JOURNAL

OF THE

AMERICAN SOCIETY OF NAVAL ENGINEERS.

VOL. XI.

NOVEMBER, 1899.

No. 4.

The Society as a body is not responsible for statements made by individual members.

COUNCIL OF THE SOCIETY
(Under whose supervision this number is published).

Lieutenant Commander A. B. WILLITS, U. S. N.	Commander H. WEBSTER, U. S. Navy.	Lieutenant W. W. WHITE, U. S. N.
Lieutenant C. A. E. KING, U. S. N.		Lieutenant E. THEISS, U. S. N.
Lieutenant Commander A. B. WILLITS, U. S. N., <i>Editor</i> .		

CONTRACT TRIAL OF THE UNITED STATES SEAGOING BATTLESHIP *KEARSARGE*.

BY LIEUTENANT CLAUDE B. PRICE, U. S. NAVY.

The *Kearsarge* is a twin-screw, armored, seagoing battleship, and was built by the Newport News Shipbuilding and Dry Dock Company, of Newport News, Va. The Navy Department furnished the general plans and specifications for hull and machinery to the contractors and builders, and the latter developed the general designs into exact details, together with the piping systems and location of the auxiliary machinery, submitting their drawings for approval to the bureaus concerned before work was begun. The contract was signed January 2, 1896, the price being \$2,250,000, and the time allowed for completion three years. The price stated above does not include the armor (exclusive of that required in the construction of the protective deck), the armor bolts, the ordnance, the ordnance outfit, and certain articles, as anchors and chains, supplied by the Government, but does include the fitting and installation of the above. The speed guarantee was sixteen knots per hour, to be maintained successfully for four consecutive hours, during which

period the air pressure in the fire rooms was not to exceed an average of one inch of water; the vessel to be weighted to a mean draught of twenty-three feet six inches. No premium for speed in excess of that required by the contract was provided for, but a penalty was inflicted at the rate of \$100,000 per knot in case the speed developed should fall below sixteen knots, but if it should fall below fifteen knots, it was optional with the Secretary of the Navy to reject the vessel or accept her at a reduced price. The weight of the machinery was limited to 1,100 tons, which weight included main engines, boilers, and appurtenances, distilling apparatus, stores, spare parts, heating apparatus, tools in workshop, and water in boilers, condensers, pumps, pipes and stern tubes, but did not include turret machinery, capstan, windlass, steering gear or winches. The penalty for over weight was \$500 per ton up to 5 per cent, beyond which an additional \$10,000 was to be attached.

HULL.

Length between perpendiculars, feet.....	368
on L.W.L., feet and inches.....	368- 1 $\frac{1}{2}$
over all (including rudder), feet and inches.....	375- 4 $\frac{1}{2}$
Beam, extreme, feet and inches.....	72-2 $\frac{1}{2}$
at L.W.L., feet and inches.....	72-2 $\frac{1}{2}$
Ratio of length to beam.....	5.20
Depth, from top of main-deck beams at side to bottom of frames at M.P., feet and inches.....	33- 8
Height of superstructure above main-deck beams to top of hammock berthing on upper deck, feet and inches.....	12- 0
Draught, normal, forward, feet and inches.....	23- 7 $\frac{3}{8}$
aft, feet and inches.....	23- 7 $\frac{3}{8}$
mean, feet and inches.....	23- 7 $\frac{3}{8}$
Displacement, corresponding to normal draught, tons.....	11,600
per inch, at L.W.L., tons.....	47.74
Area of immersed midship section to L.W.L., square feet.....	1,620
L.W.L. plane, square feet.....	20,070
Center of gravity of L.W.L. plane, aft of M.P., feet and inches.....	1- 9
buoyancy above bottom of keel, feet and inches.....	12- 9 $\frac{5}{8}$
forward of M.P., feet and inches.....	1- 0 $\frac{1}{2}$
gravity above bottom of keel, feet and inches.....	25- 0 $\frac{1}{2}$
Transverse metacenter above center of buoyancy, feet and inches.....	16-11 $\frac{1}{2}$
Longitudinal metacenter above center of buoyancy, feet and inches.....	367- 0
Coefficient of fineness on extreme dimensions.....	.643
of midship section.....	.957

Coefficient of fineness of L.W.L.....	.757
Cylindrical coefficient.....	.681
Number of frames.....	94
watertight compartments.....	292

The hull is constructed of mild steel of domestic manufacture with frames spaced four feet apart, except when intermediate frames are required, from the stem to frame No. 75; and from this point aft the frames are spaced three feet six inches apart. The ship is divided into two hundred and ninety-two watertight compartments. The double bottom extends from frame No. 28 to frame No. 64 and runs up to the armor shelf. A cofferdam thirty-six inches wide is constructed between the berth and the protective decks, on each side of the vessel, extending from the transverse armor bulkheads to the extremities of the vessel. On the berth deck a cofferdam thirty-six inches above the deck and three feet wide is worked on each side between frames No. 25 and No. 78. The cofferdams are filled with fire-proofed corn-pith cellulose packed to a density of six pounds per cubic foot. All the wood used in the construction of the vessel is fire-proofed, and the use of wood at all is avoided wherever practicable. The upper deck and the main deck, outside the superstructure, are the only ones laid with wood, the others being covered with linoleum.

Main Deck.—On the main deck, inside the superstructure, is located the 5-inch battery in broadside, fitted in stalls formed by splinter bulkheads; on this deck are also located the bakery, galleys, executive officer's and paymaster's offices, junior officers' mess room and pantry. It also forms the principal part of the crew's messing and berthing space, and has much the appearance of the old-time gun deck.

Berth Deck.—On this deck are situated the quarters of the admiral, captain and officers and a berthing space for a part of the crew, and in addition the ice machine and refrigerating rooms, sick bay and dispensary, torpedo rooms, armory, lavatories and coal bunkers above protective deck. On the protective deck are the fresh-water tanks, store rooms, and a small berthing compartment.

Splinter and Platform Decks and Hold.—Below the protective deck are the machinery spaces, dynamo room, coal bunkers, holds, chain lockers, trimming tanks, store rooms, magazines, shell rooms, blower rooms, central station for interior communications, steering gear, engineers' and ordnance work shops, air compressors and ammunition hoists.

There are thirty-four coal bunkers with a total capacity of 1,591.48 tons at forty-three cubic feet to the ton. They are distributed as follows: Eight on the berth deck with a capacity of 272.02 tons; twelve on the splinter deck with a capacity of 289.63 tons, and fourteen in the hold with a capacity of 1,029.83 tons. They are filled from either the upper or the main deck through portable chutes and trunks fitted between decks. The trunks have shunt doors fitted at the tops where they pass through the bunkers on the berth deck, and vertical doors at the bottom, for passing the coal from the upper to the lower bunkers. Armored shutters are fitted in the trunks where they pass through the protective deck. Trolley rails and buckets are fitted fore and aft in the outboard hold bunkers, with portable sections in the wake of watertight doors, for the transportation of coal. Escape doors are fitted to all bunkers, those on the berth deck open to main deck (circular plates), those on the splinter deck to ammunition passage (swinging doors), and those in the hold to deck of ammunition passage (circular plates). Steam fire-extinguishing pipes are fitted to all bunkers and holds. Over the vertical watertight sliding doors of the hold bunkers are fitted screen doors, in the shape of a hood, designed to take the weight of the coal from the watertight doors, so that they may be easily closed at any time.

