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OTTAWA May 9th, 1944.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1638.

Investigation of the Surface Condition of High Manganese Steel Produced by Electric Steels Limited, Cap de la Madeleine, Quebec.

(Copy No. 13.)

Bureau of Mines
Division of Metallic
Minerals

Ore Dressing
and Metallurgical
Laboratories

CANADA

DEPARTMENT
OF
MINES AND RESOURCES

Mines and Geology Branch

OTTAWA May 9th, 1944.

REPORT

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1638.

Investigation of the Surface Condition of High Manganese Steel Produced by Electric Steels Limited, Cap de la Madeleine, Quebec.

Origin of Material and Object of Investigation:

On May 2nd, 1944, two test bars and a C.D.P. track shoe were received for examination, under Requisition No. O.T. 4183, from the Materials Division of the Inspection Board of United Kingdom and Canada, Ottawa, Ontario. Accompanying the request letter (File No. 12/4/4) and requisition was a copy of a letter (File No. 4/10/D/RAM/O, May 1, 1944) from Mr. F. C. Wilson, of the Tank Division, I.B.U.K. & C., Ottawa, which stated:

> "Electric Steels have recently increased their soaking time with a view of getting the free carbides in the steel more in solution. In the first experiments along this line, they found that the test bar absorbed the heat quicker than the shoe itself, due to the smaller mass of metal involved, which caused slight decarburization of the bar. In order to produce a bar which would be typical of the shoe itself, they covered it to impede the heat absorption. We are anxious to find out if the covered bar which is identified is representative of the shoe."

The bars were marked A and B for identification. Subsequent examination indicated that A was the covered and B the uncovered bar.

Chemical Analysis:

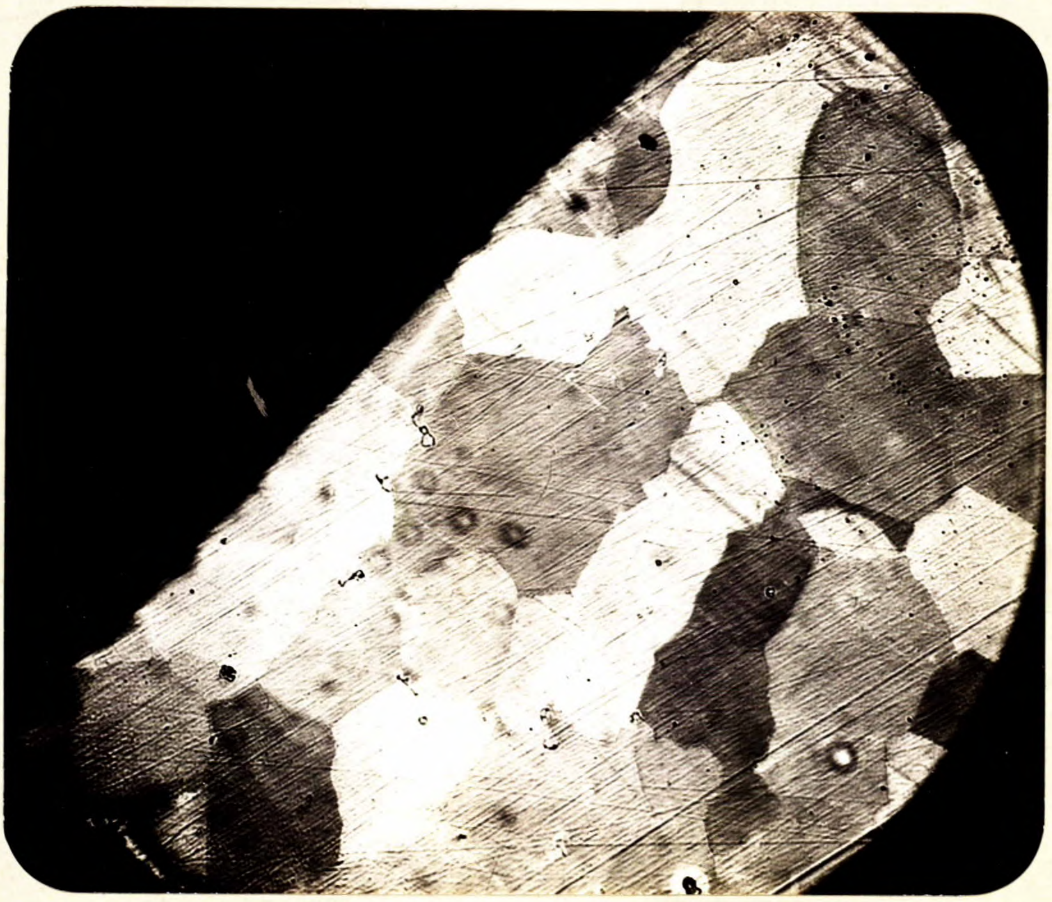
It was reported by Mr. R. O. McGee, of the Materials Division, that the two test bars and the shoe were supposedly from the same heat of steel. Drillings were taken from 1/8 inch below the surface, and these were analysed.

