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EXAMINATION OF A FRACTURED GREY CAST IRON SUPPORT RING

by

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PHYSICAL METALLURGY DIVISION

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SUMMARY OF RESULTS

Following delivery of a section of a fractured grey cast iron support ring from the Commercial Products Division of Atomic Energy of Canada Limited, a metallurgical examination was carried out to determine the cause of failure. It was explained that the ring had fractured when it was dropped on the machine shop floor.

Chemical analysis, hardness tests, and metallographic examination showed that there was nothing intrinsically wrong with the material as such.

Failure was put down to the inherently low impact strength of grey cast iron. Attention was drawn to the very small section thickness at the drilled holes.

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INTRODUCTION

On November 16th, 1965, a section of a grey cast iron support ring, fractured in two places, was submitted to the Physical Metallurgy Division, Mines Branch, Department of Mines and Technical Surveys, by the Commercial Products Division of Atomic Energy of Canada Limited, with a request to examine and determine the cause of failure.

It was reported that fracture had occurred when the ring was dropped on the floor after machining. In a covering letter dated November 16th, 1965 from Mr. M. T. Antoniades, it was stated that the ring was made of ASTM Class 30 G. 1 grey cast iron containing 3/4% nickel and had been cadmium plated. Attention was drawn to a surface discolouration which had occurred at the drilled holes as a result of the drilling operation. Since fracture arose at a drilled hole it was suggested that perhaps this machining had had a deleterious effect on the metal, rendering it susceptible to failure.

VISUAL EXAMINATION

The section of ring was received as three pieces (see Figure 1) which, when fitted together, had a peripheral length of about 12 inches. It was, approximately, 1 1/4 in. high with a section thickness of 5/16 in. at the top and 1/2 in. at the bottom. Fracture had occurred on one end at a reduced section and on the other, at a drilled hole. These fractures are shown in Figure 2 and they appeared to be normal fractures, typical of grey cast iron. Figure 2(b) shows clearly the section of the stepped drill-hole and the surface discolouration previously mentioned. Note the very thin section at the top and bottom of the hole. This was measured and found to be in the region of 0.030/0.035 inches thick.

Another similar drilled hole was located on the ring between the two fractures. Close examination of this revealed two cracks, each running the length of the thin sections. That occurring at the larger diameter end of the hole is shown in Figure 3.

CHEMICAL ANALYSIS AND HARDNESS TESTS

Drillings from the ring were analysed and results are shown in Table 1. These showed the material to be within the limits normally expected for a Class 30 grey cast iron.

Brinell hardness tests carried out on the bottom rim gave readings of 192, 197, and 192. Converted to tensile strength according to the available ASTM data, this gives an equivalent value in the range 30,000-35,000 psi. Class 30 specifies a minimum tensile strength of 30,000 psi.

The combined results of chemical analysis and hardness tests thus indicated that the material was within specification for an ASTM Class 30 grey cast iron.

TABLE 1

Results of Chemical Analysis (%)

Tot. C	Comb. C	Si	Mn	S	P	Ni
3.33	0.48	2.24	0.85	0.079	0.16	0.80

METALLOGRAPHY

Specimens for micro-examination were cut from both fractures at right angles to the fractured surface. Specimen A was cut through the thinner section of fracture A and specimen B through the same 5/16 in. thickness at the smaller diameter hole of fracture B (see Figure 2 for fracture reference). A third specimen (C) was cut from a region away from a fracture.

The same general microstructure, typical of this class of grey cast iron, was observed in each case, i.e. a uniform distribution of type A graphite flakes randomly orientated in a pearlitic matrix (see Figure 4). The structure at the fractures was completely normal and gave no indication of anything deleterious that might have caused premature failure. The surface discolouration of fracture B was harmless; the drilling operation had not affected the microstructure.

DISCUSSION

From the results of the chemical analysis, hardness tests, and metallographic examination, the material appeared to be of acceptable quality and within the specified ASTM Class 30 for grey cast iron.

The drilling operation obviously had no deleterious effect on the structure but the thin sections resulting from it were not considered a good design feature for a grey cast iron.

Grey cast iron has inherently low impact strength and it is not unusual for it to fracture on being dropped on a hard surface. Verbal communication with Atomic Energy of Canada Limited revealed that failure first occurred at the thicker section (fracture 4). Probably the ring was dropped on this area. The failure and cracks at the drilled holes were said to have occurred when this treatment was repeated. The fact that the heavier section failed, and not just the section at the drilled holes, demonstrates that failure was simply the result of the material having been subjected to a type of loading which, by its nature, it was unable to withstand.

Some concern should be expressed at the presence of the very thin sections left at the holes. For grey cast iron such design should be avoided since even under normal handling these sections could quite easily break.

CONCLUSIONS

1) The material was of normal acceptable quality of ASTM Class 30 grey cast iron.

2) Drilling did not cause any damage to the microstructure.

