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Laboratory May 23, 1933

Mr. H. F. Norton, Naval Architect.

SUBJECT: Physical Characteristics of Plates Removed from S.S. Charles Pratt, J.O. 1808-S.

Lab. Test #376.

Description:

23 plate sections 8" x 16" were removed from the shell of the S.S. Pratt by burning. These sections were forwarded to the Laboratory where they were sawed in half making two smaller sections 4" x 16". One 4" x 16" section of each plate was again sawed into a 16" x 2¼" and a 16" x 1⅝" plate.

The 16" x 2¼" sections from each of the 23 plates (except B-6-P and D-5-S added later by the American Bureau of Shipping) were shipped express May 5th to the Standard Shipping Company, c/o United Dry Docks, Mariner's Harbor, Staten Island, N. Y., to be tested by them.

Procedure:

The remaining sections of the plates were pickled and calipered for maximum and minimum thickness to determine the extent of corrosion. They were then planed to a thickness that just removed the corroded surfaces.

Each plate was then machined into two tensiles and a bend test.

One set of tensile specimens from each plate was machined in the reduced section to 8" x 1½" or 1" x thickness, the other set due to its proximity to the burned edge of the plate was made 8" x 1¼" or 1" x thickness.

The bends were 1-1/8" x thickness.

The microscopic examination of the plate structure was made from unstrained sections taken from the bend specimens.

THICKNESS OF PLATES

Plate No.	Original	Present Max.	Present Min.	Present Average	Corrosion Loss Max.	Corrosion Loss %	Remarks
A-4-S	.72"	.631"	.474"	.552"	.246"	34.1"	Badly Pitted.
A-5-S	"	.666	.550	.608	.170	23.6	Uneven Corrosion - Low Spots.
A-7-S	"	.657	.488	.573	.232	32.2	Badly Corroded - High and Low Spots.
A-15-S	"	.647	.519	.583	.201	27.9	Uneven Corrosion - Low Spots.
B-6-P	"	.582	.390	.486	.330	45.8	Badly Corroded - High and Low Spots.
C-5-S	"	.553	.524	.539	.181	25.1	Badly Corroded - High and Low Spots.
C-6-S	"	.654	.509	.582	.211	29.3	Badly Pitted - High and Low Spots.
D-5-S	"	.639	.490	.565	.230	31.9	Badly Pitted - High and Low Spots - Worse than B-6-P.
E-13-S	"	.687	.531	.604	.189	26.3	Badly Pitted - High and Low Spots.
F-3-S	"	.702	.597	.650	.123	17.1	Uneven Corrosion - One High Spot - Large and Small Pits.
F-5-S	"	.672	.534	.603	.186	25.8	Badly Pitted - High and Low Spots.
F-6-S	"	.687	.559	.623	.161	22.4	Badly Corroded - High and Low Spots.
G-4-S	"	.692	.680	.686	.040	5.55	Even Corrosion - Several Small Pits.
J-11-S	.68	.657	.653	.655	.027	3.97	Uniform Corrosion - Small Pits.
J-12-S	"	.645	.638	.642	.042	6.17	Even Corrosion - No Large Pits.
M-5-S	"	.658	.587	.622	.093	13.7	Even Corrosion - Low Spots.
N-4-S	1.10	1.081	1.077	1.079	.023	2.09	Uniform Corrosion - No Pits.
N-6-S	"	1.087	1.082	1.085	.018	1.63	Uniform Corrosion - No Pits.
N-8-S	"	1.089	1.086	1.088	.014	1.27	Uniform Corrosion - No Pits.
N-21-S	"	1.110	1.108	1.109	0	0	Uniform Corrosion - No Pits.
O-6-S	1.2	1.184	1.182	1.183	.018	1.50	Uniform Corrosion - No Pits.
Deck Stringer 363 Frame	.78	.775	.774	.7745	.006	0.77	Uniform Corrosion - No Pits - Smooth Plate.
Longitud.19	.44	.433	.430	.432	.010	2.27	Even Corrosion - No Large Pits.

