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OTTAWA May 22nd, 1944.

REPORT

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1651.

Metallurgical Examination of C.D.P. Track Shoes to Determine Cause for Early Change in Pitch.

(Copy No. 10.)

Bureau of Mines
Division of Metallic
Minerals
-
Physical Metallurgy
Research Laboratories

CANADA

DEPARTMENT
OF
MINES AND RESOURCES

Mines and Geology Branch

O T T A W A May 22nd, 1944.

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Metallurgical Examination of C.D.P. Track Shoes
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Origin of Meterial and Object of Investigation:

On April 25th, 1944, five C.D.P. track shoes were submitted by Army Engineering Design Branch, Department of Munitions and Supply, Ottawa, Ontario, under Requisition No. 645 (Lot No. 537, Report No. 23, Sec. 5C, Div. 2, Test No. 30). Three of these shoes, made by Electric Steels Ltd., Cap de la Madeleine, Quebec, had been removed from a Grizzly I tank after 1,100 miles of service at Camp Borden. The other two shoes, one of which was from Hull Iron and Steel Foundries and other from Electric Steels Limited, had been removed at some unknown mileage below 1,100 miles.

It was requested that an examination be made to determine whether the elongation of pitch was due to wear or to stretching of the metal. This work was to be carried out in conjunction with Mr. S. Mordasewicz, of A.E.D.B., who was to make a measurement survey of the dimensions of the shoes.

A Hull track shoe which had successfully passed the 3,000-mile test was received on May 2nd, to be used for purposes of comparison.

Macro-Examination:

Figures 1 and 2 show the "as received" condition of the shoes.

All test work done in order to determine the reason for change in pitch was carried out on the two single shoes (shown in Figure 1), as these were considered fully representative of the lot.

Upon close examination it was obvious that much wear had occurred upon the outer surface of the eyehole walls; while the inner walls appeared as an "as cast" surface, indicating infrequent contact of the pin with this face. Figure 3 shows portions cut from the eyehole of both the Hull and Electric Steels failed shoes. The condition of the differential wear within the eyehole is more pronounced in the case of the Electric Steels shoe.

Chemical Analysis:

		Carbon - Per Cent -	Manganese - Per Cent -
C.D.P. track shoe from Hull Iron and Steel which failed before 1,100 miles	-	0.98	11.23
C.D.P. track shoe from Electric Steels which failed before 1,100 miles	-	1.00	11.25
C.D.P. track shoe from Hull Iron and Steel which passed 3,000-mile test	-	1.32	11.39

Hardness:

A hardness survey was made on polished cross-sections of the eyehole area. The hardness was found to be fairly constant throughout, indicating that there was no definite portion that had been severely strained. The readings made on the Hull steel showed hardnesses of Vickers 180 ±10, while the Electric Steels shoe gave higher readings, Vickers 210 ±10.

X-Ray Examination:

Specimens from each shoe were etched in 50 per cent nitric acid for x-ray examination by the back-reflection method. However, the grain size in each case was too large to give a continuous ring pattern with a stationary sample and so no

(X-Ray Examination, cont'd) -

conclusive results as to strain could be obtained.

It was interesting to note the effect which the severe etching had had upon the different samples. Figure 4 shows how much more pitted the Electric Steels shoe became, indicating a dirtier casting.

Microscopic Examination:

Samples cut from the eyehole wall of each shoe were examined at 100 diameters after a picral etch. Figures 5 and 6, photomicrographs of the two shoes which failed before 1,100 miles, indicate the considerable difference in their grain sizes. Also, slip bands are quite prevalent in the case of the Electric Steels shoe, and this condition is a definite indication of cold work. Figure 7 shows the Hull shoe which passed the 3,000-mile test. It, like Figure 5, shows large grains but no signs of slip bands.

Heat Treatment and Further Examination:

Sections from all the shoes were heated to 800° F. for 1 hour and air cooled. This method of bringing out slip bands has been recommended by Krivobok.* Figures 8 and 9 indicate slip to be present in both the Hull and the Electric Steels shoes which had not passed the 1,100-mile test, while the photomicrograph (Figure 10) from the 3,000-mile shoe shows no sign of any slip within the grains.

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* V. N. Krivobok: "A Study on the Constitution of High Mn Steels." Trans. A.S.M., Vol. XV, June 1929, p. 893.

Discussion of Results:

The specification for high manganese C.D.P. track shoe steels calls for a Mn:C ratio of 10:1. In the two failed shoes the carbon is found to be low. As carbon may be considered highly responsible for inherent strength, the premature slip failure could possibly be attributed to this low carbon content.

