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MINES BRANCH INVESTIGATION REPORT IR 58-174

FAILURE OF PUMP CYLINDER CASTING

by

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by

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SUMMARY

Examination revealed that the casting had failed through an area weakened by the presence of entrapped slag. The service life before failure indicated that for normal use the factor of safety applied to the design was sufficient to compensate for the presence of the defect.

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(1 table, 5 illus.)

INTRODUCTION

A pump cylinder casting which had failed in service was submitted for metallurgical examination on August 5, 1958, by Mr. N.E. Laycraft, Chief of Testing Laboratories, Development Engineering Branch, Department of Public Works, Ottawa. The casting had a service life prior to failure of approximately thirty years, and the failure had occurred while the equipment was out on loan. Comments were requested as to whether failure was due to a metallurgical defect or to faulty operation of the equipment.

The casting, which weighed about two tons, is illustrated in Figure 1.

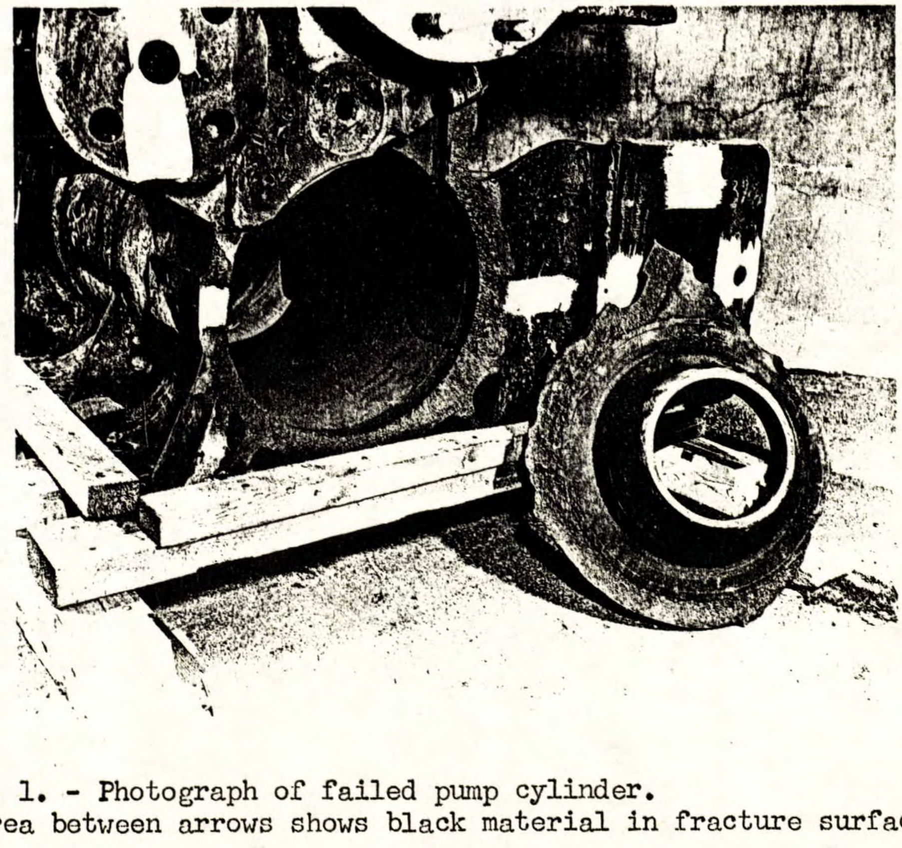
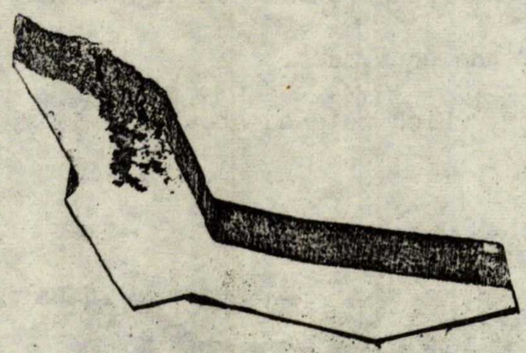


Fig. 1. - Photograph of failed pump cylinder.
Area between arrows shows black material in fracture surface.

