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DEPARTMENT OF MINES AND RESOURCES

BUREAU OF MINES

CANADA

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Ottawa, November 28, 1946.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 2144.

Examination of a Hair-Line Crack on a Malleable Iron Casting.

(Copy No. 4.)

Bureau of Mines
Division of Metallic Minerals

Physical Metallurgy
Research Laboratories

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Origin of Material and Object of Investigation:

On November 13, 1946, a section which had been broken off from a malleable iron casting was submitted for examination. Mr. J. Curzon, of the International Malleable Iron Company Limited, Guelph, Ontario, in a letter dated November 8, 1946, stated that the foundry was encountering difficulties with a hair-line crack which was appearing on a casting that was being run regularly in their plant. The sample which was submitted was broken in such a manner as to show the section at the crack. Figure 1 illustrates the fractured surface. The darkened area within the circle denotes the point at which the crack occurred. It was requested that the cause of the crack be determined, if

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

possible. The sample submitted was in the white iron condition, since it had not been malleablized.

Figure 1.

FRACTURED SURFACE.

Note darkened area of fractured surface within the circle.

(Approximately 2/3 size.)

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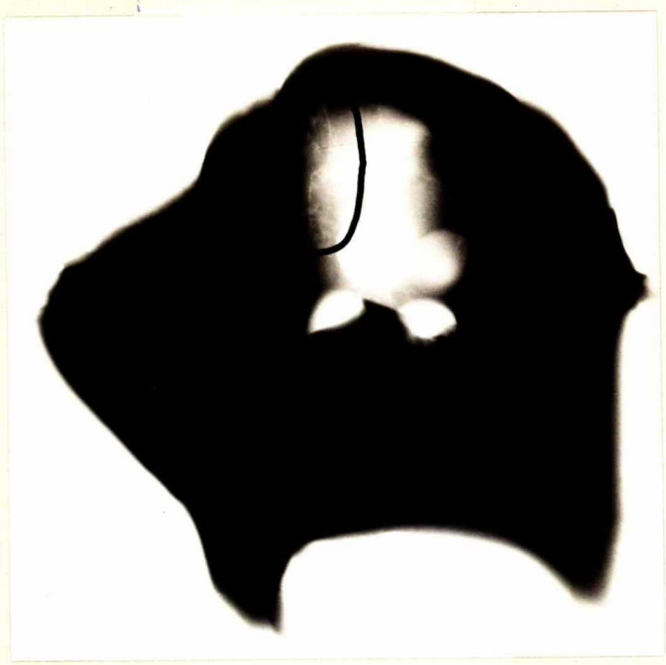
X-Ray Examination:

An X-ray picture was taken of the section of the casting where the crack had occurred. Two other cracks were found; these ran at right angles to the original crack. One of these cracks could be seen on the surface of the casting. Some slight porosity, however, was noticeable. The cracks and the porosity (lighter areas) are shown in the encircled area in Figure 2, a positive taken from the X-ray negative.

(Figure 2 follows,
on Page 3.)

(X-Ray Examination, cont'd) -

Figure 2.



X-RAY POSITIVE SHOWING CRACKS
AND SLIGHTLY POROUS AREA.

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Chemical Analysis:

In his letter of November 8, 1946, Mr. Curzon gave the following examples of representative analyses obtained on the iron being produced:

	A.M.	P.M.
	(Per Cent)	
November 5		
Silicon -	1.06	1.09
Sulphur -	0.053	0.056
Phosphorus -	0.154	0.158
Manganese -	0.38	0.39
Total carbon -	2.47	2.52
November 6		
Silicon -	1.04	1.08
Sulphur -	0.054	0.054
Phosphorus -	0.153	0.150
Manganese -	0.35	0.37
Total carbon -	2.34	2.49
November 7		
Silicon -	1.14	1.14
Sulphur -	0.055	0.054
Phosphorus -	0.158	0.157
Manganese -	0.38	0.38
Total carbon -	2.44	2.59

(Continued on next page)

(Chemical Analysis, cont'd) -

Drillings were taken on the submitted sample and analysed. The results were:

		Per Cent
Silicon	-	1.18
Sulphur	-	0.051
Phosphorus	-	0.141
Manganese	-	0.31
Total carbon	-	2.43

Hardness Test:

A Brinell hardness test was taken on a flat ground face of the specimen. The hardness was 444.

