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O T T A W A December 19th, 1944.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1764.

Metallurgical Examination of Broken Steel Castings
from Snowmobile Bogie Suspension Bracket.

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(Copy No. 10.)

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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Description of Material and Object of Investigation:

On December 9th, 1944, two broken pieces of a casting from a Snowmobile bogie suspension bracket (see Figure 1) were received, for metallurgical examination, from the Division of Metallurgy, Army Engineering Design Branch, Department of Munitions and Supply, Ottawa, Ontario, under Requisition No. 680 (A.E.D.B. Lot No. 573, Report No. 107, Section "D", Test No. 25). The covering letter, dated December 9th, 1944, contained the following information:

> "Material specified for this part is Steel Casting to ASTM Specification A-27-42, Class H."

A request was made to determine the cause of failure and to comment on the fracture.

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

Figure 1.

GENERAL VIEW OF BROKEN PIECES FROM CASTING OF SNOWMOBILE BOGIE SUSPENSION BRACKET.

(Approximately 2/5 normal size).

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Visual Examination:

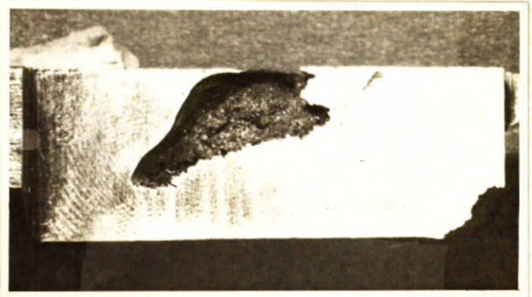
Visual examination revealed several important factors:

1. The fractured areas showed very coarse grain size.

2. The pieces contained many casting defects, such as blow-holes and dirt.

Figure 2 is a photograph showing a typical blow-hole defect in the casting.

Figure 2.



TYPICAL BLOW-HOLE DEFECT IN CASTING.

(Approximately 1½ times full size).

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Chemical Analysis:

A chemical analysis was made on a sample taken from one of the pieces. The results are as follows:

		As Found	Specification
		- Per Cent -	
Carbon	-	0.49	
Manganese	-	0.84	1.00 max.
Silicon	-	0.38	
Sulphur	-	0.031	0.06 max.
Phosphorus	-	0.023	0.05 max.
Nickel	-	Nil.	
Chromium	-	Nil.	
Molybdenum	-	Nil.	

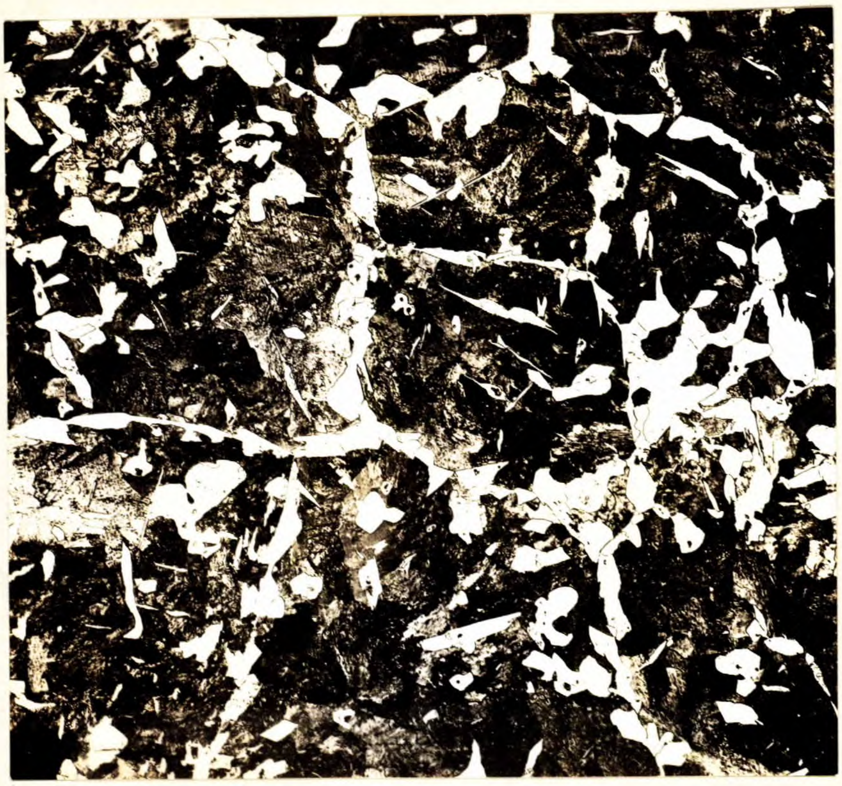
Microscopic Examination:

Microscopic examination on samples taken from both pieces showed that the steel was in the "as cast" condition. Figure 3 is a photomicrograph, taken at X100 magnification, showing a very coarse Widmanstätten structure, typical of cast steel.