PHYSICAL CHARACTERISTICS

		Specimen				Physical Characteristics - Lbs. per Sq. In.							
Test #	Plate #	Length"	Width"	Thick-ness "	Area sq.in.	Lbs. Load	Y.P.	Av. Y.P.	T.S.	Av. T.S.	Elong.	Av. Elong.	Deg. Bend
30176	A-4-S	8"	1.5	.358	.537	32500	33100		60200		25.25		180
30177	A-4-S-1	"	1.25	.343	.429	25800	32100	32600	60000	60100	25.0	25.1	"
30178	A-5-S	"	1.5	.412	.618	37000	34200		59700		24.5		"
30179	A-5-S-1	"	1.25	.409	.511	30300	33100	33700	59400	59500	24.0	24.2	"
30180	A-7-S	"	1.5	.340	.510	29900	31600		58600		25.5		"
30181	A-7-S-1	"	1.25	.332	.415	24500	30200	30900	58300	58500	23.75	24.6	"
30182	A-15-S	"	1.5	.353	.530	32200	33000		60800		23.75		"
30183	A-15-S-1	"	1.25	.351	.439	26900	32700	32900	61100	61000	21.88	22.8	"
30221	B-6-P	"	1.5	.340	.510	31300	34100		61400		29.25		"
30222	B-6-P-1	"	1.5	.345	.517	31600	34800	34450	60800	61100	24.75	27.0	"
30184	C-5-S	"	1.5	.417	.625	41500	35400		65900		24.75		"
30185	C-5-S-1	"	1.25	.416	.520	34600	34600	35000	66500	66200	23.50	24.1	"
30186	C-6-S	"	1.5	.368	.552	36300	34360		66000		23.50		"
30187	C-6-S-1	"	1.25	.368	.460	29900	34800	34600	65000	65500	22.25	22.8	"
30223	D-5-S	"	1.5	.391	.586	37600	34200		63700		27.25		"
30224	D-5-S-1	"	1.5	.395	.592	37800	34400	34300	64100	63900	28.50	27.8	"
30188	E-13-S	"	1.5	.487	.731	45600	33400		62500		24.5		"
30189	E-13-S-1	"	1.25	.481	.601	37600	32300	32850	62700	62600	24.25	24.3	"
30190	F-3-S	"	1.5	.400	.600	38600	33300		64300		23.75		"
30191	F-3-S-1	"	1.25	.402	.502	32500	32200	32750	65000	64150	22.0	22.8	"
30192	F-5-S	"	1.5	.437	.655	42200	32580		63900		25.75		"
30193	F-5-S-1	"	1.0	.438	.438	28800	32500	32500	65500	64700	25.0	25.3	"
30194	F-6-S	"	1.5	.416	.624	40200	33900		64800		23.25		"
30195	F-6-S-1	"	1.5	.412	.618	40000	32300	33100	64500	64650	23.5	23.3	"
30196	G-4-S	"	1.5	.527	.790	46900	31000		59400		24.0		"
30197	G-4-S-1	"	1.25	.527	.659	39200	30500	30250	59400	59400	23.75	23.8	"
30198	J-11-S	"	1.5	.544	.816	51300	34800		62600		24.75		"
30199	J-11-S-1	"	1.25	.538	.672	42500	32800	33800	63400	63000	24.5	24.6	"
30200	J-12-S	"	1.5	.519	.778	45200	32800		57900		30.0		"
30201	J-12-S-1	"	1.25	.486	.607	37800	33900	33350	62000	59950	28.5	29.7	"
30202	M-5-S	"	1.5	.505	.757	45900	35800		60400		26.75		"
30203	M-5-S-1	"	1.25	.503	.628	38800	32700	34250	61600	61000	25.50	26.2	"
30204	N-4-S	"	1.0	.974	.974	59100	30400		60900		30.75		"
30205	N-4-S-1	"	1.0	.974	.974	60400	30000	30200	62300	61600	27.25	29.0	"

		Specimen				Physical Characteristics - Lbs. per Sq. In.							
Test #	Plate #	Length"	Width"	Thick-ness "	Area sq.in.	Lbs. Load	Y.P.	Av. Y.P.	T.S.	Av. T.S.	Elong.	Av. Elong	Deg. Bend
30206	N-6-S	8	1.0	.929	.929	53800	24800		57900		29.0		180
30207	N-6-S-1	"	1.0	.926	.926	53000	24700	24750	57000	57450	28.75	28.8	"
30208	N-8-S	"	1.0	.970	.970	60900	30000		61800		28.0		"
30209	N-8-S-1	"	1.0	.966	.966	60500	29800	29900	62400	62100	25.0	26.5	"
30210	N-21-S	"	1.0	.982	.982	58000	25600		59200		32.5		"
30211	N-21-S-1	"	1.0	.976	.976	57300	30000	27800	58500	58850	29.5	31.0	"
30212	O-6-S	"	1.0	1.098	1.098	62150	27000		56500		29.0		"
30213	O-6-S-1	"	1.0	1.116	1.116	64000	25900	26450	58200	57350	31.5	30.2	"
30214	Dk.Stringer Frame 363	"	1.5	.637	.955	57000	31800		59400		30.5		"
30215	Dk.Stringer Frame 363-1	"	1.5	.641	.961	57370	31500	31650	59800	59600	26.0	28.2	"
30216	Long. #19	"	1.5	.386	.579	32000	35300		55170		26.0		"
30217	Long. #19-1	"	1.25	.339	.423	26500	38800	37050	63100	59100	26.25	26.1	"

The Average, Max. and Min., Physicals of the 23 Plates Tested are as follows:

23 Plates	Y.P.	Ton	T.S.	Ton	Elong.	Bend
Average	32150	14.35	61360	24.4	25.0	180°
Max.	37050	16.6	66200	29.55	30.2	"
Min.	30200	13.5	57300	25.6	22.8	"

All fractures were silky, no crystallization was noted, most fractures tended toward cup type.

