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OTTAWA December 16th, 1943.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1557.

Examination of a 6-mm. Armour Plate
Which Had Failed Ballistically.

(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

O T T A W A December 16th, 1943.

REPORT

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Examination of a 6-mm. Armour Plate Which Had Failed Ballistically.

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Origin of Request and Object of Investigation:

On October 25th, 1943, two samples of 6-mm. armour plate were submitted by Dr. C. W. Drury, Director of Metallurgy, Army Engineering Design Branch, Department of Munitions and Supply, Toronto, Ontario.

In the accompanying Requisition No. 729 (Report No. 13, Test No. 49, Request J-26), a determination of the chemical composition and the physical and metallographic characteristics was requested. One plate of Brinell hardness approximately 293 (A.E.D.B. Lot No. 814) was to be examined and the other (A.E.D.B. Lot No. 815) was to be held in reserve.

Chemical Analysis:

		Per cent
Carbon	-	0.21
Manganese	-	0.75
Silicon	-	0.40
Sulphur	-	0.022
Phosphorus	-	0.040
Nickel	-	0.80
Chromium	-	1.25
Molybdenum	-	0.28

Hardness Measurements:

A surface hardness reading on the Brinell machine gave a result of 285 B.H.N.

The results of a cross-sectional hardness survey are shown in an attached sheet at the end of the report. The estimation of the depth of decarburization can also be calculated from this chart.

Microscopic Examination:

The amount of scale present in the unetched structure is shown in Figure 1, taken at X500 magnification.

The main characteristic of the steel is its dirtiness. An estimation of the amount of inclusionscan be made from Figure 2, a photomicrograph at X100 magnification.

The microstructure of the steel is shown in Figure 3, at X500 magnification. With the exception of a few very small areas of ferrite, the steel is wholly sorbitic.

Discussion of Results:

Although the chemical analysis does not in itself supply the reason for ballistic failure, the low carbon content of the plate possibly may be responsible for its low hardness; and, as a general rule, ballistic properties are known to drop with decreasing hardness.

The scaling is not excessive, and no marked decarburization could be observed under the microscope, the amount of

(Discussion of Results, cont'd) -

free ferrite being approximately the same near the edge as in the centre of the plates. However, the depth of decarburization, as observed by the hardness survey, is shown to be 0.25 mm.

The most striking and important characteristic of this plate is undoubtedly the dirtiness of the steel, and this factor has a most detrimental effect on the ballistic properties, especially when the inclusions are present as elongated stringers. These inclusions are of the same type as those found in armour plate, A.E.D.B. Lots Nos. 817 and 818, covered by O.D.M.L. Investigation No. 1535 (November 19th, 1943). Previous U.S. Ordnance reports have shown definite correlation between the presence of elongated stringers and the tendency to spall.

CONCLUSION:

The plate submitted for examination would not be expected to give good ballistic performance, because of its high content of elongated stringers. The low hardness possibly has been a contributing factor to the lowering of the ballistic properties.

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Figure 1.

X500, unetched.

SHOWING THE EXTENT OF SCALING.

Figure 2.

X100, picral etch.

SHOWING AN INCLUSION PATTERN.

Figure 3.

X500, picral etch.

SHOWING THE MICROSTRUCTURE
OF THE STEEL.

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(Note: Page 5, following, is)
(a hardness survey chart.)

CROSS-SECTIONAL HARDNESS
SURVEY ON 6MM ARMOUR PLATE
VICKERS HARDNESS NUMBER
300
200
100
1
2
3
4
5
6
DISTANCE FROM EDGE (MM.)
THE HUGHES OWENS CO., LIMITED