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R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1482.

Examination of a Cast Steel Muzzle Brake for a 6-Pdr. Gun.

(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 Sample and Object of Investigation:

On July 26th, 1943, Colonel H. N. Sowdon, for Military Technical Adviser, Department of Munitions and Supply, Ottawa, Ontario, submitted a cast steel muzzle brake for examination. It was stated that this type of muzzle brake had been giving trouble in service. A metallurgical examination of the casting was requested.

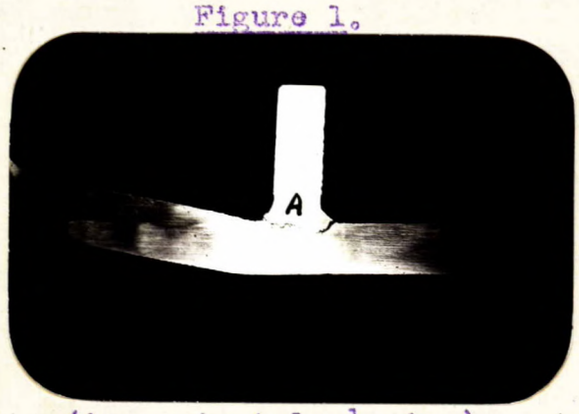
X-Ray Examination:

The casting was X-rayed by the National Research Council, Ottawa, Ontario. They reported that the casting was slightly porous in the central section. Signs of shrinkage also appeared to be present in this portion of the casting.

Macro-Examination:

The casting appeared to be sound and free from surface imperfections. The brake was sectioned in order to check the porosity observed in the X-ray films. Figure 1 shows a crack between the central baffle and the cylindrical portion of the casting.

Figure 1.



(Approximately ½ size)

Chemical Analysis:

Drillings taken from the casting were analyzed and the following results obtained:

Carbon, per cent	Manganese, per cent	Silicon, per cent	Sulphur, per cent
0.25	0.68	0.45	0.013

Phosphorus, per cent	Chromium, per cent	Nickel, per cent	Molybdenum, per cent
0.012	0.84	0.89	0.29

Physical Properties:

Physical tests were carried out on a 0.282-inch-diameter tensile test bar (2-inch gauge length) and a standard Izod test bar machined from the sound portion of the casting. The following results were obtained:

Ultimate stress, p.s.i.	-	91,300
Yield stress, p.s.i.	-	78,600
Reduction in area, per cent	-	20.9
Elongation in 1 inch, per cent	-	12.0
Brinell hardness (3,000 kg. load)	-	179
Izod impact, foot pounds	-	46, 45.

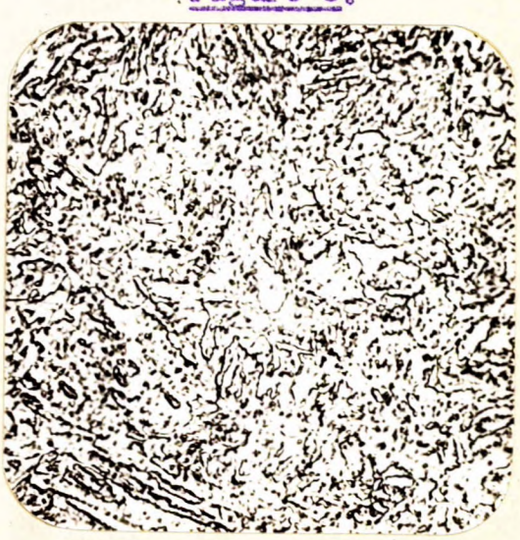
Microscopic Examination:

A section of the casting, at the junction of the cylinder baffle and outside cylinder, was given a metallographic polish and then examined under the microscope in the unetched condition. The steel was fairly clean. Figure 2 is a photomicrograph, at X100 magnification, showing an area in the steel containing shrinkage cavities. Figure 3 shows, at X1000 magnification, the picral-etched condition of the steel. The structure consists of drawn martensite. Figure 4 gives, at X100 magnification, the nital-etched structure of a decarburized area adjacent to the crack shown at "A" in Figure 1.

Figure 2.

X100, unetched.

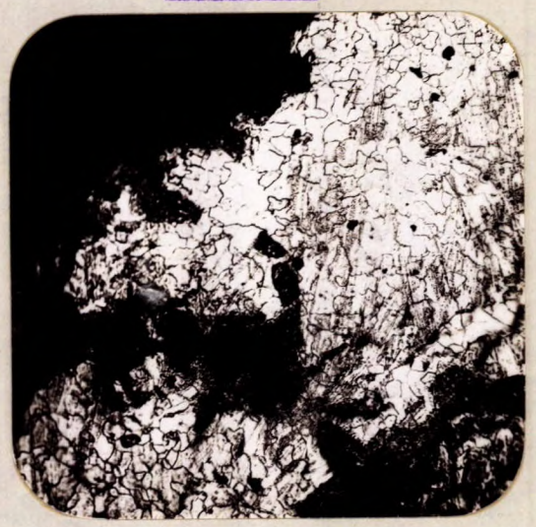
Figure 3.



X1000, etched in 4 per cent picric acid.

(Microscopic Examination, cont'd) -

Figure 4.



X100, etched in 2 per cent nital.

Discussion of Results:

The steel was found to have a chemical composition similar to that of an SAE 4330 steel and had very satisfactory physical properties. The X-ray and macro-examinations showed the casting to be fairly sound except in the central section where slight shrinkage cavities and a crack were observed.

The microscopic examination confirmed the presence of small shrinkage cavities shown in the X-ray films and also revealed that the casting had received a quench-and-draw heat treatment. In addition, a heavily decarburized area adjacent to the fracture was noted.

From the location and nature of the crack it would appear to be a hot tear.

In order to overcome the trouble encountered in casting this muzzle brake, the following suggestions are offered for consideration:

1. Concave the outside so as to avoid mass concentration of metal at the section now porous. This would involve pattern changes and outside coring. However,

(Discussion of Results, cont'd) -

it is believed such a change would eliminate the hot spot at the junction of the outer cylindrical section of the casting and the central baffle.

2. There is a possibility that the expansion and contraction properties of the core may be at fault. In order to establish whether this is so, it will be necessary to have the core properties checked in a properly equipped sand laboratory.

3. Chill centre section. This procedure, which would bring about a more equal solidification of the central baffle, would, of course, be an expensive remedy because of the cost of chill handling.

4. Gate into central section of the casting through a blind riser. This would require extensive changes in pattern.

5. Central gate plus centrifugal casting. This method doubtless would produce good sound castings but would require changes in pattern and would also require additional equipment.

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