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DEPARTMENT OF MINES AND RESOURCES

BUREAU OF MINES

CANADA

Ottawa, August 26, 1946.

REPORT

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 2094.

Metallurgical Examination of Sound and Broken Malleable Castings.

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(Copy No. 4.)

Bureau of Mines
Division of Metallic
Minerals
-
Physical Metallurgy
Research Laboratories

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Mines and Geology Branch

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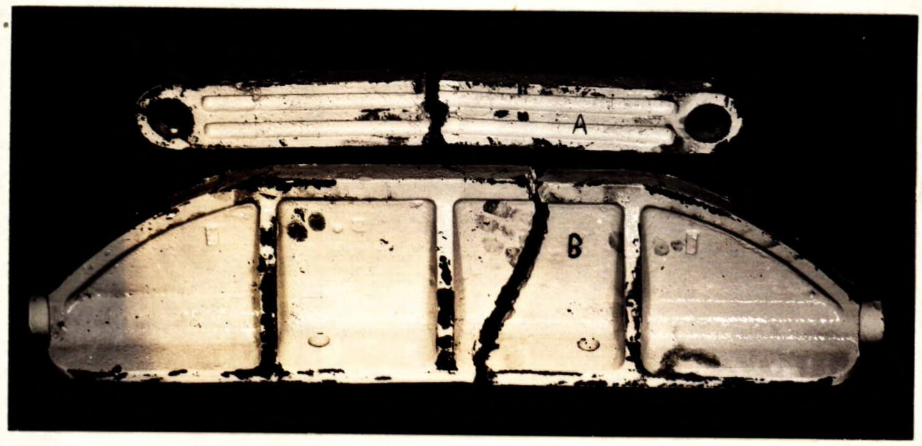
Origin of Material and Object of Investigation:

On July 12, 1946, the Brantford Coach and Body Limited, Brantford, Ontario, per F. W. Knechtel, production manager, submitted for metallurgical examination some broken malleable castings (see Figure 1) as well as some satisfactory castings. The covering letter dated July 8, 1946, stated that the castings painted white which were of recent pour were representative of many which had broken prematurely, whereas those painted black are of pre-war quality and were found to be satisfactory. A metallurgical examination was requested in order to determine the possible cause of failure.

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

Figure 1.



BROKEN MALLEABLE CASTINGS.

(Approximately 1/7 actual size).

PRODEDURE:

1. Chemical Examination:

Chemical analyses were made on samples machined from the satisfactory and broken malleable castings. The results are compared in Table I with that of the chemical limits for Standard Malleable Iron - Grade 32510 as given in the American Malleable Iron Handbook published by Malleable Founders' Society, Cleveland, 1944.

TABLE I.

	Broken Casting	Satisfactory Casting	Standard 32510
		Per Cent	
Carbon	- 1.12 *	2.19	2.30 - 2.70
Manganese	- 0.40	0.30	Less than 0.55
Silicon	- 1.03	1.02	0.80 - 1.20
Sulphur	- 0.067	0.083	Less than 0.18
Phosphorus	- 0.195	0.185	Less than 0.20
Nickel	- Nil.	Nil.	
Chromium	- "	"	
Molybdenum	- "	"	

* Very low carbon caused by decarburization during the annealing treatment.

2. Mechanical Tests:

0.505-inch standard tensile bars and 10-mm. standard Izod impact test pieces were machined from a satisfactory and

(Procedure, cont'd)

a broken casting. The results are compared in Table II with A.S.T.M. specification A47-33 for Grade No.32510 malleable iron castings.

Table II

	Tensile Strength p.s.i.	Yield Strength p.s.i.	Elongation in 2 inches, per cent	Izod ft-lb.
Broken Casting -	40,300	26,100	8.5	6
Satisfactory Casting -	48,000	27,200	11.0	10
Satisfactory Casting -	49,300	29,900	13.0	10
A.S.T.M. A47-33 (Grade 32510) -	50,000	32,500	10	-

Microscopic Examination:

Photomicrographs were taken at X100 magnification on samples cut from the broken castings, A and B (see Figure 1) and from a satisfactory casting.

