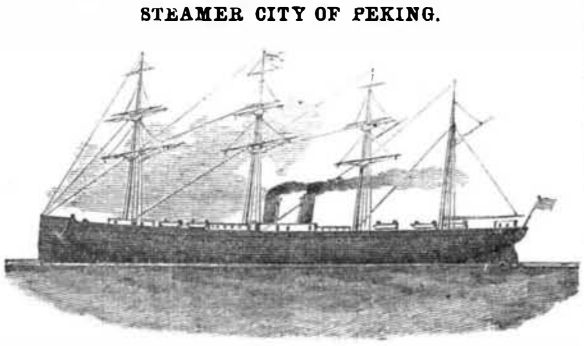
disk, as computed in my investigations, we are now able, by the aid of high powers of the microscope and under favorable circumstances, positively to distinguish stains produced by human blood from those caused by the blood of any one of the animals just enumerated; and this even after a lapse of five years (at least) from the date of their primary production."

THE ENGINEER'S TRIAL TRIP OF THE PACIFIC MAIL STEAMER CITY OF PEKING.



About fifteen hundred guests assembled, in response to invitations issued by the Pacific Mail Steamship Company, on July 22, to witness the trial of the company's new steamer City of Peking. This vessel is one of a pair, built by Messrs. John Roach & Son, in their yard at Chester, Pa., during the last year. The mate, City of Tokio, has been launched and is now receiving her machinery and equipment at the Morgan Iron Works, foot of East 9th street, New York city. These vessels were designed to meet the requirements of a law passed in 1872, granting the company a subsidy for carrying the United States mails between the United States and China, but stipulating that they should be carried in American built iron vessels of more than five thousand tuns burden. The following are the principal dimensions of the ship:

Length over all, 423 feet; length on water line, 407 feet; beam, 48 feet 9 inches; depth of hold, 38 feet 6 inches; tunnage (registered), 5,080 tuns; draft of water when loaded, forward 22 feet, aft 24 feet; displacement when loaded deep, 7,600 tuns; midship section, 930 square feet; total weight of iron used in construction of ship 2,400 tuns; thickness of iron in skin of ship, $\frac{7}{8}$ to 1 inch; tuns of space occupied by machinery, 1,120.

There are six watertight compartments. Three of the four masts are of iron, and the after or jigger mast is of wood. The total area of canvas that can be spread is 2400 yards.

The ship is propelled by two pairs of compound engines, each pair having two cylinders: Diameter of high pressure cylinders, 51 inches; diameter of low pressure cylinders, 88 inches; stroke of pistons, 4 feet 6 inches. The object of using two pairs of engines is to guard against having the ship disabled if one engine should break down. As the ship has to make a trip of more than five thousand miles, through an ocean which is almost always in a perpetual calm, the breakage of one pair of engines might necessitate her to make her way, under sail alone, twenty-five hundred miles to the nearest port. But now, if any accident (with the single exception of breaking the crank shaft of the after engine or the line shaft or screw) happens, the remaining engine will suffice to bring the ship into port at a very slightly reduced speed. In order to avoid as far as possible the liability of breaking the crank shaft, it has been made in excess of strength, the diameter being 18 inches (in place of $17\frac{1}{2}$ inches as it would usually have been made), giving an excess of strength of 8 per cent over the usual practice.

The object in using a pair of cylinders in place of a single one was to divide the maximum strain upon the machinery into two portions, which are successively applied as each engine passes the center, thus allowing the machine to be built lighter, and still to retain the advantage of a high boiler pressure and great expansion, and to obtain as good or better economy than can be had in a single cylinder.

The general style of the engines is of the type developed by the late John Elder, of Glasgow, Scotland, having two cylinders connected to cranks at right angles, and an intermediate reservoir called a receiver. The steam enters the high pressure cylinders and follows the piston through about $\frac{1}{4}$ of the stroke, at a pressure of about 50 lbs., the difference between this and the boiler pressure of 60 lbs. having been lost in the friction of the steam pipe and the intricate passages in the valves. The steam is expanded in the high pressure down to 8 lbs. above the atmosphere, and is exhausted into the receiver at a pressure of 5 lbs. above the atmosphere. From the receiver it is admitted into the low pressure cylinder during nearly $\frac{1}{2}$ of the stroke, and is still further expanded to 7 lbs. below the atmosphere or an absolute pressure of nearly $7\frac{1}{2}$ lbs., where it is exhausted into the condenser, giving a total measure of expansion of nearly 9 times. In order to obtain this in a single cylinder, the steam would have to be cut off at less than $\frac{1}{12}$ of the stroke, and the variation of pressure would be from 68 lbs. to $6\frac{1}{2}$ lbs. per square inch, in place of from 50 to 5 in the one cylinder, and from 15 to 5 in the other, as is now the case.

