Watertown Arsenal Laboratory
Report Number WAL 710/414
Problem No. B-52

6 October 1943

ARMOR

Metallurgical Examination of Cast Turret No. 757 for M4 Tank, Manufactured by Union Steel Castings Co., Ballistically Tested at Subzero Temperatures at Camp Shilo, Canada.

OBJECT

To correlate the subzero temperature ballistic properties of the turret with the metallurgical characteristics of the steel.

CONCLUSIONS

1. The unsatisfactory low temperature ballistic properties of the subject turret are traceable to improper heat treatment which resulted in very poor impact strength at reduced temperatures.

2. The casting is of relatively poor quality, containing large amounts of fine macroscopic and microscopic shrinkage distributed throughout the cross-section.

3. Ballistic failure is not attributable to the poor steel quality. Reheat treatment is capable of producing physical properties believed adequate to withstand low temperature ballistic shock tests.

A. HURLICH,
Associate Metallurgist.

APPROVED:

H. H. ZORNIG,
Colonel, Ord. Dept.,
Director of Laboratory.

INTRODUCTION

As a result of subzero temperature ballistic tests conducted by the Ordnance Department at its Winter Detachment, Ordnance Proving Center, facilities at Camp Shilo, Manitoba, Canada, it was decided to initiate metallurgical investigations in an attempt to correlate the low temperature ballistic properties with the metallurgical characteristics of the armor.

This report covers the metallurgical examination of a cast tank turret, serial number 757, produced by the Union Steel Castings Co. on 12 May 1942. A complete M4 tank, manufactured by the Pressed Steel Car Manufacturing Company in which the subject turret was incorporated, was subjected to ballistic tests during the period of 1-25 February 1943. The temperature of the armor ranged from $-15^\circ F$ to $-20^\circ F$ (-25° to $-30^\circ C$) during the time the ballistic tests were conducted.

Detailed results of the ballistic tests are incorporated in Aberdeen Proving Ground Report AD-2174, "First Partial Report on Ballistic Test of M4 Tank (Pressed Steel Car Manufacturing Company) at Subzero Temperatures". Data covering the ballistic testing of the turret, abstracted from the preceding report, is contained in Appendix A.

The turret proved unsatisfactory in resistance to shock at subzero temperatures (by acceptance specification test AXS-492-2 and by simulated combat impacts); cracking and back spalling excessively.

MATERIALS AND TEST PROCEDURE

After the test firing, the tank was disassembled and the turret casting forwarded to this arsenal. The casting was radiographed and photographed with the cracks resulting from the ballistic testing and the radiographic areas marked off with chalk. Four sections, approximately 12"x18" in size, were flame-cut from various portions of the casting and subjected to metallurgical examination, which included:

a. Chemical analysis.

b. Hardenability determination.

c. Physical tests.
   Hardness Surveys.
   Tensile tests
   V-notch Charpy impact tests.

d. Reheat-treatment to improve the physical properties.

e. Examination of macroetched sections.

f. Microscopic examination in the as-received and reheat-treated conditions.

g. Dilatometric analysis.

The four sections cut from the turret consisted of area M1, from the right side which cracked under the impact of a 75 MM T21 proof projectile; area M2, from the back of the turret from which a punching was driven under impact of a 75 MM M61 APC projectile at 45° obliquity; area M3, from the left side of the turret which received a partial penetration of a 75 MM M61 APC projectile at 25° obliquity; and area M4, from the front of the turret which cracked under the impact of a 75 MM M61 APC projectile at 45° obliquity, see Figures 1, 2, and 3.

The thicknesses of the four sections were as follows:

Section	Minimum Thickness-in.	Maximum Thickness-in.	Average Thickness-in.
M1	1.80	2.00	1.95
M2	2.15	2.20	2.18
M3	2.20	2.50	2.25
M4	1.35	3.05	--

DATA AND DISCUSSION

1. Chemical Analysis

The chemical analysis of the subject turret as determined at this arsenal is:

C	Mn	Si	S	P	Ni	Cr	Mo	Al	Cu
.28	.94	.25	.028	.031	2.50	.97	.45	.011	.05

According to the basic correspondence contained in Appendix D, turret number 757 was manufactured by the Union Steel Castings Co. on 21 May 1942. It was at that time that the transition from the high alloy to the present low alloy armor compositions occurred. The subject casting was among the last of the high alloy armor components produced.

2. Ballistic Tests

Detailed results of the ballistic tests, abstracted from A.P.G. Report AD-2174, are contained in Appendix A. Briefly, impacts of a 75 MM T21 proof projectile and 75 MM M61 APC projectiles cracked the casting excessively, and caused backspalls and a punching to be thrown off the back of the armor during test firing at temperatures of -15°F. to -20°F. (-25° to -30°C.). The turret was judged unsatisfactory in resistance to shock at subzero temperatures.

According to A.P.G. Report AD-2174 a similar impact of a 75 MM T21 proof projectile on a turret of acceptable armor at normal temperatures should cause no cracking whatsoever. Impacts of 75 MM M61 APC projectiles should cause small cracking at normal temperatures, but no punchings or backspalls.

3. Radiographic Examination

The locations of the areas radiographed, namely areas R1 to R21, are shown in Figures 1, 2, and 3. The detailed results of the radiographic examination are included in Appendix B. The soundness of the turret is generally satisfactory, with the exception of the upper left hand corner of area R13, see Figure 3, and areas R2 and R9 which contain extensive solidification shrinkage.

Area R2 presents an interesting spectacle. A 75 MM M61 APC projectile impacted the turret at high obliquity at a region containing scattered porosity. A partial penetration resulted with star cracks on the back of the armor. The cracks extended through the porous areas, but their paths were not influenced by the unsoundness, see Figure 4, which is a contact print made from the X-Ray negative.

4. Hardenability Determination

The hardenability was determined by end-quenching a standard Jominy bar according to the standard procedure after austenitizing for 2 hours at 1600°F. The hardenability curve shown in Figure 5 indicates that the steel possesses more than adequate hardenability to completely harden through upon quenching, since the maximum thickness of the casting is approximately 3" and the average thickness approximately 2".

