File.

DEPARTMENT OF MINES AND RESOURCES

BUREAU OF MINES

CANADA

FILE COPY

Ottawa, November 12, 1946.

REPORT

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 2120.

(Continuation of Invest. Report)
(No. 2076, dated July 12, 1946.)

Metallurgical Examination of a Second Defective Cast Iron Cylinder Head Casting.

==========

(Copy No. 6 .)

Bureau of Mines
Division of Metallic
Minerals

Physical Metallurgy
Research Laboratories

CANADA

DEPARTMENT
OF
MINES AND RESOURCES

OTTAWA November 12, 1946.

REPORT

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 2120.

(Continuation of Invest. Report)
(No. 2076, dated July 12, 1946.)

Metallurgical Examination of a Second Defective Cast Iron Cylinder Head Casting.

==========

Introduction:

This investigation, a continuation of Investigation No. 2076 (reported on July 12, 1946), covers the examination of a second, similar defective cylinder head casting which was submitted during the month of August, 1946, together with additional information regarding foundry practice, by Mr. A. E. Cartwright, metallurgist, Canadian Foundry Supplies and Equipment Limited, Montreal, Quebec.

The first cylinder head had been forwarded for examination on June 5, 1946.

Purpose of Investigation:

1. To examine the casting for metallurgical defects and determine their origin.

2. To suggest possible ways of reducing such defects.

PROCEDURE:

1. Chemical Analysis:

Drillings were taken from the second casting for chemical analysis, the results of which are listed below. The analysis of the first casting is also listed, for comparison.

	Casting No.1	- Per Cent -	Casting No.2
Total carbon -	3.11		3.00
Combined carbon -	0.64		0.75
Graphitic carbon -	2.47		2.25
Silicon -	2.10		2.07
Manganese -	0.64		0.64
Chromium -	0.10		Nil.
Molybdenum -	Trace.		Trace.
Nickel -	0.73		0.65
Phosphorus -	0.560		0.456
Sulphur -	0.114		0.087

The above analyses show the two castings, as received, to be satisfactorily uniform in composition. Any variation from normal daily melting practice would be checked by records of daily chemical analysis.

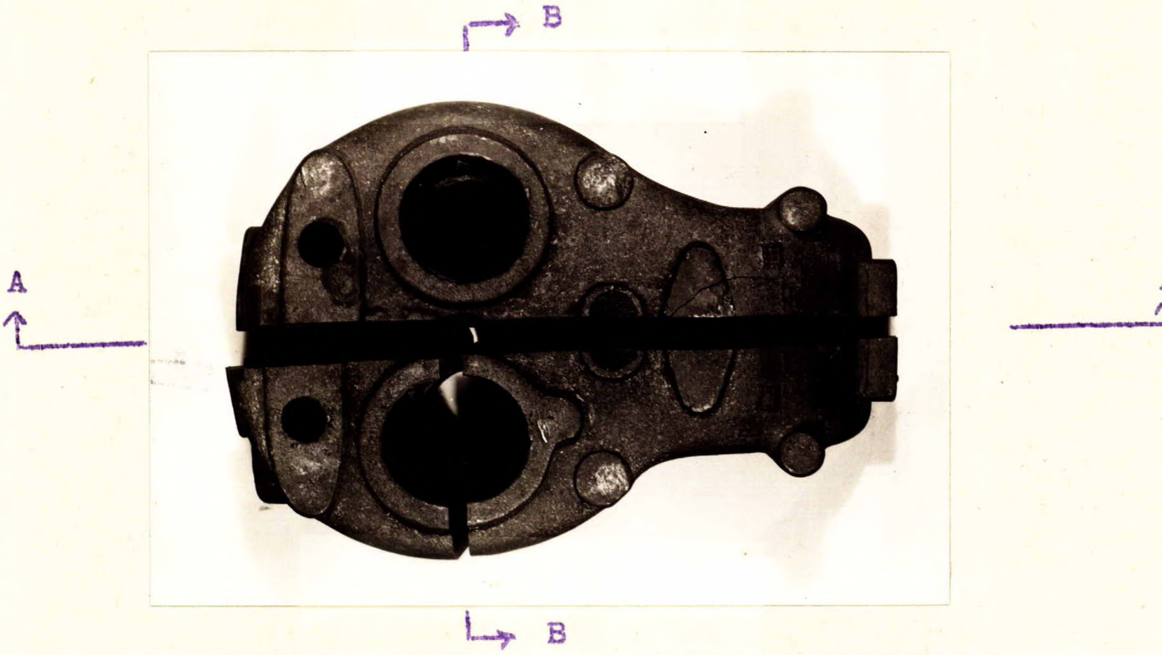
2. Visual Examination:

