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Report No. 710/270
Watertown Arsenal
CONFIDENTIAL

October 12, 1938

BALLISTIC TEST OF SPECIALLY HEAT TREATED 1/2" HOMOGENEOUS ARMOR PLATE

Purpose

The purpose of this investigation was to determine the ballistic characteristics of a homogeneous plate with hard core and soft face.

Conclusions

1. The martensitic core shows excellent resistance to caliber .30 A.P. impact but is too brittle to withstand caliber .50 A.P. impact.

Method of Procedure

A 12 x 12 x 1/2" chrome-molybdenum-vanadium armor plate made by the Jessop Steel Company was heat treated by the delayed quenching treatment at the Watertown Arsenal.

Hardness surveys and microscopic tests were made, after which the plate was sent to Aberdeen Proving Ground for ballistic test.

Result of Test

Chemical Analysis -

The chemical analysis of the plate is as follows:

C	Mn	Si	S	P	Cr	Mo	Va
.46	.57	.305	.108	.012	1.16	.70	.25

Heat Treatment -

The delayed quench given the plate consisted of heating to 1600°F, held 2 hours, furnace cooling to 1400°F, held 1/2 hour, quenching in oil, drawing to 925°F for 2 hours, and air cooling.

Hardness -

Brinell hardness of the outer portion of the plate was 385 while the inside was 600.

Ballistic Tests made at Aberdeen Proving Ground -

(a) Highest Partial - 2749 f/s. Cal. .30 A.P.

(b) " " - 2991 f/s. Cal. .30 Ml high velocity A.P. (no spalling).

(c) Complete - 2111 f/s. Cal. .50 A.P. Ml (cracked and buttoned).

Microscopic Examination -

Figures 1 - 4, inclusive, show the microstructure of this plate.

Discussion

The armor plate tested was decarburized on both faces as purchased from the manufacturer. The heat treatment could not alter this condition. Figure 1 shows an area where the completely ferritic structure of the extreme edge is merging into a sorbitic structure.

Figure 2 shows the tempered martensitic structure found on the interior of the plate. Considerable micro-segregation is also found. Figure 3 shows a uniform distribution of fine nonmetallic inclusions present in the plate.

Figure 4 illustrates typical carbide banding in the plate.

Due to the fact that the plate was decarburized, no conclusions can be drawn as to the efficacy of the heat treatment.

Respectfully submitted,

E. L. Reed
Research Metallurgist

S. L. Kruegel
Jr. Phys. Science Aide

1/2" Homogeneous Armor Plate #J

Fig. 1 - Taken near the edge, this structure shows the diminution of ferrite patches as they merge into sorbite.

1% Nital etch, X1000, MA-1319

Fig. 2 - The center of the plate shows considerable micro-segregation and a tempered martensitic structure.

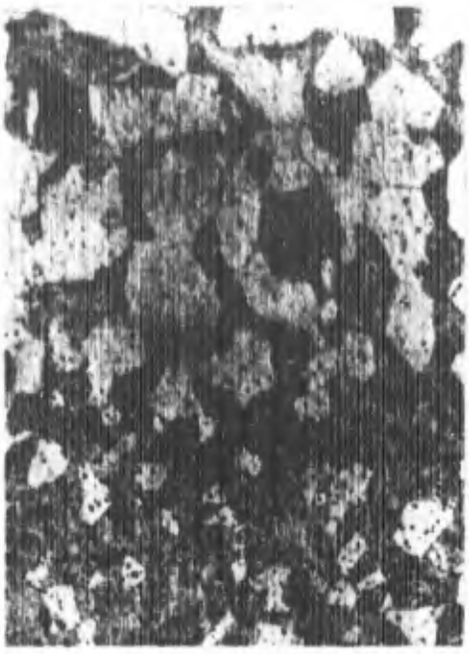
1% Nital etch, X1000, MA-1318

Fig. 3 - Good dirt condition.

Unetched, X100, MA-1365

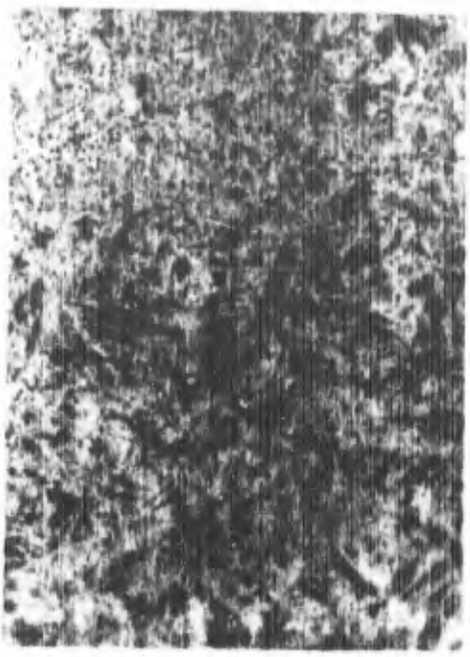
Fig. 4 - Carbide banding brought out by Murakami etch.

X1000, MA-1367



X1000

(1)



X1000

(2)

X100

(3)

X1000

(4)

639-3275