5. Physical Properties

a. Hardness Surveys

Brinell hardness surveys were made across the thickness of strips cut from the four sections with the following results:

Section No.	Brinell Hardness
M1	235, 241, 235
M2	241, 235, 248
M3	248, 235, 235
M4	235, 241, 235

Hardness impressions made on the surfaces of the four sections show an average hardness of 241 Brinell.

b. Tensile Tests

One .505" tensile test bar was machined from each of sections M1 and M3. The tensile bars were taken from the region half way between the plate surface and the center of the section and parallel to the plate surface. The tensile results follow:

Section No.	Yield Strength 0.1% Set P.S.I.	Tensile Strength P.S.I.	% Elong.	% R.A.
M1	85,000	87,500	4.0	8.0
M3	96,000	117,500	10.0	19.1

The fractures of the tensile bars indicate the material to be unsound. Gas cavities and solidification shrinkage cover large amounts of the fractured surfaces. The erratic values of the tensile strength and the extremely poor ductility result from the excessive unsoundness.

c. V-notch Charpy Impact Tests

Six standard V-notch Charpy impact test specimens were machined from each of sections M1 and M3 with each specimen taken from half way between the casting surface and the midsection, and notched on the surface closest to the surface of the casting. Two of the impact specimens of each section were tested at a temperature of +20°C (+68°F), two of each at -10°C (+14°F) and two at -40°C (-40°F).

The results of the individual tests and a description of the resulting fractures are contained in Appendix C, and curves of impact strength vs. temperature are shown in Figure 6. The room temperature impact strength of the turret steel (10-20 ft.lbs.) is at least 40 ft. lbs lower than that usually possessed by sound, well heat-treated cast armor steels at a hardness of 240 Brinell. The impact strength at the temperature level at which the ballistic testing was conducted, namely -15° to -25°F (-25° to -30°C), is 7-10 ft.lbs. The poor resistance of the turret to shock at subzero temperatures is readily understandable in view of its very poor impact strength at those temperatures.

Poor impact properties and fractures such as possessed by the subject turret are indicative of poor heat treatment resulting in incomplete quench hardening and the formation of high temperature transformation products.[1]

d. Fracture Tests

Specimens 2" x 10" x thickness were cut from each of sections M1, M3, and M4, notched in the middle, and broken by impact blows of a steam forge hammer. The fractures of all three pieces were completely crystalline, indicating extremely unsatisfactory quench hardening.[1]

6. Reheat-treatment

A 2" x 12" x 3/4" piece of section M1 was reheat-treated to a tempered martensitic microstructure as follows:

Temperature	Time at Temp.	Coolant	BHN
1600°F	2 hrs.	Water	495
1175°F	2 hrs.	air	321
1250°F	2 hrs.	air	262
1275°F	2 hrs.	air	241

The purpose of the retempering cycles was to produce the same hardness after the final temper that the steel originally possessed. A .505" tensile test bar, six (6) V-notch Charpy impact specimens, and a fracture test specimen were machined from the reheat-treated section.

The tensile properties of the reheat-treated piece of section M1 are as follows:

Yield Strength 0.1% Set P.S.I.	Tensile Strength P.S.I.	% Elong.	% R.A.
84,000	89,500	4.0	10.5

The fracture of the tensile bar showed the presence of scattered shrinkage porosity which is undoubtedly responsible for the poor ductility. Reheat-treatment to a tempered martensitic microstructure caused no improvement in tensile properties over

1. "Armor, Development of a Fracture Test to Indicate the Degree of Quench Hardening of Armor Steels Upon Quenching" Watertown Arsenal Laboratory Report No. 710/532, A. Hurlich.

the as-received condition.

Considerable improvement was however, effected in the impact strength, see Figure 6 and Appendix C. The room temperature V-notch Charpy impact strength was raised from 10-20 ft.lbs. to approximately 35 ft.lbs. at the same hardness. After reheat-treatment, the impact strength remains relatively constant down to a temperature of -40°C (-40°F).

The fractured surfaces of several of the Charpy bars exhibited fine shrinkage porosity. Sound, well heat-treated cast armor has an average V-notch Charpy impact strength of approximately 60 ft.lbs. at a hardness of 240 Brinell. The fact that the subject turret steel, heat treated to possess a microstructure of tempered martensite, has an impact strength of only 35 ft.lbs. indicates poor steel quality with respect to micro shrinkage. The presence of large amounts of fine shrinkage scattered throughout the tensile and impact test specimens was also confirmed in the macroetched sections and the specimens for microscopic examination. Macroscopic and microscopic porosity of this nature is responsible for poor ductility and lowered impact strength.

In spite of the fact that the steel is of relatively poor quality, if it had been properly heat treated to have an impact strength of 35 ft.lbs. over the temperature range of +20° to -40°C (+68°F to -40°F) it would undoubtedly have withstood the ballistic shock test at subzero temperatures.

A piece of the reheat-treated steel was notched and fractured. The fracture was completely fibrous, again exhibiting fine shrinkage.

7. <u>Macroscopic Examination</u>

Strips cut from sections M1, M2, M3, and M4 were macroetched in a hot 50% hydrochloric acid solution. The strips were cut so that the macroetched surfaces represent vertical sections of the turret casting. Photographs of etched sections M2, M3, and M4 are included in Figure 7.

Sections M1 and M3 have identical macrostructures. The metal is free of centerline shrinkage, but very fine interdendritic shrinkage is uniformly distributed throughout the sections. Section M2 represents the junction of the back and the sloping roof of the radio compartment, and the jagged end of the section is the area from which a punching was driven through the casting as a result of impact #3, see radiographic area R14, Figure 3. A repair weld with a ferritic electrode had been made in the sloping roof section. Porosity, incomplete fusion, and weld cracking occur at the root of the weld. Hot tears and centerline shrinkage occur at the region of the inside curvature.

Section M4 contains the ballistic crack which opened up between the impacts of rounds #5 and #6. Incompletely fused chaplets or tie-rods are located near the gun mount opening in the front of the turret. The thick section of area M4 contains center-line shrinkage, while hot tears and fine shrinkage exist in the thinner section.

8. Microscopic Examination

Specimens for microscopic examination were cut from sections M1, M3, and the reheat-treated piece of section M1.

The microstructure of the turret in the as-received condition evidences extremely poor heat treatment. The microstructure contains large amounts of ferrite rejected in a coarse Widmanstatten pattern in the middle of the cross-section, with less rejected ferrite in the two outer thirds of the section, see Figures 8A,B, and C. The steel is moderately dirty, with a tendency for the globular nonmetallics to be segregated at grain boundaries, Figure 8D.