The steam to work these engines is furnished by 10 cylindrical boilers, having each 3 internal cylindrical furnaces. The products of combustion return through tubes above the furnace, each furnace having its own nest of tubes, separated from the others by water legs. The steam passes through two superheaters on its way to the engine, where it is freed from the water held in mechanical suspension, and slightly superheated. The boilers are arranged in two sets, each set having its own superheater and smoke stack, coal bunker, feed pipes, and all fittings complete, as if placed in separate ships. The following are the principal dimensions of the boilers: Diameter, 13 feet; length, 10 feet 6 inches; diameter of furnaces, 3 feet 2 inches; length of grate bar, 5 feet 6 inches; diameter of tubes, 3 to $3\frac{1}{4}$ inches; length of tubes, 7 feet 6 inches; thickness of shell, $\frac{7}{8}$ inch; thickness of furnace, $\frac{1}{2}$ inch; diameter of smoke stack, 8 feet 6 inches; hight of smoke stack, 70 feet; total grate surface, 520 square feet; total heating surface, 16,500 square feet; total superheating surface, 1,600 square feet.

It will be seen from the foregoing that, with the exceptions of the late Ville du Havre and the Great Eastern, the City of Peking is the largest trading ship yet built. The Great Eastern, on account of the tremendous space occupied by her machinery, did not prove a commercial success until she was employed in laying telegraph cables. The Ville du Havre was wrecked too early in her career as a screw vessel to determine her economy; but she was increased in size, after having been run a number of years, with the expectation of an improvement. The following comparison of the two ships shows that the City of Peking is not an experiment in marine engineering, as the managers of the French line gave their ship the same proportions after years of trial, although both vessels were being constructed independently at the same time

	City of Peking	Ville Du Havre
Length	423 feet	423 feet
Beam	48 feet 9 inches	49 feet
Tunnage	5,080 tuns	5,086 tuns
Draft	22 to 24 feet	22 to 24 feet
Diameter of screw	20 feet 3 inches	19 feet 6 inches
Pitch of screw (mean)	30 feet	29 feet 6 inches
Grate surface	520 square feet	532 square feet
Total length of ship occupied by machinery	92 feet	90 feet

The results of experiment may be more plainly seen by reasoning from the following facts: 1. The cost of a ship depends upon her tunnage or displacement. 2. The cost of fuel to propel her at a given speed is proportional to the square of the cube root of the displacement.

Take then the cases of two ships, to make a voyage of 5,000 miles at a speed of 15 knots per hour; and we have the following.

Tunnage	5080 tuns	2600 tuns
Displacement	7200 tuns	3600 tuns
Power required	5270 horse	3400 horse
Space occupied by machinery and coal	2130 tuns	1380 tuns
Available space for cargo and crew	2950 tuns	1220 tuns
Ratio of paying load	100	41
Ratio of cost to run	100	64
Ratio of first cost	100	52

Thus, it appears that, as the size of a ship increases, the economy increases, from the less cost of fuel to propel her in proportion to the paying load that she can carry, without considering the less proportionate cost of officers and crew for a larger ship. The size of ocean steamers has been continually increasing since their introduction, wherever they are able to run full and can be rapidly discharged and loaded. In addition to their economy, the large ships are much more comfortable for passengers on account of their less motion in rough weather.

The City of Peking will take the place, on the China and Japan route, of a vessel of 3,500 tuns burden. She is fitted for 150 cabin and 1,800 steerage passengers. The saloon and state room accommodations are as luxurious as in any ship entering the harbor of New York, while the comforts of the steerage are probably in excess, as will be appreciated by any one noticing the hight between decks, 8 feet, and the numerous air ports, whose hight above the water line at deep draft will allow of their being kept open in smooth weather. There is a Root's rotary exhauster, worked by a separate engine placed in the engine room, from which pipes are led into the most inaccessible portions of the hold and through the steerage, to withdraw the foul air and gas which would otherwise accumulate, its place being supplied by fresh air from the deck. The application of this exhauster is an experiment on merchant vessels, but it is believed that it will mitigate the poor ventilation incident to all ships, and the tendency of the inside of the skin of the ship to sweat, sometimes a serious objection to iron ships in warm climates.

The diagram shows the arrangement of the boilers and machinery in the City of Peking. The shaded portion shows the coal bunkers. There are eight doors to the coal bunkers for getting the coal into the fire room, four being forward and aft.

The starting engines and working handles are on the platform above the floor of the ship, allowing room for the oilers to walk beneath while watching the bearings, without interfering with the men working the engines, on the platform. The two independent centrifugal circulating pumps—one for each engine—are on the starboard side, on the floor of the ship. All other pumps, as also the donkey boilers, are on the deck, in order to be accessible if the lower hold of the ship be filled with water.

On the trial made on August 22, it was not attempted to run the engines at full speed, but only slowly, in order to wear the journals smooth, preliminary to the more extended trial which has since taken place, and to test the working of all parts of the machinery at sea. Such a trial was the more necessary, as the ship has, in addition to the propelling machinery, steam engines to move the rudder and to hoist the anchor. The ship left the North river, abreast of pier 42, at ten minutes past eleven, steamed around the lightship off Sandy Hook and returned, arriving abreast of the Battery at five minutes past four, having been under way five hours and fifty-four minutes. Only eight of the ten boilers were in use, and the pressure of steam carried was 50 lbs. The tide was running in during the whole trip, and there was a fresh east wind.