The bends under 3/4" thickness were made 180° around a pin whose diameter was twice the thickness of the plate.

Bends over 3/4" thick were bent 180° around a pin whose diameter was three times the plate thickness as per A. B. S. Rules.

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Five plates N-4-S, N-6-S, N-8-S, N-21-S and O-6-S show a yield point less than 50.0% of the tensile strength as required by the American Bureau of Shipping. The tensile strength with the exception of N-8-S is also less than 62,000 p.s.i. as required by the A. B. S. The elongation, however, is well above the minimum limit.

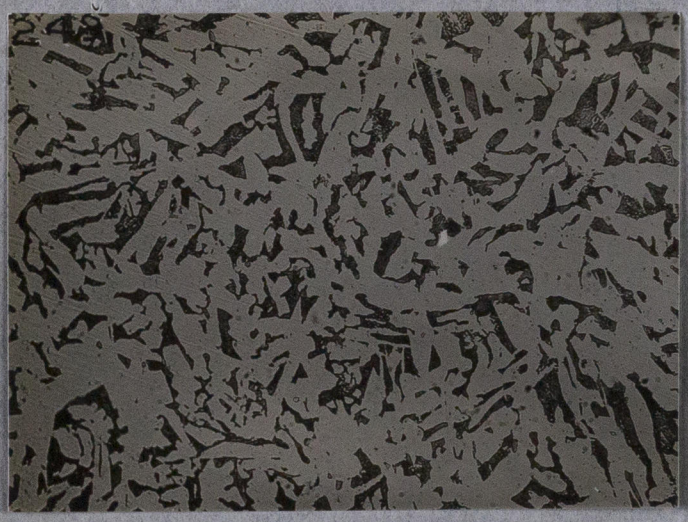
It should also be noted that the physicals of cracked plates B-6-P and D-5-S taken by the American Bureau of Shipping at locations adjoining the cracks of the respective plates also show good results.

Photomicrographs:

Sections approximately ½" x ½" were taken from the bend specimens before bending and examined microscopically. These sections at right angles to the direction of rolling were polished and examined before and after etching with a 5.0% solution of picric acid in alcohol. The unetched examination showed the steel to be normally clean with the usual small manganese sulfide particles and inclusions. The etched specimens all show the general pattern of mild steel with its ferrite and pearlite in a normal condition, no slip or strain lines were noted in any plate at a magnification of 500X. The etched photomicrographs were taken at a magnification of 100X in order that a larger field might be studied than would be the case with a magnification of 500X.

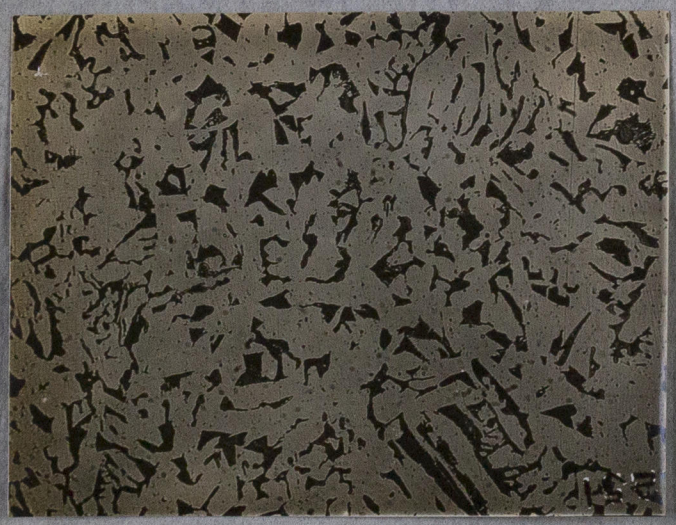
The photomicrographs of the various sections follow:

Microstructure of Plates Taken
at right angles to rolling
Magnification 100 Diameters

