been given the same treatment in these Laboratories and have not cracked. It would appear, therefore, that there is some fundamental defect peculiar to the shoes of this producer. As mentioned above, this defect might be insufficient refining in the steelmaking.

It is not possible to determine whether the cracks in the shoes occurred on quenching. This could be definitely established only by observing the process in the foundry.

The metallographic examination indicates the presence of microshrinks, particularly at the grain boundaries. Some carbides were observed also, but the condition is not a serious one.

The cause of the cracks cannot be definitely determined by a routine metallurgical examination. The microshrinks certainly contributed to some extent, but it is felt that the shoes cracked largely because of some fundamental defect in the steel. If it is true that the steel has not been sufficiently refined, this may well be the underlying cause.

---

CONCLUSIONS:

1. There has been no excessive decarburization of the links.

2. Chromium is present in the steel. If it has been introduced in the scrap, insufficient refining in the steelmaking is indicated. The amount of chromium present is, per se, not sufficient to have any marked effect on the properties of the steel.

3. The shoes of this producer tend to crack, while those of other producers do not.

4. There are microshrinks in the metal, particularly at the grain boundaries.

5. The cause of the cracks cannot be definitely determined by a routine metallurgical examination, but there appears to be some fundamental defect in the steel. This defect might be insufficient refining, as mentioned above.

oooooooooooo
oooooo
oo

JPO:GHB.