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DEPARTMENT OF MINES AND RESOURCES

BUREAU OF MINES

CANADA

Ottawa, February 27, 1947.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 2185.

Examination of Porosity in a Cast Iron Specimen.

(Copy No. 4.)

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Bureau of Mines

Mineral Dressing and Metallurgy Division

Physical Metallurgy Research Laboratories

DEPARTMENT OF MINES AND RESOURCES

Mines and Geology Branch

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Origin of Material and Object of Investigation:

On December 19, 1946, Mr. H. C. D. Briercliffe, of Vulcan Iron Works Limited, Winnipeg, Canada, submitted for examination a broken piece from a grey iron casting which showed a great deal of porosity (see Figure 1). In a letter, received on January 17, 1947, it was stated that:

"The piece of casting is from a grate bar and from a regular run of cast iron, no intentional alloys being added. The casting was made about a month and a half ago, when we experienced trouble two days running. The scrap we use is known to the trade as No. 1 Cast Iron Scrap. However, lately,

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

owing to the scarcity of scrap, we do not think it is up to grade. Most of it consists of motor cylinder castings, some cast iron radiator sections, and other miscellaneous agricultural and industrial scrap. None of it is of any large section. In fact, it is of such poor grade that we have detailed one of our men to re-sort it and pick out parts of aluminum, zinc, babbitt, lead, etc.

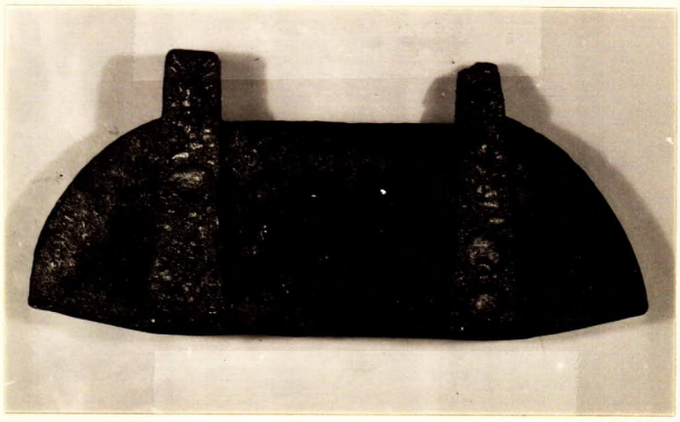
"It is such a long time since we encountered this trouble that we believe it was caused by something in the scrap. This occurred on two heats only. We lost practically the whole of one day's heat. The other heat we noticed the melt showing something wrong and we dropped the bottom and melted an entirely new charge. This new charge proved satisfactory. However, on the charge that we dropped we believe that some of the scrap castings from the previous heat had been in it. One of the troubles is that we cannot put it down to anything definite, and we are not very sure about the first heat on which we had trouble owing to not discovering it early enough, but the pourers seem to think that it occurred on a heat that the metal seemed to rise in the risers."

"We might mention that our scrap in the yard is not covered and therefore might be subject to accumulation of snow and moisture. This might have some bearing on the problem, although we rather doubt it, as we have been using this method of storage for a very long time and have not experienced this trouble before."

(Figure 1 follows,
on Page 3.)

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

Figure 1.



SAMPLE OF BROKEN CASTING, AS RECEIVED.

(Note excessive porosity.)

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Chemical Analysis:

Drillings were taken for chemical analysis. The results were:

		Per Cent
Total carbon	-	3.14
Graphite	-	2.50
Combined carbon	-	0.64
Silicon	-	2.60
Sulphur	-	0.080
Manganese	-	0.63
Phosphorus	-	0.334
Aluminium	-	0.063

Spectrographic Analysis:

A spectrographic analysis was carried out to determine whether significant amounts of elements other than those tested by the wet method were present. Only minute traces of other elements were reported.

Gas Analysis:

A determination of the gas content was made, using the vacuum fusion method. Table I, below, compares

(Gas Analysis, cont'd) -

the percentages usually obtained for a normal casting with those found in the casting submitted for examination.

TABLE I.

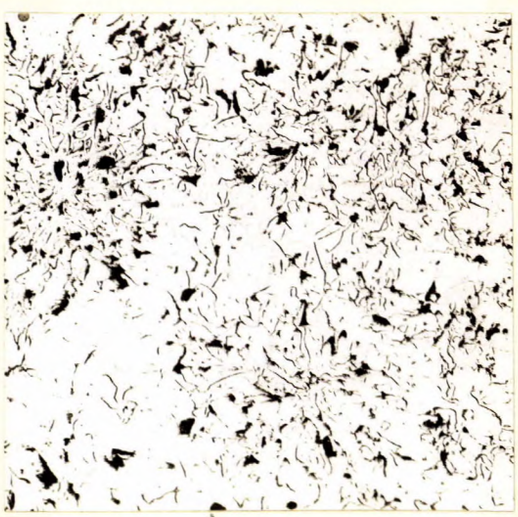
	Vulcan Iron	Normal Castings
Hydrogen, c.c. per 100 gm. -	2.7	2.0
Nitrogen, per cent by weight -	0.0025	0.0014 to 0.0030
Oxygen, per cent by weight -	0.016	0.0015 to 0.0030

Microscopic Examination:

A microspecimen was cut from the casting. It was polished and examined under the microscope in the unetched condition. Figure 1 (X100) illustrates the graphite flakes. The A.S.T.M. graphite flake size is 6, Type B.

The specimen was etched in 2 per cent nital. Figure 2 (X500) illustrates the structure obtained. This consists of pearlite, steadite and some ferrite.

Figure 2.



X100, unetched.

A.S.T.M. graphite size 6, Type B.

Figure 3.

X500, etched in 2 per cent nital.

Pearlite, ferrite and steadite.

Discussion:

The gas analysis shows the presence of an abnormal amount of oxygen in the casting. This indicates a faulty melting practice. Several possibilities exist which might explain the cause for excessive oxygen gassiness:

(1) An aluminium content of 0.063 per cent has been reported. It has been found in the past that aluminium additions to the cupola can result in highly porous castings. This is the most probable cause for gassiness, especially since it was found that upon cleaning the scrap of foreign elements the quality of the castings improved.*

(2) Too low a coke bed will allow oxygen from the tuyeres to enter into the metal. The low carbon content, 3.14 per cent, suggests this possibility.

(3) Use of wet coke without making allowance for the moisture content may also result in (2) above.

Conclusions:

1. An abnormal amount of oxygen was found in the casting. This indicates that the porosity is caused by a faulty melting practice.

2. Chemical analysis shows 0.063 per cent aluminium to be present. This element can cause gassiness in grey iron, and should be avoided.

3. The low carbon content, 3.14 per cent, suggests a possibility of a low coke bed.

4. The graphite grain size is A.S.T.M. No. 6 and it is type B.

5. The usual pearlite, ferrite and steadite structure was found on polished and etched specimens.

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* Information supplied in letter of January 14, 1947.

Recommendations:

1. Continue to cull from the scrap all pieces containing elements troublesome in grey iron melting.

2. Watch the coke bed height.

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