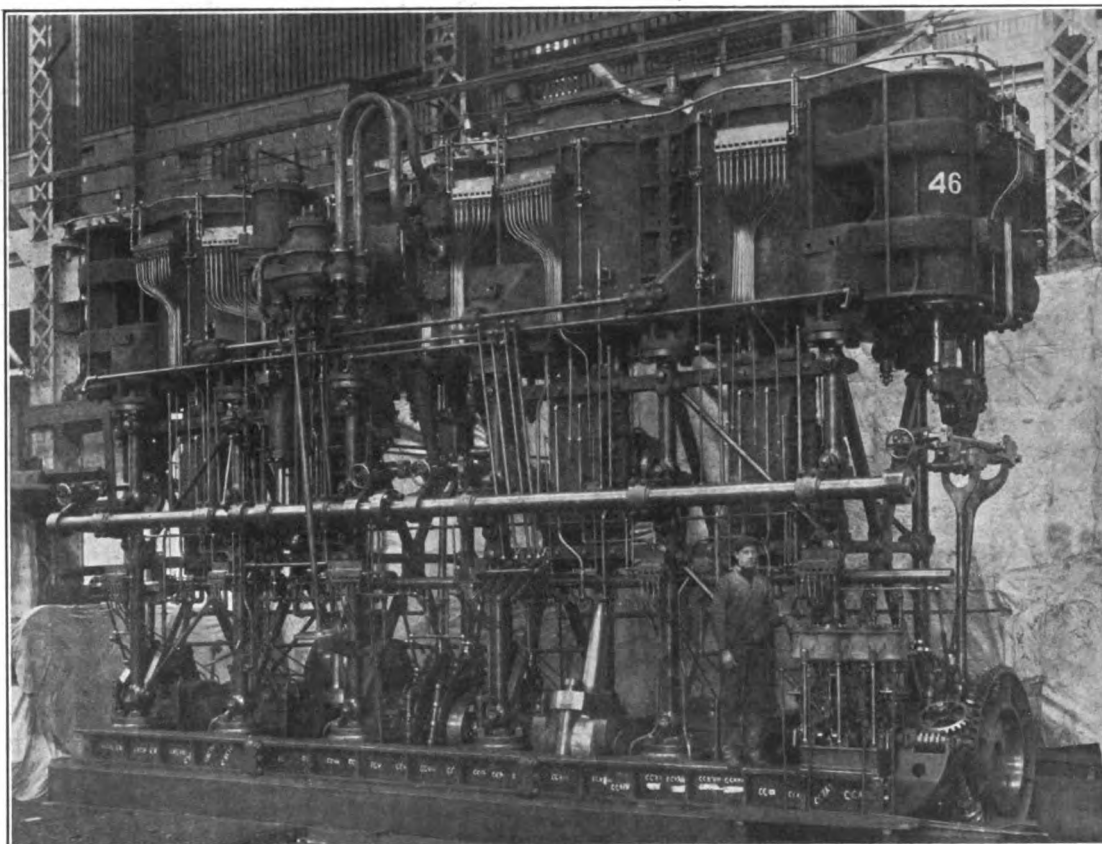


CONTRACT TRIAL PERFORMANCE OF THE UNITED STATES BATTLESHIP MINNESOTA.

BY A. F. BOWEN AND H. B. GREGORY.
GENERAL DESCRIPTION.

The *Minnesota** (BattleShip No. 22), built by the Newport News Shipbuilding & Dry Dock Company, Newport News, Virginia, is one of the twin-screw battleships of the *Vermont* class, authorized by Congress in an act approved March 3, 1903. The contract for the *Minnesota*, signed June 20, 1903, provided for the delivery of the completed vessel within forty-two months from that date; that is, on or before December 20, 1906. The keel was laid October 27, 1903, and the vessel launched April 8, 1905. The contract price for the vessel, exclusive of armor, armament, etc., which are supplied by the government, is \$4,110,000, of which \$3,110,000 was allotted for the hull, and \$1,000,000 for the machinery.

Breadth, molded	76 feet 5½ inches
Breadth, extreme	76 feet 10 inches
Ratio length to beam	5.856
Depth molded to main deck side at midship section.	43 feet 1¾ inches
Draft	24 feet 6 inches
Displacement, normal—24 ft. 6 in. draft.....	15,970 tons
Displacement, per inch—24 ft. 6 in. draft.....	63.2 tons
Area of immersed midship section.....	1,808 square feet
Area of the load water plane.....	26,560 square feet
Area of wetted surface at normal draft.....	44,500 square feet
Center of gravity of L.W.L. plane aft of M.S....	4.4 feet
Center of buoyancy above bottom of keel.....	13 feet 4 inches
Center of buoyancy aft of M. S.....	0.765 feet
Transverse metacenter above center of buoyancy	18 feet 9½ inches
Longit'nal metacenter above center of buoyancy	538 feet 6 inches



THE STARBOARD ENGINE OF THE BATTLESHIP MINNESOTA, LOOKING FORWARD, AS ERECTED IN BUILDERS' SHOP.

The guaranteed speed of the *Minnesota* was 18 knots, to be maintained for four consecutive hours, on a mean draft of 24 feet 6 inches, corresponding to a displacement of about 15,970 tons. The designed power to produce this speed was about 16,500 collective indicated horsepower of propelling machinery, at about 120 revolutions per minute of the main engines; this to be attained at an average air pressure in the fire rooms of not more than 2 inches, with a maximum air pressure of 2¼ inches. And it was further stipulated, that the vessel should be subject to an endurance trial, under all boilers, of twenty-four hours consecutive duration in the open sea, at an average of not less than 13,200 indicated horsepower. A standardization run was also required by the department.

HULL DIMENSIONS.

Length between perpendiculars (also L.W.L.)	.450 feet 0 inches
Length over all456 feet 4 inches
Projection of ram forward of F. P.....	6 feet 4 inches

*For dock trial, see page 468 of our issue for December, 1906. For launching, see page 251, June, 1905.

Coefficient of fineness—block.....	0.6592
Coefficient of fineness—midship section.....	0.9604
Coefficient of fineness—L.W.L. plane.....	0.7683
Coefficient of fineness—cylindrical.....	0.6963
Number of frames (spaced 4 feet throughout).	112
Number of watertight compartments.....	314

In general, the particulars of arrangements and outfit are the same as those of the *Louisiana*;* but the following items may be mentioned:

The hawse pipes enter the main deck, and the anchor chains lead to the windlass house, which projects through the deck. Bill boards and cranes for each of the sheet anchors, Navy type, are on this deck. The Baldt type of anchor is used for the bowers, and is stowed in the hawse pipes. The wireless telegraph station is also located on this deck, in the after part of the superstructure.

