File

FILE COPY

O T T A W A March 19, 1946.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 2023.

Metallurgical Examination of Hobbed Steel Blank
Containing Tears Incurred During Hobbing Operations.

==========

(Copy No. 4.)

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

CANADA

DEPARTMENT
OF
MINES AND RESOURCES

Mines and Geology Branch

O T T A W A   March 19, 1946.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 2023.

Metallurgical Examination of Hobbed Steel Blank Containing Tears Incurred During Hobbing Operations.

==========

Origin of Material and Object of Investigation:

On March 5, 1946, the Laurentian Metal Products Co. Limited, 40 Montcalm Street, Hull, Quebec, submitted for metallurgical examination one (1) hobbed steel blank containing tears in the metal, incurred during the hobbing of the cavity. (See Figure 1.)

The covering letter, dated March 4, 1946, stated that six such cavities had been hobbed with identical results, i.e., tearing of the metal at the sides. It was also stated that the material used for the hobbing blanks was Atlas

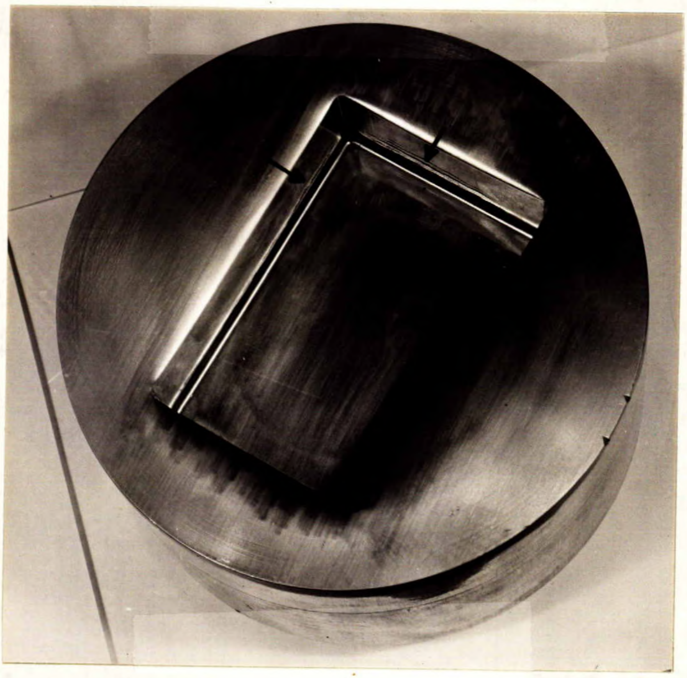
(Origin of Material and Object of Investigation, cont'd) -

Hobbing Iron.

In a telephone conversation with Messrs. R. Wilson and H. Turner, of the company, on March 20, it was revealed that the hobbed cavity was produced in one pushing operation.

A sample cut from the bar stock was also submitted, for hardness tests.

Figure 1.



CAVITY HOBBED IN ATLAS HOBBING IRON.

Dimensions of cavity: 3-5/8 in. X 2½ in. x 1 in. deep.
Note tears in wall of cavity.

(Approximately ½ actual size).

PROCEDURE:

1. Chemical Analysis:

The results of the chemical analysis are compared, in the following table, with that recommended by one authority[1]:

(Continued on next page)

(Procedure, cont'd) -

TABLE I.

		As Found	Recommended
		(Per Cent)	
Carbon	-	0.10	0.05-0.10
Manganese	-	0.15	0.15-0.25
Silicon	-	0.16	0.03-0.05
Sulphur	-	0.014	0.02-0.05
Phosphorus	-	0.014	0.02-0.03
Nickel	-	0.12	-
Chromium	-	0.15	-
Molybdenum	-	Trace.	-
Vanadium	-	Nil.	-

2. Hardness Examination:

Hardness readings were made on the bar stock, using a Brinell hardness tester. Readings were also made on a sample cut from the hobbed blank in areas away from the cavity and immediately adjacent to the cavity. The results are as follows:

		HARDNESS	
		Brinell	Vickers (10-kg. load)
Bar stock	-	103	125
Hobbed blank			
(Remote from cavity)	-	131-137	147-156
(Adjacent to cavity)	-	-	202-236

