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FEDERAL BUREAU OF INVESTIGATION

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May 6, 1942

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Watertown Arsenal **UNCLASSIFIED**

Examination of four experimental
heats of armor plate. Heats
H640, H668, H669 and H670.

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Lab. #5984-6

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Y. S. #140
H. Dittmar
3/4/42

Subject Examination of four experimental heats of armor plate manufactured by the Watertown Arsenal. Heats H640, H668, H669 and H670.

Object To determine some of the physical properties of this material.

Data Submitted for examination were four experimental ingots of armor plate made at the Watertown Arsenal, each weighing about 800 lbs. The ingots were charged into a furnace at 1550°F and forged to slabs at a temperature of 2200-2250°F. Ingots H668 and H670 were forged completely to 3" x 14" slabs; ingots H640 and H669 were reheated to complete the forging of the top end, and forged to 3" x 14" and 4" x 13" respectively. The former ingot developed several transverse checks on edges during the second stage of forging. All slabs were charged into a furnace at 1250-1350°F and furnace cooled.

The ladle analyses of the heats involved were as follows:

Heat #	C	Mn	Si	Cr	Ni	Mo	V
H640	.29	.46	.175	1.12	-	.65	.19
H668	.23	1.33	.34	-	-	.49	-
H669	.26	.59	.23	1.05	1.54	.51	-
H670	.24	.57	.23	.51	.37	.37	-

Conclusions

The macroetched sections indicate a reasonably clean steel except for heat H640 which contained excessive non-metallics. The McQuaid-Ehn grain size is medium fine. The Jominy hardenability of heats H640 and H669 is about 50 R. C. at the quenched end and 30-35 at the opposite end. That of the remaining two heats is only 45 and 20 respectively.

D. Niconoff
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Work outline

Macroetch
Grain size
Critical points
Jominy hardenability

Macroetch

The top and bottom sections of finished slabs were etched in hot 1:1 hydrochloric acid. As illustrated in Figs. 1 and 2, both sections of ingot H669 and the bottom section of ingot H640 contained some non-metallic inclusions and the top section of ingot H670 indicated slight center porosity.

Grain size

As determined by the McQuaid-Elm method, the austenitic grain size of these heats was as follows:

<u>Heat</u>	<u>Grain size</u>
H640	7-8 (6s)
H668	7-5 (90-10)
H669	6-7 (4s)
H670	7-5 (80-20) (3s)

Critical points

The following values were obtained by the dilatometric method:

<u>Heat #</u>	<u>A_{c1}</u>	<u>A_{c3}</u>	<u>A_{r3}</u>	<u>A_{r1}</u>
H640 B	1420°F	1530°F	1415°F	1320°F
H668 B	1360	1540	1410	1320
H669 B	1350	1450	1290	1240
H670 B	1380	1510	1400	1170

Jominy hardenability

Standard Jominy test pieces were machined from both the top and the bottom sections of each ingot, and end quenched from 1575°F. The data are tabulated and plotted on following pages.