The protective deck extends the entire length of the ship, and is 3 inches thick on the slope and 1½ inches on the flat. The

*See INTERNATIONAL MARINE ENGINEERING, May, 1906, pages 165 to 174, for complete data of trial and description of ship.

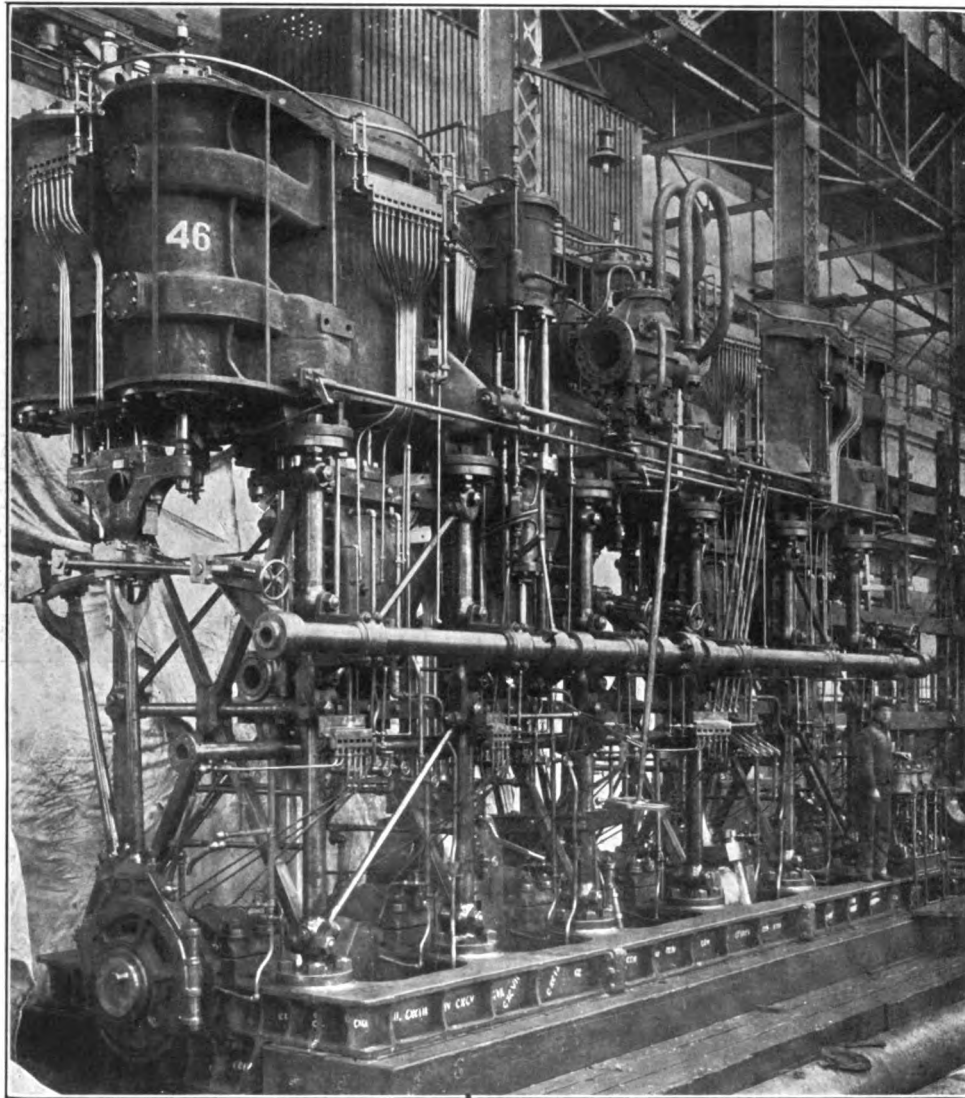
space between the protective and berth decks is utilized for stores, except abreast the fire rooms, where it is used for coal.

On the upper platforms are the magazines, handling rooms, store rooms, forward and after dynamo rooms, and steering engine room. The lower platform contains the forward and after torpedo rooms, magazines, and store rooms. In the hold are store rooms, magazines, chain lockers, coal bunkers, engine and boiler compartments and trimming tanks. There are thirty-four coal bunkers, twenty-four in the hold and ten on the protective deck, with a total capacity of 2,403 tons, at 43 cubic feet to the ton.

the hull, the ship's sides are protected by upper and lower casemate armor 6 inches and 7 inches thick respectively. Forward and aft on the main deck are the two 12-inch elliptical balanced turrets, turning over circular barbettes. The armor for these turrets is 12 inches thick on the port plates, and 8 inches thick on the sides and back. There are also four 8-inch elliptical balanced turrets, having port plates $6\frac{1}{2}$ inches thick, with back and sides 6 inches.

ORDNANCE.

Main battery: four 12-inch breech-loading rifles; eight 8-inch breech-loading rifles; twelve 7-inch rapid-fire rifles.



STARBOARD MAIN ENGINE OF UNITED STATES BATTLESHIP MINNESOTA, LOOKING AFT.

There is one Hyde Windlass Company steam windlass, capable of hoisting two anchors of approximately 17,600 pounds each, at a speed of 6 fathoms per minute. The windlass is driven by a double upright engine, with steam cylinders 17 inches in diameter, and 14 inches stroke, located on the gun deck, and connected to the windlass through a vertical shaft and a set of worm and bevel gears.

ARMOR.

A complete waterline belt, 9 feet 3 inches wide amidships, is fitted from stem to stern. In wake of the machinery the armor is 11 inches thick at top and 9 inches at the bottom. On the quarters, the armor is reduced to 9 inches at top and 7 inches at the bottom, then to 7 inches at top and 5 inches at bottom, then to 5 inches constant thickness, and finally to 4 inches constant thickness. Above the main belt, and covering the central portion of

Secondary battery: twenty 3-inch 50-caliber rapid-fire rifles; ten 3-pounder semi-automatic Hotchkiss rapid-fire rifles; two 1-pounder automatic guns; two .30-caliber machine guns. The ship has also four 21-inch submerged torpedo tubes, two forward and two aft, with complete outfit of compressors, accumulators, etc.

PROPELLING MACHINERY.