There are two ash chutes on each side fitted inside the vessel. The upper ends of the chutes extend above the main deck, where hoppers are formed inside, and so arranged that the fire-main pressure may be used to clear the chute. Trolley ways for carrying the ash bunkers are fitted under the deck beams above, leading from the ash hoists to the chutes.

For convenience in referring to the compartment plans of

the ship the following list of capacity of each coal bunker is given.

HOLD AND PLATFORM DECK.

Compartment.	Capacity.	
	Cubic feet.	Tons.
B- 5	2,031	47.23
B- 6	1,781	41.42
B- 7	4,675	108.72
B- 8	4,675	108.72
B-15	3,598	83.68
B-16	3,598	83.68
B-19	3,717	86.44
B-20	3,717	86.44
B-27	3,707	86.21
B-28	3,707	86.21
B-25	3,214	74.74
B-26	2,895	67.32
C- 3	1,484	34.51
C- 4	1,484	34.51
Total..... — 14	44,283	1,029.83
SPLINTER DECK.		
B-31	1,584	36.84
B-32	1,584	36.84
B-35	1,151	26.77
B-36	1,151	26.77
B-53	1,673	38.90
B-52	1,693	39.37
B-48	596	13.86
B-49	596	13.86
B-59	601	13.98
B-60	601	13.98
C-17	612	14.23
C-18	612	14.23
Total..... — 12	12,454	289.63
BERTH DECK.		
B-102	1,103	25.65
B-103	714	16.61
B-114	1,700	39.53
B-115	1,700	39.53
B-123	1,727	40.16
B-124	1,727	40.16
B-131	1,510	35.12
B-132	1,516	35.26
Total..... — 8	11,697	272.02
Total ship..... 34	68,434	1,591.48

Drainage System.—The main drain pipe is of galvanized steel, 14 inches in diameter, and runs from the forward boiler rooms

along the port side of the center-line bulkhead above the inner bottom to the engine rooms, having branches connecting it with the starboard compartments. It is fitted with screw-down non-return valves in each boiler room, and with screw-down valves in each engine room, all worked from the berth deck. The suction pipes leading from the valves in the boiler rooms do not dip into drainage wells, but have their mouths located as low down as practicable and covered with coarse strainers. The main drain pipe leads to the main circulating pumps, and is also provided with branches and flanges for connections to the principal steam pumps, other than the main feed pumps.

For the auxiliary drainage system manifolds are fitted in the forward and after eight-inch handling rooms, and in convenient locations throughout the machinery space, with suction pipes leading to the double-bottom compartments, trimming tanks and principal lower compartments of the ship, and to sea connections as required. Where these pipes drain water from compartments above the inner bottom a small well is fitted projecting six inches into the inner bottom and covered by a plate strainer. All manifold valves are worked from the manifolds only. A five-inch drain connects the forward and the after manifold, with flanges for the pump connections. In the boiler and engine compartments the suctions are fitted with flanges for a direct connection to the pumps in that compartment, and the crank pits are drained independently of the remainder of the bilge. The compartments above the protective deck are drained by scuppers or portable pumps. The small store rooms below the protective deck are drained by portable pumps, and the coal bunkers below the protective deck by their own vertical sliding doors. The waste water from bath and wash rooms is led by pipes to tanks (two) located in the after part of the engineer's workshop, and is pumped overboard by an ejector.

ARMOR.

The armor consists of a side belt of Harveyized nickel-steel extending 3 feet 6 inches above and 4 feet below the 23½-foot load line. The thickness amidships of the side belt is 16½ inches at

the top, and $9\frac{1}{2}$ inches at the top of the armor shelf. The maximum thickness of armor at the water line is maintained from the center line of the after barbettes, where the belt begins, to the forward coal-bunker bulkhead, tapering to $10\frac{1}{2}$ inches to the center line of forward barbettes, thence to 4 inches in a distance of 30 feet, which thickness is then maintained to the bow of the vessel. The triangular armor extends from the slopes of the protective deck to the top of the armor belt at the forward and after ends of the machinery spaces, the forward bulkhead being 10 inches and the after bulkhead 12 inches in thickness. Above the side belt there is a casemate 6 inches thick made up of two $\frac{1}{2}$ -inch plates and one 5-inch plate; the athwartship bulkheads are 4 inches thick, and are worked from the sides of the vessel to the centers of the barbettes. The thickness of the superstructure armor is 6 inches. The protective deck between armor bulkheads is $2\frac{3}{4}$ inches thick, and at the extremities on side slopes are fitted plates of armor 4 inches thick. The splinter bulkheads between 5-inch gun stations are each one piece of plate, 80 pounds per square foot.

The barbettes are 15 inches thick at the front and $12\frac{1}{2}$ inches thick at the rear; the 13-inch turrets are 17 inches thick at the front and 15 inches thick at the rear; the 8-inch turrets are 11 inches thick at the front and 9 inches thick at the rear. The conning tower is elliptical in shape, and is 10 inches thick. An armor tube 7 inches thick is fitted between the base of the conning tower and the protective deck, to afford protection to the voice pipes, electric wires, engine telegraphs, steering gear and engine tell-tales.

ARMAMENT.

The main battery consists of four 13-inch breech-loading rifles, 35 calibers, mounted in pairs, in two balanced turrets, on the fore-and-aft center line of the ship, on the main deck; four 8-inch breech-loading rifles, 40 calibers, mounted in pairs, in two turrets superposed on the 13-inch turrets; and fourteen 5-inch rapid-fire breech-loading rifles, 40 calibers, mounted in broadside, on the main deck within the superstructure.

The secondary battery consists of twenty 6-pounder rapid-fire

guns, eight 1-pounder rapid-fire guns, four of which are automatic, four Colt automatic machine guns, and two 3-inch field guns. There are four tubes for Whitehead torpedoes, two on each side, discharging directly from the berth deck. The turrets are trained by electricity, and the 13-inch guns are elevated and loaded by the same power. The 5-inch guns are worked by hand on central-pivot carriages.

The boats carried are as follows :

- One 40-foot steam cutter.
- One 33-foot steam cutter.
- One 33-foot sailing launch.
- Three 30-foot cutters.
- Two 30-foot whaleboats.
- One 30-foot gig.
- One 30-foot barge.
- Two 20-foot dinghies.
- Two 18-foot balsas.

MAIN ENGINES.