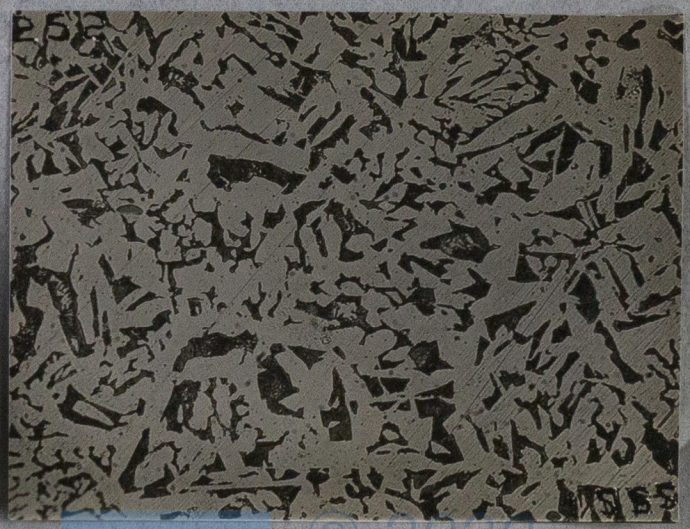


A-4-S

A-5-S



A-7-S



A-15-S

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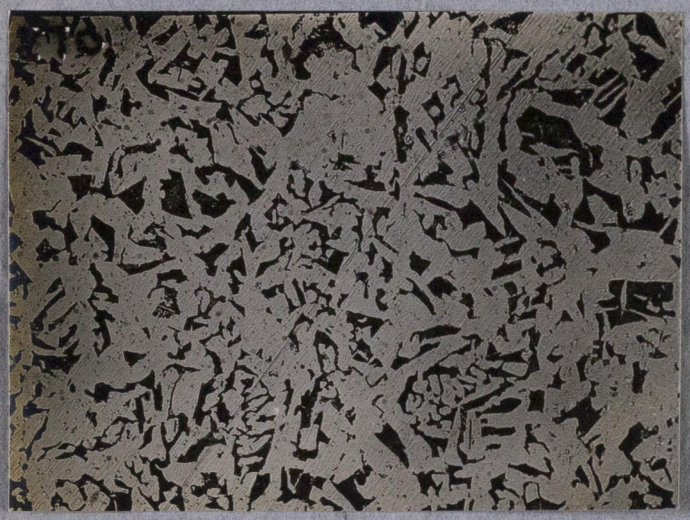
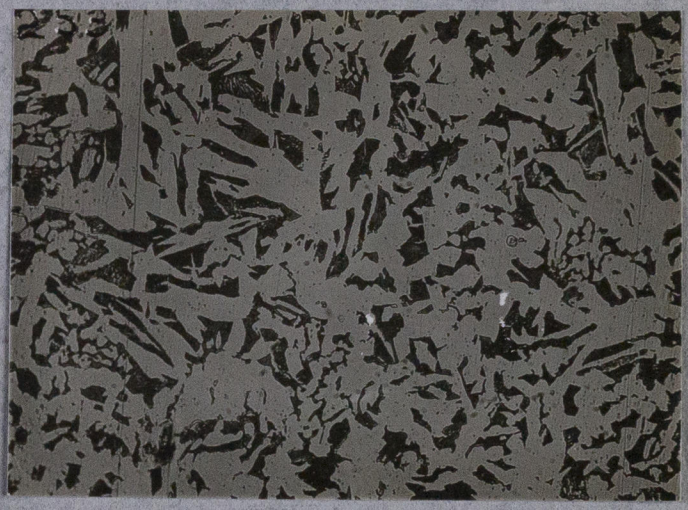
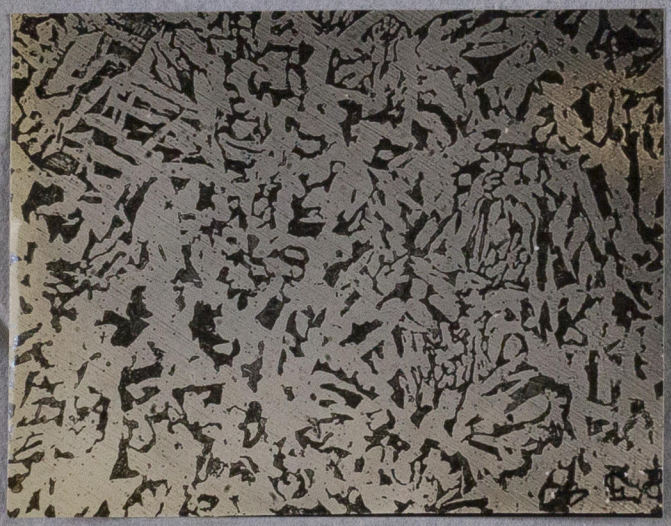
Microstructure of Plates Taken
at right angles to rolling
Magnification 100 Diameters