Specification A-27-42, Class H, clearly calls for annealing after casting. A sample was annealed by heating in a furnace at 1450° F., followed by a slow cooling in the furnace. Figure 4, taken at X750 magnification, shows the microstructure of the steel resulting from this annealing treatment. Note the refined grain structure.

(Continued on next page)

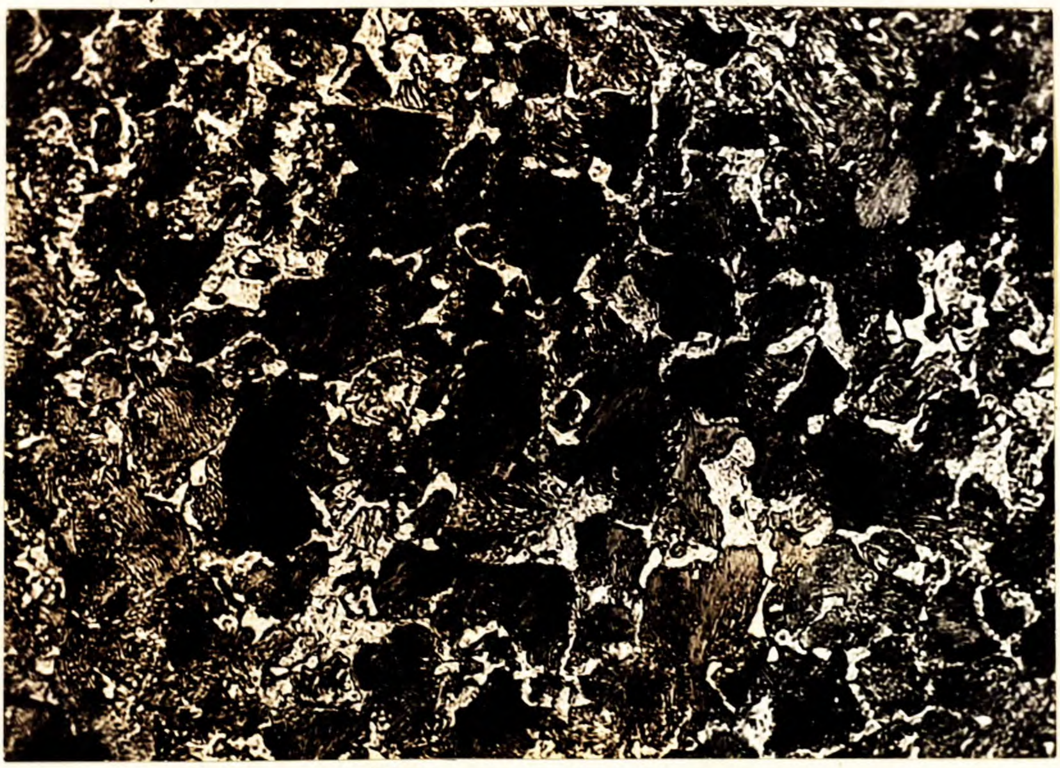
Figure 3.



X100, nital etch.

COARSE WIDMANSTÄTTEN STRUCTURE,
TYPICAL OF CAST STEEL.

Figure 4.



X750, nital etch.

MICROSTRUCTURE OF STEEL
ANNEALED AT 1450° F.

Note refined grains.

Discussion and Conclusions:

The results of the chemical analysis showed that the chemical content of the steel conformed satisfactorily with the requirements of the specifications.

Visual examination of the fracture revealed very coarse grain size, a finding which was corroborated by the micro-examination. The latter revealed a coarse Widmanstätten structure, which is typical of cast steel. Steel in this condition is very weak, brittle, and totally incapable of withstanding shock. Hence, it is reasonable to conclude that failure resulted because the steel had not been properly heat-treated as required by Specification A-27-42, Class H. This specification calls for annealing after casting. This annealing increases ductility and consequently markedly improves the shock resistance properties of the casting.

The many severe casting defects, such as blow-holes and dirt, found in the pieces would also materially add to the weakness of the steel.

Summarizing, it has been concluded that failure resulted from:

(1) Lack of annealing subsequent to casting.

(2) The use of steel containing many severe casting defects.

Recommendations:

1. It is recommended that these parts be annealed after casting, as required by Specification A-27-42, Class H, by heating in a furnace at 1450° F. and furnace-cooling.

2. Rigid examination should be adopted to prevent the use of parts containing serious casting defects.

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