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August 24th, 1943.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES

Investigation No. 1483.

Examination of a Broken Bolt from an Autoclave.

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(Copy No. 10.)

Bureau of Mines
Division of Metallic
Minerals
Ore Dressing
and Metallurgical
Laboratories

CANADA
DEPARTMENT
OF
MINES AND RESOURCES
Mines and Geology Branch

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Origin of Material and Object of Investigation:

On August 17th, 1943, Lt. Comm. C. E. Olive of the Department of National Defence, Naval Services, Ottawa, Ontario, brought in a broken bolt which had been removed from an autoclave. This bolt showed a duplex fracture, being coarsely crystalline at the outside and fine-grained in the centre. A fissure had also opened up in the very centre of the bolt. The bolt, which was required to withstand, along with other bolts, the autoclave pressure, had broken in the tightening of the nut. A metallurgical examination was requested in order to determine the nature of the material and also to find out whether the duplex fracture was caused by material variations or by the nature of the failure.

Chemical Analysis and Physical Properties:

The material was found to contain 0.03 per cent carbon and 0.06 per cent manganese. A small 0.282-inch-diameter test specimen machined from the bolt was found to have the following physical properties:

<u>Ultimate stress, p.s.i.</u>	<u>Yield stress, p.s.i.</u>	<u>Elongation, per cent in 1 in.</u>	<u>Reduction of area, per cent</u>
51,300	35,200	28.7	32.4

Microscopic Examination:

Bolt structures, as shown in the etched and unetched conditions, are shown respectively in Figures 1 and 2. Both photomicrographs were obtained from the longitudinal sections. The dark particles shown are slag. The background is ferrite (the iron constituent). A large piece of slag was found in the vicinity of the centre crack. Apart from variations in slag particle size, the structure was uniform across the section.

Figure 1.



X100, unetched.

Figure 2.



X100, etched in
2 per cent picral.

CONCLUSIONS:

Examination shows that the bolt was made from wrought iron of fairly good physical properties. Uniformity of slag size and distribution is none too good and apparently the fissure in the bolt occurred as a result of opening up around a rather large slag particle. The uniformity of structure across the section indicates that the duplex nature of the fracture could not be due to material variations. It seems likely, then, that the centre of this bolt broke some time before the final fracture.

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