VISUAL OBSERVATIONS

The fracture surface appeared normal for cast iron except for several large black covered areas which had the appearance of slag. A section was cut through one of these black areas and the defect was seen to be large. A photograph of the section is shown in Figure 2.



(Approximately 1/3 actual size)

Fig. 2. - Photograph of section through fractured end of casting where black material was evident.

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CHEMICAL ANALYSIS

TABLE 1

Chemical Analysis of Casting

Element	Analysis %
Carbon	3.45
Manganese	0.41
Silicon	1.96
Sulphur	0.060
Phosphorus	0.55

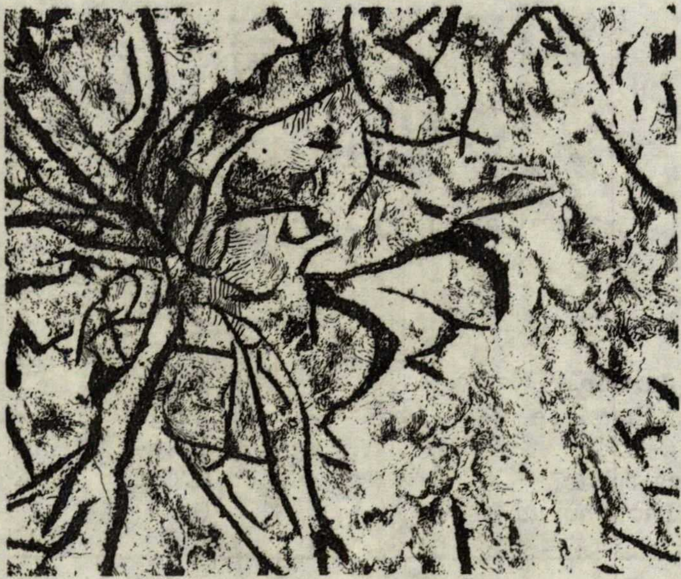
The analysis does not reveal the iron to be abnormal. The carbon equivalent of this material (% carbon plus 0.3 times the sum of % silicon and % phosphorus) is 4.2. This indicates a low-strength iron, such as ASTM Class 20. Today, a casting of this type would be made of a higher-strength iron (lower carbon equivalent), such as ASTM Class 40, so as to reduce the weight of the part.

X-RAY DIFFRACTION

X-ray diffraction studies of the black material revealed it to be mainly magnetite (Fe_3O_4) with a trace of Fe_2O_3.

METALLOGRAPHIC EXAMINATION

Microspecimens were cut from the section shown in Figure 2, and were polished and examined. Photomicrographs illustrating the structure are shown in Figures 3 to 5.



(X100 - etched in 2% nital)

Fig. 3. - General structure BHN 131 shows large graphite flakes and some steadite (phosphide eutectic-mottled area).

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(X500 - etched in 2% nital)

Fig. 4. - Graphite (dark), pearlite (lamellar structure), and steadite (speckled).

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(X100 - etched in 2% nital)

Fig. 5. - Shows an area with an entrapped slag particle.

DISCUSSION

The high silicon content of the casting is the primary reason for the large size of the graphite flakes. The phosphorus content was high, but this is to be expected in a casting of this age. The black material found on areas of the fractured surface was seen to be extensive. X-ray diffraction revealed it to be slag, undoubtedly formed in melting and entrapped on solidification of the casting. Microscopic examination revealed no indication of a fatigue failure, and no flaws other than the slag.

CONCLUSIONS

The presence of entrapped slag and coarse graphite flakes served to weaken the casting, but since it had a service life prior to failure of thirty years, and since the examination revealed no evidence of fatigue, it is felt that the primary cause of failure was overloading.

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