There are two three-cylinder triple-expansion engines of the vertical, inverted, direct-acting type, placed abreast of each other in separate watertight compartments, the H.P. cylinders being forward. The engine framing consists of twelve wrought-steel, cylindrical columns, well trussed and stayed diagonally, fore-and-aft and athwartship; in addition, the H.P. and L.P. cylinders of one engine are secured to the corresponding cylinders of the other, the rod passing through a stuffing box in the center-line bulkhead; also the high and low-pressure cylinders are secured longitudinally to the athwartship bulkheads. The valves are all of the single-ported piston type, there being one for each high-pressure cylinder, two for each intermediate and four for each low-pressure cylinder. The link motion is of the double-bar Stephenson type, and the valve gears of the three cylinders are interchangeable. Independent adjustable cut-off blocks are fitted to each link, with a range from .5 to .7 of stroke. The main valves are provided with balance pistons, the cylinders of which form part of the upper covers of the valve chests. There are no

ONE MAIN ENGINE.
(SET UP IN SHOP.)

starting valves on the cylinders, provision being made for starting the engines by admitting live steam to the receivers. The high-pressure cylinder is steam jacketed around the working linings, and the intermediate and the low-pressure cylinders are steam jacketed around the working linings and at both ends. Each main engine is fitted with a double-disc, balanced, stop and throttle valve, worked by a lever and adjusted by a screw stem and hand wheel from the working platform. The main steam pipes are of copper, and where above 9½ inches in internal diameter are strengthened with steel bands spaced 6 inches between centers. In the starboard engine room there is a 50-gallon distributing oil tank for supplying the oil manifolds of both main engines. This tank is supplied from the main tanks by a Worthington duplex steam pump, and by a hand pump, and can be used as either a pressure or a gravity tank. The main pistons are steel castings, dished, and are each fitted with two packing rings and a follower. The piston rods are of forged nickel-steel, oil tempered and hollow, the outside diameter being 7½ inches and the inside diameter 3½ inches; a screw plug is fitted and riveted over at the upper end. The connecting rods, with their caps and bolts, are of forged nickel-steel, oil tempered; the rods have a 4½-inch axial hole bored through their entire length. The body of the crosshead is forged on the end of the piston rod, and a manganese-bronze slipper, whose sliding faces are fitted with white metal, is bolted to its under side. The crosshead guides are of cast iron, and are made hollow for the circulation of water to keep them cool. At the top they are bolted to lugs cast on the cylinder casings, and at the bottom are bolted to forged-steel cross bars, secured to the engine columns. The backing guides are also of cast iron, and are bolted to flanges provided for that purpose on the go-ahead guides. The eccentrics are of cast iron. Each backing eccentric is securely keyed on the shaft, and each go-ahead eccentric is secured to the corresponding backing one by through bolts in slotted holes. The eccentric straps are of composition, faced with white metal, and the eccentric rods are of forged steel. The I.P. and L.P. valve stems have cast-steel crossheads which take hold of the

link blocks directly. Each engine bedplate consists of three sections of steel castings.

There is a steam float-lever, reversing gear, with a hydraulic controlling cylinder, which can also be adjusted to work by a hand pump, there being a common piston rod for both steam and water pistons.

The turning engine is a double, inverted, simple, 7 by 5 engine, operating a worm shaft, which in turn operates a second worm shaft and gear made to readily engage in a worm wheel secured on forward end of low-pressure section of crank shaft. The turning-engine shaft is squared at the end and fitted with a ratchet wrench for turning by hand.

ENGINE DATA.

Cylinders, number for each engine.....	3
H.P., diameter, inches.....	33 $\frac{1}{2}$
I.P., diameter, inches.....	51
L.P., diameter, inches.....	78
Stroke of pistons, inches.....	48
Valves, H.P. (one for each cylinder), diameter, inches.....	19 $\frac{1}{2}$
I.P. (two for each cylinder), diameter, inches.....	18
L.P. (four for each cylinder), diameter, inches.....	18
Balance pistons, H.P., diameter, inches.....	6
I.P., diameter, inches.....	7 $\frac{1}{2}$
L.P., diameter, inches.....	7 $\frac{1}{2}$
Valve stems, H.P. (1), diameter, inches.....	2 $\frac{3}{4}$
H.P. (1), diameter through valve, inches.....	1 $\frac{7}{8}$
I.P. (2), diameter, inches.....	2 $\frac{3}{4}$
I.P. (2), diameter through valve, inches.....	1 $\frac{7}{8}$
L.P. (4), diameter, inches.....	2 $\frac{3}{4}$
L.P. (4), diameter through valve, inches.....	1 $\frac{7}{8}$
Main steam pipe (13 inches diameter) area cross section, square inches....	132.73
Exhaust pipes to I.P. cylinder, (1) 17 inches H.P. end, 17 inches I.P. } end, area of cross section, square inches.....	226.86
L.P. cylinder, (4) 15 inches I.P. end, (8) 11 inches.. }	706.50
L.P. end, area of cross section, square inches.....	759.88
condenser, (2) 19 inches diameter, area of combined cross section, square inches.....	566.77
Volume swept by H.P. piston (mean), per stoke, cubic feet.....	23.84
I.P. piston (mean), per stroke, cubic feet.....	56.09
L.P. piston (mean), per stroke, cubic feet.....	132.04
Net area of I.P. to H.P. piston.....	2.34
L.P. to I.P. piston.....	2.36

Net area of L.P. to H.P. piston.....	5.53
Clearances of H.P. cylinders, per cent.....top, 18.9; bottom,	22.8
I.P. cylinders, per cent.....top, 18.9; bottom,	24.7
L.P. cylinders, per cent.....top, 17.5; bottom,	22.9
Piston rods, diameter, inches.....	7½
length from piston to crosshead, feet and inches.....	6- 6½
Connecting rods, length from center to center, feet.....	8
diameter of upper end, inches.....	7⅞
diameter of lower end, inches.....	8½
crosshead bolts (2), diameter, inches.....	4½
crank-pin bolts (2), diameter, inches.....	4½
Crossheads, surface (ahead), square inches.....	459
(backing), square inches.....	357
pins, diameter, inches.....	9½
length, inches.....	14
Reversing gear, steam cylinder, diameter, inches.....	15
controlling cylinder, diameter, inches.....	7½
Crank shafts, diameter, inches.....	14½
axial hole, inches.....	7½
coupling discs, diameter, inches.....	29
thickness, inches.....	3½
bolts in one flange (6), diameter, inches.....	3½
journals, diameter, inches.....	14½
length, inches.....	16½
length of each section, feet and inches.....	8-10
Crank pins, diameter, inches.....	14½
length, inches.....	17
axial hole, inches.....	7½
Crank webs, width, inches.....	16½
thickness, inches.....	10
Thrust shaft, diameter, inches.....	14
diameter of coupling disc, inches.....	29
axial hole, inches.....	9
collars, number each shaft.....	11
diameter, inches.....	21½
thickness, inches.....	2
distance between, inches.....	3½
surface, total for both engines, square inches.....	4,600.64
length, feet and inches.....	15- 5½
Line shafts, diameter, inches.....	14
axial hole, inches.....	9
diameter of coupling discs, inches.....	29
length, feet and inches.....	31-10½
Propeller shafts, diameter, inches.....	14½
axial hole, inches.....	9½
Propeller shafts, outboard, length, feet and inches.....	26- 5½

