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O T T A W A December 12, 1945

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1976.

Investigation of Defective Grey Iron Casting.

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(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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Origin of Material and Object of Investigation:

On November 27, 1945, a letter was received from the Canadian Foundry Supplies and Equipment Limited, Montreal, Quebec, describing a defective casting which was being submitted to these Laboratories. It was stated that the casting represented the type of difficulty being encountered in a small foundry in Windsor Mills, Quebec.

Further information was given to the effect that the metal was melted in a cupola, 27 inches in diameter, which should melt over 5,000 pounds per hour but actually produced only half of that amount; also, that the original charge of 1,000 pounds used in a cupola of this size is

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

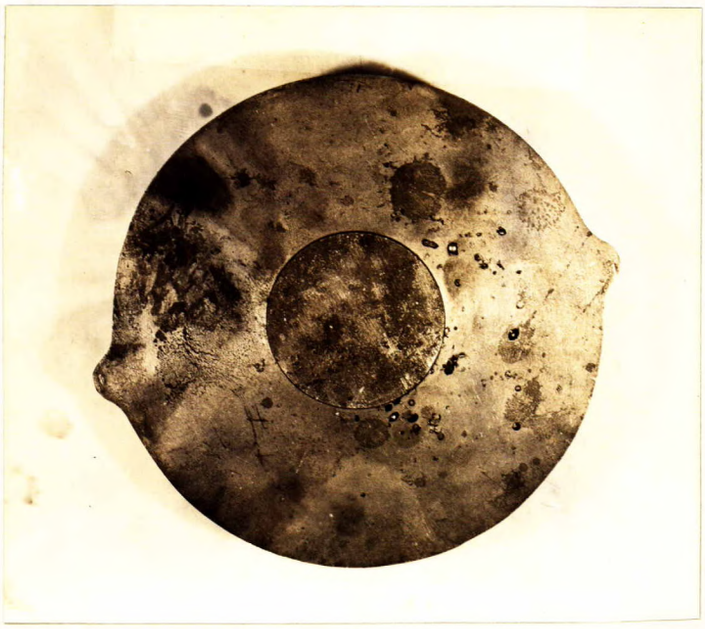
too large. The practice is to use a 36-inch-deep coke bed under this first charge and a 50-pound charge of coke between each of the following 500-pound charges of iron.

It was requested that the casting be examined metallurgically and that to the results of this investigation be added any comments concerning possible improvement of the foundry practice used in this operation.

Description of Casting:

Figure 1 illustrates the porous nature of the casting.

Figure 1.



CASTING AS RECEIVED.

(Approximately ½ actual size).

Chemical Analysis:

		Per Cent
Carbon	-	3.50
Silicon	-	1.99
Manganese	-	0.40
Sulphur	-	0.103
Phosphorus	-	0.505

Microscopic Examination:

Results of microscopic examination are shown in Figures 2, 3 and 4. Except for a great number of oxide inclusions (see Figure 3), the microstructure was typical for a normal stove-plate iron.

(Figures 2, 3 and 4)
(follow, on Page 4.)
(Text is resumed on)
(Page 5.)

(Microscopic Examination, cont'd) -

Figure 2.

X500, nital etch.

Figure 3.

X500, unetched.

Figure 4.

X100, nital etch.

DISCUSSION OF RESULTS:

The results of the examination indicate that the porosity occurring in this casting was caused by a condition of the metal known as "oxidized iron".

The evidence leading to this conclusion is as follows:

(a) Iron oxide in large amounts was observed during the microscopic examination (see Figure 2). The gas holes are made when iron oxide reacts with carbon, forming CO gas.

(b) Gas analysis showed that the metal had a low hydrogen content. The normal hydrogen gas content in satisfactory metal is 0.004 per cent, and therefore porosity in the submitted casting was not due to any melting or moulding factors which cause hydrogen gas to be formed. However, the content of oxygen gas as found in the casting submitted is much greater than that normally expected.

(c) The chemical analysis shows rather low manganese content, since the normal content of manganese in grey iron castings of this size and type is usually of the order of 0.60 per cent. If the manganese content of the iron in the submitted casting is supposed to approximate this amount, then oxidation of this element is occurring during the melting process in the cupola. The other elements are present in satisfactory amounts for a metal used in casting medium weight machinery parts.

(d) Information given in the letter accompanying the casting stated that the weight of the first or original charge placed in the cupola is 1,000 pounds, twice the weight of the succeeding or following charges used in the cupola. The cupola has an internal diameter of 27 inches, and a cupola of this size is normally expected to melt at least 4,000 pounds of iron per hour. The height of the coke bed used is stated to be 36 inches, which should be sufficient.

(Discussion of Results, cont'd) -

However, the practice of using a double charge of iron on the coke bed is quite wrong and in all probability is the principle reason for the difficulties being experienced in producing satisfactory metal for the castings. The first or original charge of iron placed in the cupola should be of exactly the same weight (although not necessarily of the same composition) as all of the following charges.

The reason for using the same weight of all charges can be readily understood when the operation and the reactions taking place within the cupola are considered.

Assuming that the cupola has been properly repaired and prepared for melting, the original coke placed on the bottom is ignited and allowed to burn through, then additional coke is added to bring the top to the desired height above the tuyeres through which the blast of air is supplied for combustion. These charges of coke form what is known as the "bed". On the bed is placed the first charge of metal, then a charge of coke, followed by successive charges of metal and coke. When the blower or fan is started, the air blast forced through the tuyeres causes the coke to burn rapidly, giving off heat to melt the metal immediately above it. With the melting of the metal the coke is consumed, but with properly balanced charges of metal and coke another layer of coke is supplied to replace that consumed, and this coke in turn melts the metal charge above it. This alternate burning up and replenishing of the coke bed continues for the duration of operations. However, if the coke bed burns down too low or too close to the tuyeres, the air supplied for the coke combustion comes in contact with the melting iron and an unfavourable reaction takes place between the iron and its elements (especially manganese and silicon) and the oxygen of the air blast, resulting in oxidized or "burnt" iron. Such

(Discussion of Results, cont'd) -

metal, when poured into moulds, does not produce satisfactory castings.

Conclusion and Recommendations:

The metallurgical investigation of the submitted defective casting shows that it was made from iron which had been oxidized during melting.

To correct this condition it is suggested that proper attention be given to the operation of the cupola, and, especially, that all charges of metal be of the same weight.

Regarding the slowness of melting, it is suggested that, in addition to making all metal charges of the same weight, consideration be given to the weight and size of material used in making up the charges. Mechanical details of blower or fan operation, air supply, possible air loss through leaks, or insufficient tuyere area, should also be investigated, and corrective measures taken if necessary.

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