An examination of the casting gating system was made. The casting was cut as shown in Figure 1, to examine the internal cored sections.

(Continued on next page)

(Visual Examination, cont'd) -

Figure 1.

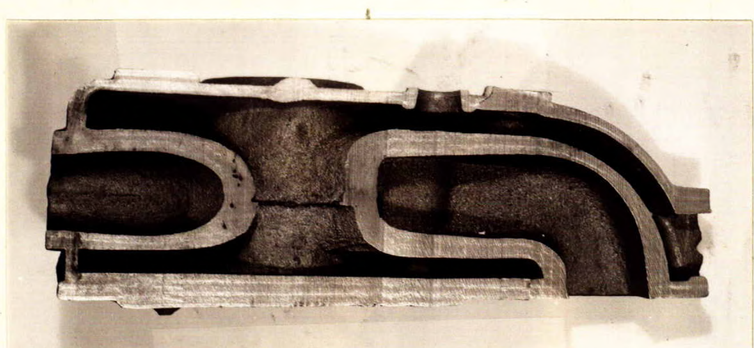


THE CASTING AS SECTIONED FOR EXAMINATION.

-

Figures 2 and 3 show the sections A-A and B-B exposed.

Figure 2.



SECTION A-A (from Figure 1).

-

(Visual Examination, cont'd) -

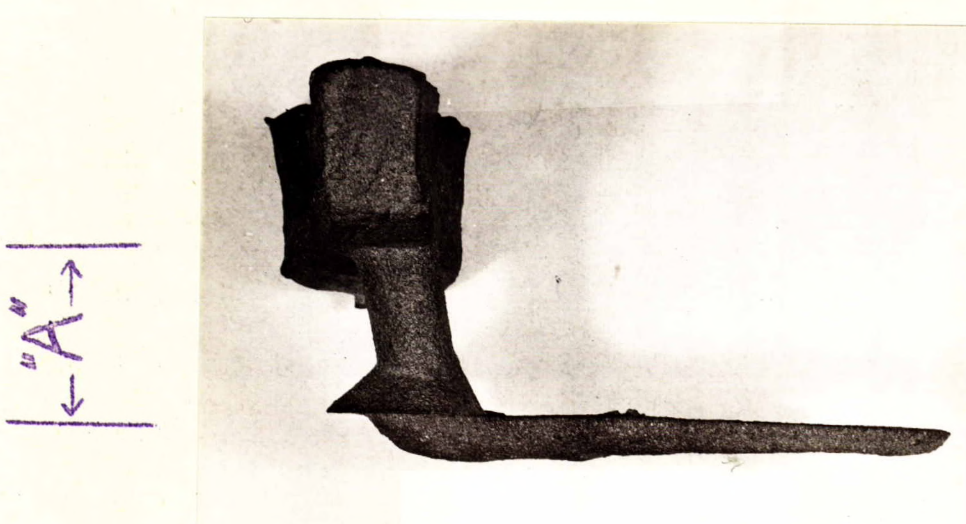
Figure 3.

HALF-SECTION OF B-B.

-

Figure 4 shows the pouring basin and gating system into the casting, as used on the casting when received.

Figure 4.



POURING BASIN AND GATING SYSTEM OF CASTING RECEIVED.

Pouring height "A" appears to be too low.