Propeller shafts, outboard, coupling, diameter, inches.....	21
length, feet and inches.....	4- 8½
inboard, length, feet and inches.....	31-10
Stern bracket bearing, length, inches.....	48½
diameter, inches.....	16½
tube bearing, length, forward, inches.....	40½
aft, inches.....	42

Shafting and Bearings.—The crank shafts are of forged steel, and for each engine are made in three interchangeable and reversible sections, the cranks being 120 degrees apart, and for the ahead motion follow in the order H.P., I.P. and L.P. There is a 7½-inch axial hole through crank shaft and pin. The line, thrust and propeller shafting is hollow and of forged nickel-steel. The propeller shafts are fitted with a composition casing from inboard of the stern-tube stuffing box to the propeller hub. The propeller shaft is in two sections connected by an outboard sleeve coupling fitted near the after end of the stern tube, and protected by a water-tight covering. The thrust bearings are of the horseshoe pattern; the pedestals are of cast iron, the ends and side walls forming an oil trough; at each end there is a bearing, lined with white metal, for taking the weight of the shaft. The horseshoes are eleven in number and are of cast steel, faced with white metal, and fitted with oil cups and holes for the distribution of oil to the bearings. At each end of the bearing there is a divided stuffing box and gland to prevent the escape of oil. The pedestal is bolted to a cast-iron sole plate, fitted with wrought-iron wedges at each end of the pedestal for adjusting the bearing fore and aft.

Main Condensers.—There are two main condensers, one for each engine, the shells are of wrought-steel plate, with an angle-iron riveted around each end forming a flange for securing the water chests. The water chests and tube sheets are of composition. The circulating water passes through the tubes. Baffle, circulating and tube-supporting plates are fitted. There are by-pass valves in the after water chests to allow the water from the circulating pumps to pass directly overboard.

Diameter of shell (inside), feet and inches.....	5- 8½
Thickness of shell, inch.....	1½

Length over heads, feet and inches.....	13- 4
Tubes, diameter (outside), inch.....	$\frac{1}{8}$
length between tube sheets, feet and inches.....	11- 6
thickness, No. 18 B.W.G., inch.....	.049
number in each condenser.....	3,749
Cooling surface, each condenser, square feet.....	7,050
Total cooling surface, square feet.....	14,100
Ratio of total cooling to total heating surface.....	1 to 1.56

Main Air Pumps.—For each main engine there is a Worthington twin-cylinder, vertical, single-acting air pump. The steam cylinders are placed directly over the pump cylinders, the pump rods and piston rods forming a continuous length. The pumps are connected by means of a beam, which is pivoted at its center, and from which beam the valve motion is actuated. The beam receives its motion through links swinging from crossheads on the pump and piston rods. The pump valves are each made of three flat discs of rolled manganese-bronze.

Diameter of steam cylinders (2), inches.....	12
pump cylinders (2), inches.....	25
Stroke, inches.....	18
Diameter of piston rods, inches.....	$2\frac{7}{8}$
pump rods, inches.....	$2\frac{1}{4}$
Diameter of pump valves, inches.....	3, 4, $4\frac{1}{8}$
Ratio of volume swept by L.P. piston, net area, per stroke, to that of the two air-pump buckets, per stroke.....	13

Main Circulating Pumps.—For each condenser there is a centrifugal, double-inlet circulating pump, which is arranged to draw from the sea, bilge and main drain pipe, and to discharge either into the condenser or directly overboard. The sea and bilge injection valves are fitted with a self-locking arrangement so that both cannot be operated at the same time. One of these pumps was tested under conditions assimilated to that of drawing water from the bilge and discharging directly overboard, the length and size of the piping and the head at discharge being the same as would occur in actual service. The velocity at discharge was measured by a small propeller, and the results were well over their rated capacity of 10,000 gallons per minute.

Diameter of steam cylinders, inches.....	11
Stroke, inches.....	8
Diameter of pump runner, inches.....	42
Width of runner, inches.....	8½
Diameter of inlet and of outlet nozzle, inches.....	15½

Auxiliary Condensers.—There is in each engine room an auxiliary condenser connected with the auxiliary exhaust pipes. The heads and shell are of composition and the tube sheets of rolled brass. Each has a Worthington horizontal, duplex, combined air and circulating pump, the steam cylinders being between the water cylinders, and all the pistons being on one rod. The tubes are arranged and packed as in the main condensers.

Cooling surface, one condenser, square feet.....	801
Diameter of steam cylinders, inches.....	7½
circulating-pump cylinders, inches.....	8½
air-pump cylinders, inches.....	8½
Stroke, common, inches.....	10

Feed-Water Heaters.—In each engine room there is a feed-water heater which is similar in construction to a condenser. The auxiliary exhaust pipe has a by-pass valve, so that the exhaust steam may be passed around the tubes of the heater and thence to the condenser. The heaters are located between the feed pumps and the feed main, and the valves are so arranged that the feed water can pass directly to the feed main without passing through the heaters. The heating surface is 496.5 square feet for each heater. The tubes are 1 inch in outside diameter, No. 13 B.W.G. in thickness, and are expanded into the tube sheet. The tubes are tinned inside and out.

Screw Propellers.—The propellers are rights and lefts, of manganese-bronze, each with three adjustable blades bent back 30 inches. They are true screws, with the pitch adjustable from 16 to 18 feet. Each boss is secured to the shaft by two feather keys and a wrought-steel nut screwed on and locked in place. The end of the hub is covered with a composition cap. The blades and boss are tinned, and the outboard sections of propeller shafts are protected by a covering of insulated copper wire, wound tightly around the shaft casings.

Forward.

Number of blades.....	3
Diameter, feet and inches.....	16- 9
of hub, feet and inches.....	4- 4½
Length of hub, feet and inches.....	3- 1
Pitch as set, feet and inches.....	17- 3
Greatest width of blade, feet.....	5
Helicoidal area of each screw, square feet.....	84.2
Projected area, square feet.....	69.2
Disc area, square feet.....	220.35
Pitch ÷ diameter.....	1.03

BOILERS.

There are three double-ended and two single-ended steel boilers of the horizontal, return, fire-tube type, all 15 feet 8 inches in diameter. Each double-ended boiler has eight and each single-ended boiler four corrugated furnaces. The shell of each double-ended boiler is made up of three courses of three plates each; the longitudinal joints are treble riveted with double butt straps; the circumferential joints are lapped and treble riveted, and the heads lapped and double riveted. The shell of each single-ended boiler is in one course of four plates, double butt strapped and treble riveted, the joints with the head lapped and double riveted. The joints in the furnaces and combustion chambers are single riveted. The heads of all boilers are curved at the top to a radius of 3 feet 7 inches.

