

File.

FILE COPY

O T T A W A

July 22nd, 1942.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1267.

Heat Treatment of a Medium Carbon
Molybdenum-Manganese Cast Steel.

REPRODUCED FROM THE ORIGINAL FILE COPY



CANADA

BUREAU OF MINES
DIVISION OF METALLIC MINERALS
ORE DRESSING AND
METALLURGICAL LABORATORIES

DEPARTMENT
OF
MINES AND RESOURCES
MINES AND GEOLOGY BRANCH

O T T A W A

July 22nd, 1942.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1267.

Heat Treatment of a Medium Carbon
Molybdenum-Manganese Cast Steel.

Source of Material and Object of Investigation:

On July 11th, 1942, Mr. N. Turner, Chief Chemist, Hull Iron and Steel Company Limited, Hull, Quebec, submitted a sample from a 10-ton heat of medium carbon molybdenum-manganese cast steel for izod impact test. It was stated that the sample had been normalized at 1650° F. and then annealed at the same temperature. After this treatment the steel was said to have had the required tensile properties. The izod values obtained on the sample submitted, however, failed

(Source of Material and Object of Investigation, cont'd) -

to meet the specification. Additional samples were then provided so that a heat treatment method could be developed for this steel. The steel from this heat was used to cast T-49 track shoes.

Specification:

A tentative specification for the T-49 steel track gave the following chemical analysis and physical properties:

	<u>Tentatively Specified</u>	<u>H. I. & Steel</u>	<u>Bureau of Mines</u>
	- P e r c e n t -		
Carbon	0.30-0.40	0.43	0.44
Manganese	1.35-1.55	1.27 [⊙]	1.26
Phosphorus	0.06	0.032	0.034
Sulphur	0.06	0.016	0.019
Silicon	0.25-0.45	0.57	0.58
Molybdenum	0.20-0.30	0.43	0.41
Copper	0.50-0.60	0.94	0.91

⊙ No. 1 ladle, 1.27 per cent Mn.
 No. 2 ladle, 1.47 " "

PHYSICAL PROPERTIES -

(Tentatively Specified)

Ultimate stress, p.s.i.	-	105,000 min.
Yield stress, p.s.i.	-	90,000 "
Elongation, per cent in		
2 inches	-	15.0 "
Brinell hardness	-	217 min.

HEAT TREATMENT -

(Tentatively Specified) -

Normalize from 1650° F.

Investigative Work:

<u>Test No.</u>	<u>Heat Treatment</u>	<u>Size of bar</u>	<u>Izod impact value, in ft.lb.</u>
1.	Normalized 1650° F.	Full-sized coupon	4 [Ⓢ]
2.	Normalized 1650° F., annealed at 1650° F.	Full-sized coupon	9 [Ⓢ]
3.	Normalized 1700° F., drawn at 1100° F.	0.45 [Ⓢ] diam. bar	16
4.	Normalized 1700° F., drawn at 1250° F.	0.45 [Ⓢ] diam. bar	32, 39, 43
5.	Normalized 1700° F., drawn at 1250° F.	Full-sized coupon	31, 33, 32

[Ⓢ] Heat treated by H. I. & S. Co. Ltd.

Physical Properties:

The following physical properties were obtained on a 0.564-inch-diameter test bar machined from the bar heat-treated in Test No. 5:

Ultimate strength, p.s.i.	-	117,000
.1% Proof stress, p.s.i.	-	85,600
.2% Proof stress, p.s.i.	-	87,800
Reduction in area, per cent	-	26.0
Elongation in 2 inches, per cent	-	16.0
Brinell hardness	-	235
Average izod impact value, ft.lb.	-	32

(Test No. 5)

Microscopic Examination:

Figures 1 and 2 are photomicrographs, at X100 magnification, of the steel as heat-treated in Tests Nos. 2 and 5 respectively. Their respective structures are shown, at X500 magnification, in Figures 3 and 4.

(Figures 1 to 4 appear at end of report)

Discussion of Results:

The chemical analysis was found to vary somewhat from the tentative specification. This is to be expected in such a large trial heat. The low sulphur and phosphorus contents and the soundness of the steel indicate that good melting and moulding practice was followed. The normalizing temperature given in the tentative specification was not high enough to produce the required izod impact properties on the steel examined. It is also apparent that a subsequent annealing heat treatment after normalizing did not improve the properties. The structure is shown in Figures 1 and 3. Comparing this structure with that obtained by normalizing at 1700° F. and drawing at 1250° F. (Figures 2 and 4), it will be noted that the normalizing and draw heat treatment produced a much finer structure. The steel in this final condition had over three times the izod impact value of the first structure and also had all the other required physical properties.