-

(Continued on next page)

(Visual Examination, cont'd) -

The low pouring head as used at present may be increased to give additional ferrostatic pressure. (The above dimension "A" is only two inches on the actual casting.)

DISCUSSION:

As is readily admitted by foundrymen in general, the successful production of high-quality castings depends on careful attention being paid to a great number of little details all important in themselves.

The moulding, ramming, sand tempering, clean gating, venting, the use of strainer cores, choke gates, core baking and core patching -- all require proper attention and workmanship if high quality castings are to be produced. Castings can be lost every day through dirty moulds; slag; loose sand falling down the sprues; excessive core-oil consumption causing abnormal gassing, blows, etc.

With regard to gating a casting, it is impossible to determine in advance how a particular casting should be gated to yield sound castings.

There are, however, certain basic principles which can be applied to castings, regarding solidification, non-turbulent flow, venting, chilling, risering, gating, choking the metal to restrict and slow its velocity of flow. These have to be considered with all castings.

It is not easy to diagnose the trouble precisely, since there are many factors which can operate together to cause a scrap casting; however, several suggestions can be offered which may assist in remedying the trouble.

It is known that a low pouring head or low riser is a major cause of shrinkage porosity in castings. The trend, in some successful producers of pressure-tight bronze castings, is to pour down a sprue two to three feet high above the casting, eliminating all risers completely.

(Discussion, cont'd) -

Another type of defect is due to a combination of dirt and shrinkage; the dirt picked up from dirty cores, soft ramming, or sand washed in through a carelessly constructed gate or pouring basin, interferes with the feeding of the metal during solidification, causing porosity.

The remedy is to provide a perfectly clean pouring basin and mould, properly tempered with water and clay and controlled to their definite limits. The mould should be well vented, to prevent the slightest commotion causing sand to fall from the mould walls.

Suggested Alterations:

1. Increase the pouring head or height of the pouring basin above the casting, as suggested in Figures 8 and 9.

This change could be justified by the fact that too low a pouring head or a low riser is a prolific cause of shrinkage porosity.

Definite evidence of metal unsoundness can be seen in the print below, Figure 5 (taken from Investigation Report No. 2076, page 11):

Figure 5.

(Approximately X9 magnification.)

(Suggested Alterations, cont'd) -

This small piece was removed from section C as shown below in Figure 6.

Figure 6.

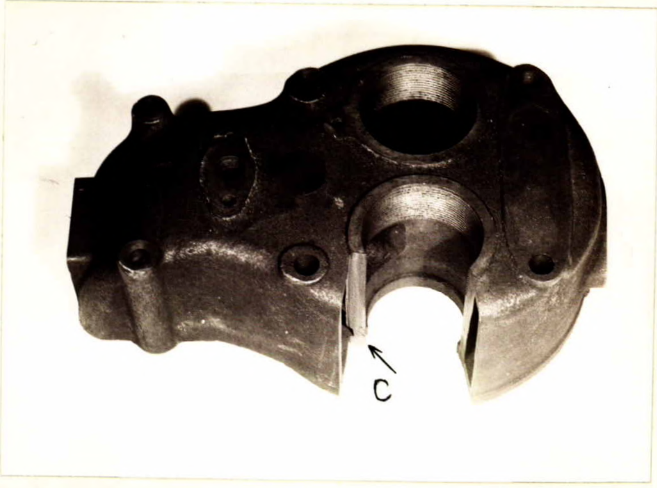
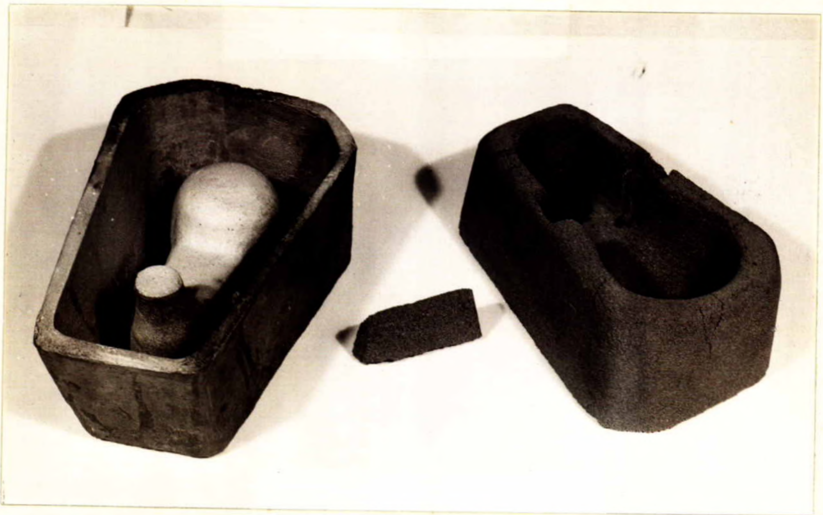