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Fig. 1



1669 B



1019 H



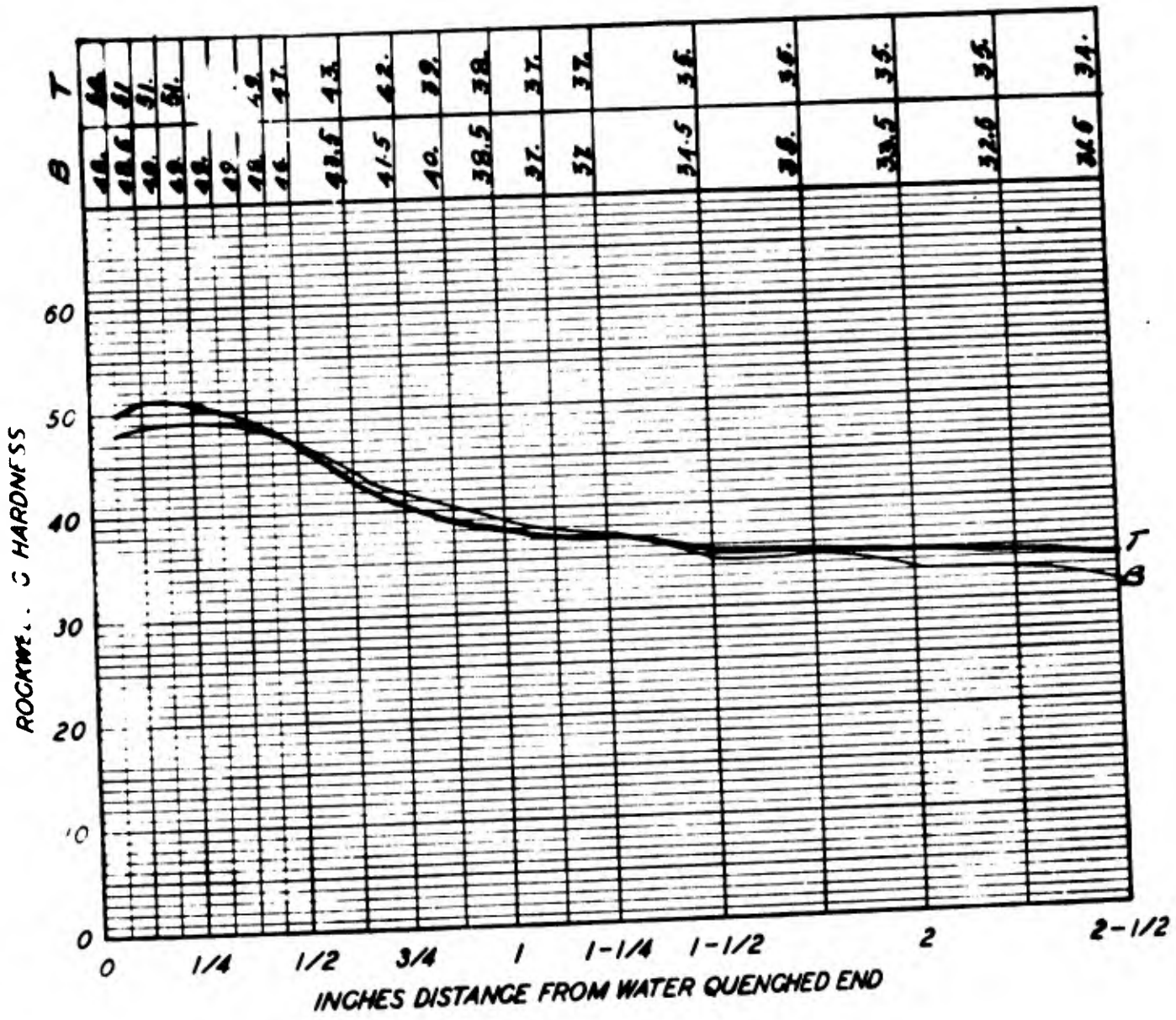
H670B

Fig. 2

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JOMINY HARDENABILITY