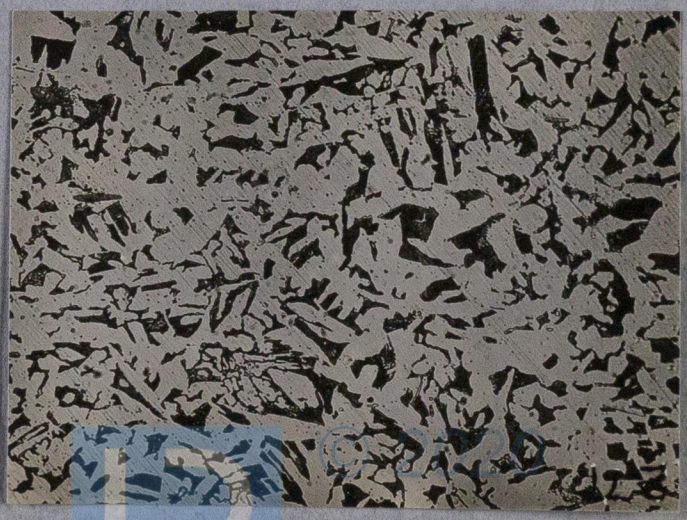
B-6-P



C-5-S



C-6-S



D-5-S

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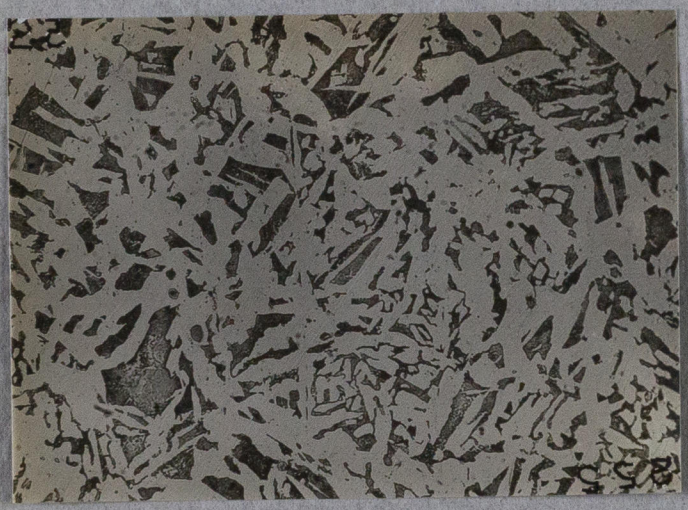
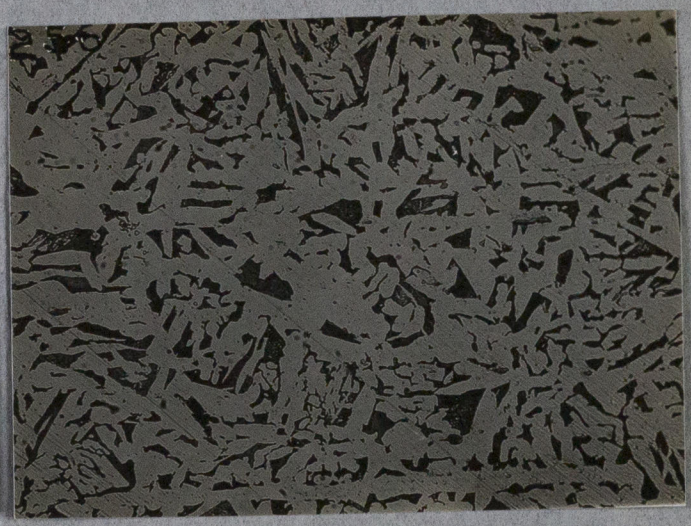
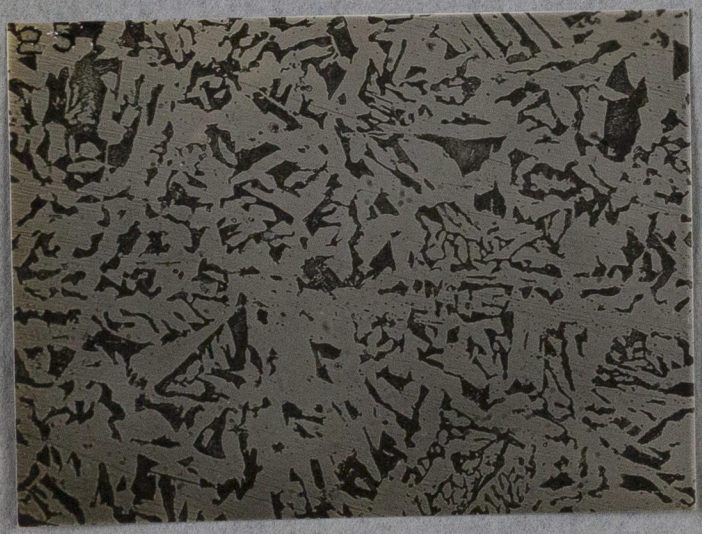
Microstructure of Plates Taken
at right angles to rolling
Magnification 100 Diameters