The furnaces are fitted with the ordinary cast-iron fixed grate bars. Each double-ended boiler has four 4½-inch spring safety valves, two in one case, and each single-ended boiler two 4½-inch safety valves in one case. The internal feed pipes are fitted with suction branches to the bottom of the boilers, the combined feed and "circulated" water being discharged near the water level through down-pointing branches. The auxiliary feed pumps may also be used to circulate the water. The tubes in all boilers are of knpbbled charcoal iron.

The boilers are placed fore and aft in four water-tight compartments, the two single-ended boilers occupying the after port compartment. The passageways are outboard and alongside of the boilers, with passage amidships connecting the port engine room with the port after fire room. There are two athwartship fire

rooms in each boiler compartment, and eight fire rooms in all. There are two circular smoke pipes. The working pressure is 180 pounds per square inch.

DOUBLE-ENDED BOILERS.

Length, feet.....	one of 21 and two of 19
Diameter, outside of all, feet and inches.....	15- 8
Thickness of shell and heads at top, inches.....	1 $\frac{7}{8}$
heads, bottom, inch.....	$\frac{3}{4}$
tube sheets, inch.....	front $\frac{7}{8}$, back $\frac{3}{4}$
furnaces, inch.....	$\frac{9}{16}$
Combustion chambers, number in each boiler.....	4
thickness of plates, inch.....	$\frac{9}{16}$
depth at top, inches.....	27 $\frac{1}{2}$
Furnaces, greatest internal diameter, feet and inches.....	3- 5 $\frac{1}{8}$
least internal diameter, feet and inches.....	3- 3
length of grate, feet and inches.....	6- 7
number in each boiler (corrugated).....	8
Tubes, outside diameter, inches.....	2 $\frac{1}{4}$
length between tube sheets, 21-foot boiler, feet and inches...	7- 7 $\frac{3}{8}$
19-foot boilers, feet and inches...	6- 7 $\frac{3}{8}$
number of ordinary.....	816
number of stay.....	332
spaced vertically, inches.....	3 $\frac{1}{4}$
horizontally, inches.....	3 $\frac{1}{4}$
thickness of ordinary, B.W.G. No. 10, inch.....	.132
stay, B.W.G. No. 6, inch.....	.203
Diameter of rivets in shell sheets, inches.....	1 $\frac{5}{8}$
screw stays, inches.....	1 $\frac{1}{2}$
Number and diameter of through upper braces, inches.....	10 of 2 $\frac{3}{4}$
lower braces, inches.....	2 of 1 $\frac{1}{4}$
braces from head to back tube sheets, inches.....	15 of 1 $\frac{1}{4}$
Heating surface, tube, square feet, 19-foot boiler, 4,473; 21-foot boiler,	5,150
plate, square feet, 19-foot boiler, 847; 21-foot boiler,	901
total, square feet, 19-foot boiler, 5,320; 21-foot boiler,	6,051
Grate surface, square feet.....	171.2
Area through tubes, square feet.....	23.8
over bridge walls, square feet.....	24.5
Volume of furnaces and combustion chambers above grates, 21-foot boiler, cubic feet.....	725
Volume of furnaces and combustion chambers above grates, 19-foot boiler, cubic feet.....	699
Steam room, 4 inches above highest heating surface, 21-ft. boiler, cu. ft..	808.5
19-ft. boiler, cu. ft.,	716

AUXILIARY STEAM AND EXHAUST PIPES, FIRE ROOMS.

Water surface, 4 ins. above highest heating surface, 21-ft. boiler, sq. ft..	284.75
19-ft. boiler, sq. ft..	258
Smoke pipes (2), diameter, feet and inches.....	8-0
area of both, square feet.....	100.6
height above lowest grates, feet.....	87
Number and diameter of safety valves (2 on one base), inches.....	4 of 4½
Diameter of boiler main stop valves, inches.....	9½
auxiliary stop valves, inches.....	1
Totals for three boilers :	
Heating surface, tube, square feet.....	14,096
plate, square feet.....	2,595
total, square feet.....	16,691
Grate surface, square feet.....	513.6
Area through tubes, square feet.....	71.4
over bridge walls, square feet.....	73.5
Volume of furnaces and combustion chambers above grates, cu. ft.	2,123
steam room, cubic feet.....	2,240.5
Area of water surface, square feet.....	800.75
Ratios :	
Tube H.S. to G.S.....	27.44
Plate H.S. to G.S.....	5.05
Total H.S. to G.S.....	32.40
Area through tubes to G.S.....	.139
Volume of furnaces and combustion chambers above grates to G.S..	4.13
Steam room per square foot of G. S.....	4.36

SINGLE-ENDED BOILERS.

Length, feet and inches.....	9-11½
Diameter, outside, feet and inches.....	15- 8
Thickness of shell, inches.....	1⅞
heads, top, inches.....	1⅞
bottom, inch.....	¾
tube sheets, inch.....	front ⅞, back ¾
furnaces, inch.....	1⅞
Combustion chambers, number in each boiler.....	2
thickness of plates, inch.....	1⅞
depth at top, inches.....	27½
Furnaces, greatest internal diameter, feet and inches.....	3- 5½
least internal diameter, feet and inches.....	3- 3
length of grate, feet and inches.....	6- 7
number in each boiler, corrugated.....	4
Tubes, outside diameter, inches.....	2½
length between tube sheets, feet and inches.....	6- 6½
Tubes, number of ordinary.....	428
stay.....	164
spaced vertically, inches.....	3½

Tubes, spaced horizontally, inches.....	3½
thickness of ordinary, B.W.G. No. 10, inch.....	.132
stay, B.W.G. No. 6, inch.....	.203
Diameter of rivets in shell sheets, inches.....	1 ⁵ / ₁₆
screw stays, inches.....	1½
Pitch of screw stays, inches.....	7 and 7½
Number and diameter of through upper braces, inches.....	10 of 2½
lower braces, inches.....	3 of 1½
braces from head to back tube sheets, inches,	14 of 1½
Heating surface, tube, square feet.....	2,280
plate, square feet.....	426.4
total, square feet.....	2,706.4
Grate surface, square feet.....	85.6
Area through tubes, square feet.....	12.42
over bridge walls, square feet.....	12.25
Volume of furnaces and combustion chambers above grates, cubic feet,	349
Steam room, water four inches above highest heating surface, cu. ft.,	355
Water surface, water four inches above highest heating surface, sq. ft.,	116
Number and diameter of safety valves (2 on one base), inches.....	2 of 4½
Diameter of boiler stop valves, inches.....	7
auxiliary stop valve, inches.....	6
Totals for two boilers:	
Heating surface, tube, square feet.....	4,560
plate, square feet.....	852.8
total, square feet.....	5,412.8
Grate surface, square feet.....	171.2
Area through tubes, square feet.....	24.84
over bridge walls, square feet.....	24.50
Volume of furnaces and combustion chambers above grates, cubic feet,	698
steam room, cubic feet.....	710
Area of water surface, square feet.....	232
Ratios:	
Tube H.S. to G.S.....	26.63
Plate H.S. to G.S.....	4.92
Total H.S. to G.S.....	31.62
Area through tubes to G.S.....	.145
Volume of furnaces and combustion chambers above grates to G.S..	4.07
Steam room per square foot of G.S.....	4.14

ALL BOILERS.

