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O T T A W A   October 22, 1945.

REPORT

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1946.

Metallurgical Investigation of Rock Drill Bits for Lake Shore Mines Limited.

(Copy No. 6.)

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

CANADA
DEPARTMENT
OF
MINES AND RESOURCES
Mines and Geology Branch

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Introduction:

Following a visit (September 17-19, 1945) by Mr. C. S. Parsons, Chief of the Division of Metallic Minerals, to the plant of the Lake Shore Mines Limited at Kirkland Lake, Ontario, Mr. A. L. Blomfield, President, submitted a set of five (5) Detachable Rock Drill Bits and a short length of the shank to which the bits are fitted for use.

It was suggested that the bits be examined and recommendations made for improving their life, particularly in respect to the property of holding "gauge" or diameter of the drilled hole.

This mine forges and hardens its own bits and has elaborate plant for this purpose.

The report, being the first of several intended on this subject, will be confined to the bits and will not discuss the shank.

Description of Specimens:

The nature of the bits and shank is shown in Figures 1 and 2. The bits were colour coded, apparently for selection of gauge, and, reading from left to right, had gauge dimensions as shown in Table I.

TABLE I.

Colour -	Green.	Yellow.	Red.	Blue.	White.
Gauge, in. -	1-1/4	1-9/32	1-3/8	1-13/32	1-1/2

Figure 1.

BITS AND SHANK AS RECEIVED.

Figure 2.

BITS AS RECEIVED.

Chemical Analysis:

The analysis of the white bit is compared, in Table II below, with that of a typical melting specification for a plain carbon hollow drill steel.

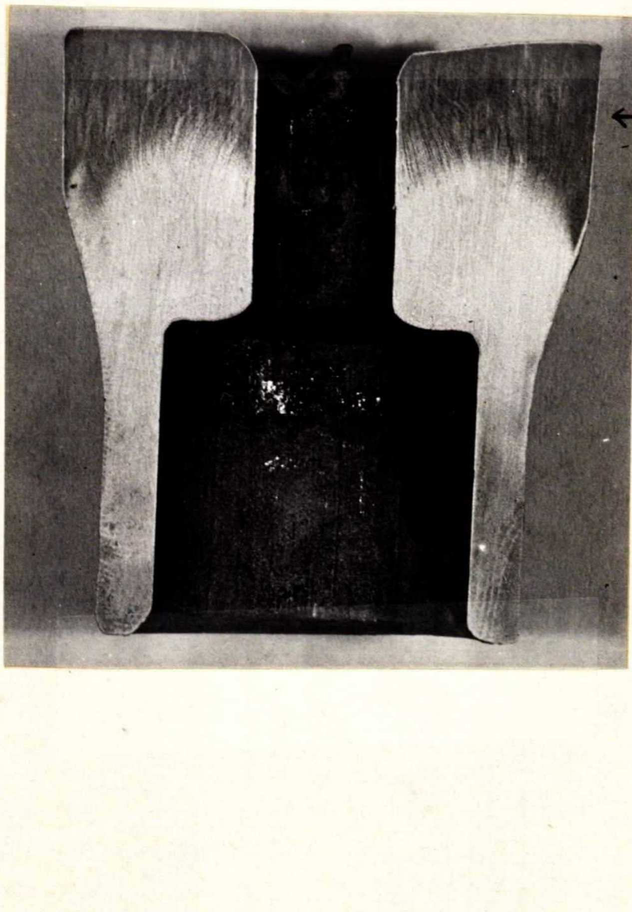
TABLE II.

Sample		Found	Typical Specification
		- Per	Cent -
Carbon	-	0.78	0.75-0.85
Manganese	-	0.34	0.20-0.35
Silicon	-	0.16	0.20 max.
Chromium	-	Nil.	
Nickel	-	Nil.	
Molybdenum	-	Trace.	
Vanadium	-	Nil.	
Tungsten	-	Nil.	

Macro-Examination:

The blue bit was cut longitudinally through the plane of two opposite cutting edges and etched in hot 50 per cent hydrochloric acid solution to reveal the structure shown in Figure 3.

Figure 3.



X2.
MACRO-ETCH OF A SPLIT BIT.

Heat-Treating Experiment:

One sample (green) was drawn at 325° F. for 5 hours, then annealed and re-hardened in 10 per cent brine from 1450° F., followed by a draw at 325° F. for 5 hours.

Hardness Tests:

Hardness readings were taken on the Rockwell Hardness Tester with the diamond indenter and a 150-kg. load. These readings are shown in Table III.

TABLE III. - Hardness Tests on Cutting Edges of Green Bit.