There are two main engines, of the four-cylinder, vertical, inverted, direct-acting, triple expansion type, placed abreast in two separate watertight compartments, with communicating watertight door in the center line bulkhead at the working platform. The order of the cylinders, beginning forward, is: forward L. P., H. P., I. P., and after L. P. The crank sequence is: H. P., I. P., F. L. P., and A. L. P., all crank angles being ninety degrees. The engines are right and left, and turn outboard when

going ahead. The designed indicated horsepower of the main engines was 16,500 at about 120 revolutions per minute, with a steam pressure of 250 pounds at the high-pressure steam chest.

The H. P. and F. L. P. cylinders and the I. P. and A. L. P. cylinders are securely bolted together, but there is no rigid fastening between the two cylinder pairs thus formed, which are guided together to prevent athwartship motion, but allowing fore-and-aft play for expansion.

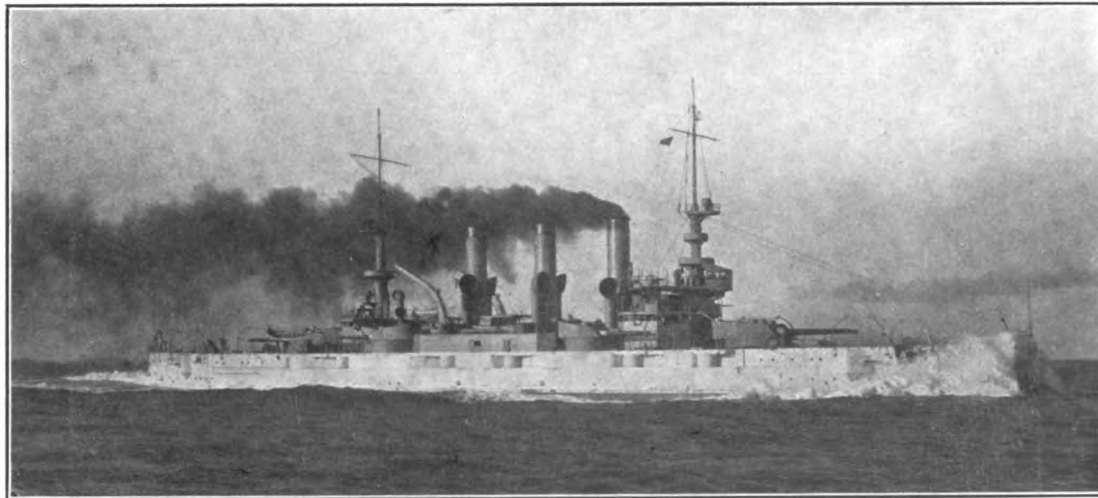
The cylinders are supported on twelve forged steel cylindrical columns, tied fore and aft by heavy cast steel horizontal I-braces and forged steel horizontal and diagonal rods, and strengthened athwartships by forged steel X-frames, extending from top to bottom of the columns, and horizontal tie rods at the center of the columns and X-frames. The engines are also stiffened by fore-and-aft and athwartship tie rods between the cylinders of opposite engines, and between the forward and after engine room bulkheads and the engine cylinders.

Stern tube shafts, diameter, inches 16½
 Propeller shafts, diameter, inches 16½

The auxiliary machinery is, in general, the same as that of the *Louisiana*. It may be noted, however, that the thickness of the tubes of the two main condensers is of No. 16 B. W. G., or 0.065 inch, instead of No. 18 B. W. G., or 0.049 inch. The same may be said with regard to the four auxiliary condensers.

All the living spaces are heated by steam radiators. The heating system is divided into thirteen independently controlled circuits (including galley, pantry, and wash room circuits). Each radiator is also independently controlled. In this way any circuit or radiator may be shut off without interfering with the balance of the system. Steam is supplied from the auxiliary steam line, reducing valves being fitted at all connections.

A pneumatic plant is provided for the purpose of operating pneumatic tools and cleaning boilers. It consists of an air compressor and accessories located in the forward end of the port



THE UNITED STATES BATTLESHIP MINNESOTA STEAMING AT 18.74 KNOTS ON STANDARDIZATION RUN NO. 2.
 (Copyrighted, 1906, N. L. Stebbins.)

The main valves are of the single ported piston type. They are built up with top and bottom cast steel heads, and a steel distance piece between the heads. Each head is fitted with a single cast iron packing ring and cast steel follower. The H. P. cylinders have one valve and the I. P. and L. P. cylinders two valves each. A balance piston, fitted at the top of each valve stem and working in a small cylinder in the top of the valve chest cover, is provided to relieve a part of the weight of the valve gear, which is of the double bar Stephenson link and sliding block type. The H. P. valve stem connects direct to its link block, while the two stems of each I. P. and L. P. cylinder are secured to a cross-head, which in turn is connected to the link block.

The main engines are duplicates of those of the *Louisiana*.

Cylinders, H. P., diameter, inches.....	32½
I. P., diameter, inches.....	53
L. P. (2), diameter, inches.....	61
Stroke of all pistons, inches.....	48
Piston valves, H. P. (1 each cylinder), diameter, inches....	17½
I. P. (2 each cylinder), diameter, inches....	19
L. P. (2 each cylinder), diameter, inches....	19
Net area of I. P. to H. P. piston, ratio.....	2.659 to 1
Net area of L. P. pistons (2) to H. P. piston, ratio....	7.046 to 1
Connecting rods, length center to center, inches.....	96
Crank shaft, diameter, inches.....	16½
Crank pin, diameter, inches.....	17½
Crank webs, width, inches.....	19
thickness, inches.....	10¼
Thrust shaft, diameter, inches.....	15½
collars, number in each shaft.....	13
Line shafts, diameter, inches.....	15½

engine room. An air main is led through the engine and fire rooms, with branches to workshop and evaporator room, all fitted at suitable intervals with connections for attaching flexible hose for pneumatic tools, etc.

SCREW PROPELLERS.

