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O T T A W A October 1, 1945.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1941.

Metallurgical Examination of a Cast Iron Mould.

(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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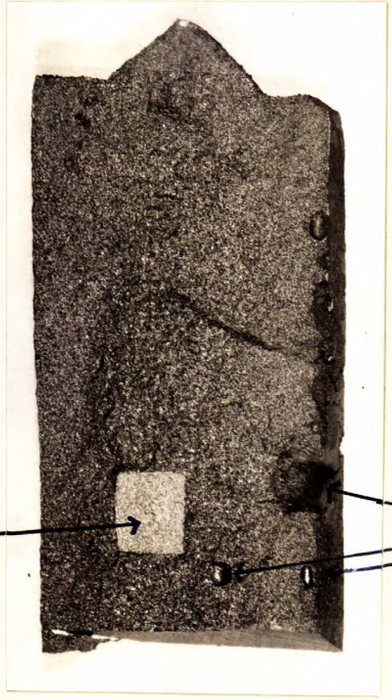
Source of Material and Object of Investigation:

On August 25, 1945, Mr. Louis Fleck, General Manager, Alexander Fleck Limited, Ottawa, Ontario, submitted for examination a stock sample of the steel reinforcing bar and a fractured section of a cast iron mould. The steel bar was provided for reinforcing the cast iron mould in case of failure. In previous castings this method of reinforcing the mould had proven satisfactory. However, in castings made recently by this method for the International Nickel Co. of Canada Limited, the steel bar fractured in service. It was desired to carry out a complete metallurgical examination of the steel used, and also of a section of one of the moulds, in order to determine, if possible, the cause of failure.

Macro-Examination:

Figure 1 is a photograph showing a fractured section of the mould. The reinforcing steel bar shown at "A" appeared to have been cast in good sound metal. Some porosity of iron was observed at "B". The steel bar had a coarse-grained fracture.

Figure 1.



CROSS-SECTION OF CAST IRON MOULD, WITH STEEL REINFORCING BAR SHOWN AT "A".

(Approximately 2/5 actual size).

Chemical Analysis:

Drillings taken from the stock steel bar sample and the cast iron mould had the following chemical composition:

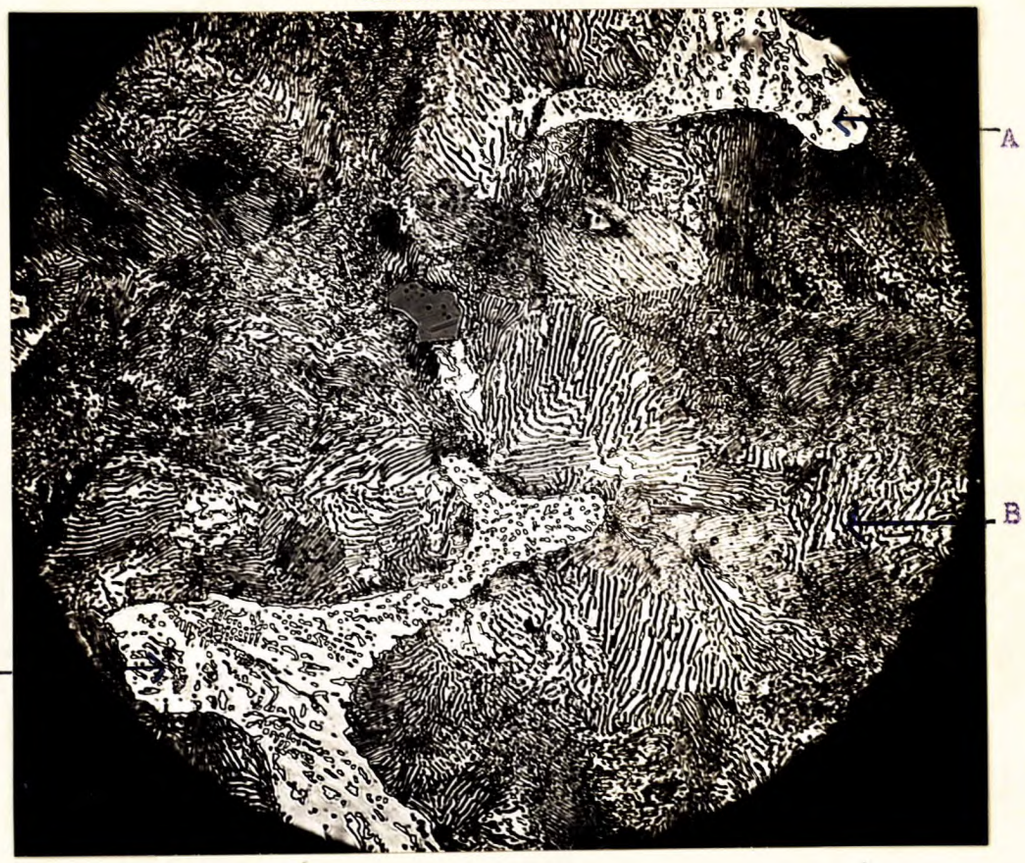
	CAST IRON MOULD	STEEL BAR
	- Per Cent -	
Total carbon -	N.d.	0.18
Graphitic carbon -	1.46	-
Manganese -	0.55	0.51
Silicon -	1.73	0.01
Phosphorus -	0.60	0.024
Sulphur -	0.060	0.034
Chromium -	Nil.	-
Nickel -	Nil.	-

N.d. = Not determined.