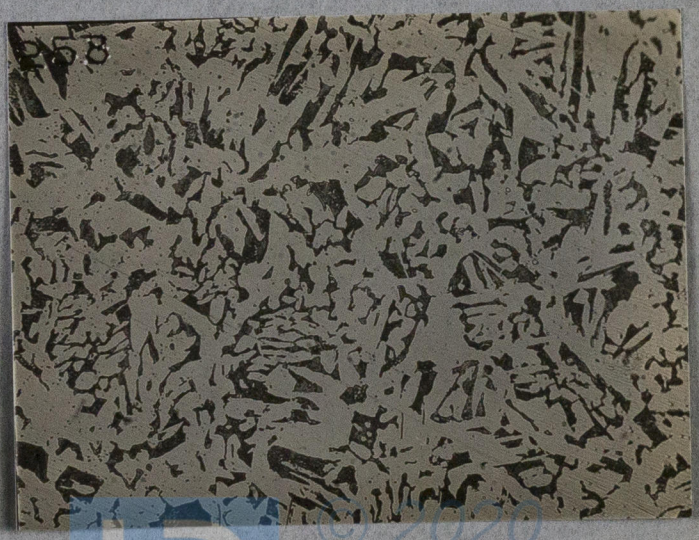
E-13-S



F-3-S



F-5-S



F-6-S

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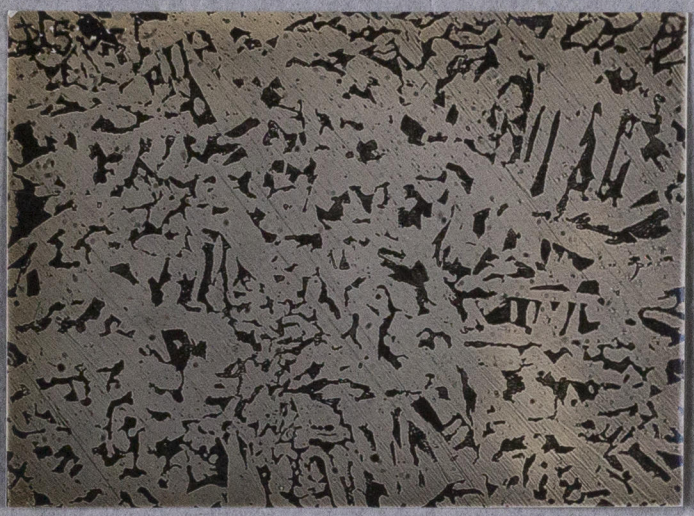
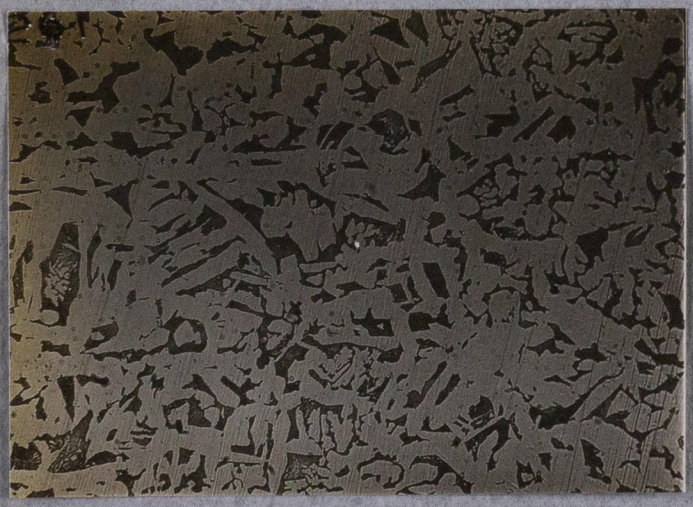
Microstructure of Plates Taken
at right angles to rolling
Magnification 100 Diameters