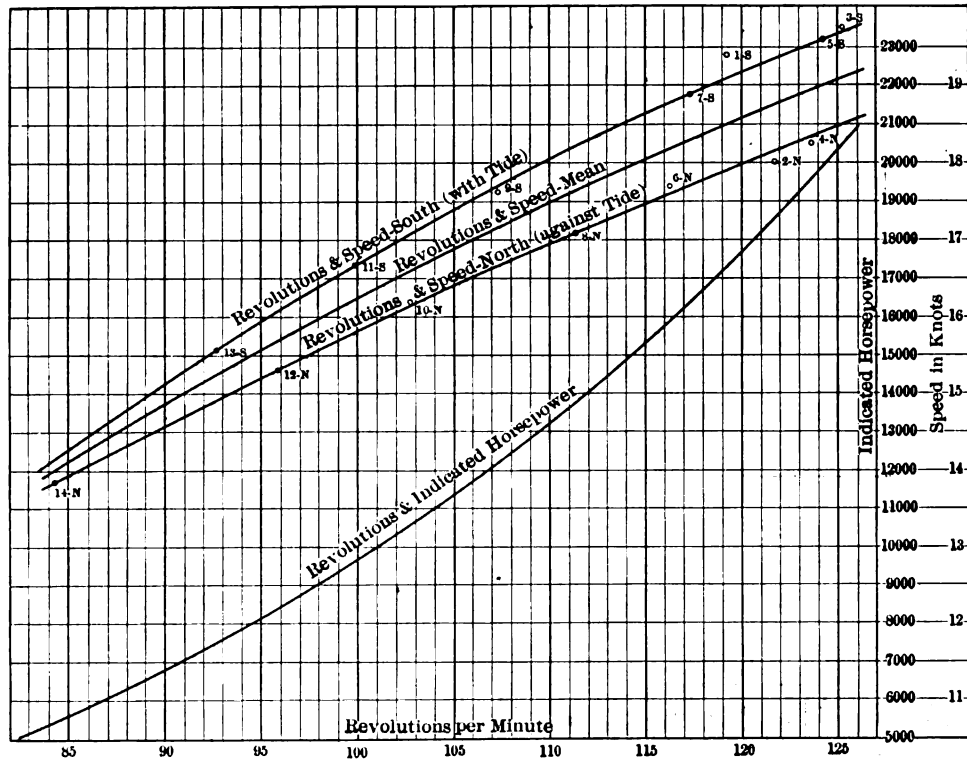
The two built-up propellers are of manganese bronze, turning outboard when going ahead. They have three blades and are designed as true screws.

Diameter of propeller.....	17.365 feet
Diameter of hub.....	4.375 feet
Pitch, as set.....	18.07 feet
Pitch, ratio to diameter.....	1.0405
Pitch, adjustable between.....	17 and 19 feet
Helicoidal (developed) area, square feet.....	85.735
Projected area, square feet.....	72.78
Disk area, square feet.....	236.85
Ratio, projected area to disk area.....	0.307

BOILERS.

Steam is supplied by twelve Babcock and Wilcox watertube boilers designed for a working pressure of 265 pounds per square inch, and arranged, two each, in six communicating watertight compartments, with athwartship fire rooms between each two boilers. There are three smoke pipes, 8 feet 3 inches internal diameter and 92 feet 5 inches above the grates. Four boilers connect to each smoke pipe.

Grates, length.....	7 feet 0 inches
width.....	6 feet 6.576 inches
Grate surface, square feet.....	91.67
all boilers, square feet.....	1,100.00



CURVES PLOTTED FROM RESULTS OF STANDARDIZATION RUNS OF BATTLESHIP MINNESOTA.

Heating surface, square feet	4,396.
all boilers, square feet	52,752.
Heating surface, ÷ grate surface	47.96
Grate surface ÷ cross section smoke pipe	6.859

OFFICIAL PRELIMINARY TRIALS.

The standardization method of trial was decided upon, and the government measured mile course off Rockland, Maine, was selected for the trial. The *Minnesota* sailed from Newport News on Saturday morning, October 20, 1906. On the run up the coast a forced draft run of about an hour and a half duration was indulged in, to satisfy the engineers that everything was in prime condition for the trials. Rough sea and occasional thick weather were encountered, and Rockland was not reached until a little after noon, Monday, October 22.

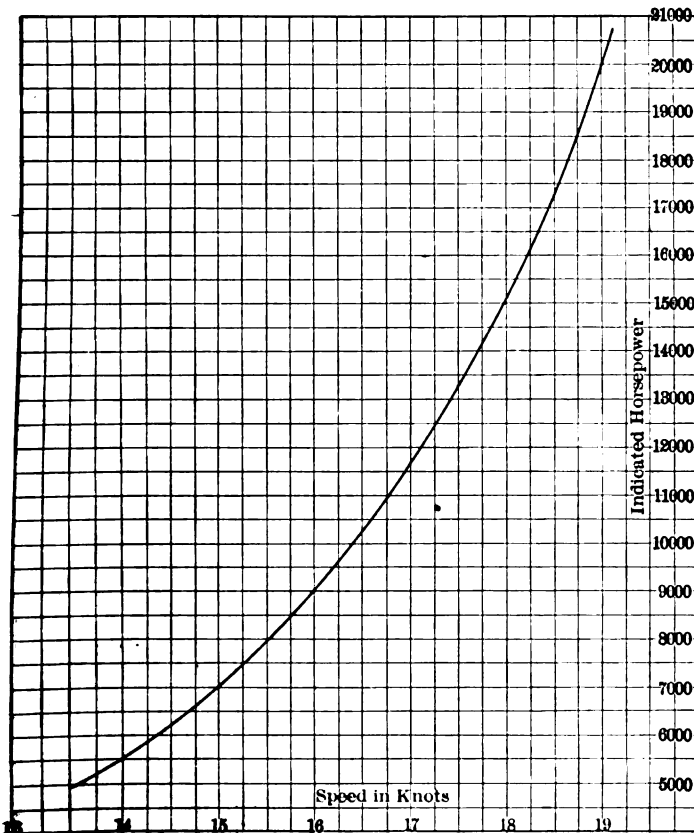
As previously noted, this vessel was required to stand three distinct trials, as follows: first, the standardization run, for the purpose of establishing the revolutions and corresponding speeds; second, the four-hour full power run, to demonstrate the ability to maintain the contract speed for four consecutive hours; third and lastly, the twenty-four endurance run, at four-fifths of full power. The latter requirement is a new feature, this being the first vessel for the United States navy to be subjected to it.

The standardization trial was run on October 24. The morning broke fine and clear, and the sea was smooth. Fourteen successful progressive runs were made over the course, the data obtained being shown in the table. The curves are plotted from this data. The results showed 114.5 revolutions per minute of the main engines to be necessary to make the contract speed of 18 knots.

FOUR-HOUR TRIAL.

On October 25, the four-hour trial was run at sea, between Rockland and Boston. Thick weather, rough sea and a head wind were encountered, but an average speed of 18.851 knots was maintained for the four consecutive hours, thus exceeding the contract speed by 0.851 knot. The machinery plant worked admirably throughout the entire run. The coal used was hand-picked, put up in bags of 112 pounds each (20 bags to the ton) and an accurate record of the bags of coal burned during the four hours was kept, for the purpose of arriving at the coal consumption.