The reheat-treated piece of section M1 has a microstructure of tempered martensite free from high temperature transformation products, Figure 8E and F.

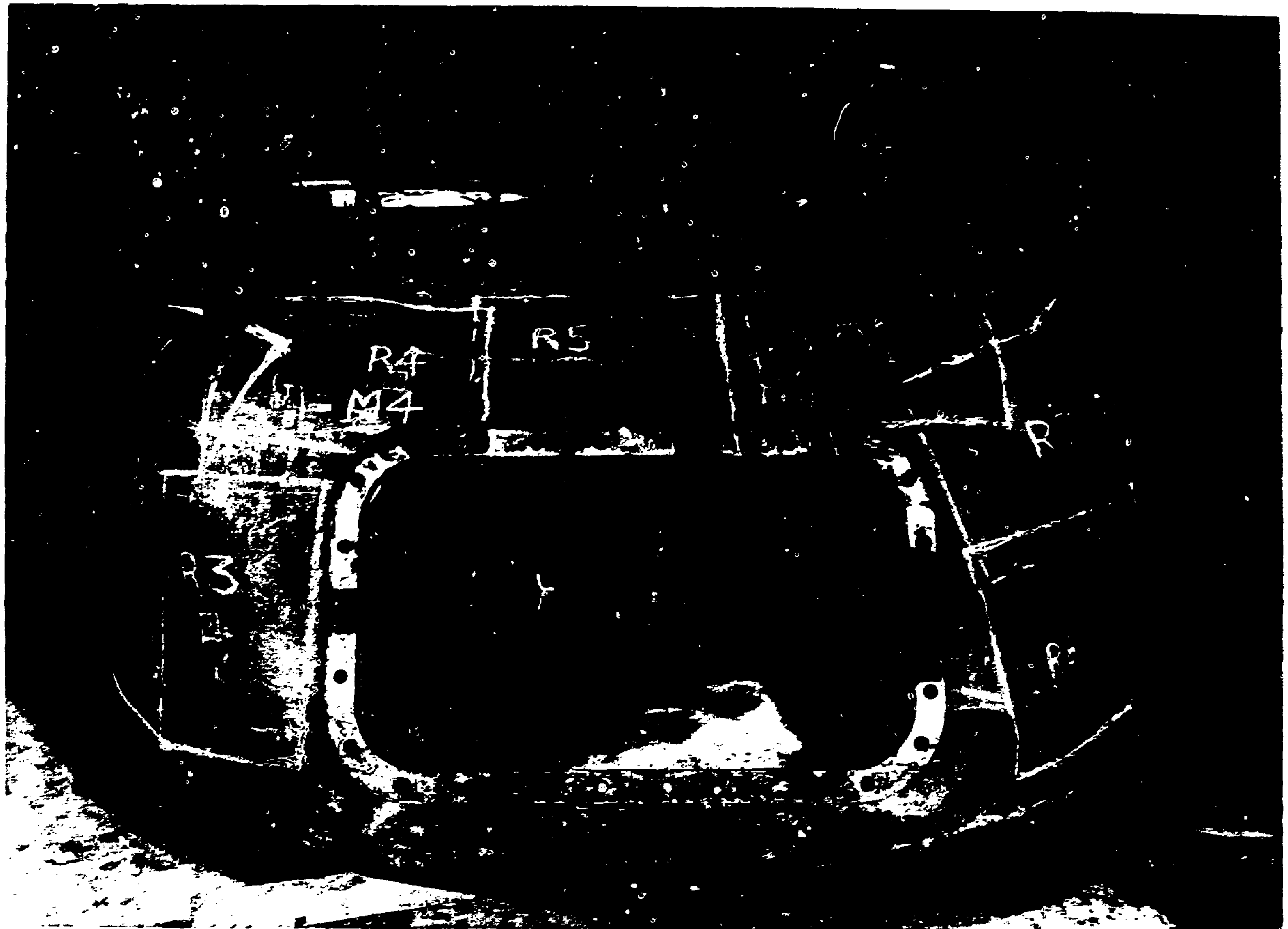
All of the microspecimens exhibited fine interdendritic shrinkage scattered throughout the cross-section. Shrinkage of this nature may result from a cold pour causing rapid solidification and the prevention of proper feeding of molten metal from the risers into the casting, and is too fine to be revealed by radiography.

Dilatometric analysis of a specimen machined from section M1 revealed the Ac_1 Temperature to be 1380°F (750°C) and the Ac_3, 1435°F (780°C). Examination of the C.A.S. 2 forms indicate that the Union Steel Castings Co. heated their castings of the same alloy content as the subject turret to 1475°F for hardening. In consideration of the chromium content of the steel, it is believed that 1475°F is too low an austentizing temperature to obtain complete carbide solution. In addition, since the quenching temperature is but 40°F higher than the Ac_3 point, slight variations in the furnace temperature may easily result in incomplete formation of austenite prior to quenching. In view of the excellent hardenability of the steel, the fact that the microstructure contains large amounts of rejected ferrite and carbides indicates that transformation to these high temperature transition products must have been essentially complete before the casting was quenched. It is believed that a hardening temperature of at least 1600°F should have been employed for turret castings of this composition.

SUMMARY

It is believed that the poor low temperature ballistic properties of the subject turret resulted primarily from the poor impact properties of the metal caused by unsatisfactory heat treatment. The turret was incompletely quench hardened and the steel consequently exhibited crystalline fractures and very low impact strength at reduced temperatures.