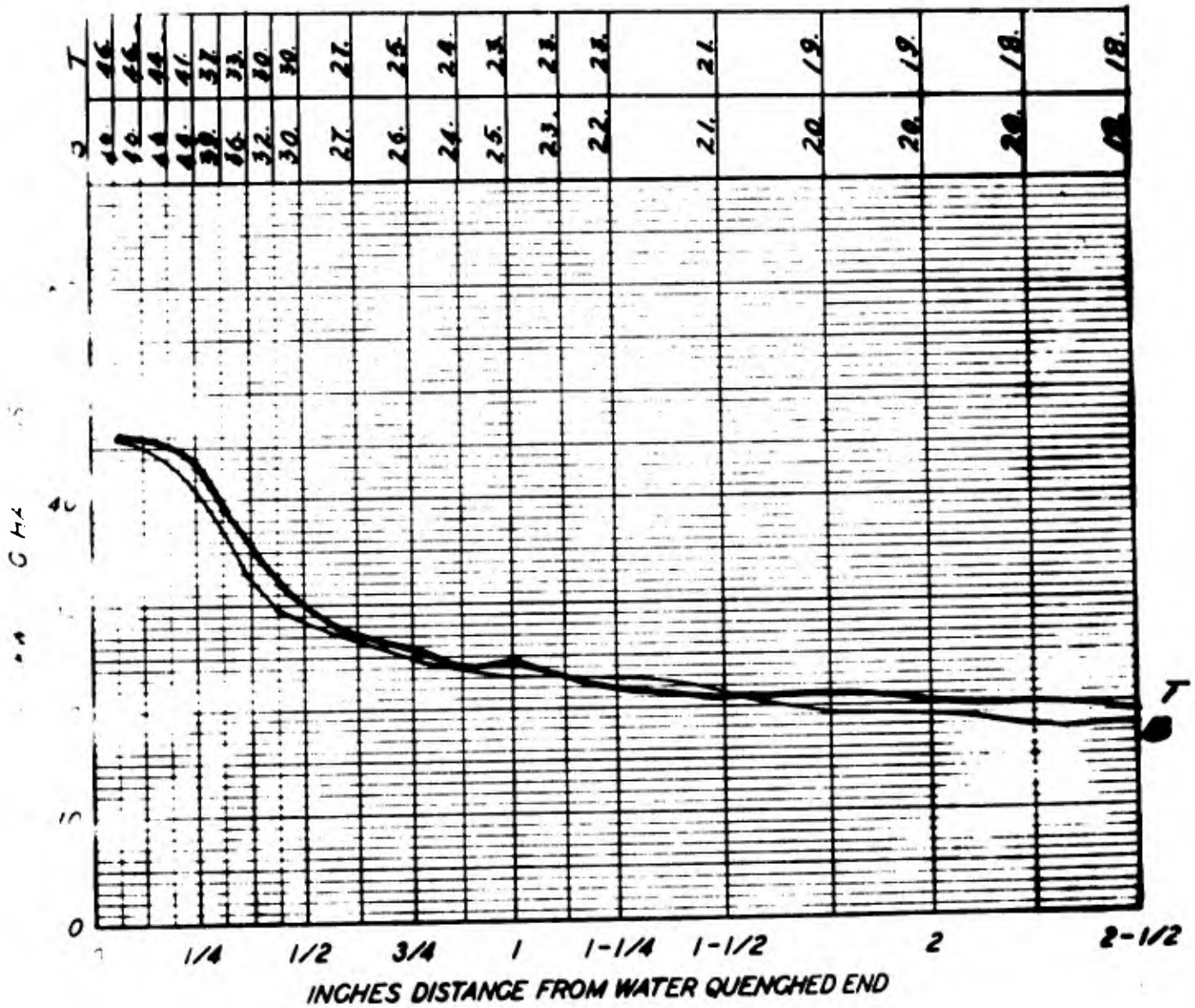
TYPE	HEAT	SAMPLE	CHEMICAL ANALYSIS								QUENCH TEMP.	
			C	Mn	P	S	Si	Cr	Ni	Mo		V
H640			.29	.46			.175	.112		.65	.19	1575°F