The firing of the furnaces was controlled by an electric signal, automatically operated by a small motor. The furnace doors

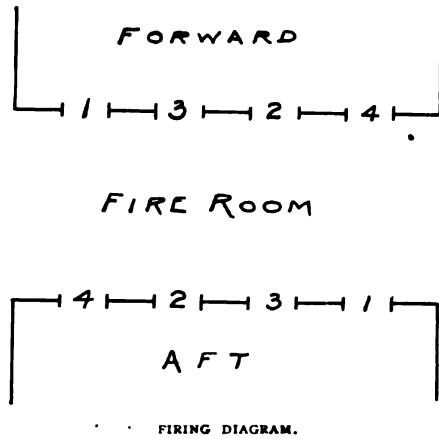


SPEED-POWER CURVE FROM STANDARDIZATION RUNS.

U. S. S. MINNESOTA. DATA FROM STANDARDIZATION TRIAL ON MEASURED MILE OFF ROCKLAND, MAINE, WEDNESDAY, OCTOBER 24, 1906.

Number and Direction of Run.	Time on Course. Min. Sec.	Revolutions of Main Engines.			Speed in Knots.	Steam Pressures.				Mean Effective Pressures.				Air Pressure in Inches of Water.	Indicated Horsepower.					Cut-off in Cylinders.									
		For one Nautical Mile.	Per minute.	Average.		In Boilers.	At Engines.	H. P. Steam.	1st Rectr.	2nd Rectr.	H. P. Cyl.	I. P. Cyl.	F. L. P. Cyl.		A. L. P. Cyl.	Referred to F. P. Cyls.	Vacuum in Inches.	H. P. Cyl.	I. P. Cyl.	F. L. P. Cyl.	A. L. P. Cyl.	Total.	Total Both Engines.	Auxiliaries in Operation.	Total All Machinery.	H. P.	I. P.	F. L. P.	A. L. P.
1-S	3-5.45	S	366.	118.32	119.20	19.412	235	220	105	34	108	47.5	19	19.5	52.24	26.2	1.67	2514	2979	1582	1624	8699	17581.1	1003.3	18584.4	.837	.726	.687	.687
2-N	3-20.	P	371.4	124.07	121.80	18.000	235	223	108	36	103.2	48.7	19.5	20.2	52.5	25.3	1.93	2430.5	3097.7	1647.2	1706.7	8882.1	18111.9	1033.6	19145.5	.828	.852	.828	.828
3-S	3-2.5	S	403.	120.90	125.21	19.726	245	230	97.5	36	107	47	17.6	19	51	25.2	1.45	2545	3012	1498	1617	8672	20318.6	917.3	21235.9	.852	.852	.852	.852
4-N	3-17.25	P	408.95	122.69	123.71	18.251	245	242	113	38.5	109	50	20.4	20.9	54.79	26.4	1.03	2623.6	3250.4	1761.2	1804.7	9439.9	19827.5	794.1	20621.6	.852	.852	.852	.852
5-S	3-3.8	S	378.2	124.58	124.30	19.587	255	247	130	42.5	106	54.8	21.9	23.5	58.19	25.2	.92	2549	3665	1841	1886	10027	19200.4	797.5	20783	.852	.792	.837	.816
6-N	3-23.4	P	382.	125.84	116.27	17.699	247.5	247	122.5	40	104	54.5	21.5	22.5	56.9	26.5	.51	2628	3483.4	1745.7	1920.4	9777.5	16400.5	654.3	17114.8	.852	.837	.837	.837
7-S	3-10.45	S	404.45	123.37	117.32	18.903	250	237	120	39.8	108	53	20	22	56.45	25.6	.71	2542	3575	1862	1969	9948	15694.9	602.7	16297.6	.852	.792	.837	.816
8-N	3-30.83	P	395.4	116.78	111.34	17.075	207.5	205	99	32.5	91	44.5	17.5	17.3	46.9	26.9	.21	2674.2	3558.5	1864.1	1943.2	10040	13710.9	564.4	14275.3	.852	.837	.837	.837
9-S	3-23.95	S	372.6	117.36	107.39	17.651	213	210	98	32.2	103	44.8	17.3	18.3	49.13	25.8	.52	2400.6	2729.9	1453.4	1511.6	8227.5	12148.5	465.7	12614.2	.852	.762	.744	.657
10-N	3-42.63	P	391.85	111.64	102.81	16.170	230	215	82.5	28	105	38	15.1	15.8	44.4	27.4	.21	2363	2249	1186	1242	6983	10841.6	423.7	11265.3	.852	.731	.731	.731
11-S	3-35.6	S	389.75	111.04	99.97	16.698	240	215	78	28	110.2	35.3	14	14.8	43.1	25.9	0	2405.5	1795.2	938.5	946.3	6085.5	9718	417.1	10135.1	.852	.610	.610	.610
12-N	3-55.3	P	365.1	107.23	95.87	15.299	250	230	71	23.5	112	31.5	12.4	12.9	40.1	27.4	0	2179	1615	801	852	5447	8386.4	391.6	8781	.852	.610	.610	.610
13-S	3-51.	S	359.35	99.99	92.78	15.584	250	215	57	22	107.6	28.8	11.3	11.4	37.24	26.2	0	2363	1790	936	974	6063	7486.6	395.9	7882.5	.852	.610	.610	.610
14-N	4-20.2	P	359.15	99.95	84.08	13.836	255	255	57	19.5	102	25.5	10.1	10.6	34.3	27.5	0	2007	1331	711	746	4815	5474	392.9	5866.9	.852	.610	.610	.610
			359.15	99.95	84.08	13.836	255	202	57	20.5	101	26.5	10.7	10.9	34.96	26.6	0	1980.4	1403.4	752.5	766.7	4993	7486.6	395.9	5866.9	.852	.610	.610	.610
			376.45	96.12	92.78	15.584	255	185	52.5	18	94.5	22.7	9.3	9.6	31.2	27.6	0	1787	1157	629	650	4223	7486.6	395.9	5866.9	.852	.610	.610	.610
			374.45	95.61	84.08	13.836	254	183	52	18.5	89.8	23.3	9.7	9.6	30.99	26.9	0	1684.4	1180.4	652.6	646	4163.4	7486.6	395.9	5866.9	.852	.610	.610	.610
			355.95	92.48	84.08	13.836	248	175	47	16.5	83.5	22.2	8.7	8.9	28.8	27.6	0	1520	1088	566	679	3753	7486.6	395.9	5866.9	.852	.610	.610	.610
			358.25	93.07	84.08	13.836	248	170	48	18.2	85	20.2	9.1	9	28.59	26.9	0	1552	996.1	596	589.5	3733.6	7486.6	395.9	5866.9	.852	.610	.610	.610
			364.35	84.08	84.08	13.836	244	135	35	13	61.5	17	6.8	6.3	21.5	27.6	0	1017	757	402	373	2549	5474	392.9	5866.9	.852	.610	.610	.610
			366.25	84.52	84.08	13.836	243	142	42	16.5	73	18.1	7.5	7.7	24.68	27.0	0	1210.4	810.6	446	458	2925	5474	392.9	5866.9	.852	.610	.610	.610

were numbered as per sketch. The signal interval was 30 seconds, the cycle of operations being as follows:



- | | |
|-----------------------|-----------------------|
| 1st bell, fire No. 1; | 5th bell, rake No. 1; |
| 2d bell, rake No. 2; | 6th bell, fire No. 2; |
| 3d bell, fire No. 3; | 7th bell, rake No. 3; |
| 4th bell, rake No. 4; | 8th bell, fire No. 4. |
- Thus each furnace was fired every four minutes.

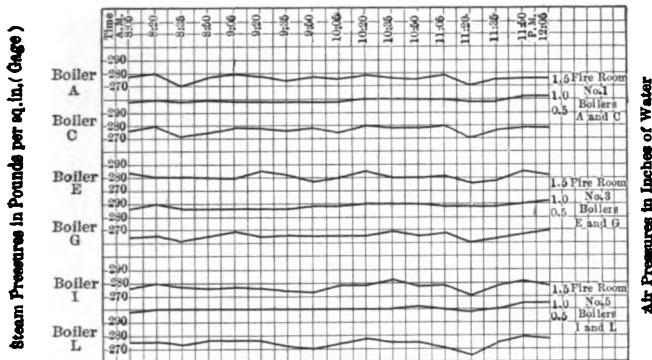


CHART FROM STARBOARD FIRE ROOMS, FOUR-HOUR TRIAL.

The following men were on watch during the trial:
Engine Rooms: 1 chief engineer, 6 assistant engineers, 4 machinists, 26 oilers, 10 pump men, 2 store keepers; total, 49.
Fire Rooms: 1 chief engineer, 3 assistant engineers, 28 firemen, 30 coal passers, 6 water tenders, 6 blower men, 2 machin-

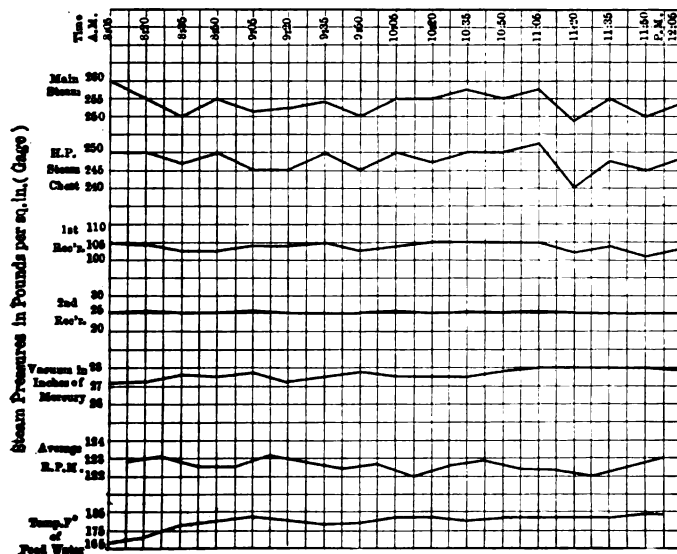


CHART FROM STARBOARD ENGINE ROOM, FOUR-HOUR TRIAL.

ists; total, 76; grand total, 125. Two hundred and seventy-three men constituted the engineering force.

The tabulated comparative figures between the *Louisiana's* trial performance and that of this vessel may be of interest. Both these vessels are identical in every respect, save the direction of rotation of the propellers.

	Propellers Turn	To make 18 Knots		Data from Four-hour Trials					Admiralty Constant
		R. P. M.	I. H. P.	R. P. M.	I. H. P. Main Eng's	I. H. P. Total	Slip %	Kn'ts	
<i>Louisiana</i> .	Inboard	119.1	15,730	127.68	20,442	21,350	17.00	18.823	197.
<i>Minnesota</i> .	Outboard	114.5	15,140	122.93	19,896	20,572	14.01	18.851	201.5
Difference in favor <i>Minnesota</i>		4.6	590	4.75	546	778	2.99	0.028	4.5

The comparison indicates an advantage in outboard turning propellers for this design of vessel.

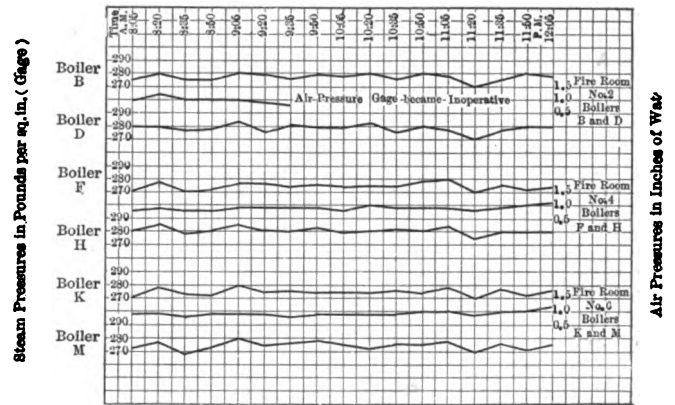


CHART FROM PORT FIRE ROOMS, FOUR-HOUR TRIAL.

TWENTY-FOUR-HOUR ENDURANCE TRIAL.