Figures 2, 3 and 4 taken from the broken casting (A) illustrate the presence of free graphite, decarburization, and porosity, respectively.

Figure 5 shows a crack extending from the surface through a layer of metal containing primary graphite. (Broken casting B).

Figure 6 shows the microstructure of a satisfactory casting.

Discussion:

The results of the chemical analysis show that the compositions of both the broken and the satisfactory castings are practically identical and comply with those generally specified for malleable iron of this grade. The carbon in the broken casting was quite low, due in part to considerable decarburization which is plainly evident in the microscopic examination, but it should be mentioned that accurate carbon

(Discussion, cont'd) -

determinations in malleable iron are difficult to achieve. In view of the size and thickness of the section of these castings, it is felt that the silicon content of the metal might be lowered 0.10 per cent with safety, although the satisfactory castings previously made had a similar silicon content. The sulphur content in both cases is satisfactory, as is the manganese content. However, the manganese content in the broken casting is approaching the upper limit where, due to the formation of complex carbides, difficulty in completely breaking down the combined carbon into temper carbon and ferrite may be encountered. It should be noted that the phosphorus content is also close to the upper limit in both cases. No trace of the common alloying elements, nickel, chromium and molybdenum, was detected.

The results of the mechanical tests indicate a lower strength and ductility for the broken casting as compared with the satisfactory castings. The mechanical properties of the latter are considered to be satisfactory when compared with the A.S.T.M. specifications.

The microscopic examinations revealed the presence of two conditions in the broken castings which are undoubtedly responsible for the lower mechanical properties. The first is the presence of primary graphite (see Figures 2 and 5), a condition which is carried over from the melting practice and which is very harmful, and must therefore be rectified. Secondly, both visual and microscopic examination has revealed the presence of very extensive decarburization, extending in the casè of casting (A) to a depth of approximately 3/16 inch. This may be due to over-annealing or air leakage during the annealing cycle.

Conclusions:

1. The chemical composition of the broken casting is similar to that of the satisfactory casting and complies with the requirements of A.S.T.M. specifications, with the exception of the carbon content.

2. The carbon content of the broken castings is low due to decarburization. This condition may be due to over-annealing or leakage of air during the annealing cycle.

3. The presence of primary graphite is undoubtedly responsible for the low mechanical properties of the metal.

Recommendations:

1. A close check should be made on the white cast iron before annealing to ensure the absence of primary graphite.

2. A check on the annealing practice should be made to determine the cause of the decarburization.

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(Figures 2 to 6 follow,)
(on Pages 6 and 7.)

Figure 2

X100, unetched.

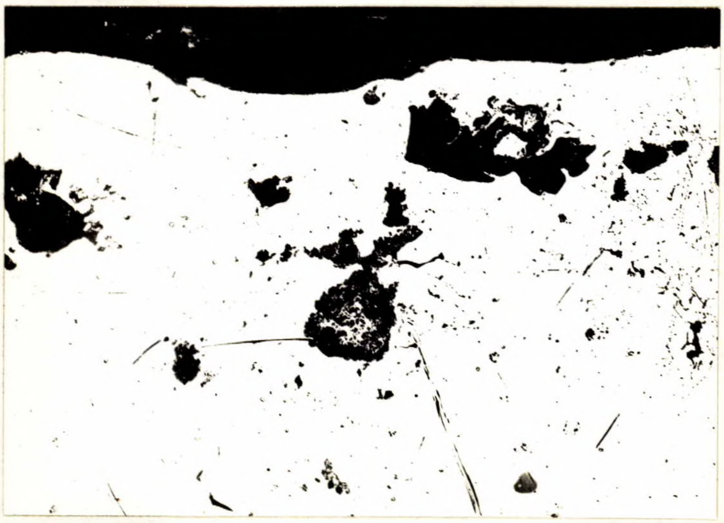
PRIMARY GRAPHITE

Figure 3

X100, unetched.

DECARBURIZED LAYER EXTENDING TO A DEPTH OF APPROXIMATELY 3/16 INCH.