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JOMINY HARDENABILITY

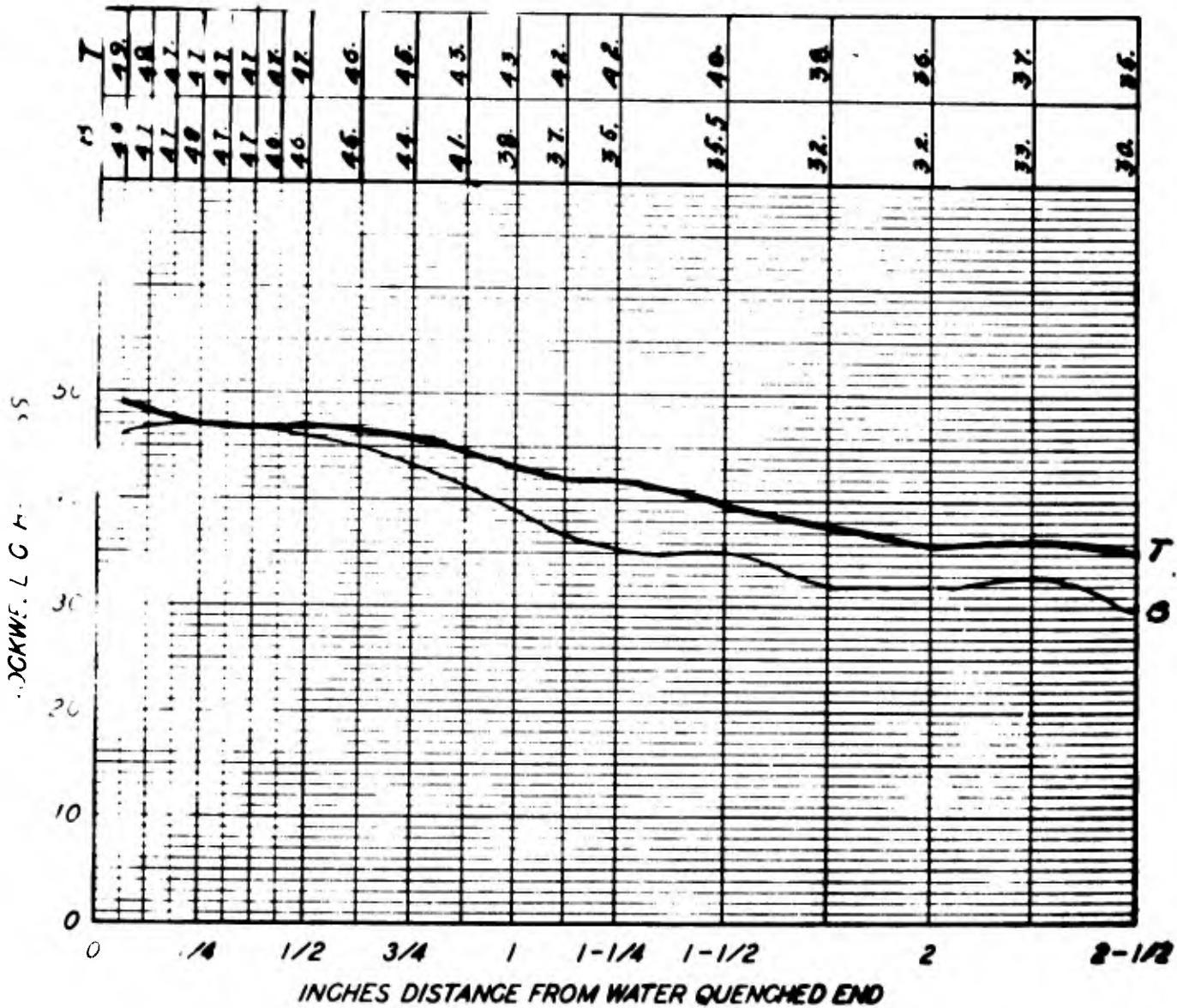
HEAT	SAMPLE	CHEMICAL ANALYSIS								QUENCH TEMP.
		C	Mn	P	S	Si	Cr	Ni	Mo	
H668		.23	1.33			.34			.49	1575°F



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JOMINY HARDENABILITY

HEAT	SAMPLE	CHEMICAL ANALYSIS								QUENCH TEMP.
		C	Mn	P	S	Si	Cr	Ni	Mo	
H669		.26	.59			.23	1.05	1.54	.51	1575°F



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JOMINY HARDENABILITY

TYPE	HEAT	SAMPLE	CHEMICAL ANALYSIS							QUENCH TEMP.	
			C	Mn	P	S	Si	Cr	Ni		Mo
	H670		.24	.57			.23	.51	.37	.37	1575°F