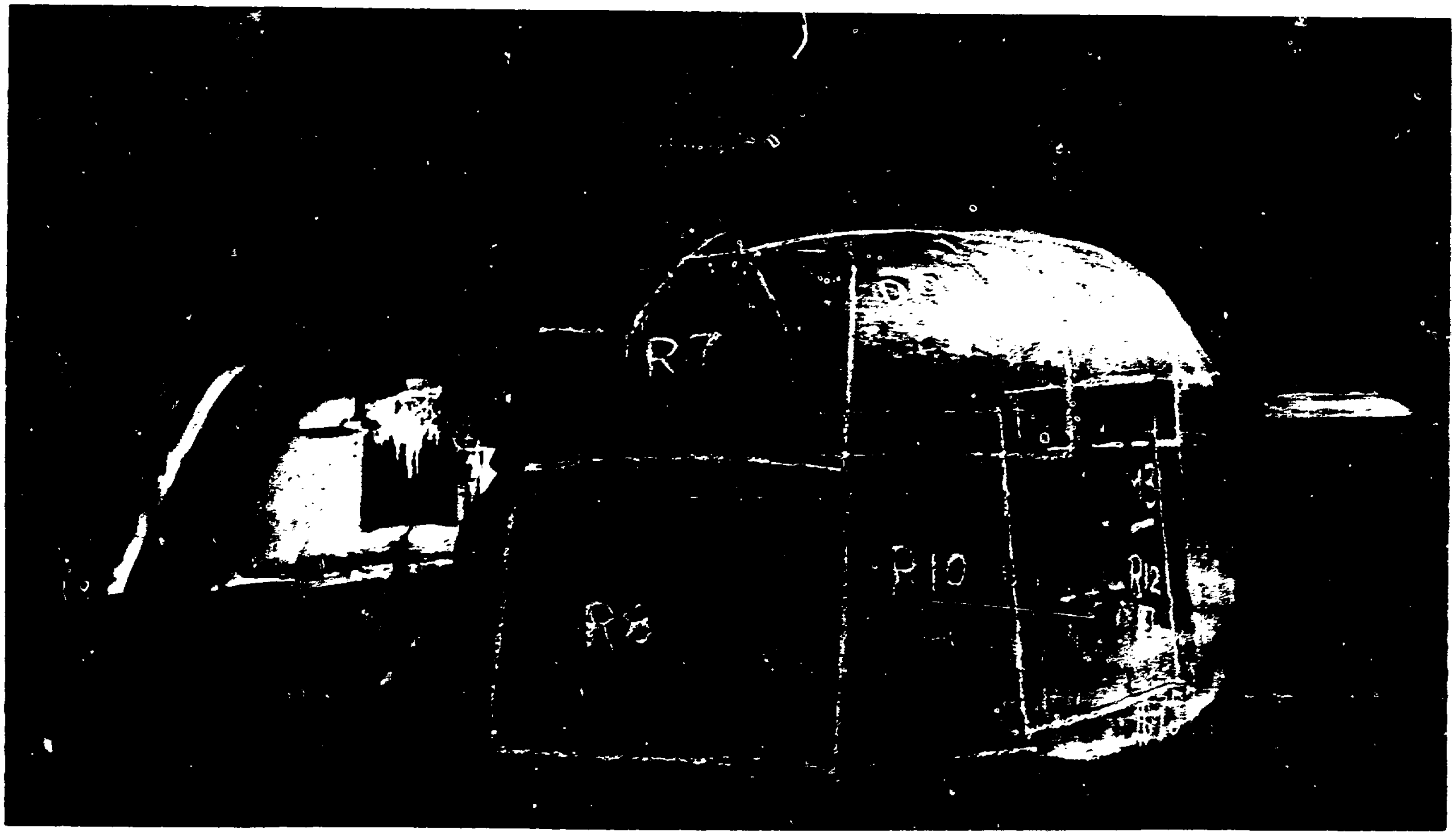
The steel quality was poor; fine macroscopic and microscopic shrinkage distributed throughout the cross-section caused low ductility and reduced impact strength even upon reheat-treatment to tempered martensite. It is believed, however, that properly heat treated, the metallurgical properties of the turret casting would have been adequate to successfully withstand the low temperature ballistic shock test.



WATERTOWN ARSENAL

VIEW OF M4 TURRET MFG BY UNION STEEL CASTINGS CO. TESTED AT CAMP SHILO, CANADA, SHOWING AREAS RADIOGRAPHED AND SELECTED FOR METALLURGICAL EXAMINATION
WTN.710-2093