	Shoe	Test Bar A	Test Bar B
Carbon -	1.11	1.23	1.14
Manganese -	11.10	11.65	11.25
Silicon -	0.79	0.76	0.76
Sulphur -	0.009	0.010	0.007
Phosphorus -	0.086	0.091	0.092

Microscopic Examination:

Microspecimens were cut from each of the test bars and the link. They were polished and etched in 2 per cent nital. Figures 1, 2 and 3, photomicrographs taken at X250 magnification, show respectively the structures at the surfaces of Bar A, Bar B, and the link.

Figure 1.



X250, nital etch.
COVERED BAR A.
(Note: Surface has not been decarburized - no martensitic layer.)

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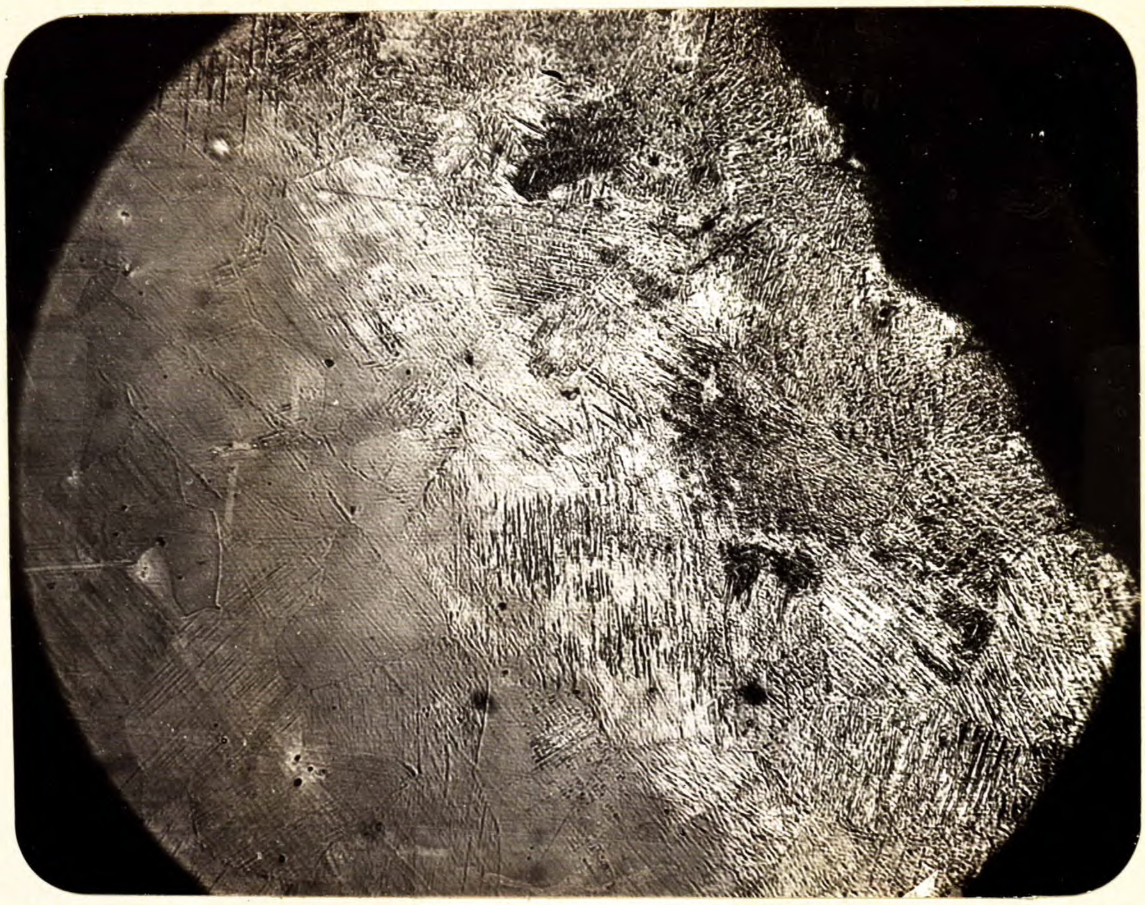
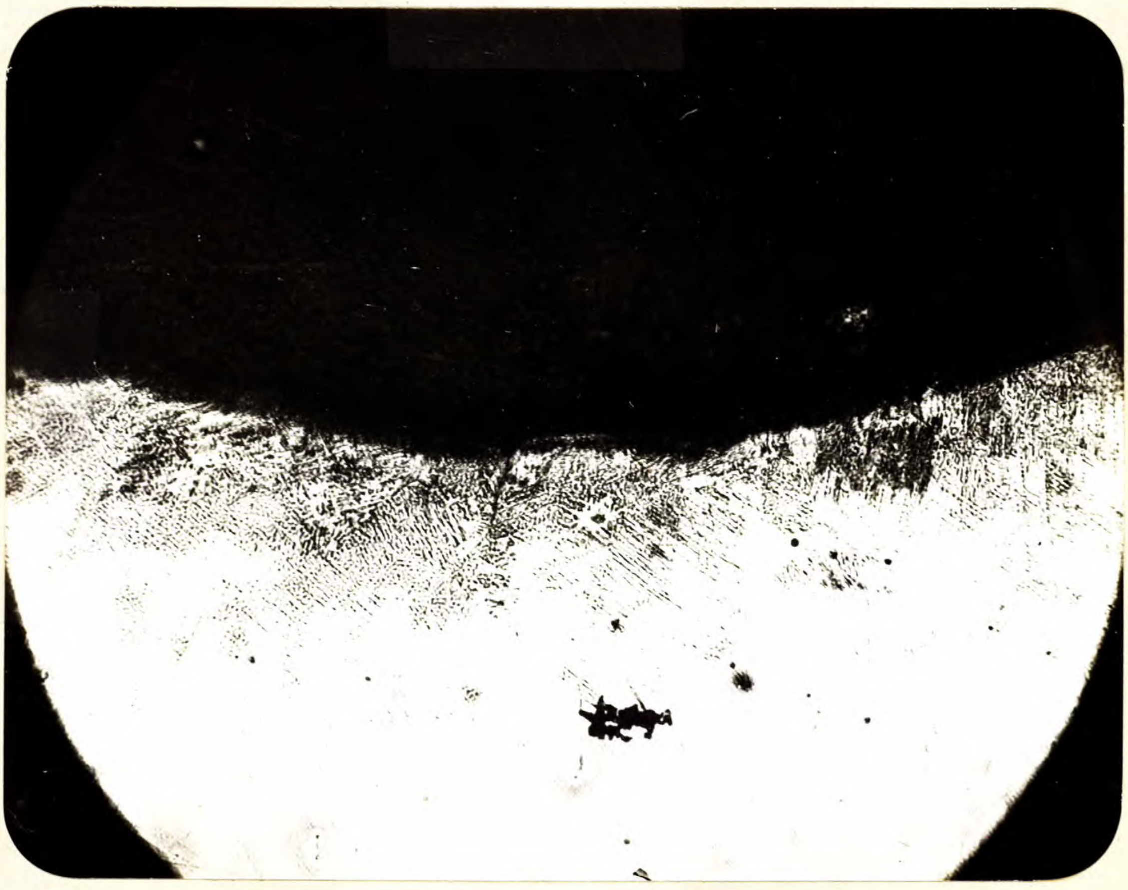
Figure 2.