If it is to be considered that the two shoes had the same hardness before use, the difference in hardness would certainly indicate a greater degree of cold work in the shoe from Electric Steels than in that from the Hull Iron and Steel Foundries. However, the possibility of this hardness difference being present in the original condition of the shoes must not be overlooked.

The greater the amount of cold work the more severe and prevalent is the appearance of slip bands. Comparing the appearance of these lines definitely shows a greater amount of deformation present in the case of the Electric Steels shoe.

Upon heating of these austenitic manganese steels, the austenite goes through a partial transformation, precipitating carbide. The scattered appearance of the product, as shown by Figure 10, indicates the absence of cold work, while the decided orientation of the particles in Figure 8 shows that there must have been some deformation.

Although the results indicate deformation in the failed shoes, it must be understood that this is not conclusive. The straightening operation during manufacture is often severe enough to cause the appearance of slip bands in even the eyehole section of the shoe. The best method to check these results would be careful measurement around the eyehole and comparison with the original casting.

CONCLUSIONS:

1. Both of the Hull and Electric Steels shoes which failed under 1,100 miles show signs of deformation as well as wear.

2. Their manganese-to-carbon ratios fall below specification, owing to low carbon content.

3. The Electric Steels shoe has undergone more severe deformation than the Hull shoe.

4. The Electric Steels shoe is of a much finer grain and is not as clean as the Hull shoe.

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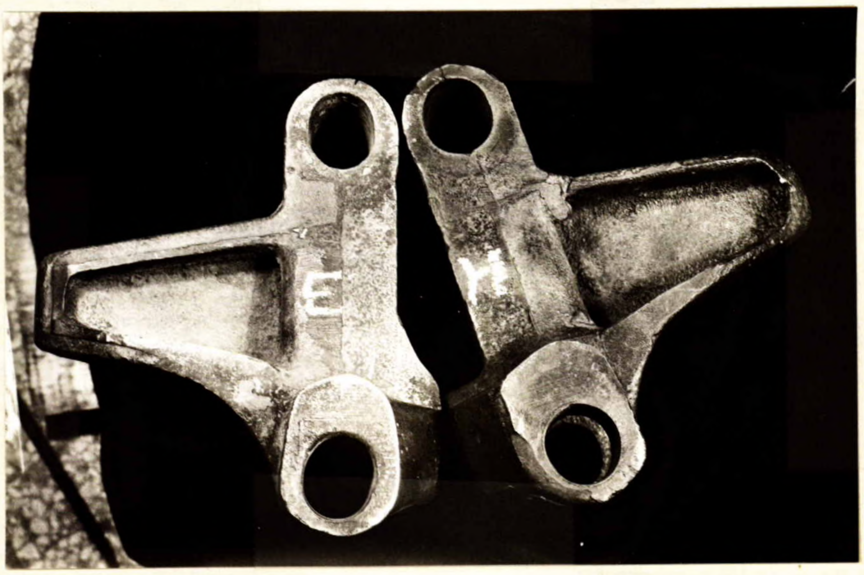
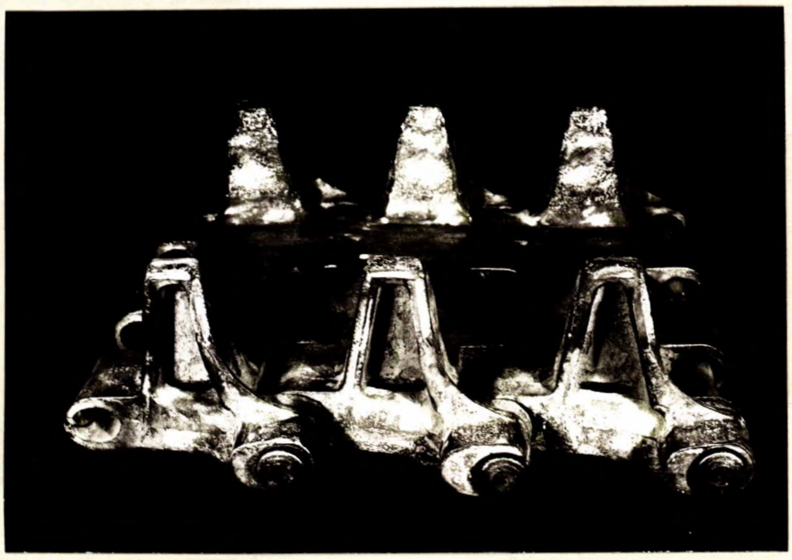
Figure 1.



FAILED SHOES AS RECEIVED.