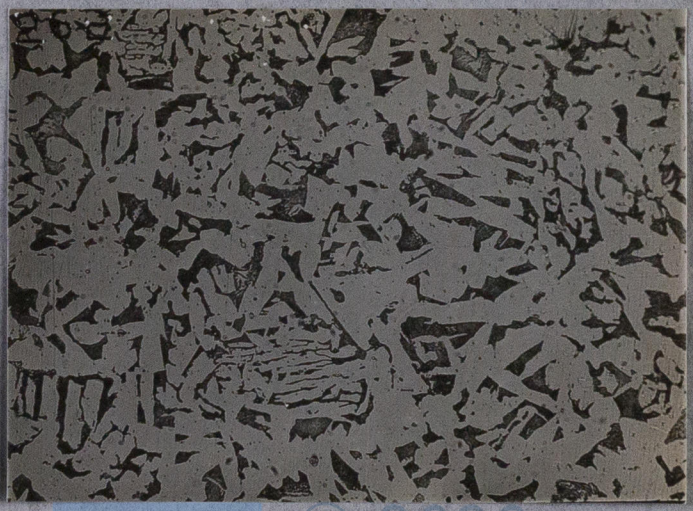


G-4-S

J-11-S



J-12-S



M-5-S

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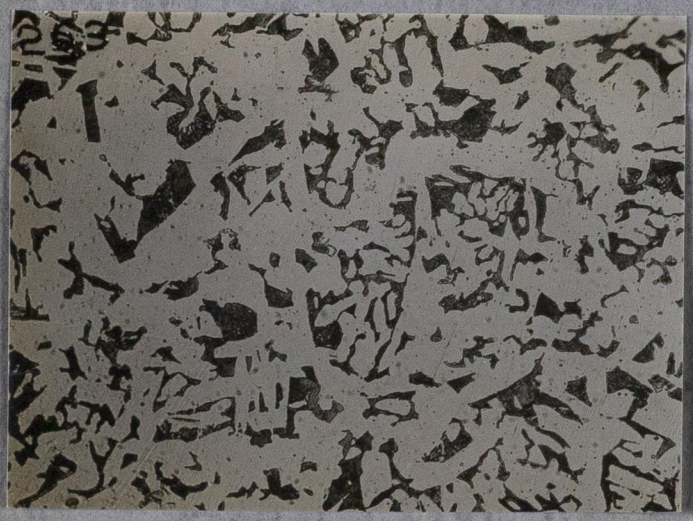
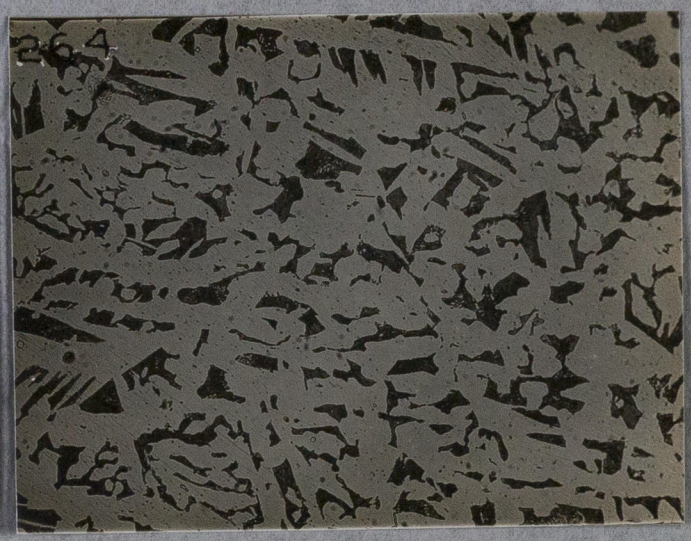
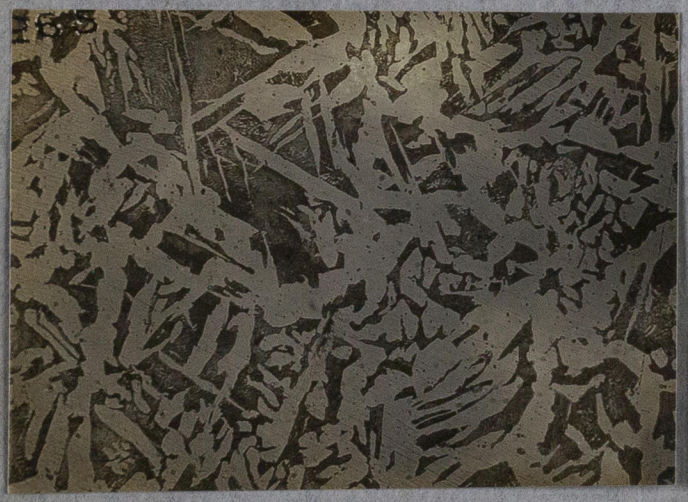
Microstructure of Plates Taken
at right angles to rolling
Magnification 100 Diameters