Microscopic Examination:

The nital-etched structure of the cast iron is shown in Figure 2, a photomicrograph at X500 magnification.

Figure 2.



X500, etched in
2 per cent nital.

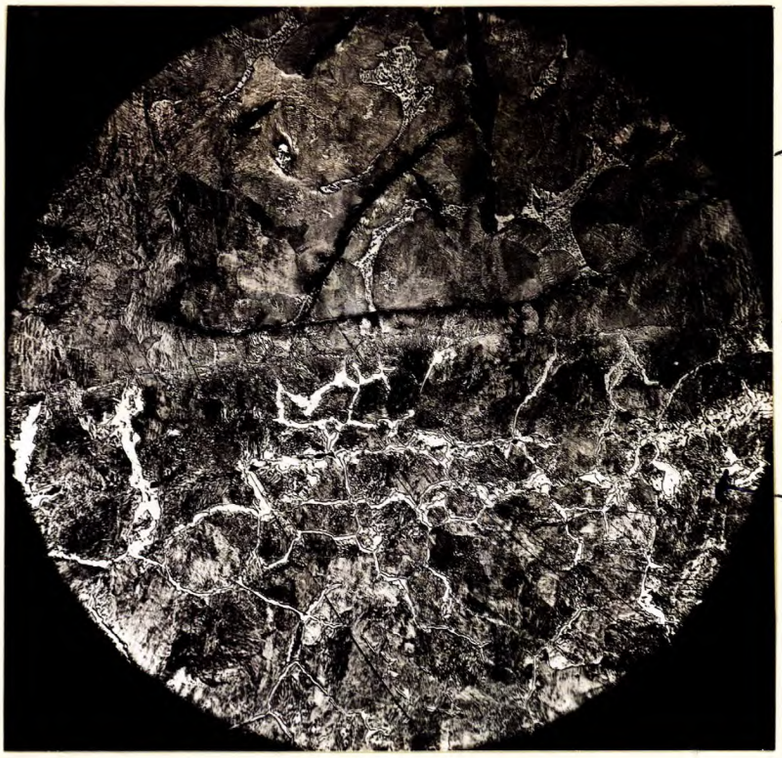
Note the phosphide eutectic at A, and
the pearlitic structure of the iron at B.

Figures 3 and 4 show the structure at the transition point of the cast iron and the steel reinforcing bar. It will be observed that the steel has been carburized at the point of contact with the cast iron and also that considerable grain growth has taken place.

(Figures 3 and 4
(follow on next page.)

(Microscopic Examination, cont'd) -

Figure 3.



X100, etched in
2 per cent nital.

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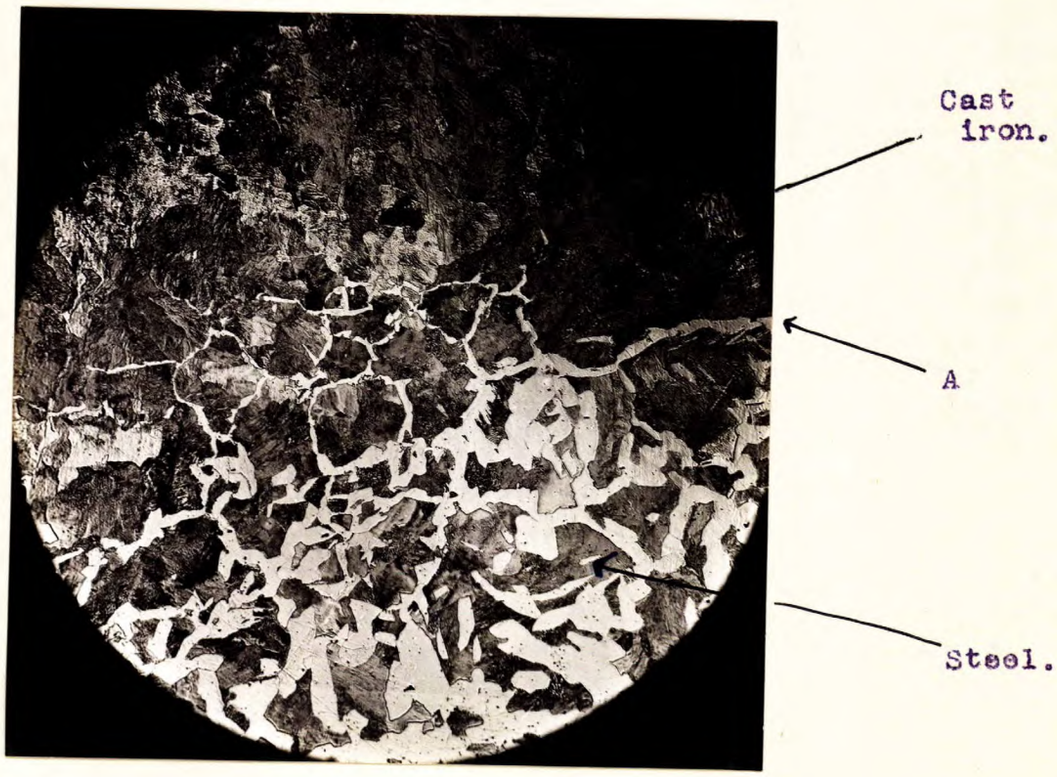
Figure 4.