Figure 7 shows a baked sand core which can be used for controlled pouring and slag check gate in the runner-box. The left-hand view shows the core box used for making the pouring basin.

Figure 7.



CORE BOX (LEFT), AND BAKED SAND POURING-BASIN WITH SLAG CHECK-GATE.

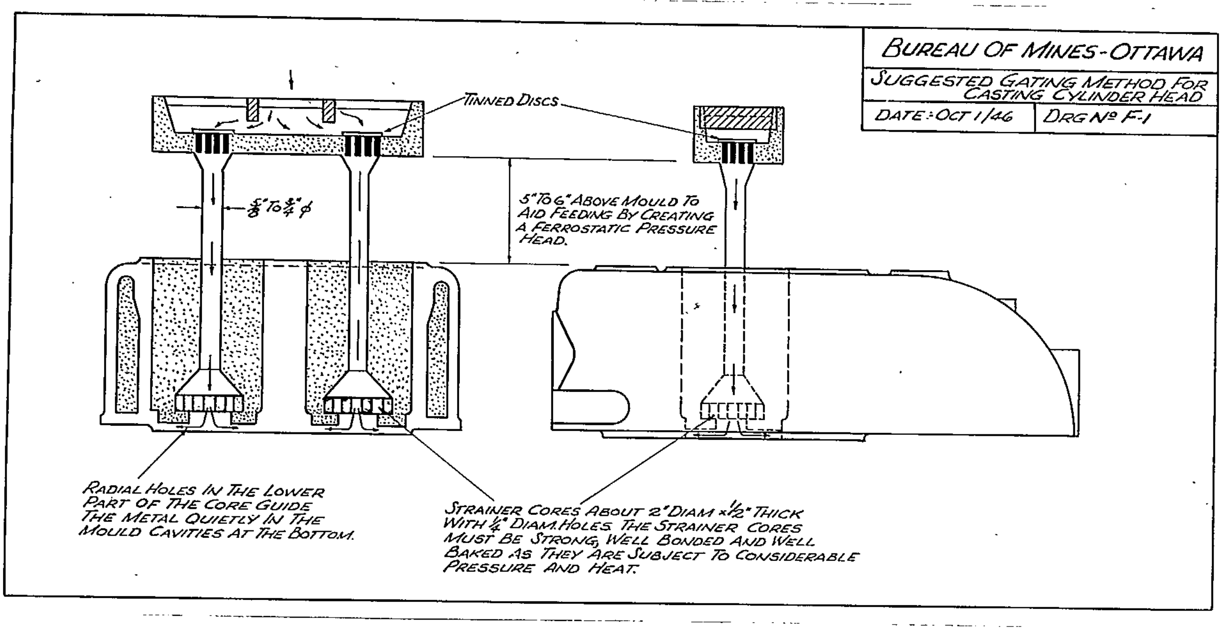
-

(Suggested Alterations, cont'd) -

Figure 8 shows one method of controlled pouring directly down the two centre cores.

Figure 8 also shows side elevation of pouring through centre cores.

Figure 8.



SECTION THROUGH ROUND CORED CAVITY WHICH MIGHT BE USED TO CARRY DOWN-GATES AS SHOWN IN FIGURE 8.