3) Failure was caused by the ring being dropped on the floor. Grey cast iron, by virtue of its inherent low impact strength, is unable to withstand such treatment in light sections.

WMC/bb

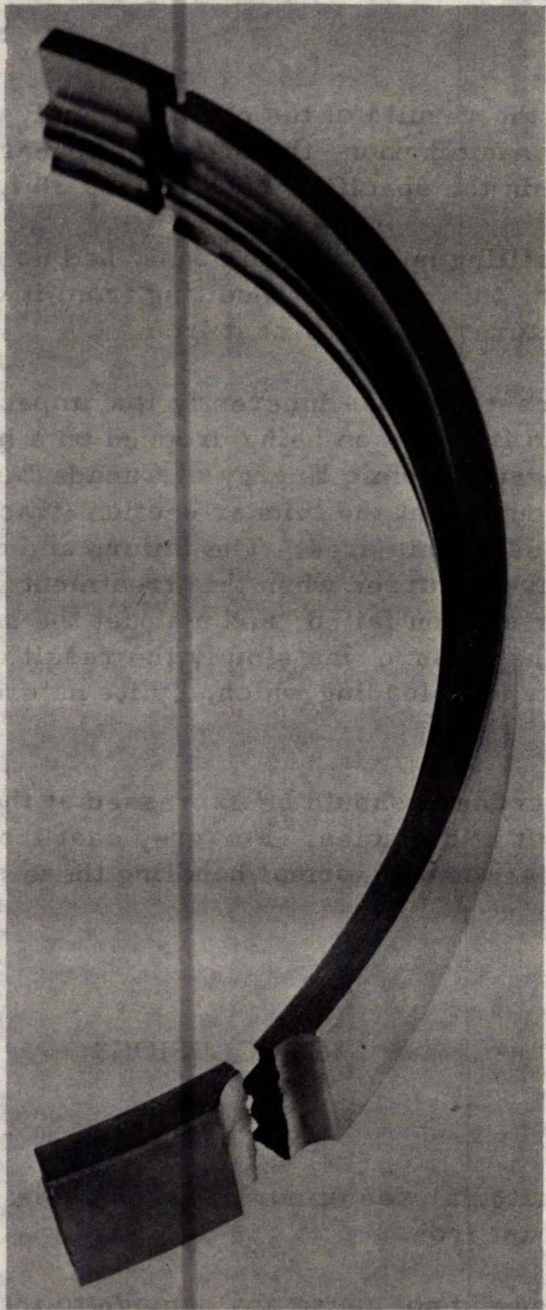
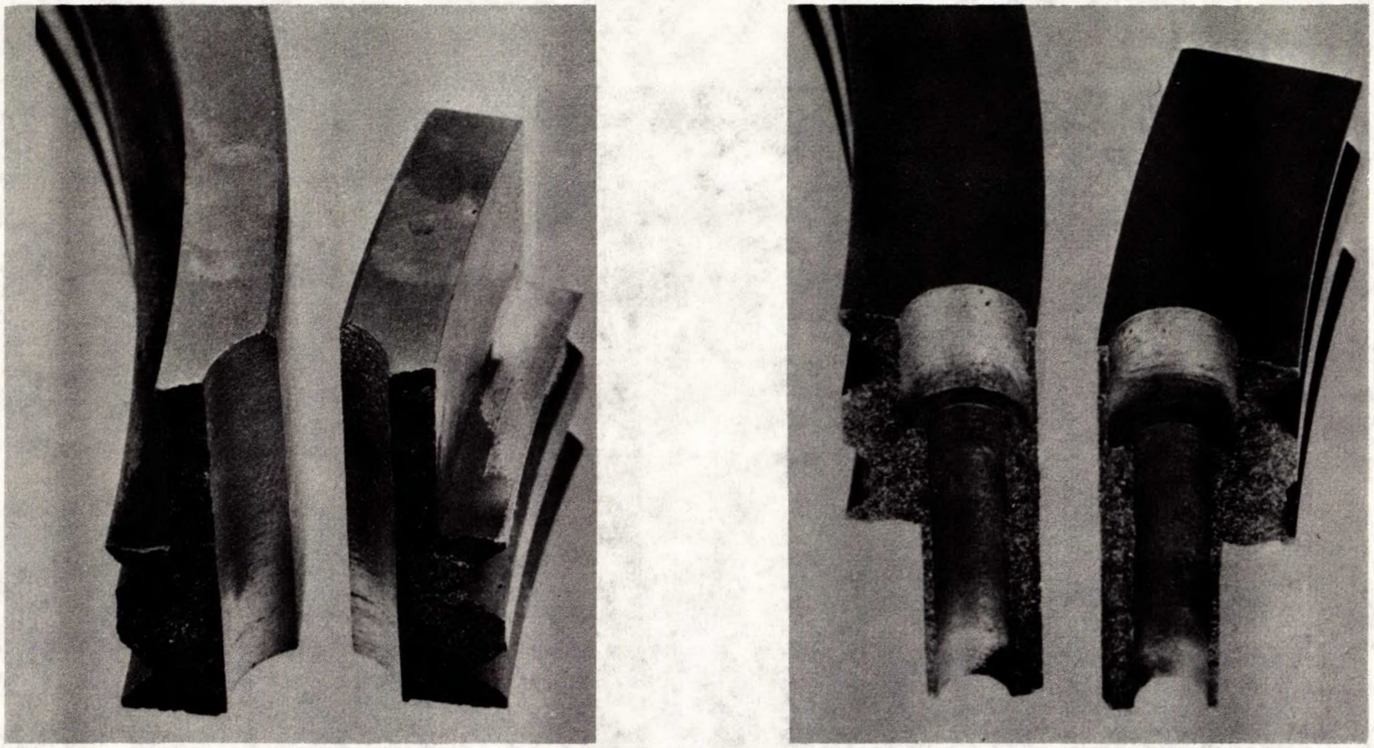