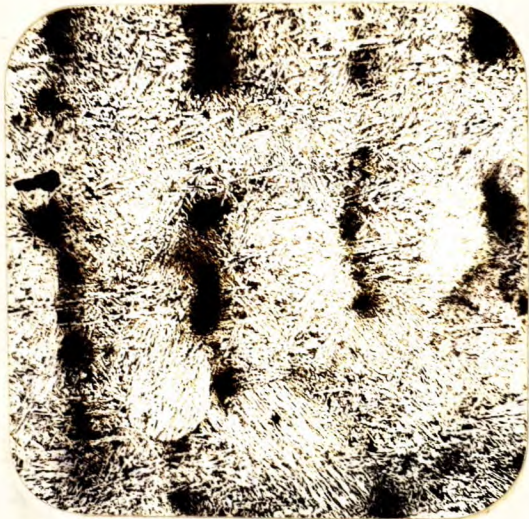
Conclusions:

The heat treatment given in the specification failed to give the required izod impact properties.

The tensile and izod properties specified can be obtained by normalizing at 1700° F. and drawing at 1250° F.

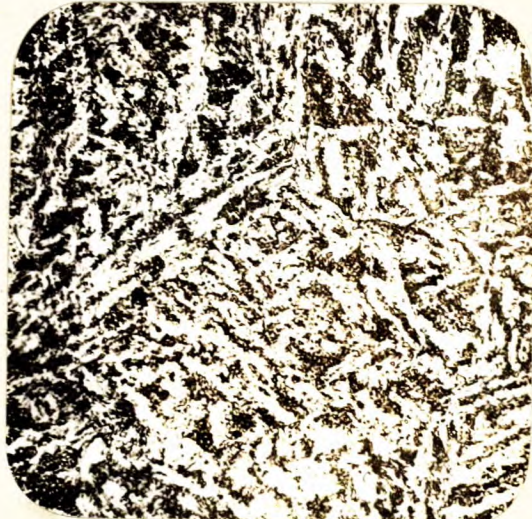
oooooooooooo
oooooo
oo

Figure 1.



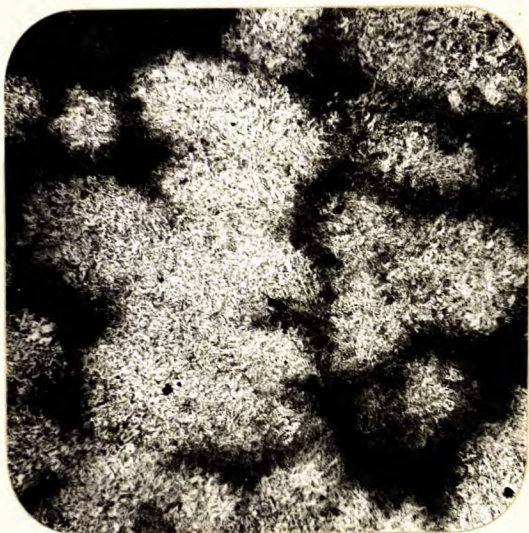
X100, picral etch.
Normalizing - 1650° F.
Annealing - 1650° F.

Figure 2.



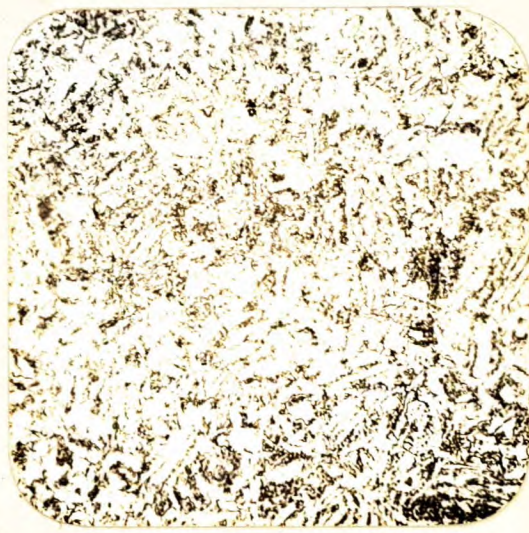
X500, picral etch.
Normalizing - 1650° F.
Annealing - 1650° F.

Figure 3.



X100, picral etch.
Normalizing - 1700° F.
Drawing - 1250° F.

Figure 4.



X500, picral etch.
Normalizing - 1700° F.
Drawing - 1250° F.

Micrographs are the property of the U.S. Government and are not to be distributed outside the Government without the express permission of the U.S. Government.