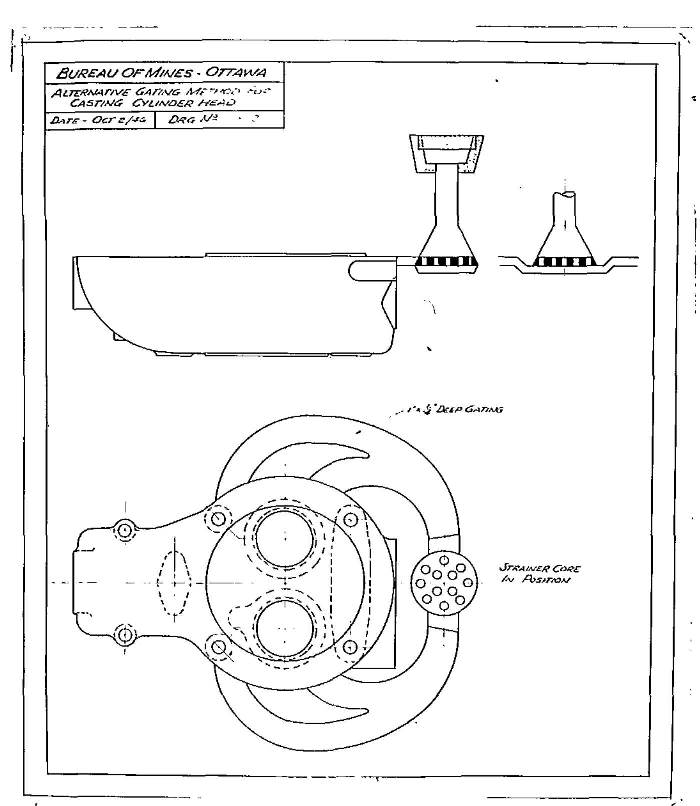
(Suggested Alterations, cont'd) -

The above pouring method shows a cross-sectional view through the two large round cores. The increase in pouring height over that used as shown in Figure 4 can be easily increased to 8 or 10 inches if additional ferrostatic head is considered necessary to overcome shrinkage porosity.

The suggested sizes of sprues, and number of strainer-core holes may be altered to increase or decrease the metal flow at particular locations.

Figure 9 gating shows a uniform distribution of metal into the casting from the top. In this manner, no one gate is subjected to excessive heat and erosion from the metal. This type of gating would best be made into a loose wood pattern and thus make clean, standardized gates, from mould to mould.

Figure 9.



ALTERNATIVE GATING METHOD FOR CASTING CYLINDER HEAD.

(Suggested Alterations, cont'd) -

In this gating method the same principle of ferro-static pressure can be applied to overcome shrinkage porosity, by increasing the pouring-basin height 6 or 8 inches above the casting.

The entrance of the metal on both sides of the casting tends to produce a more uniform distribution of metal flow into the casting.

Making one change at a time, to observe the effect of the change, the pouring height could be increased with very little additional metal consumption. To produce positive control of the metal flow into the moulds, the gating could be arranged as shown in drawings Figures 8 and 9.

o o

2. <u>Adopt, as standard practice, the use of a baked sand pouring-basin rammed up on top of the mould to provide a clean, baked receptacle for the molten metal.</u>

o o

3. <u>Adopt use of tin-coated discs anchored over the down gates, or sprues, in the pouring-basin, in order to restrict to a minimum the personal factor involved during pouring of moulds.</u>

These thin discs restrain the first flow of metal rushing into the mould carrying slag, loose sand, etc. In this way they give the pouring man time to fill the pouring-basin and confine the impurities to the metal surface. The tin discs will melt after a few seconds and clean metal then enters the mould.

o o

From the cost point of view the method of casting in Figure 9 may involve less drilling and work in gate removal than the method shown in Figure 8.

(Suggested Alterations, cont'd) -

The basis for a decision as to preference would be based on the quality of the castings produced by either method, after testing.

OOOOOOOOOOOO
OOOOOO
OO

HJK:GG.