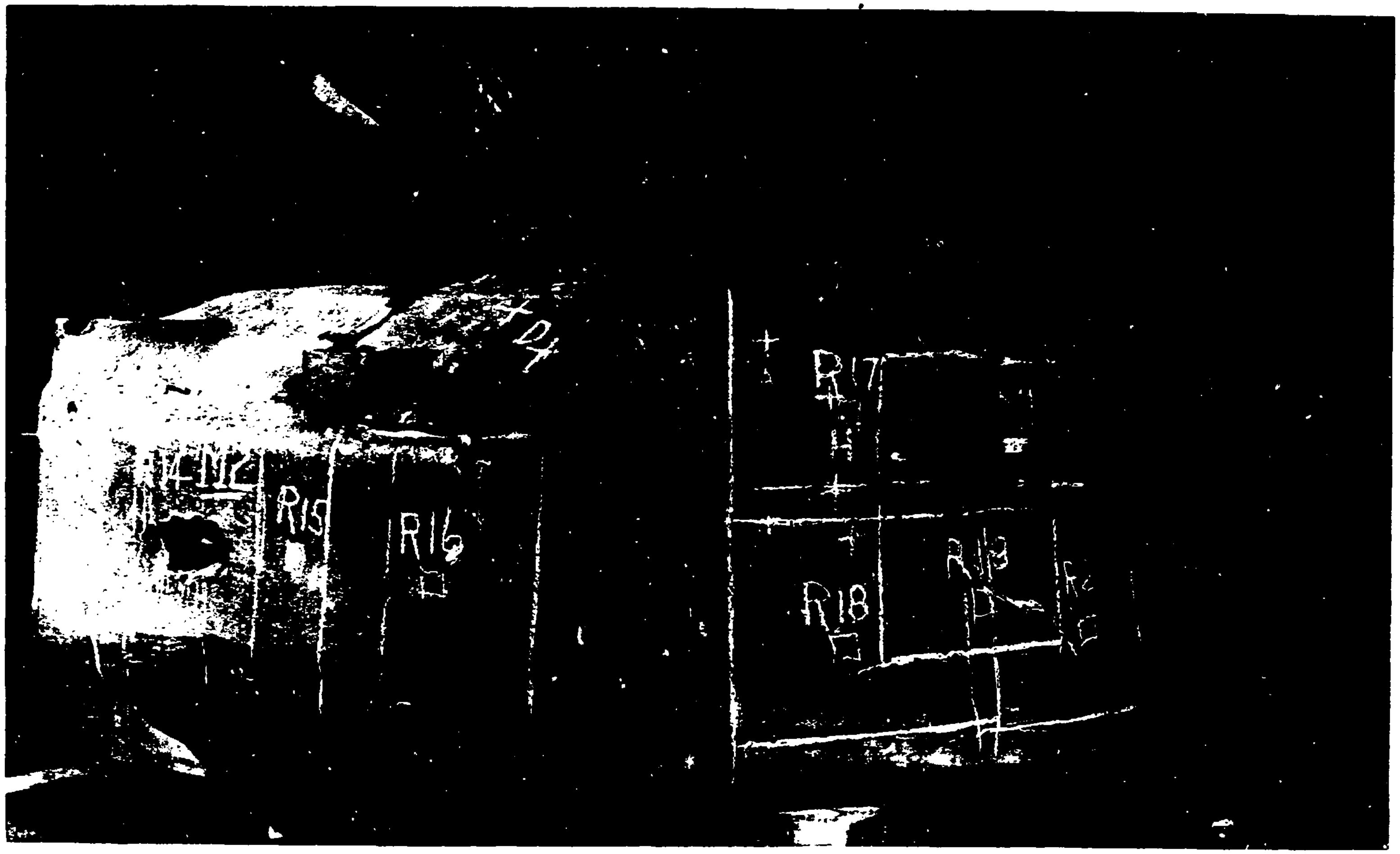
FIGURE 1



WATERTOWN ARSENAL

VIEW OF M4 TURRET MFG BY UNION STEEL CASTINGS CO. TESTED AT CAMP SHILO, CANADA, SHOWING AREAS RADIOGRAPHED AND SELECTED FOR METALLURGICAL EXAMINATION
WTN.710-2092

FIGURE [illegible]



WATERTOWN ARSENAL

VIEW OF M4 TURRET MFG BY UNION STEEL CASTINGS CO. TESTED AT CAMP SHILO, CANADA, SHOWING AREAS RADIOGRAPHED AND SELECTED FOR METALLURGICAL EXAMINATION
WTN.71 –[illegible]

FIGURE

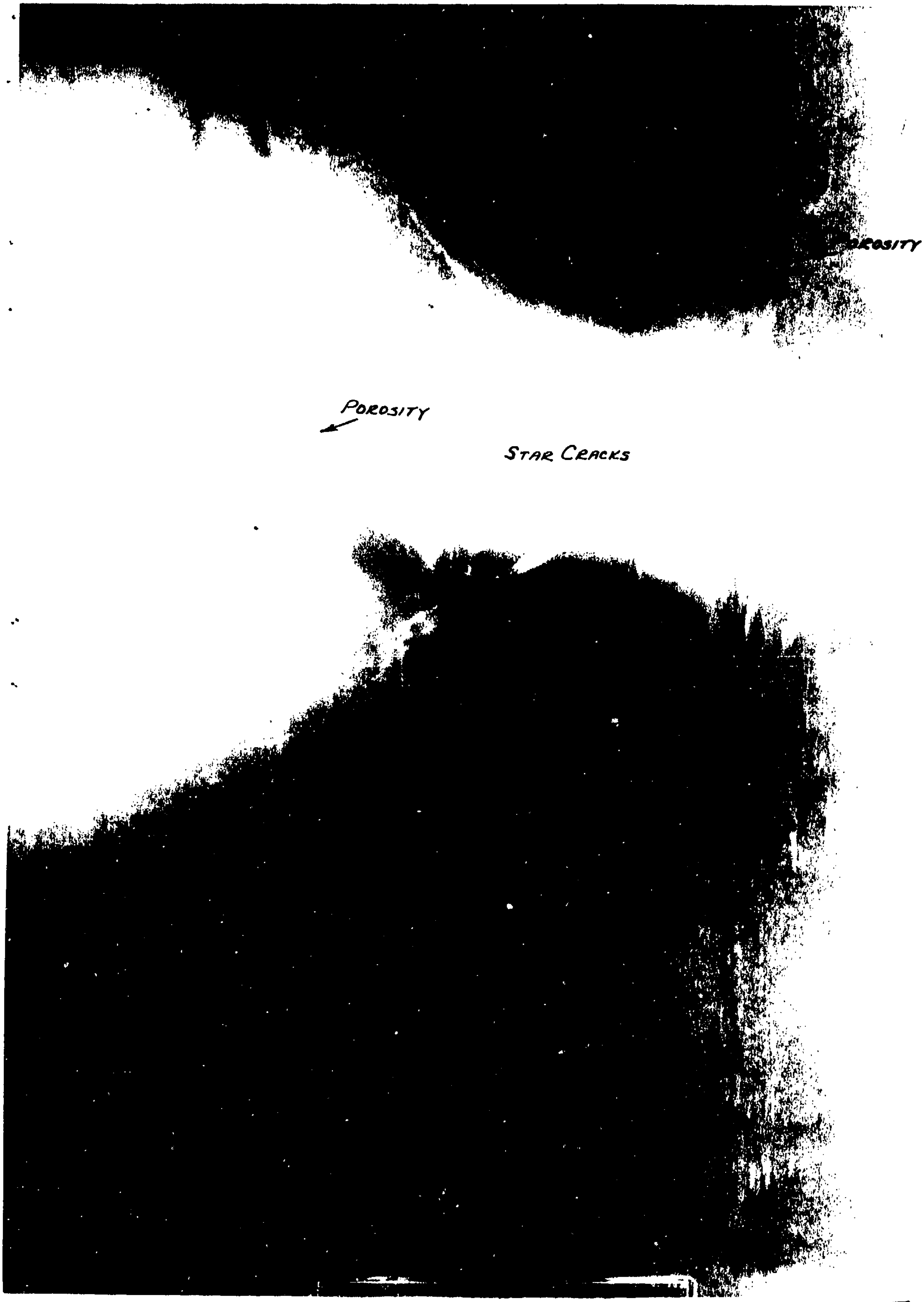


FIGURE [illegible]