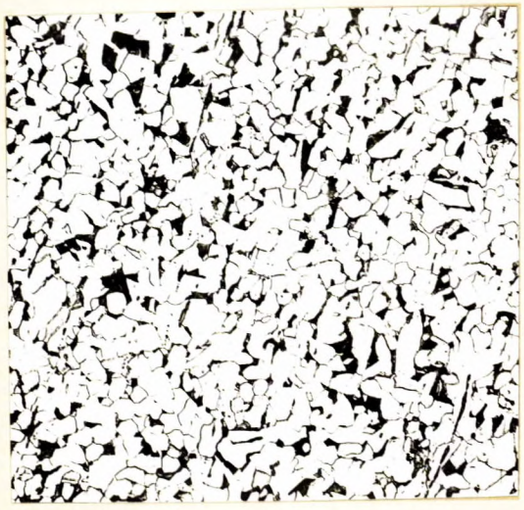
X100, etched in
2 per cent nital.

-

(Microscopic Examination, cont'd) -

The structures of the stock sample and the fractured steel bar are shown in Figures 5 and 6 respectively. The former has a structure of a normalized and the latter of an annealed low carbon steel. The structure in each consists of pearlite, the iron-iron carbide constituent, the dark etching material, and ferrite, the iron constituent, the light etching material.

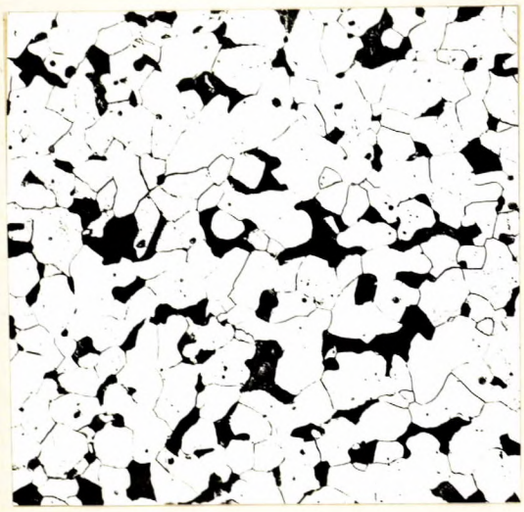
Figure 5.



X100, etched in
2 per cent nital.

STRUCTURE OF STEEL BAR "AS RECEIVED".

Figure 6.



X100, etched in
2 per cent nital.

STRUCTURE OF STEEL BAR AFTER
CASTING "IN SITU".

(Microscopic Examination, cont'd) -

The grain size as determined by the McQuaid-Ehn method is shown in Figure 7. The grain size is rated as 2.

Figure 7.

X100, etched in
2 per cent nital.

SHOWING COARSE-GRAINED STRUCTURE OF STEEL
AFTER CARBONIZING AT 1700° F. AND
COOLING IN THE BOX.

Discussion of Results:

The steel used in the cast iron mould had a chemical composition similar to that of an SAE 1020 steel. The composition of the mould was similar to that of a high phosphorus grey iron and contained no alloying additions. The microscopic examination showed the stock sample of the steel reinforcing rod to be in the normalized condition and coarse-grained. However, the structure was altered after casting the cast iron around it. The high temperature of the molten cast iron in contact with the steel bar caused grain growth, and on slow cooling the steel became annealed. Coarse-grained steels are more subject to grain growth at temperatures above the upper critical than fine-grained steels. For this service

(Discussion of Results, cont'd) -

a fine-grained, aluminium-killed, low carbon steel or a high-purity iron, such as Armco iron, is recommended. The carburization of steel bar noted at the point of contact with cast iron can be greatly reduced by tinning, or by painting the steel bar with red lead. Some consideration should be given to the use of alloy additions to the iron to improve the physical properties, such as resistance to growth, etc. In this connection, chromium additions of 0.60 to 1.25 per cent are generally recommended.

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NBB:LB.