		Rockwell "C" Readings
(1) As received	-	64-65
(2) After drawing 325° F.	-	59-60
(3) After annealing and re-hardening	-	65-66
(4) After drawing 325° F. second time	-	61-62

The hardness of the sockets ranged from "C" 22 to 26.

Micro-Examination:

Figure 4 shows the structure of the hardened tooth of the green bit as revealed by a 2 per cent nital etch.

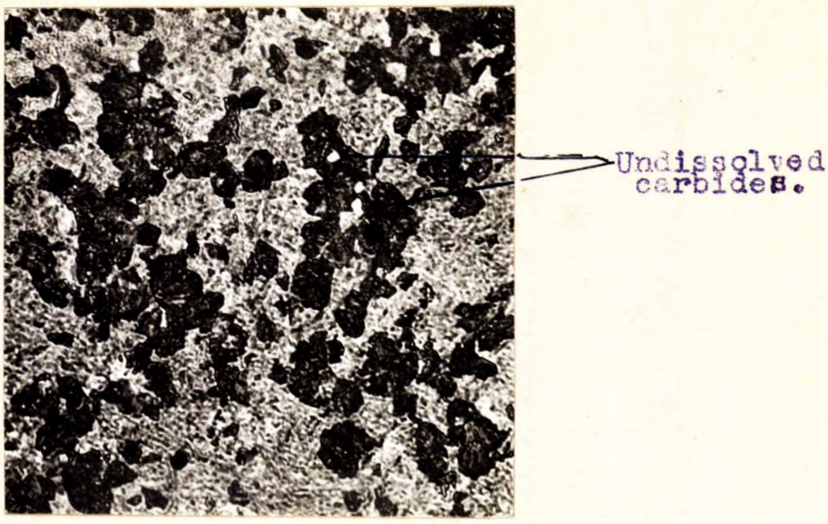
Figure 5 shows the structure of the same bit after re-hardening.

Figure 6 is a transverse section through the socket, the upper edge of the picture being the outer surface.

(Figures 4 to 6 follow,)
(on next page.)

(Micro-Examination, cont'd) -

Figure 4.



X700, nital etch.

STRUCTURE OF "AS RECEIVED" BIT.

Figure 5.

X500, nital etch.

STRUCTURE OF RE-HARDENED BIT.

Figure 6.

X50, nital etch.

STRUCTURE OF SOCKET WALL.

Discussion:

The analysis is typical of a shallow-hardening tool steel and should be satisfactory.

The depth of hardening shown in Figure 3 is indicated by the dark area on the teeth and is usual for this type of work.

The hardness shown in Table III after tempering the as-received bit was lower than normal expectancy. Development of higher hardness after retreating indicated that the original hardening was not the best. There are three possible causes:

(a) Insufficiently high temperature before quenching.

(b) Insufficient time at heat.

(c) Poor quenching medium.

The hard martensite (needle-like constituent) in Figure 4 contains areas of softer troostite (dark). The undissolved carbides in the troostitic areas would, if soaked longer, have dissolved to form a richer austenite from which an all-martensite structure would have resulted. This desirable structure was obtained by re-hardening, as Figure 5 shows.

It is apparent that the bits were given little or no draw after quenching. This operation is often overlooked in hardening carbon tool steels. In spite of the slightly lowered hardness which a thorough draw produces, the over-all picture of wear and impact resistance should be improved by its use. A thorough draw can only mean four or five hours at 300-325° F.

Contrary to a popular belief, long draws in this temperature range do not lower the hardness below that revealed in the first hour. The stress relief is, however, considerably improved.

Decarburization, shown in Figure 6, is complete to

(Discussion, cont'd) -

0.005 inch and partial to 0.015 inch. This layer will not harden to the same extent as the base material and suffers from impaired wear resistance. It is not improbable to expert 1/32 inch loss of gauge due to this decarburization.

Rapid dulling of the cutting edges is another result of decarburization.

If any considerable number of bits are breaking in use, this may be largely due to fatigue originating in the decarburized area.

It is not possible to determine the source of the decarburization from the samples submitted.

The finishing temperature in forging was correct, as shown by the fine, uniform grain size of Figure 4.

Recommendations:

It is realized that the examination of one or two bits may not be representative of practice at the mine and, therefore, this report should be considered only as an introduction to the general investigation. It would be well to follow up along three principal lines, namely:

1. Check a series of soaking times in the hardening furnace microscopically and with hardness tests, to obtain the maximum amount of martensite.

2. When the conditions for obtaining an all-martensite structure are established, the effect of time and temperature of drawing should be studied on a representative number of performance tests in service.

3. It would be interesting to compare the gauge-holding properties of ordinary bits with those of bits that have been ground on the gauge surface to remove all decarburization after hardening.

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JP:LB