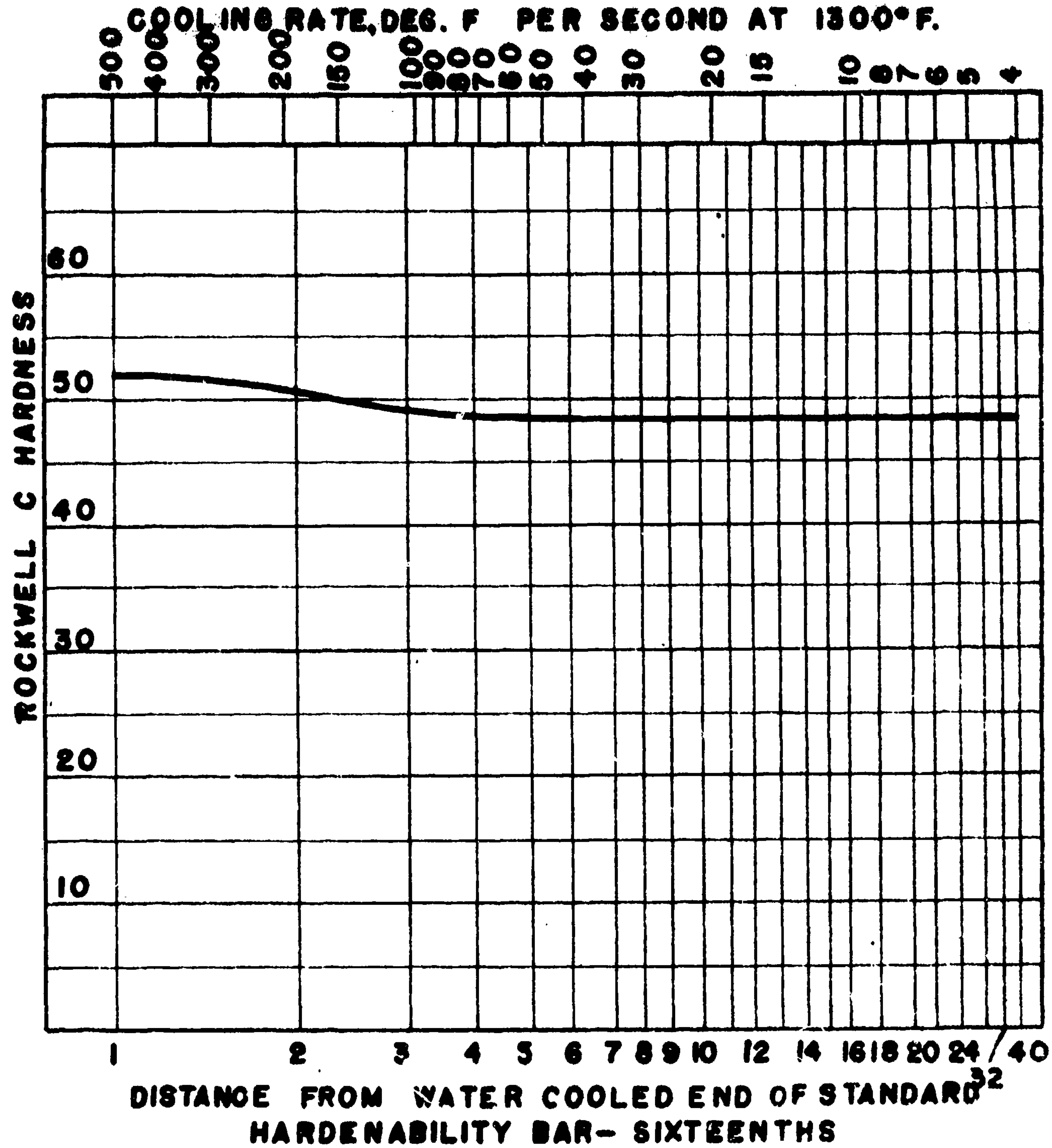


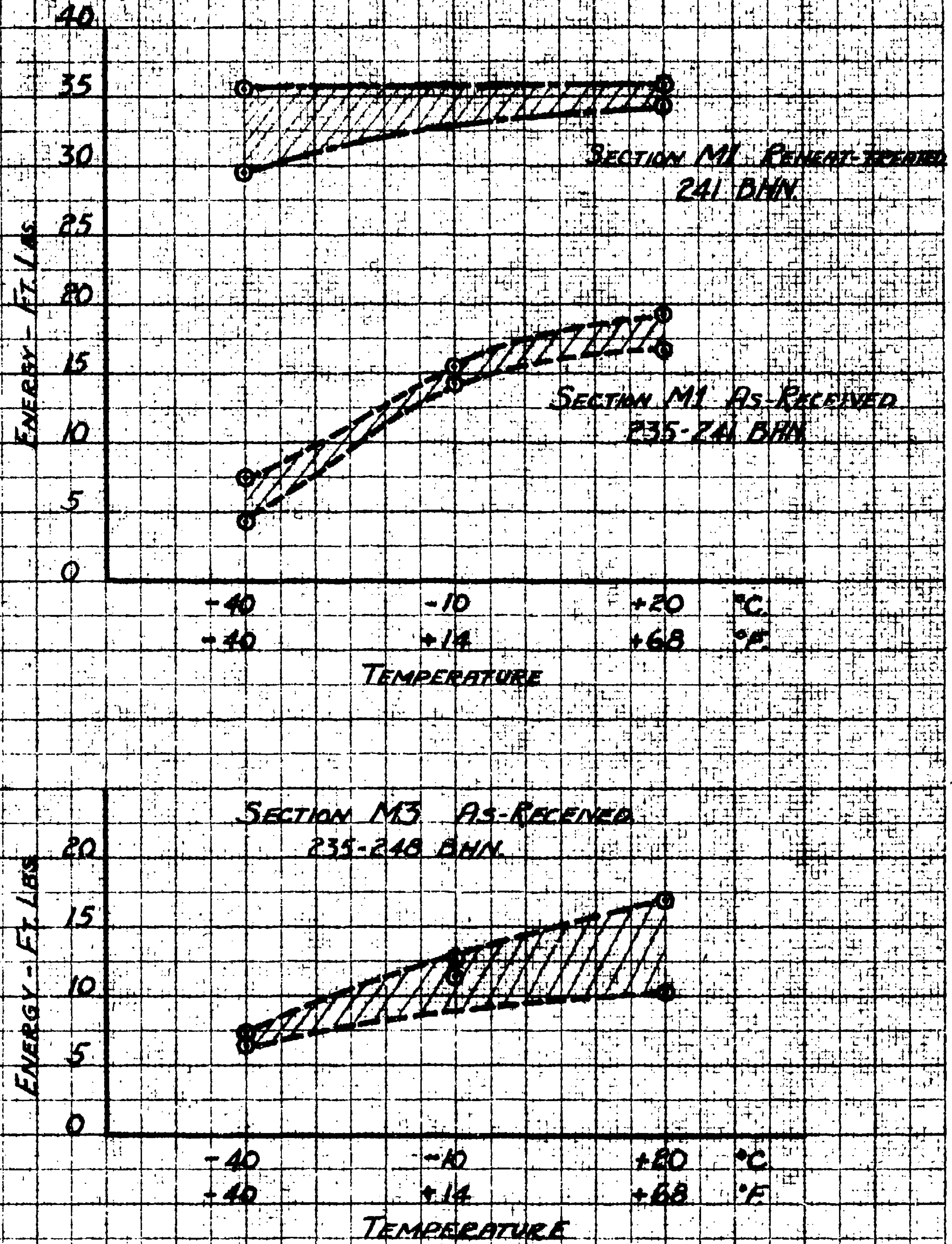
PLATE NO.	HEAT NO.	C	MN	SI	S	P	NI	CR	MO	CU	AL	QUENCH TEMP. °F	QUENCH TIME HRS.	G.S.
M3		.28	.94	.25	.028	.031	2.50	.97	.45	.05	.011	1600	2	