Figure 4

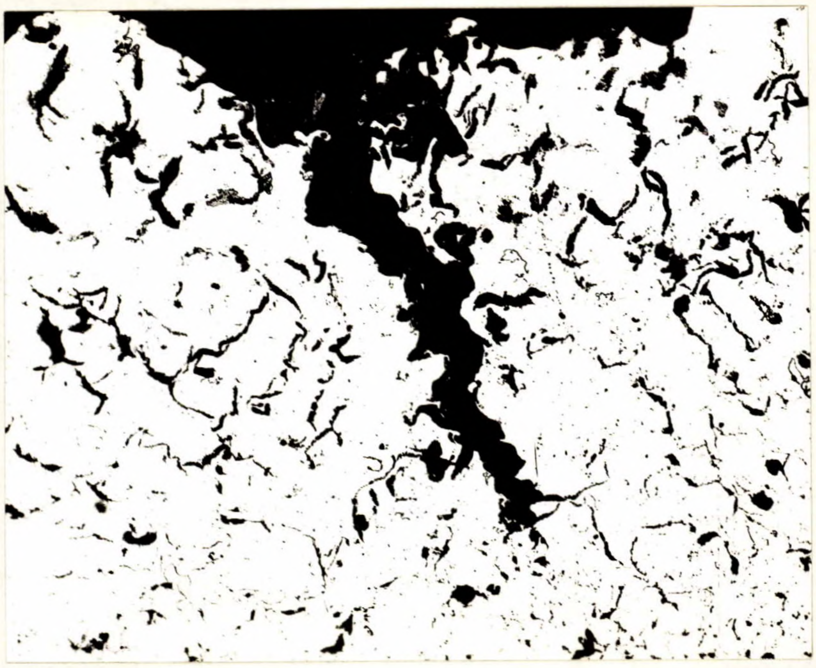


X100, unetched.

DECARBURIZED LAYER AND CASTING POROSITY NEAR SURFACE.

Microphotos taken from broken casting. (A)

Figure 5



X100, unetched.

SURFACE CRACK EXTENDING THROUGH AREA OF PRIMARY GRAPHITE.

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Broken Casting B.

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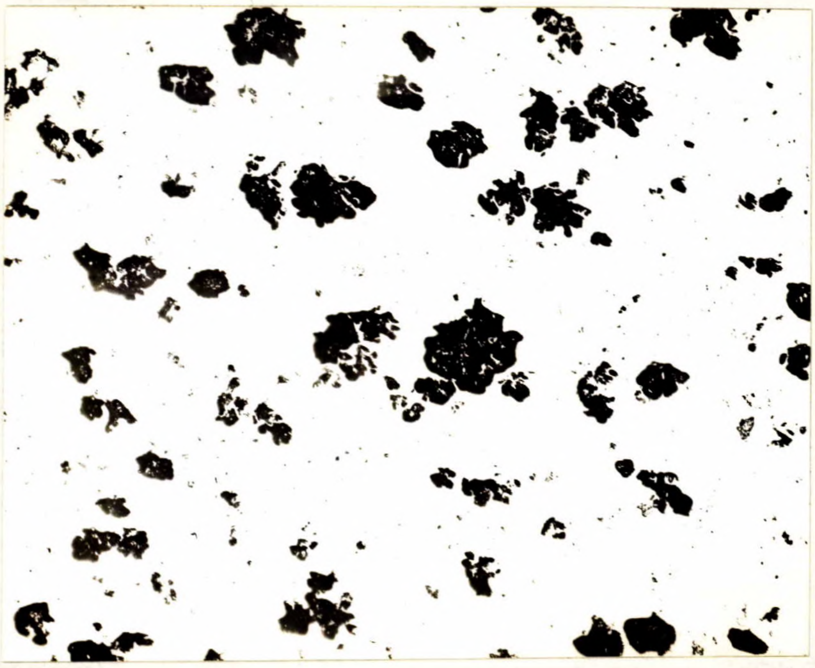
Figure 6



X100, unetched.

MICROSTRUCTURE OF SATISFACTORY CASTING.

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