Heating surface, tube, square feet.....	18,656
plate, square feet.....	3,447.8
total, square feet.....	22,103.8
Grate surface, square feet.....	684.8
Area through tubes, square feet.....	96.24
over bridge walls, square feet.....	98.00

Volume of furnaces and combustion chambers above grates, cubic feet,	2,821
steam room, cubic feet.....	2,950.5
Area of water surface, square feet.....	1,032.75
Ratios:	
Tube H.S. to G.S.....	27.24
Plate H.S. to G.S.....	5.03
Total H.S. to G.S.....	32.28
Area through tubes to G.S.....	.14
Volume of furnaces and combustion chambers above grates to G.S..	4.11
Steam room per square foot of G.S.....	4.31

Forced Draft.—The closed fire-room system of forced draft is used. The air is supplied by eight Sturtevant blowers, one in each fire room. The fans are driven by two-cylinder, vertical, simple, enclosed engines with cranks at 180 degrees.

Diameter of steam cylinders, inches.....	5
Stroke, inches.....	4
Diameter of fan, inches.....	60
Width of fan at rim, inches.....	14
Area of induction nozzle, square inches.....	1,060.7
Area of eduction nozzle, square inches.....	2,220

Feed Pumps.—There are two main and four auxiliary feed pumps, all of the Admiralty type, Worthington duplex, and all of the same size, 10 inches by 7 inches by 12 inches, with a capacity of 400 gallons per minute. The main feed pumps are located one in each engine room and draw water from the feed tanks and air-pump suctions and deliver to the boilers; the auxiliary feed pumps draw from the feed tanks, the air-pump suctions, the sea, the drainage system and the boilers, and discharge into the boilers, fire main or overboard. These pumps are located one in each of fire rooms Nos. 3, 4, 5 and 6. The discharges of the main and auxiliary pumps are not connected, the auxiliary feed pumps only feed through the auxiliary feed main. In the port after fire room there is a small duplex Worthington pump, 4½ inches by 3 inches by 4 inches, of 65 gallons per minute capacity, for feeding the auxiliary boilers in port.

Fire and Bilge Pumps.—In each engine room there is a vertical, duplex Worthington pump which draws from the sea, the

bilge and the drainage system, and delivers into the fire main or outboard. The steam cylinders are 10 and the water cylinders 7 inches in diameter; stroke, 12 inches.

Water-Service Pumps.—In each engine room there is a vertical, duplex Worthington pump which draws from the sea, and delivers into the water-service pipes, the distiller circulating pipes, and into the fire main. These pumps have a capacity of 400 gallons per minute; size, 10 inches by 7 inches by 12 inches.

Bilge and Sanitary Pumps.—There are two single-acting plunger pumps on each main-engine shaft, driven by eccentrics; one pump on each shaft is arranged to draw from the bilge and discharge overboard; the other to draw from the sea, and discharge into the flushing main.

Grease Extractors.—A grease extractor is fitted on the discharge of both main feed pumps. It is similar in action to a Macomb strainer; the cartridge is perforated and covered with burlap, through which the water filters. By-pass valves are fitted so that the extractors may be overhauled without interrupting the boiler feed.

Feed Tanks.—There is a feed tank of 2,000 gallons capacity in each engine room. A part of the tank is fitted as a filter, into which the water from the air pumps is delivered. The filter has a movable cover and is provided with sponges. Each tank has a manhole, glass water gage, shut-off and drain cocks. An overflow pipe is fitted and so arranged that any water passing down it may be seen. Each feed-pump suction is provided with a balance valve operated by a float in the feed tank, and so arranged that no air will enter the feed pipes.

Ash Hoists.—In each fire-room hatch there is a Williamson Bros. double, reversible ash hoist, by means of which one bucket of ashes of 300 pounds (with a steam pressure of 80 pounds) can be hoisted in five seconds. The steam cylinders are $4\frac{1}{2}$ inches in diameter, with a stroke of $4\frac{1}{2}$ inches.

Steam Traps.—The separators, the jackets, the main and auxiliary steam pipes, the radiators, and all places where condensed steam can accumulate are fitted with drain pipes and locks, or valves, and with automatic traps which discharge into the feed

tanks. The traps are provided with by-pass pipes and valves for convenience in overhauling.

Engineer's Workshop.—The workshop is situated on the splinter deck, just forward of the engine rooms. It is fitted with a vertical engine, 7 inches by 7 inches, a 24-inch lathe, a 14-inch screw-cutting lathe, a shaping machine, a double-gearred drilling machine, a hand drill press, combined punch and shears, and emery wheels.

Distilling Apparatus.—There are two Williamson Bros. straight-tube distillers, and two evaporators, Bureau pattern, with a combined capacity of 7,500 gallons of potable water at a temperature of 90 degrees Fahrenheit per day of 24 hours. The water-service pumps are used for the distiller-circulating water. There are two distiller feed pumps of the Worthington horizontal, duplex type, two combined brine and fresh-water pumps of the same type, and two trap pumps of the same type, except that they are vertical. There are two filters and two water meters fitted.

Ice Machine.—There is an Allen dense-air ice machine capable of producing the cooling effect of one ton of ice per day; steam cylinder, 9 inches; air-compressor cylinder, $5\frac{3}{4}$ inches, and air-expander cylinder, $4\frac{3}{4}$ inches in diameter; stroke, 10 inches. The circulating, water and primer pumps are single acting, each $1\frac{1}{8}$ inches in diameter and 10 inches stroke. The cooling pipes connect to the ice tank, to the refrigerating room and to the scuttle butt.

Ventilating Fans.—There is in each engine-room hatch a 50-inch steel-plate fan, driven by a 12-H.P. electric motor, for engine-room ventilation only. For the general ventilation of the ship there are eight 50-inch steel-plate fans, located two on the berth deck and six on the splinter deck, for supplying air to the various parts of the ship. These fans are each driven by 12-H.P. electric motors. There are also three small exhausters driven by 3-H.P. electric motors, located two on berth deck and one in the steering-engine space, for exhausting air from the crews' W. C., officers' W. C., and the steering-engine room. All the fans were furnished by the Sturtevant Company, and the electric driving motors by the General Electric Company.

Steam Cutters.—There are two steam cutters, one 40 and the other 33 feet long. They have Ward boilers, type 5-G-1, round, and 5-D, square, respectively, compound engines and keel condensers. The cylinders for the 40-foot cutter are 5 and 10½ inches in diameter by 8 inches stroke, and those for the 33-foot cutter, 4 and 8 inches in diameter by 6 inches stroke.