UNION STEEL CASTINGS CO. TURRET NO. 757.

JOMINY HARDENABILITY CURVE.

A.H. 9/17/43

FIGURE 5



UNION STEEL CASTINGS CO. TURRET NO. 757.
V-NOTCH CHARPY IMPACT VS. TEMPERATURE

FIGURE 6

MACROETCHED SECTIONS OF M4 TURRET MFG BY UNION STEEL CASTINGS CO.
WTN.710-2138

FIGURE 7

[illegible] 757 Nital-Picral Etch

-A- X200

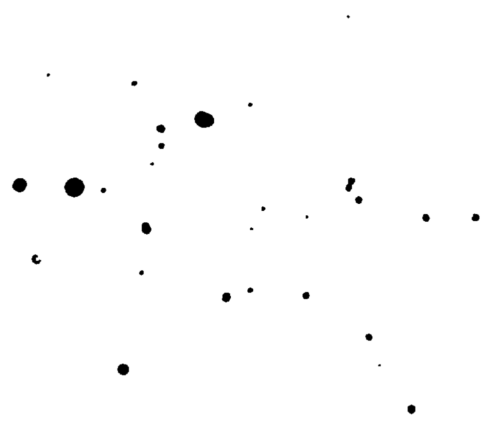
Section M1. As received. Dendritic segregation and rejected ferrite in dendrite axes.

-B- X1000

Section M1. As received. Outer third of section. Incompletely quench hardened. Rejected ferrite.

-C- X1000

Section M1. As received. Middle of section. Widmanstätten structure. Large amount of rejected ferrite.

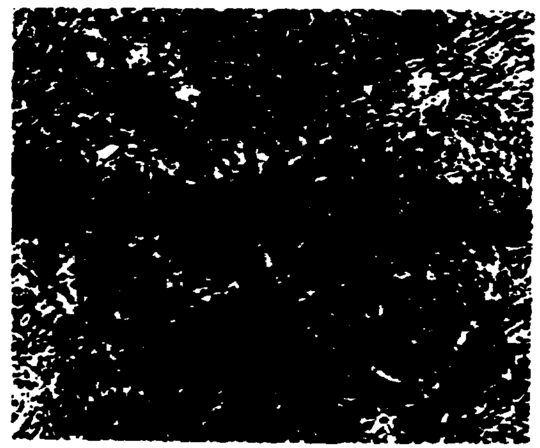


-D- X100

Section M1. As received. Globular inclusions occasionally [illegible] at grain boundaries.

-E- [illegible]

Section M1. Reheat-treated. Dendritic segregation. No rejected ferrite.



-F- [illegible]

Section M1. Reheat-treated. Tempered martensite throughout section.

FIGURE 8

APPENDIX A

Ballistic Test Data Abstracted From

Aberdeen Proving Ground Report AD-2174

"First Partial Report on Ballistic Test of M4 Tank

(Pressed Steel Car Manufacturing Company)

at Subzero Temperatures".

The turret was tested for resistance to shock with various projectiles with the following results:

75 MM Proof Projectile T21

Round #1. Striking velocity 1366 ft/sec. Temperature of armor (-15°F)
Thickness at impact - 2.07". Temperature of projectile (+50°F)

The projectile impacted the right side of the turret 18" above the bottom edge. The casting cracked through the entire thickness of the armor, from the base to the top edge of the turret hatch opening, the crack being 37" long. An additional 10" crack developed through the impact and a 20" crack 10" from the impact. Star cracking developed on the inside of the turret and a punching started, no fragment being thrown into the interior of the turret. (Radiographic area R19, Figure 2).

75 MM APC M61 - 40° Obliquity

Round #2. Striking velocity 1575 ft/sec. Temperature of armor (-15°F)
Thickness at impact - 2.0". Temperature of projectile (+50°F)

The projectile impacted the left front of the turret 13" from the bottom edge. Partial penetration with two 6" cracks originating at the impact. Punching started on inside of turret with 4", 3", 4" cracks. (Radiographic area R8, Figure 1).

75 MM APC M61 - 45° Obliquity

Round #3. Striking velocity 1728 ft.sec. Temperature of armor (-15°F)
Thickness at impact - 2.25". Temperature of projectile (+50°F)

The projectile struck the rear of the turret, 12" from the bottom edge of the casting. The projectile ricocheted but caused a punching in the armor 5" x 3" on the outside and 9" x 6" on the inside including back spall. 12" crack on outside of armor, 10" below point of impact. Fragment of armor thrown into the turret caused considerable damage to installations and dummy personnel. (Radiographic area R14, Figure 2).

75 MM APC M61 - 25° Obliquity

Round #4. Striking velocity 1039 ft/sec. Temperature of armor (-15°F)
Thickness at impact - 2.02". Temperature of projectile (+50°F)

The projectile struck the left side of the turret 12" above the bottom edge of the casting. Partial penetration. No cracks on the outside; on the inside there were cracks 4", 4", 4½" and 2" long, with incomplete backspall. (Radiographic area R12, Figure 3).

75 MM APC M61 - 45° Obliquity

Round #5. Striking velocity 1527 ft/sec. Temperature of armor (-20°F)
Temperature of projectile (+54°F)

The projectile struck the front of the turret 6" above the upper right edge of the casting and ricocheted, causing a 7" crack in the armor on the outside. On the inside of the turret there were cracks 9", 4", 4", 3" and 2" (star cracking). (Radiographic area R4, Figure 1).