X250, nital etch.
UNCOVERED BAR B.
(Note: Heavy layer of martensite (0.012 in.) at the surface.)

Figure 3.



X250, nital etch.
SURFACE OF A PRODUCTION LINK.
(Note: Martensite layer at the surface (0.003 in.) - some decarburization has taken place.)

Discussion:

The chemical analysis indicates that Bar A may not come from the same heat of steel as either Bar B or the link. From the point of view of this investigation, however, this factor is immaterial.

It can be seen readily, from the photomicrographs, that no noticeable decarburization occurs when the test specimen is covered, e.g. Bar A. When it is placed in the annealing furnace uncovered, a heavy decarburization takes place which, on the subsequent quench, gives a martensitic layer. This was approximately 0.012 inch thick, as shown by Bar B.

The shoe, which represents a production lot, has a layer of martensite about 0.003 inch. It is probably difficult to avoid some decarburization, especially if a long soaking period is used.

Bar A does not represent the surface of the shoe. A covered specimen of this type, if from the same heat, does represent, however, the metal in the shoe. The bend test will consequently give an indication as to the relative ductility of the heat of steel produced, not taking into account the actual surface condition of the shoes.

Examination of the shoe structure indicated that a satisfactory solution of the carbides has been obtained.

During the period when the headless pin was being tried, some difficulty was experienced when an attempt was made to peen the collars of the Electric Steels Limited track shoes. Figure 3 indicates that this difficulty may possibly have been caused by the cracking, on rivetting, of the brittle martensitic skin. This may not only have caused the peening difficulty but also may have been responsible for the failure to keep the pin locked in during service.

CONCLUSIONS:

1. Chemical analysis indicates that Bar A, which was covered, may be of a different heat from either Bar B or the shoe.

2. The covered test bar has not been decarburized and has no martensitic layer at the surface.

3. The uncovered test bar has been decarburized and has a martensite layer of 0.012 inch.

4. The shoe has been decarburized and has a martensite layer of 0.003 inch. With the long soaking period it would be difficult to avoid some decarburization.

5. Although the surface of a covered specimen is not representative of the shoe surface, a bend test on this specimen will represent the relative ductility of the heat of metal from which the shoes were cast.

6. A satisfactory solution of carbides has been obtained.

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SLG:GHB.