, *Telegraphs and Revolution Indicators.*—There is a Cory mechanical telegraph in each engine room connected to transmitters in conning tower and pilot house, and a mechanical gong in each engine room with bell pulls in the pilot house and on the flying bridge near the after bridge. Mechanical tell-tales are fitted in the conning tower and in the pilot house to show the direction of revolution of the main engines. In each engine room there is a mechanical indicator to show the relative speed and direction of revolution of the propellers on one dial.

Telephones and Voice Pipes.—For communication between the various parts of the ship there is a complete system of telephones and voice pipes with call bell. All battle stations are connected direct to the conning tower and central station. The central station is provided for use in battle and in case of accident to conning tower.

Steering Engine.—On the after platform deck there is a Williamson Bros. combined hand and steam-steering engine: cylinder, 14 inches diameter; stroke, 11 inches. The engine is connected to a horizontal fore-and-aft shaft, on the after end of which there is a right and left-hand screw. The screw works in the crossheads, one on the starboard and one on the port side, the rudder yoke being connected by rods to these crossheads. With the steam gear the rudder can be put from hard over to hard over in 20 seconds when the ship is going full speed. The engine is controlled from the conning tower and the pilot house by means of a hydraulic telemotor or by wire ropes.

Steam Windlass.—In the windlass house forward of the forward turret there is a steam windlass. The engine is reversible, double-cylinder, vertical, direct-acting, with cylinders 15 inches in diameter, and a stroke of 14 inches. The windlass is fitted with two wild cats to take the chains.

Steam Winch.—There is a double-cylinder steam winch in the windlass house forward of forward turret. The cylinders are 8 inches in diameter; stroke, 8 inches. The winch is fitted with two drums for taking hawsers.

Electric Plant.—The installation consists in general of seven generating sets, 750 incandescent lights, 4 search lights, 2 sets of signalling apparatus, 1 main switch board, 3 main distribution boards, 7 auxiliary distribution boards, together with the necessary wire, wiring accessories, molding and fixtures and the motors given in table. The seven generating sets were made by the General Electric Company. In each set there is a 50-kilowatt dynamo of multipolar type, having a capacity of 625 ampères at 80 volts, compound-wound six-pole. The engines driving the dynamos are compound, tandem, vertical, inverted; diameter of cylinders, $10\frac{1}{2}$ and 18 inches; stroke, 8 inches. The engines are designed to run with full load at 310 revolutions per minute with 110 pounds steam pressure. The bed plate is common to both engine and dynamo. The incandescent lights are of 16 and 32 candle power, designed for 80 volts.

Each of the dynamos are connected to the main switch board, and to the equalizer board. The main switch board, containing only the panels for the dynamos and lighting and motor bus bars, distributes the current to the main distribution boards, which contain the switches of lighting circuits and motor feeders. The auxiliary distribution boards receive current from main distribution boards, and are for motors only.

The ship is wired on the three-wire system, with 80 volts between neutral wire and each leg, and 160 volts between outside legs. This gives a smaller amount of copper than would be necessary in the two-wire system and a wider range in speed of the motors, which are generally wound for both 80 and 160 volts.

There are four search lights, made by the General Electric Company, two mounted on a platform on the mainmast and two on a platform on the foremast. The projectors are 30 inches in diameter, and hand controlled. All lamps are of the horizontal type with combination hand or automatic feed, and designed for

a current of 75 to 90 ampères at about 50 volts. The carbon holders are adjustable and the life of the carbon is six hours.

The signal apparatus is in two sets, one for each mast, of the usual Ardois type, and consists of four double signal lanterns to each set, cable connections and key board on the forward and after bridges.

Electric speed indicators and transmitters are fitted in the pilot house and in conning tower; also, electric helm indicators and electric steering-engine telegraphs.

There are thermostats in each coal bunker and in certain store rooms, with an annunciator on bulkhead forward of cabin.

ELECTRIC MOTORS.

Name.	Number.	Horsepower.	Revolutions.	Volts.	Ampères.
Upper-deck winches.....	4	25	320	80 or 160	150
Main-deck winches.....	2	25	320	80 or 160	150
Forward boat cranes.....	2	50	400	80 or 160	265
After boat cranes.....	2	20	350	80 or 160	111
Ventilating fans.....	10	12	500	80 or 160	64
Small exhausters.....	3	3	1,030	80	35
Turret turning.....	4	50	400	80	600
13-inch ammunition hoist.....	4	20	350	80 or 160	111
8-inch ammunition hoist.....	4	6	375	80 or 160	37
5-inch and 6-pdr. chain ammunition hoist...	10	3.75	375	80 or 160	22
6-pounder winch ammunition hoist.....	2	6	375	80 or 160	37
13-inch elevating.....	4	2.5	300	80	30
13-inch rammer.....	4	5	775	80	60

Pneumatic Plant for Torpedoes.—There are two 9½-inch by 4-inch duplex torpedo compressors with the three-stage air cylinders and two accumulators. Both compressors and accumulators are on the splinter deck, one of each forward and aft. The compressors were made by the Rand Drill Company.

OFFICIAL SPEED TRIAL.

The official speed trial took place off the New England coast on Monday, September 25, 1899. It consisted of two runs over a measured course of 33 nautical miles. The time occupied in

making the first run (to the northward,) was 1 hour 54 minutes and 19 seconds, and the return run, 2 hours and 55.5 seconds. Total time in making the two runs, 3 hours 55 minutes 14.5 seconds. Tidal corrections applied to the trial run made the true mean speed 16.816 knots. The weather was fair, brisk to fresh breeze from southeast, and considerable sea while going north; strong southeast wind with lumpy sea and hazy weather on return run. At the end of run, with both engines full speed ahead, the helm was put hard to port and the turn made in two and one-half times her length and came inside her own circle. All boilers were in use under forced draft, all fire rooms being connected. All the steam generated was used by the main engines and auxiliaries except that used in the steering engine, ice machine, and in the engine for the dynamo to light the engine and boiler compartments. The coal used was hand-picked Nuttallberg coal from the New River region. The boilers and engines worked well throughout the run barring one accident (the bursting of several tubes in the port feed-water heater), which happened during the run north and which indisputedly prevented the ship from making an average of at least 17.25 knots. No water was used at any time during the run on the main engines. All the auxiliaries worked well.

The engineer force during the trial consisted of the following :

- 7 engineers.
- 6 water tenders.
- 10 machinists.
- 24 oilers.
- 6 apprentices.
- 3 dynamo oilers.
- 3 pumpers.
- 3 storekeepers.
- 3 ice-machine men.
- 29 firemen.
- 29 coal heavers.
- 5 boiler makers.

After the trial the boilers, main engines and auxiliaries were examined and reported in good condition, except the feed-water heater above mentioned.