This trial, which was commenced at 8.00 P.M. on the day of the four-hour trial, was at sea, between Boston and Newport News. Excellent weather was encountered and an average I. H. P. of 15,116 was developed, which exceeded the requirement (13,200 I. H. P.) by a good margin. The firing was controlled as on the four-hour trial, except that the interval

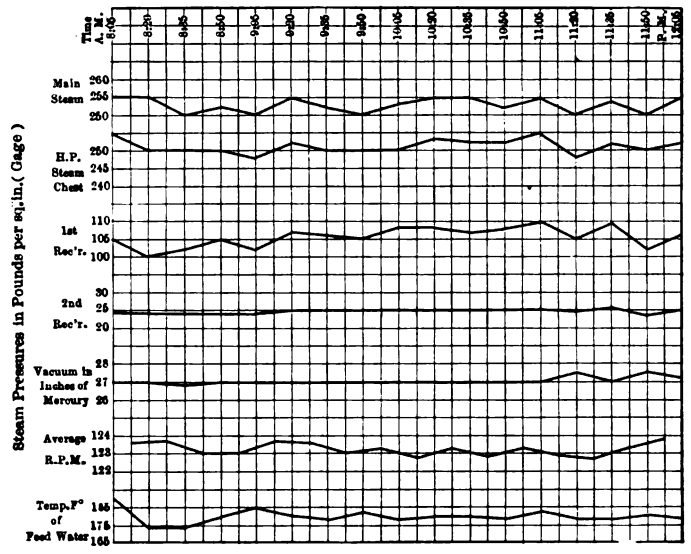
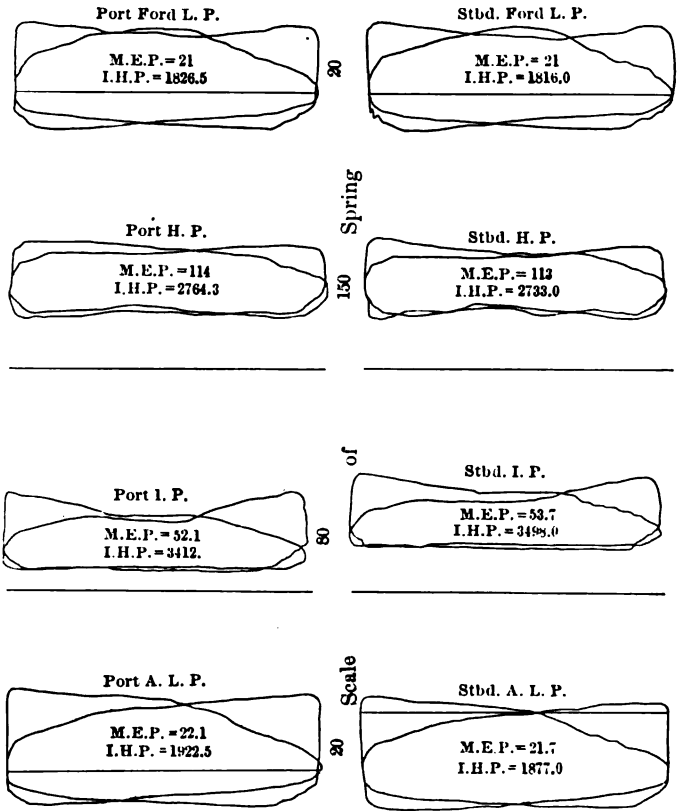


CHART FROM PORT ENGINE ROOM, FOUR-HOUR TRIAL.

SYNOPSIS OF TRIALS.

	Four-Hour		Twenty-Four Hour	
	Starb'd	Port	Starb'd	Port
Steam pressures:				
at boilers, gage.....	275.6		245.19	
engine room, gage.....	254	252.2	226.5	228.8
H. P. steam chest, gage.....	249	250.8	221	225.5
1st receiver, absolute.....	119	122.7	88.5	85.4
2d receiver, absolute.....	40.1	39.7	31	29.9
Vacuum in Condenser.....	26.2	26.24	26.2	26.2
Revolutions per minute:				
main engines.....	122.6	123.26	114.04	113.8
average for both.....		122.93		113.92
circulating pumps.....	183	194	168.16	166.87
blower engines.....		349.2		349.4
dynamo engine.....		352		339.21
Double strokes per minute:				
main air pumps.....	18	23.6	17.41	15.91
main feed pumps.....	32	36	21.64	22.13
fire and bilge pumps.....	43.1	52.3	44.54	40.79
auxiliary condenser air and circulating pump.....		44.6		43.21
Speed of ship, knots.....		18.851		17.939
Slip of propellers, in percent of their own speed, based on mean pitch.....	13.78	14.01	11.12	12.28
Air pressure in fire rooms, in inches of water.....		0.94		0.6
Cut-off, in decimal of stroke:				
H. P. cylinder.....	0.852	0.852	0.73	0.70
I. P. cylinder.....	0.726	0.726	0.73	0.73
F. L. P. cylinder.....	0.687	0.687	0.69	0.69
A. L. P. cylinder.....	0.687	0.687	0.69	0.69
Mean effective pressures:				
H. P. cylinder.....	111.4	112.2	108.3	109.5
I. P. cylinder.....	53.1	53.7	37.55	38.18
F. L. P. cylinder.....	20.1	21.6	15.76	15.42
A. L. P. cylinder.....	21.9	22.5	16.54	16.04
Mean equivalent pressure, referred to combined area of L. P. pistons.....	57.1	57.94	45.43	45.36
Indicated horsepower, main engines:				
H. P. cylinder.....	2,688	2,713	2,430	2,443
I. P. cylinder.....	3,450	3,509	2,268	2,301
F. L. P. cylinder.....	1,818	1,876	1,265	1,235
A. L. P. cylinder.....	1,891	1,951	1,327	1,285
Totals.....	9,847	10,049	7,290	7,264
Total, both main engines.....	19,896		14,554	
main air, circulating, feed and hotwell pumps.....	339		232	
all other auxiliaries in operation.....	337		330	
Total, all machinery.....	20,572		15,116	
Total I. H. P. per sq. ft. grate.....	18.702		13.74	
Sq. ft. H. S. per total I. H. P.....	2.564		3.49	
Temperatures, degrees Fahrenheit:				
atmosphere.....	58.7		61.6	
engine rooms, working level.....	78.4		83.	
fire rooms, working level.....	85.3		90.1	
injection.....	51.4		62.3	
discharge.....	110.		114.9	
hotwell.....	92.8		95.	
feed.....	178.4		182.1	
smoke pipes.....	577.		479.	
Coal, New River, hand picked:				
pounds per hour, total.....	42,896		—	
per sq. ft. of grate.....	38.996		—	
per I. H. P. main engines.....	2.156		—	
per I. H. P. total.....	2.065		—	



CARDS FROM FOUR-HOUR FULL-POWER TRIAL TRIP.

between signals was increased to 60 seconds, making the firing period eight minutes instead of four. No coal tally was kept on this trial.

