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O T T A W A September 9th, 1941.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1089.

Examination of Military Vehicle Towing Hooks.

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 Problem and Nature of Investigation:

In a letter dated August 9th, 1941, Mr. S. C. McLaren, for Director of Engineering, Automotive Production Branch, Department of Munitions and Supply, Ottawa, Ontario, requested examination of four towing hooks and two test blocks, the latter having been taken from the same heat as the hooks.

These hooks, received here on August 29th, were cast by the Canadian Car and Foundry Limited at Montreal, Quebec, for the General Motors of Canada Limited, and had

(Origin of Problem and Nature of Investigation, cont'd) -

been single-normalized, whereas the specifications call for double normalizing or for quench-and-draw. The claim was that the physicals would be up to specification with the single heat treatment.

The Department of National Defence specifies:

Minimum ultimate strength, p.s.i.	-	75,000
Minimum elongation, per cent in 2 inches	-	13 per cent.
Minimum reduction of area, per cent	-	20 per cent.

Physical Tests:

Test pieces were cut from the base of the castings. The cross-section of the test piece was 0.375 inch by 0.375 inch. Elongation was recorded from a length equal to $4\sqrt{\text{cross-section area}}$.

PROPERTY	SPECIMEN				
	Test Block	Hook 1	Hook 2	Hook 3	Hook 4
Ultimate strength, p.s.i.	82,800	79,100	79,500	72,400	78,800
Yield point, p.s.i.	43,900	45,400	49,700	48,300	49,700
Elongation in 2 inches, per cent	30.	13.	13.	7.	7.
Reduction of area, per cent	36.	16.	9.	8.	8.
Impact, foot pounds (average of three determinations)		13	13	14*	11
Hardness, Vickers (30-kilogram load)	192	185	189	186	184
Remarks:-		Fracture at point where internal chill could be seen. Fracture showed the metal to be of medium grain size.			

* This value is slightly higher due to one impact fracture at point where internal chill was present.

Chemical Analysis:

A sample taken from one test block analysed as follows:

		Per cent
Carbon	-	0.29
Manganese	-	0.75
Silicon	-	0.44
Phosphorus	-	0.032
Sulphur	-	0.054

Microstructure:

Figure 1 (X100, nital etched) shows the normalized structure of the casting. The dark areas are pearlite and the white matrix is ferrite. Examination of a section taken in the hook portion of the casting revealed a fairly clean steel. However, numerous shrinkage cavities were visible. Figure 2, magnification X40, shows one of these cavities.

X-Ray Examination:

The X-ray examination was conducted by L. W. Ball (on loan from the National Research Council, Ottawa). X-ray pictures revealed a large blow-hole in the base of Hook 2 and a shrinkage crack in the hook portion of Hook 1.

Discussion of Results; Conclusion.

The results obtained on the test sample taken from the test block seem to indicate that the material after a single normalizing can meet the required specifications. The poor physical properties observed on three of the four hooks are mainly due to the fact that the test bars were machined from sections containing internal chills. The fracture, as mentioned above, took place at the point where a chill could

(Discussion of Results; Conclusion, cont'd) -

be plainly seen. A low-carbon steel wire is used as chill and it will eventually lower the yield point and the ultimate of the test bar, fracture occurring prematurely due to the zone of weakness introduced by the chill. As a consequence, lower values in elongation and reduction of area are also obtained. In some cases, the use of an internal chill will promote soundness in the casting but such a chill will also develop a zone of weakness which can be considered as a possible source of failure in the finished article. Furthermore, it might lead to misunderstanding in the interpretation of the results obtained in physical tests. In brief, external chills should be used in preference to internal chills whenever possible.

Summary and Recommendation:

1. The material used in the manufacture of these military vehicle towing hooks seems to have satisfactory physical properties after a single normalizing.

2. The castings under examination were relatively sound, although a few shrinkage defects were observed.

3. External chill should replace the internal chills wherever possible, especially at those places in the casting where excessive stresses might develop.

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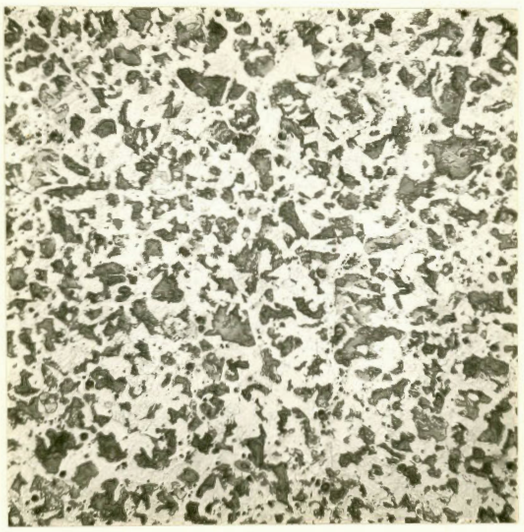
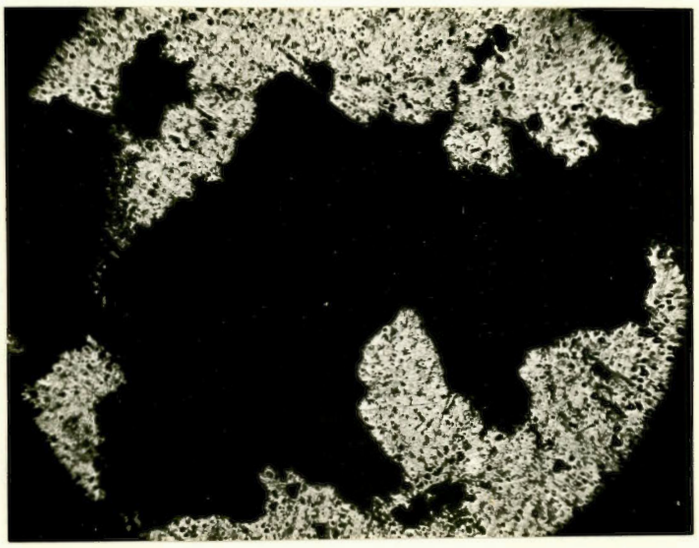
Figure 1.



X100, nital etched.

Normalized structure - section taken at the bend section of the hook.

Figure 2.



X40, nital etched.

Shrinkage cavity - section taken at the bend section of the hook.

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