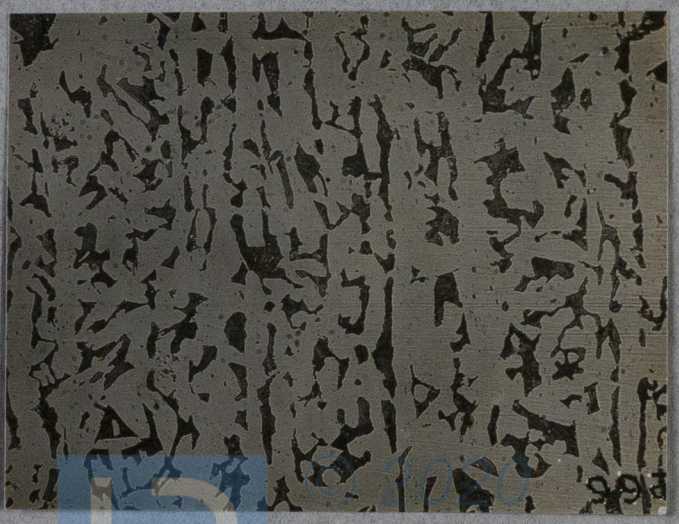
N-4-S



N-6-S



N-8-S



N-21-S

X

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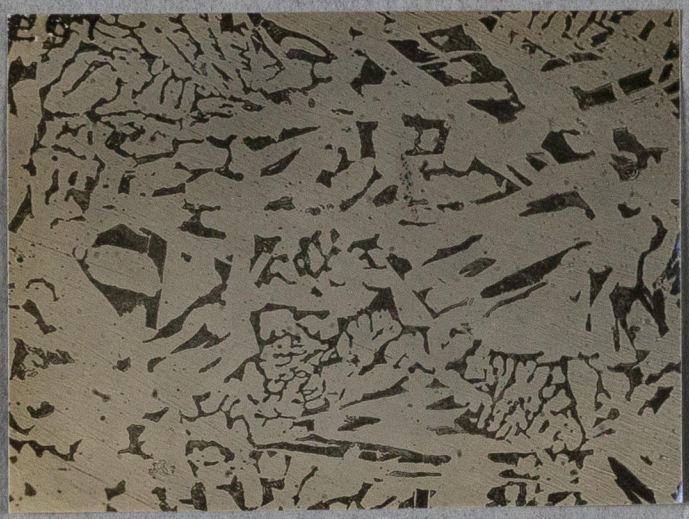
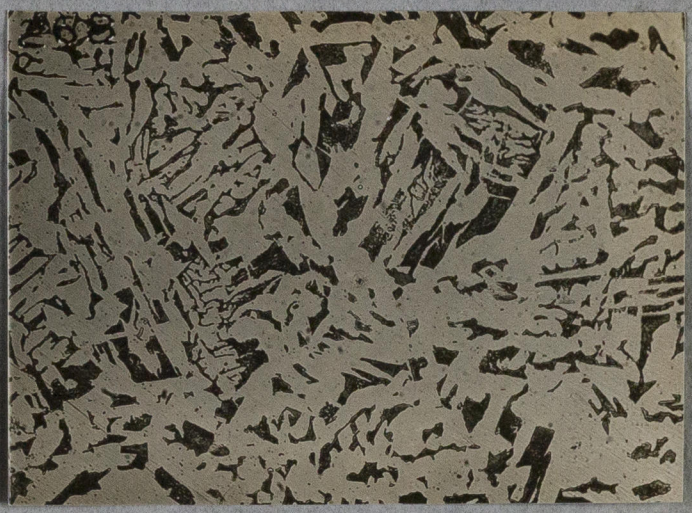
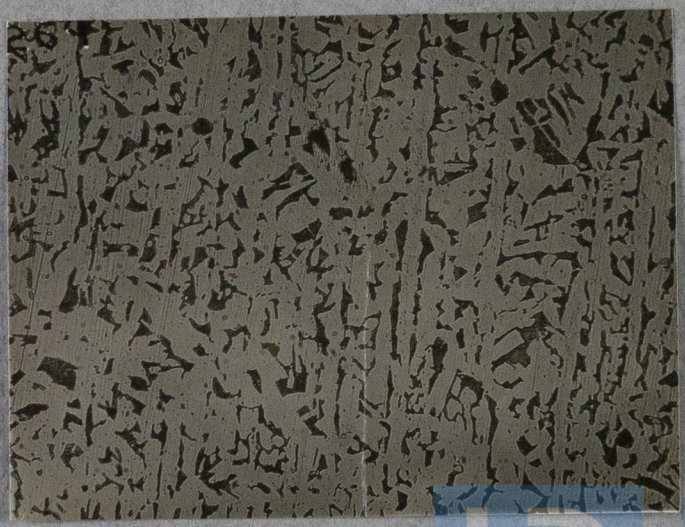
Microstructure of Plates Taken
at right angles to rolling
Magnification 100 Diameters



0-6-S



Dk. Stringer Frame 363



Longitudinal #19

Conclusion:

The average physical properties of the plates indicate that they are very close to the original properties as specified by Lloyd's Register of Shipping at the time the ship was built.

It should be noted that a plate as received from the mill has had the maximum amount of work done on its surfaces and will show higher physical properties in its original thickness than if the plate is reduced in thickness and the rolled surfaces removed. The above plates were corroded badly and in addition the remaining surfaces were machined to a thickness that removed all corrosion. This we believe has reduced the present physicals to the results obtained rather than the result of fatigue.

We would also expect the ratio of the yield point to the tensile strength to be increased if the plates had been subjected to excessive stress. This effect would be more noticeable had we been able to determine the Elastic Limit instead of the Yield Point.

The microstructure of the plate also indicate an unstrained condition due to the absence of strain lines and the undistorted ferrite and pearlite pattern.

All results taken into consideration leads us to believe that the plate failures were not due to any physical defect of the material itself but due to corrosion which in some cases wasted the plates to a thickness where there was insufficient area or plate section to withstand the stresses set up in actual service.

Copy:
Standard Shipping Co.
Mr.H.K.Peebles
American Bureau of Shipping
Lloyd's Register of Shipping
File

R. L. Angell
Metallurgist

12/12

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