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O T T A W A

July 3rd, 1942.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.


Investigation No. 1257.

Heat Treatment and Examination of
High Speed Steel Cutters.

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


CANADA
DEPARTMENT
OF
MINES AND RESOURCES
MINES AND GEOLOGY BRANCH

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Origin of Request and Object of Investigation:

On June 15th, 1942, four high speed steel cutters were received from the Department of National Defence (Naval Services), Ottawa, Ontario, for heat treatment. It was stated that these cutters had been made from Atlas High Speed Steel Spartan No. 7 and it was requested that they be heat-treated to a Brinell hardness of 611. A chemical analysis was desired and also a microscopic examination of the steel in the "as received" and "after heat treatment" conditions. A letter dated June 19th, 1942, (File No. N.S. 1074-1-3)

(Origin of Request and Object of Investigation, cont'd) -

was received from Lt. Comm. C. E. Olive, outlining the heat treatment specified for these cutters and requesting comments regarding this work.

Chemical Analysis:

One of the cutters, as received, was sampled for chemical analysis and the following results obtained:

		<u>Found</u>	<u>Atlas Spartan No. 7</u>
		<u>-Per cent-</u>	
Carbon	-	0.66	0.70
Manganese	-	0.29	0.25
Silicon	-	0.25	-
Tungsten	-	18.66	18.0
Chromium	-	4.09	4.0
Vanadium	-	0.88	1.0

Hardness Tests:

The hardness was determined by the Vickers method, using 30-kilogram and 50-kilogram loads on the steel in the "as received" and "after heat treatment" conditions respectively. The values given below have been converted from Vickers to Brinell:

Brinell Hardness Numbers

<u>Cutter</u>	<u>No. H1</u>	<u>: No. H1</u>	<u>No. H-100</u>	<u>: No. H-100</u>
"As received"	230	: 226	231	: 242
"Heat treated"	-	: 634	637	: 631

Heat Treatment:

The following heat treatment is given in the Atlas Steels Limited catalogue (p.51), for Spartan No. 7 high speed steel:

Hardening -

"Preheat carefully to about 1500° - 1600° F., bring up rapidly to 2250° - 2375° F., and then quench in oil."

(Heat Treatment, cont'd) -

Tempering -

"Tempering should be done immediately after quenching and is necessary to develop red hardness, to relieve hardening strains, and to increase toughness. A high draw of 1050° - 1100° F. is always recommended for cutting tools. Draws as low as 950° F. may be used for certain applications where maximum toughness is required, such as punches and file-cutting chisels. In all cases, accurately controlled temperature is essential and we recommend good muffle furnaces or tempering baths."

"The exact time of the draw depends largely on the mass and design of the tool, but a long draw, or a double draw, is recommended wherever possible. It is not uncommon to use two hours per inch of thickness as a basis for calculating the drawing time."

Experimental Heat Treatment:

Three of the cutters were placed in a Sentry "Diamond" heat-treating box to prevent decarburization and heat treated as follows:

		<u>Temperature.</u>	<u>Time.</u>
Preheat	-	1550° F.	1½ hrs.
Oil hardened	-	2360° F.	6 minutes
Temper	-	1100° F.	1 hour, cooled in air.

Microscopic Examination:

Figures 1 and 2 are photomicrographs of specimens of the steel in the "as received" and "after heat treatment" conditions respectively. Both specimens were etched in a solution of 10 per cent nitric acid in alcohol. The structure

(Microscopic Examination, cont'd) -

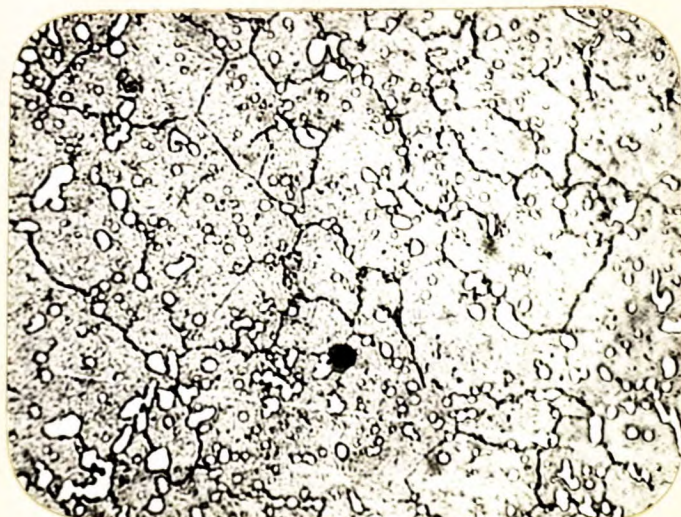
of the "as received" specimen (Figure 1) shows spheroidized carbides. Figure 2 shows how these carbide particles have been dissolved after heat treatment.

Figure 1.



X1000, etched in
10% nital.
AS RECEIVED.

Figure 2.



X1000, etched in
10% nital.
AFTER HEAT TREATMENT.

Discussion of Results:

The cutters were heat treated before the letter outlining the specified heat treatment was received. The heat treatment used in these laboratories followed very closely that recommended by the steel manufacturer.

The steel was found to have a composition practically identical with that given by Atlas Steels Limited in their catalogue (page 31) for Spartan No. 7 High Speed Steel.

The hardness of the steel after heat treatment was very close to the desired Brinell hardness of 611. An average of 634 Brinell was obtained on the three cutters heat-treated. The photomicrograph, Figure 2, shows how the carbides have been uniformly dissolved after heat treatment.

Conclusions:

The material conforms to the approximate composition for Atlas Spartan No. 7 High Speed Tool Steel and was found to be amenable to the heat treatment recommended by the manufacturer.

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