Figure 1. Photograph (approximately half size) showing fractured support ring as-received.



(a) (b)

Figure 2. Photographs (slightly enlarged) showing fractures. (For reference, fracture of Figure 2(a) is designated A, and that of Figure 2(b) - B).

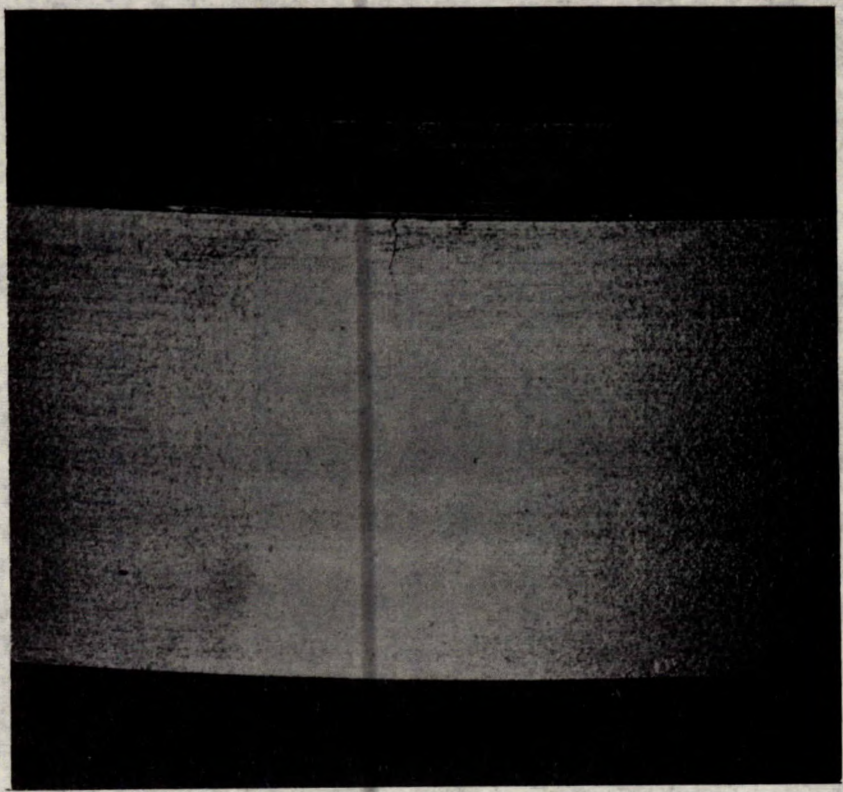
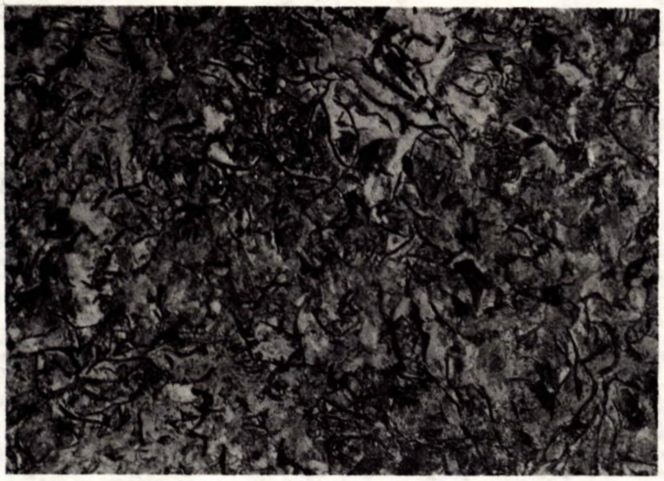


Figure 3. Photograph (approx. X2) showing crack at drilled hole.



A - Adjacent to fracture A

B - Adjacent to fracture B

C - Away from fractures

Etched in 2% Nital

Figure 4. Photomicrographs (X100) of typical microstructures at three locations on the support ring.