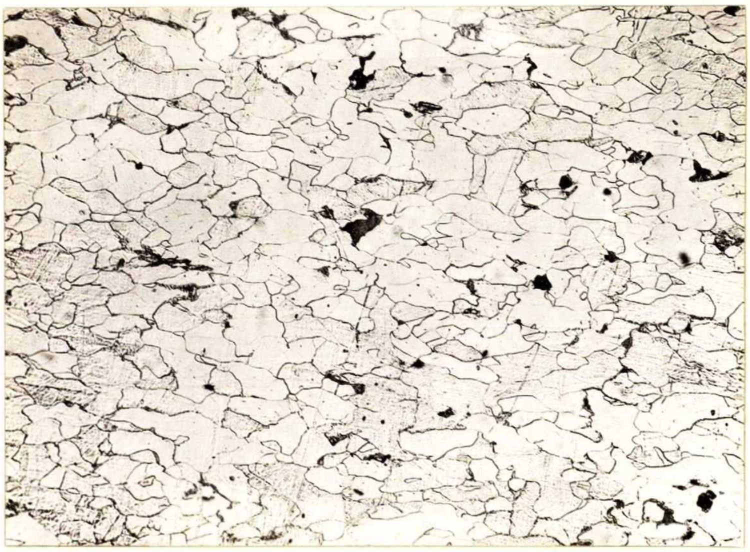
3. Microscopic Examination:

A sample was cut from the hobbed blank in one of the areas where tearing had occurred. Figure 2, taken at X100 magnification, shows the microstructure of the metal remote from the cavity.

Figure 3, also taken at X100 magnification, shows the microstructure of the metal immediately adjacent to the cavity. Note the extreme distortion of the grains caused by the hobbing operation. The extent of the tear is also evident (approximately 0.04 inch).

(Procedure, cont'd) -

Figure 2.



X100, nital etch.

STRUCTURE OF HOBBED STEEL BLANK,
REMOTE FROM CAVITY.

-

Figure 3.

STRUCTURE OF HOBBED STEEL BLANK,
ADJACENT TO CAVITY.

Note the severely worked metal, as evidenced by the extreme distortion of the grains.

Depth of tear: 0.04 inch.

Discussion and Conclusions:

Hobbing is a method of producing moulds to be used mainly in the plastics industry. The process consists of pushing a hardened die into a soft metal, called a hobbing blank, by means of a hydraulic press. The hobbing blank employed is usually steel and is supplied in the annealed condition in order to obtain the maximum flowability of the metal. The cavity is not necessarily formed in one pushing operation, because of the work hardness produced. The usual procedure is to employ several operations, subjecting the metal to an anneal before each push. As many as six separate pushing operations are sometimes employed.

The analysis of a recommended steel for the hobbing blank is given in Table I. It should be noted that the recommended carbon content is 0.05 to 0.10 per cent. The actual carbon content was found to be 0.1 per cent. The carbon content is important, since a small increase in carbon will result in a large increase in resistance to the entrance of the die. The nickel and chromium found in the steel may be considered residual alloys and do not materially affect the steel.

The recommended maximum hardness for the hobbing blank is 100 Brinell. This compares with the hardness of 103 Brinell as obtained on the bar stock. It was found that the hardness had increased from 125 Vickers to 236 Vickers at an area where tearing had occurred. This great increase in hardness resulted from the work hardening of the metal.

The very severe distortion of the grains is clearly shown in Figure 3, and it may safely be concluded that the tearing of the metal occurred as a result of the extreme stresses applied to the metal. The tearing could have been prevented by using at least two stages, instead of the one actually employed, and annealing the blank before the second

(Discussion and Conclusions, cont'd) -

push. The adequacy of a two-stage operation can only be determined by actual experiment.

If it is desired to eliminate the multiple-stage operations, then it would be necessary to obtain a steel lower in carbon than 0.1 per cent, possibly nearer 0.05 per cent.

SUMMARIZING,

1. The tearing of the metal occurred as a result of over-straining the steel.
2. This tearing can be prevented by either of two methods:
   (a) Employment of two or more stages of hobbing, thoroughly annealing the steel between pushing operations.
   (b) Employment of a plain carbon steel lower in carbon content.

Recommendations:

1. It is recommended that at least two, or more if necessary, pushing operations be employed, and that the steel be thoroughly annealed between operations.

2. If it is desired to produce the cavity in one pushing operation, then it is recommended that experiments be made on a hobbing blank containing a lower carbon content (in the neighbourhood of 0.05 per cent).

References

(1) "The Procedure of Die Hobbing," by T. Thomas and J. Hohl. MODERN PLASTICS, January 1945, p. 123.

(2) "Die and Hobbing Steels for Plastic Moulds," by R.P. Kells. MODERN PLASTICS, June 1945, p. 130.

oooooooooooo
oooooooo
oo

AF:LB.