OFFICIAL TRIAL TRIP OVER COURSE FROM CAPE ANN TO CAPE PORPOISE.
DISTANCE, 33 NAUTICAL MILES AND RETURN. SEPTEMBER 25, 1899.

No. station.	Chronometer time.			Elapsed time.	Speed, knots.	Formula used:
						$D = \text{Distance between stations.}$ $E = \text{Elapsed time in minutes.}$ $S = \text{Speed.}$
1	<i>h.</i> 3	<i>m.</i> 23	<i>s.</i> 10.5	 22 <i>m.</i> 37.5 <i>s.</i>	...	$S = \frac{D \times 60}{E} = \frac{6.6 \times 60}{22.625} = \frac{396}{22.625} = 17.50$
2	3	45	46	22.625 22 <i>m.</i> 37.5 <i>s.</i>	17.50	
3	4	08	25.5	22.625 23 <i>m.</i> 10 <i>s.</i>	17.50	
4	4	31	35.5	23.166 23 <i>m.</i> 4.5 <i>s.</i>	17.09	
5	4	54	40	23.075 22 <i>m.</i> 49.5 <i>s.</i>	17.16	
6	5	17	29.5	22.825 1 <i>h.</i> 54 <i>m.</i> 19 <i>s.</i>	17.35	
					17.32*	

RETURN.

6	5	41	9.5	24 <i>m.</i> 3 <i>s.</i>	
5	6	05	12.5	24.05 23 <i>m.</i> 49 <i>s.</i>	16.47
4	6	29	1.5	23.816 24 <i>m.</i> 11 <i>s.</i>	16.63
3	6	53	12.5	24.166 24 <i>m.</i> 37.5 <i>s.</i>	16.385
2	7	17	50	24.625 24 <i>m.</i> 15 <i>s.</i>	16.08
1	7	42	05	24.25 2 <i>h.</i> 0 <i>m.</i> 55.5 <i>s.</i>	16.33
					16.379*

* Average speed.

$$\begin{array}{r} 17.32 \\ 16.38 \\ \hline 2) 33.70 \end{array}$$

16.85 Average speed for both ways.

US B.S. No. 5 Kearsarge

Card No. 6 - Starb'd. Engine, Sept. 25, 1899 - OFFICIAL TRIAL

Corrected for actual Cylinder Dimensions.

NO LIVE STEAM ADMITTED TO I.P. CYLINDER.

STEAM PRESSURES

AT BOILER	Gauge	adjusted
• BOILER	170	184.7
• I. RECEIV.	63	77.7
• 2.	12	26.7
VACUUM	24.5	31.2" Hg.

H.P. Cyl.

SCALE - 90

MEP IND. 32.157

MEP 31.125

M.E.P.

EACH Cylinder. reduced to I.P.

H.P. 76.976 13.912 88.88%

I.P. 24.908 14.828 55.00%

L.P. 13.023 13.625 38.16%

TOTAL 42.365 100.00%

I.P. Cyl.

SCALE - 40

MEP IND. 24.908

MEP 24.908

Revolutions 110

Piston speed 880

L.P. Cyl.

SCALE - 20

MEP IND. 13.023

MEP 13.023

I. H.P.

H.P. 1764.0

I.P. 1880.0

L.P. 1787.5

TOTAL 5431.5 I.H.P.

CONTRACT TRIAL DATA.

Draught of water, beginning of trial, forward, feet and inches.....	23- 4
aft, feet and inches.....	23-10
end of trial, forward, feet and inches.	23- 2
aft, feet and inches.....	23- 8
mean, forward, feet and inches.....	23- 3
aft, feet and inches.....	23- 9
average on trial, feet and inches.....	23- 6
Displacement (mean), tons.....	11,550
Area immersed midship section, square feet.....	1,618
Wetted surface, square feet.....	33,700
Mean speed, knots per hour.....	16.816
I.H.P., main engines only.....	11,674.3
main engines, air, circulating and feed pumps. (B).....	11,787.856
all machinery in use.....	11,954.37
Speed ^s × area immersed midship section ÷ I.H.P. (B).....	652.67
Speed ^s × displacement ^{*†} ÷ I.H.P. (B).....	206.11
I.H.P. per 100 square feet wetted surface, (B).....	34.98
Screw propellers, number.....	2
number of blades each.....	3
diameter, feet and inches.....	16- 9
helicoidal area, square feet.....	84.2
pitch on trial, feet and inches.....	17- 3

SYNOPSIS OF STEAM LOG.

	Starboard.	Port.
Slip of screws, per cent.....	12.93	13.3
Revolutions of main engines per minute.....	113.6	114.5
mean.....		114
Piston speed, feet per minute.....	908.8	916
Steam pressure (mean) at engines.....	172.4	169
first receiver, absolute.....	79.6	82.4
second receiver, absolute.....	28	29.7
Vacuum in condenser, inches.....	24.6	24.5
Throttle-valve opening.....		Wide.
Steam cut-off in fraction of stroke from beginning, { H.P.	.67	.66
I.P.	.72	.71
L.P.	.70	.69
Temperatures in degrees Fahrenheit, { Engine rooms.....		88.1
Injection	61	61
Discharge.....	125.3	125.3
Feed at tank.....	124.7	139.8
Air pressure in fire rooms in inches of water.....		1.089
Mean effective pressures, { H.P.	79.75	79.78
I.P.	36.94	35.75
L.P.	14.63	14.635
Aggregate equivalent pressure referred to L.P. piston.....	44.74	44.23

		Starboard.	Port.
Revolutions or double strokes per minute,	Main air pumps.....	17.1	27.4
	Main circulating pumps.....	134.6	178
	Main feed pumps, average.....		34
	Eight forced-draft blowers, av'ge..		427
I.H.P.	H.P. cylinder.....	1,887.07	1,894.63
	I.P. cylinder.....	2,055.80	1,996.45
	L.P. cylinder.....	1,916.92	1,923.43
	Collective, each main engine.....	5,859.79	5,814.51
	Main air pumps, each.....	9.116	10.54
	Main circulating pumps.....	11.52	22.38
	Four main boiler feed pumps.....		60
	Eight forced-draft blowers.....		76.512
	Other auxiliaries.....		90
	Collective, main engines, air, feed and circulating pumps (B).....	11,787.85	
Total all machinery in use.....		11,954.37	
Square feet cooling surface (2) main condensers.....		14,100	
per I.H.P. main engines.....			1.18
Heating surface in use.....		22,103.8	
Grate surface in use.....		684.8	
Square feet total H.S. per total I.H.P.....			1.849
I.H.P. per square foot grate surface, total.....			17.45
ton machinery (penalty weight).....			10.64
Kind of coal.....		New River (picked).	
Pounds per hour, total.....		28,209.5	
I.H.P., all machinery.....			2.36
main engine, auxiliary, circulating and feed pump.....			2.39
square foot grate surface.....			41.18
heating surface.....			1.276