During the first part of the trip, the engines were run slowly, but were allowed to increase in speed; and during the last hour, they averaged the following:

Revolutions per minute, 46; horse power, 2,250; vacuum, 26 inches; temperature of feed water, 85°; temperature of discharge water, 87°; temperature of injection water, 70°: steam pressure 40 lbs.; speed, $12\frac{1}{4}$ knots; draft of water forward, 18 feet; draft of water aft, 19 feet.

The draft to the furnaces was very strong, and they will probably be able to burn 15 lbs. of coal per square foot. Therefore the following is an estimate of the probable performance of the ship at maximum power: Consumption of coal per hour $= 520 \times 15 = 7{,}800$ lbs.; horse power $= \frac{7800}{2} = 3900$; speed of ship $= \sqrt[3]{\frac{3900}{2250}} \times 12\frac{1}{4} = 14\frac{3}{4}$ knots. This speed can probably be maintained in smooth water without the assistance of the wind.

In a series of voyages, the winds blow as long in favor of as against any ship. When the wind is against her, she furls her sails; but when it is in her favor, she spreads them and takes all the advantage. Thus, on a long voyage or series of voyages, the wind helps more than it hinders. It appears from an average of a number of voyages that the wind increases the available power of a ship about one third, and therefore the available power of the City of Peking will be equivalent to 5,200 horse power, and the average speed, if worked at full power, at a draft of water of 18 feet 6 inches, will be: $\sqrt[3]{\frac{5200}{2250}} \times 12\frac{1}{4} = 15{\cdot}9$ knots. This speed would carry the vessel from San Francisco to China in 13 days on 85 tuns of coal per day. The amount of coal carried would have to be 1,500 tons, leaving 4,000 tuns of space for crew and paying load.

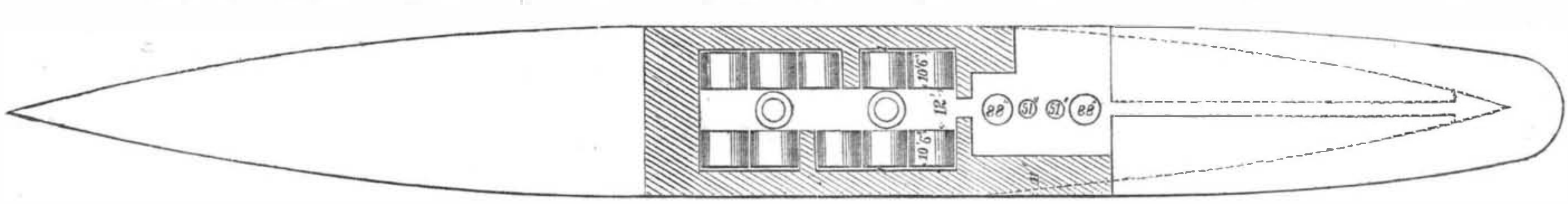


DIAGRAM SHOWING THE GENERAL ARRANGEMENT OF THE MACHINERY AND COAL BUNKERS OF THE CITY OF PEKING.

The Royal Yacht.

The new royal yacht Osborne was launched in 1870, but, proving weak, has been strengthened, replanked, and finally finished. She recently made a trial trip of six hours, and attained a speed of 14·85 knots per hour. The following are some of her particulars: Extreme length, 278 feet; extreme breadth, 35 feet 1 inch; oscillating engines, cylinders, 6 feet $8\frac{1}{2}$ inches; feathering paddle wheels, floats 11 feet 6 inches; 2 funnels, twenty furnaces; mean steam pressure, 23·3 lbs.; mean revolutions, 24·98; mean speed, 14·85; mean indicated power, 3,374; mean consumption of coal, per indicated horse power per hour, 3·95 lbs.; capacity for fuel, two days' steaming.

The Liverpool Landing Stage.

This structure, probably the most magnificent floating platform in the world, was recently totally destroyed by fire. It consisted of a large number of pontoons, having iron frames and wooden fittings, which in all aggregated a length of 700 yards, and a width of 80 feet. The structure was used as a place of debarkation and embarkation for the many steamships in the harbor. The timbers were creosoted or tarred, and it is believed that the gas arising therefrom became ignited, communicating the flames to the newly caulked deck.

John E. Gavit.

We regret to learn of the death of Mr. John E. Gavit which took place on August 25, at Stockbridge, Mass. Mr. Gavit was President of the American Bank Note Company, Secretary of the American Institute, and an earnest student and promoter of microscopical science, in which branch of knowledge he was recognized as an authority. He was also identified with the art of steel engraving.

AMERICAN shad have been lately shipped in cans to Persia