Microscopic Examination:

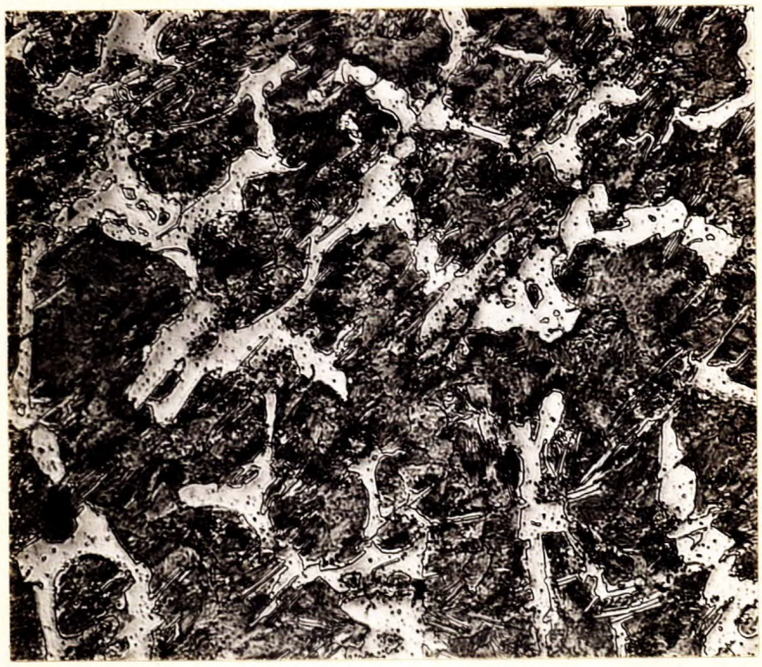
A section was cut through the oxidized area of the fractured surface and examined under the microscope after it had been polished. Figure 3 (X100) illustrates the unetched surface of the specimen. Figure 4 (X300) was taken of the nital-etched sample. This shows the pearlite-cementite structure normally associated with white iron.

Figure 3.

X100.
UNETCHED SPECIMEN.

(Microscopic Examination, cont'd) -

Figure 4.



X300, etched in 2 per cent nital.

PEARLITE AND CEMENTITE.

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Discussion:

The chemical analysis presented by the foundry and the analysis obtained in these Laboratories on the specimen examined indicate that the composition of the metal is satisfactory.

It should be pointed out, however, that, notwithstanding the analysis, the raw material used (i.e., the composition of the charge) and the melting practice are of importance in the production of satisfactory castings. If any change made at the furnace appears to be coincident with the cracking, it should be thoroughly investigated.

Metallurgically the metal appears to be normal white iron, the microscopic examination having revealed the characteristic structure of pearlite and cementite.

The cracks shown in the X-ray were probably caused by the blow which broke the sample from the original casting. Some very slight porosity is also noted in the X-ray picture.

(Continued on next page)

(Discussion, cont'd) -

More data are required if an attempt is to be made to definitely establish whether the crack is due to shrinkage or is a hot tear. Further castings which have not been broken up should be submitted for X-ray. The A.S.T.M. X-ray terminology for a hot tear is as follows:

> "Cracks of a decidedly ragged nature with numerous branches. They have no definite line of continuity and may exist in groups. They may or may not terminate at the surface. Small cavities from which these tears radiate may be found associated with them."

Since changes to eliminate shrinkage are of a major character such as altering the gating and risering set up, it is suggested that until definite proof of the type of crack is obtained the foundry act on the assumption that the cracks are hot tears. Some experimental castings can be made using weaker cores and other methods generally applied to eliminate hot tears.

Conclusions:

1. The chemical analysis obtained indicated that the composition of the metal is satisfactory.

2. Metallurgically, the metal appears to be normal white iron, as shown by microscopic examination.

3. The hardness is 444 Brinell.

4. The X-ray shows two cracks and some porosity.

5. More data are required to establish whether the crack is a hot tear or due to shrinkage.

Recommendations:

1. More castings (unbroken, both with and without the hair-line crack) should be X-rayed.

2. Some experimental castings should be made using weaker cores, since this can be carried out very readily.

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