Each watch during this trial consisted of one chief engineer and the following number of men:

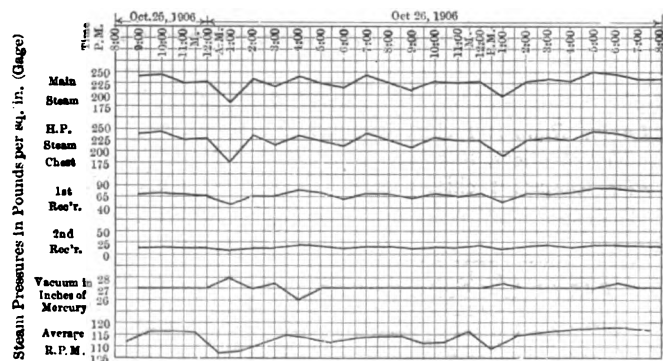


CHART FROM PORT ENGINE ROOM, TWENTY-FOUR-HOUR TRIAL.

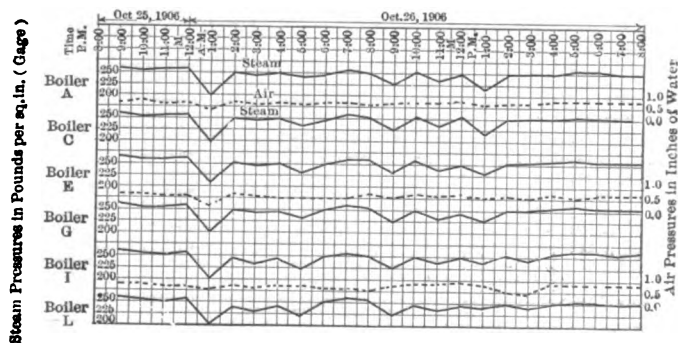


CHART FROM STARBOARD FIRE-ROOMS, TWENTY-FOUR-HOUR TRIAL.

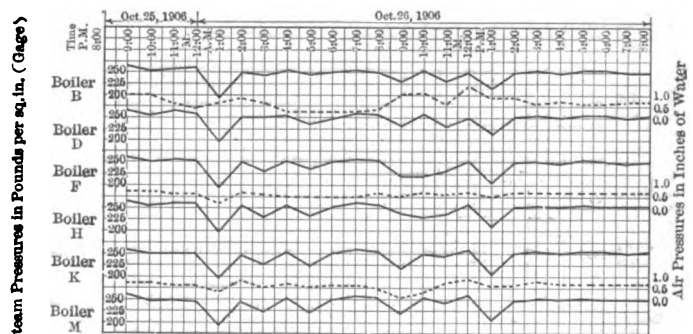


CHART FROM PORT FIRE-ROOMS, TWENTY-FOUR-HOUR TRIAL.

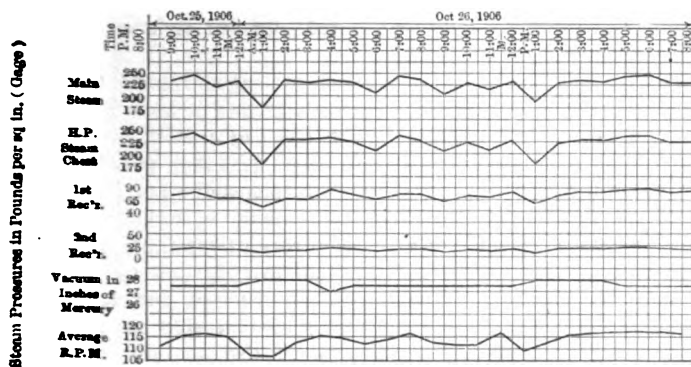


CHART FROM STARBOARD ENGINE ROOM, TWENTY-FOUR-HOUR TRIAL.

Engine Room: 3 assistant engineers, 4 machinists, 12 oilers, 5 pump men, 1 store keeper; total, 25.

Fire Room: 1 assistant engineer, 24 firemen, 24 coal passers, 6 water tenders, 3 blower men, 1 machinist, 1 ash hoist man; total, 60; grand total, 86.

eral equipments are in all respects to the requirements of the Board of Trade and the Canadian Steamboat Inspection Act.

There are two sets of inverted, vertical, direct-acting triple expansion surface condensing engines, having three cylinders working on cranks placed at angles of 120 degrees with each other. The sequence is high, low, and intermediate when going ahead. The engines, running at 130 revolutions per minute, will develop collectively 2,300 indicated horsepower. The cylinders are respectively 19, 30 and 49 inches in diameter, with a stroke of 27 inches. There are cast iron liners in the high-pressure cylinders only. The steam distribution valves are of the piston type for the high-pressure cylinders, trick type for the intermediate-pressure cylinders, and double ported flat form for the low-pressure cylinders. Each is actuated by Stephenson valve gear of double eccentric link motion, with direct acting reversing gear. The columns are box section iron castings. Centrifugal pumping engines for supplying the circulating water are fitted for each condenser, but there is a cross connection, so that either pump can circulate through either or both condensers.

Two sets of propellers are provided—a light set for summer



LAUNCHING OF THE CANADIAN ICE-BREAKING STEAMER LADY GREY.

The Lady Grey.

We present a photograph of the new ice-breaking and surveying steamer *Lady Grey*, built by Vickers, Sons and Maxim, Ltd., Barrow, for the Canadian government, and specially designed to break ice in the River St. Lawrence for navigation in the winter season. She will also be used by the marine and fisheries board for surveying the coast and channels, and powerful pumps are fitted for salvage work. The *Lady Grey* is also fitted with towing gear and has great engine power for towing service when required.

Her dimensions are: Length between perpendiculars, 172 feet; breadth molded, 32 feet; depth molded, 18 feet; draft normal, 12 feet; draft, mean when breaking ice, 13 feet; displacement, 1,055 tons; speed, 14 knots. The hull is of great strength to withstand the ice floes and to pound the ice. Fittings and gen-

use, and a heavy set specially designed for ice work. The propellers are all of the built-up type, with three blades.

Steam is supplied at a working pressure of 180 pounds per square inch by four single-ended cylindrical boilers, 12 feet 9 inches in diameter and 10 feet 6 inches long. Jones' underfeed mechanical stoker system, with fan for air supply, is fitted, and in the stokehold there is a See ash ejector, in addition to two hand ash hoists.

The officers and engineers are accommodated in a large steel deckhouse on the main deck, with mess room, galley and pantry, and a spacious saloon. A smaller private saloon and suite of cabins is provided in a teak deckhouse on the hurricane deck, and cabins are also provided on the lower deck aft. The crew are housed in the forecabin and on the lower deck forward.

The ship has an electric lighting installation, and there is a