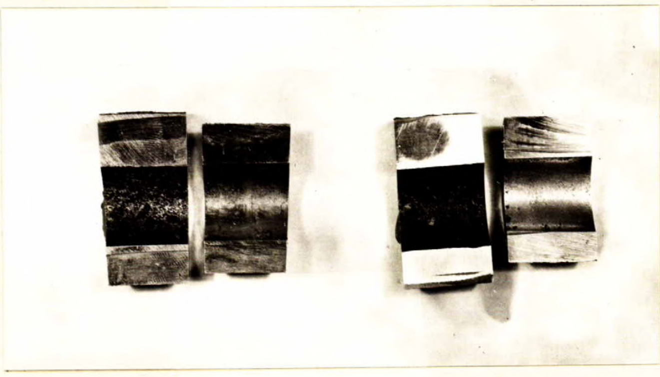
Note deformation of eyehole.

Figure 2.



THREE FAILED ELECTRIC STEELS
SHOES LINKED TOGETHER.

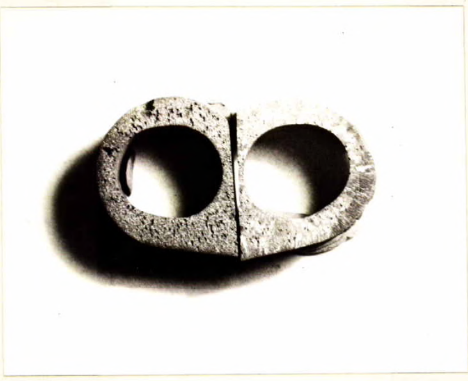
Figure 3.



PORTIONS CUT FROM EYEHOLE OF HULL (left, above) AND ELECTRIC STEELS (right, above) SHOES.

Note: The right sample of each pair is the outer wall; the left sample, the inner wall.

Figure 4.



SHOWING PITTING AFTER SEVERE ETCHING.

Left side, Electric Steels shoe; right side, Hull shoe.

Figure 5.

X100, picral etch.

HULL SHOE (FAILED), AS RECEIVED.

Note large grains and absence of slip bands.

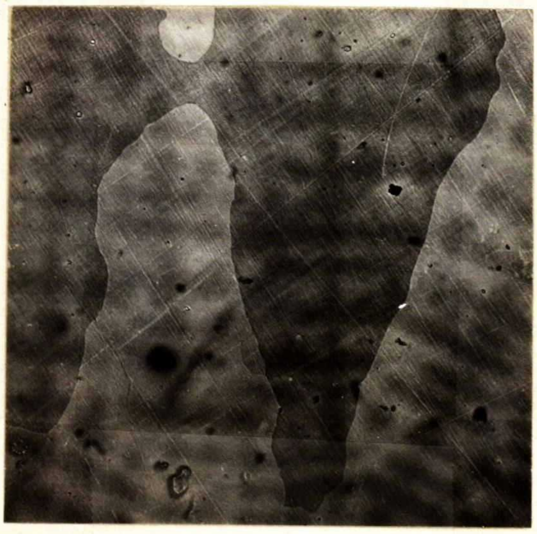
Figure 6.

X100, picral etch.

ELECTRIC STEELS SHOE (FAILED), AS RECEIVED.

Note smaller grain size and presence of slip bands.

Figure 7.



X100, picral etch.

HULL SHOE WHICH PASSED 3,000-MILE TEST, AS RECEIVED.

Note large grain size, and absence of slip bands.

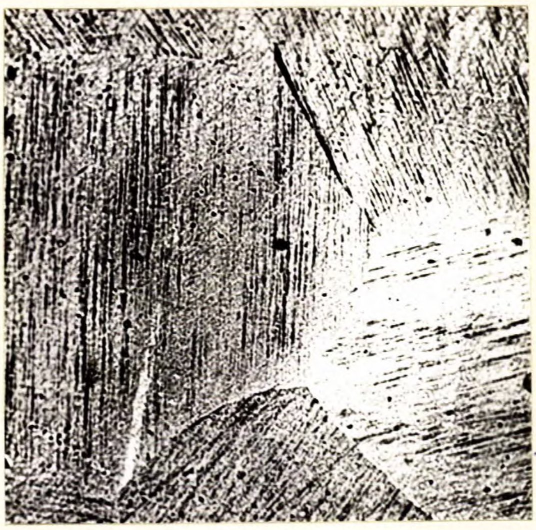
Figure 8.

X1000, picral etch.

HULL SHOE (FAILED), AFTER DRAWING TO 800° F.

Orientation of carbides within grains indicates cold work.

Figure 9.



X1000, picral etch.

ELECTRIC STEELS SHOE (FAILED), AFTER DRAWING TO 800° F.

Original slip bands indicating cold work are even more pronounced than before heat treatment.

Figure 10.

X1000, picral etch.

HULL SHOE WHICH PASSED 3,000-MILE TEST, AFTER DRAWING TO 800° F.

Scattered appearance of carbides indicates that there has been no cold work.

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