Round #6. Striking velocity 1513 ft/sec. Temperature of armor (-20°F)
Temperature of projectile (+54°F)

The projectile struck the left front of the turret 4" above the top edge of the gun mount casting. The projectile hit the left lifting eye, displacing it and then ricocheted off the turret. Impact was 30" left of impact #5. Crack developed extending the entire distance between impacts #5 and #6. Further cracks 8" and 7" long developed on Round #5. On the inside of the turret 30" long crack developed between impacts #5 and #6. 3 cracks, 6", 5" and 3" (star cracking) on inside of impact #6. (Radiographic area R6, Figure 1).

APPENDIX B

Results of Radiographic Examination

of Turret No. 757.

X-Ray Test No. B-2941 Turret No. 757.

Locations of 21 areas radiographed, R1-R21, are shown in Figures 1, 2, and 3.

Results of Radiographic Examination

Area No.	Interpretation of Film Based Upon Specification AXS-476, Appendix 2, Revision 1.
1	O.K. Sound metal
2	Worse than 3D5, 4-1, 5-1, Cracks result from ballistic impact. Paths of star cracks not influenced by shrinkage, see Figure 4.
3	3C2
4	3D1, 1-2, 4-1, Cracks result from ballistic impact.
5	5-2, 3A2
6	3C2, 1-3, 4-1, Cracks result from ballistic impact.
7	Film missing.
8	3C3, 4-1 cracks result from ballistic impact.
9	Worse than 3C5.
10	3C4
11	1-3, 3C2, 4-1, cracks result from ballistic impact.
12	3A2, 4-1, incipient back spall, cracks result from ballistic impact.
13	Worse than 3D5.
14	3B3, 4-1, complete penetration of round #3
15	3A1, 1-3, 4-1.
16	Film missing.
17	3A2, Ballistic cracks in sound metal.
18	3A1
19	3A3, 1-1, 4-1, incipient back spall, 12" in diameter at impact #1. Star cracks result of ballistic impact. Side of casting cracked.
20	1-3, 3A2, 4-1 cracks result from ballistic impact.
21	1-1, 4-1, cracks result from ballistic impact.

APPENDIX C

CHARPY IMPACT DATA

V-Notch Charpy Impact Data

Specimen No.	Temp. °C	Temp. °F	Impact Ft.Lbs.	Fracture*	Specimen No.	Temp. °C	Temp. °F	Impact Ft.Lbs.	Fracture
As Rec'd					**As Rec'd**				
M1-1	+20	+68	16.8	C	M3-1	+20	+68	10.3	C
M1-2	+20	+68	19.3	C	M3-2	+20	+68	17.0	C
M1-3	-10	+14	14.4	C	M3-3	-10	+14	11.5	C
M1-4	-10	+14	15.5	C	M3-4	-10	+14	12.6	C
M1-5	-40	+40	7.4	C	M3-5	-40	-40	6.5	C
M1-6	-40	+40	4.3	C	M3-6	-40	-40	7.3	C
Reheat-treated									
M1-1R	+20	+68	35.8	F					
M1-2R	+20	+68	34.4	F					
M1-3R	-40	-40	35.6	Fc					
M1-4R	-40	-40	29.5	Fc					

* F - Fibrous Fc - Mostly Fibrous and slightly Crystalline

C - Crystalline

Rating adopted from "Correlation of Metallographic Structure and Hardness Limit in Armor Plate" C. H. Lorig, A.R. Elsea, P. C. Rosenthal, Battelle Memorial Institute, May 21, 1943.

APPENDIX D

CORRESPONDENCE

COPY

WAR DEPARTMENT

WATERTOWN ARSENAL

WATERTOWN 72, MASS.

20 August 1943

Wtn. 400.112/2783
Attention of
Laboratory(NAM)

Subject: Chemical Analysis of M4 Tank Turret Tested at Camp Shilo, Reference A.P.G. Report AD-2174.

To: Chief, Tank-Automotive Center
Fisher Building
Detroit 2, Michigan

Attn: Armor & Welding Unit

1. Chemical analysis has been completed on the subject turret and the result is as follows:

C	Mn	Si	S	P	Ni	Cr	Mo	Cu	Al
.28	.94	.25	.028	.031	2.50	.97	.45	.05	.011

This turret was marked with the number 757. It is unquestionably a turret produced by Union Steel Castings Company since this facility was the only one making turrets with a high nickel content.

2. Referring to firing records, Heat 606A of Union Steel Castings Company, tested at Erie Proving Ground on 29 and 30 April 1942, E.P.G. Firing Record No. 15772, had the following analysis:

C	Mn	Si	S	P	Ni	Cr	Mo
.27	.93	.25	.017	.031	2.50	.97	.49

It, therefore, appears that the turret may have come from this heat, or at least a heat produced by this facility during this approximate period.

For the Commanding Officer:

H. H. ZORNIG,
Colonel, Ord. Dept.,
Assistant.

COPY

TAC 470.4/226
Attn: SPOME-E-22.1
Wtn. 400.112/2783 1st Ind. Kahl/el
Ext.396

Engineering-Manufacturing Branch, Tank-Automotive Center, Fisher Building, Detroit (2), Michigan, 7 September 1943.

To: Commanding Officer, Watertown Arsenal, Watertown (72), Mass.
Attn: Major Matthews

1. With reference to paragraph 1 of basic communication, tank turret serial number 757 was cast at Union Steel Castings Co. on 21 May 1942. Chemical analysis as supplied by Union Steel Castings Co. follows:

C	.29	M	.92	P	.031	S	.015
Si	.20	Ni	2.44	Cr	1.00	Mo	.50

2. This turret was 1 of 4 shipped to Murray Corporation of American on 11 June 1942, on their purchase order No. 113X287. This turret was received by Pressed Steel Car Company against their purchase order dated 4 June 1941, No. 114X243 on 25 June 1942. Other turrets in this lot include serials 776 - 825 - 801. M4 welded tank U.S. serial 630, in which turret #757 was incorporated was shipped 29 November 1942 on government bill of lading, WQ 7507564, shipping order #1147.

By order of the Chief of Ordnance:

J. V. COOMBE
Major, Ord. Dept.
Assistant.

UNCLASSIFIED

UNCLASSIFIED