NAVAL ARCHITECTURE OF GREAT BRITAIN.

ECONOMY OF FUEL IN STEAMSHIPS—THE WAVE-LINE THEORY.

In our last number, we presented the substance of William Fairbairn's paper on the subject of iron ships, read before the congress of naval architects in London. The following are abstracts of two other papers read on that occasion:—

Robert Murray read an essay on the various means and appliances for economizing fuel in steamships. He commenced by remarking that the naval architect and marine engineer were now intimately connected in the endeavor to produce the grandest effort of modern science—a perfect steamship. His subject naturally divided itself into two heads, namely, how to raise steam most economically in the boilers, and how to use it most economically in the engines. In considering these questions, Mr. Murray first showed the importance of having boilers large enough to insure a constant command of steam without the necessity arising for "forcing" the fires, which caused loss in many ways, as was explained in detail. The importance of good stoking was next strongly insisted upon, as the stoker might be wasting coals by the tun at the furnaces while the engineer was puzzling his brain to save a few pounds weight in the engine-room. Mr. Murray recommended the employment of slides or rails for reducing the labor of the stoker in passing the coals from the bunkers to the front of the fires, and urged that ventilating fire-doors and smoke-box doors should be more generally used for keeping the stock-place cool. Large hatches, windsails, and air-tubes should also be employed, not only to promote the health and comfort of the stokers, but also to aid the steaming power of the boilers. He thought that the invention of an effective method of surface condensation was still an unsolved problem in marine engineering. Were such a method devised, not only would there be an actual saving of at least 15 per cent of fuel from the use of fresh water, but the boilers would last longer, and much valuable time which is now consumed in cleaning would be saved. The process of scaling a boiler, as usually practiced, is a very tedious and troublesome one, and is seldom so effectual as could be wished. In some recent experiments at Portsmouth, a boiler was filled with hot air, at a temperature of 400°, which acted most successfully in detaching the scale from the plates and tubes, in consequence of the rapid expansion induced in the metallic surfaces. The plan of heating the feed water, by means of either the brine which is blown off or the heat at the foot of the chimney, was next mentioned with approval; and then the advantages of superheating the steam were described, these advantages being the evaporation and neutralization of the fine spray which is usually carried up with the steam, and the prevention of condensation in the cylinder. The plan of superheating adopted by the Peninsular and Oriental Company was stated to be very successful. A great many reliable experiments had been made at Southampton in the vessels of the Royal Mail Company, the Peninsular and Oriental Company, the Cape Mail Company, and others, to test the actual economy of the superheating process by comparison with the previous consumption of coal before the superheating apparatus was fitted; and in every instance that had come under the author's observations there had been a perceptible improvement, sometimes taking the shape of increased speed in engine and vessel, sometimes a marked saving of fuel was effected, while both the results were combined in other cases.

Mr. Murray then pointed out the advantages of expansion, and how the piston, under diminished pressure, came gently to the end of its stroke at top and bottom of the cylinder. Steam jackets had also proved very beneficial, and there had been a great saving of fuel experienced in the high expansion carried on in the marine engines built by Messrs. Randolph & Elder, of Glasgow, for the Pacific Mail Company. In these steamships, each engine has two cylinders, into the large one of which the steam is worked entirely by expansion, and no doubt about one-half the fuel formerly consumed was now saved; still there were many instances of single cylinder engines in which the same beneficial results were secured. He believed that the day was not far distant when the average consumption of fuel by marine engines would be reduced one half.

J. Scott Russell, who has been called the author of the wave-line theory of shipbuilding," was called upon to read an explanation of his theory. He stated that he had made a very great number of experiments for the purpose of discovering, if possible, the best form of vessels—that of least resistance—and the kind of resistance which vessels met with in moving through the water. The first inquiry that he had proposed to himself was, what becomes of all the water which a ship removes out of her way? and how does it get out of the way? In prosecuting these inquiries, he first employed a small trough or canal, one foot wide and one foot deep, and of a considerable length. He raised a small heap of water above the natural level of that in the trough by means of a partition at one end, then he withdrew this partition to see what would be the effect. He found that the raised water assumed a beautiful wave form, and ran along the whole length of the canal, and left the surface of the water over which it passed as smooth as it was before. Had the end of the trough been just level with the surface of the still water, the wave would have leapt over it, and left the whole water in the canal undisturbed. This phenomenon is now known as "the solitary wave of translation," and it will travel to an almost incredible distance. He had followed such a wave on horseback, and by other means for miles, but it leaves a little of itself along the whole surface over which it passes.

The next fact ascertained was that whenever the bow of a ship is moved through the water a wave of this kind is produced which is "the traveling or carrier wave," and this gets rid of all the water in the channel which the vessel excavates while moving through it. This wave spreads itself in a thin film along the surface of the water ahead of the vessel (not behind it, nor on each side) with a far greater velocity than that of the vessel itself. After having made experiments on a small scale, Mr. Russell then proceeded with others on a large scale, and made vessels that required to be dragged by horses in a canal. He made positive observations and took measurements; and he found that this was what became of the water displaced by the bow of a boat. On one occasion he drew a large number of boats in one direction on a canal, and the "traveling wave" carried a great part of the water from one end of the canal to the other; in the evening the water was found raised 18 inches at one end, and depressed to the same extent at the other. The velocity with which the "traveling wave" moved was found to depend entirely on the depth of water. At three feet deep, the wave travels at the rate of 6 miles per hour; at five feet, 8 miles; at seven, 10 miles; at ten, 12 miles; at fifteen, 15 miles; at twenty, 18 miles; at thirty, 20 miles; at forty, 25 miles; and at fifty, 30 miles.

In addition to a constant velocity, the wave has a constant shape, and it corresponds with the long hollow wedge-shaped bow, which he exhibited in a diagram. In the "traveling wave," the particles of water composing it were continually being replaced by others, while the wave itself advanced without apparent change. It was the form of wave which led Mr. Russell to adopt that bow for ships, called the "wave form," because it was conformable to the wave of motion in water.

Like many others, he at first thought the stern of a vessel ought to be of the same form as the bow, but a series of experiments satisfied him that the "following wave" (that which runs after a ship to fill up the hollow) always moved with the velocity of the ship; it had not an independent velocity of its own, and did not depend on the depth of water. The "following wave" also repeated itself on an endless series astern of the vessel. The stern of a ship, however, should be formed of cycloidal curves.

But what became of the water at the bow supposing the boat to be dragged with a greater velocity than the "traveling wave"—that is, faster than the water can spread itself? With a force sufficient to compel a boat to go faster than the wave, the water would rise up and stand on both sides of the boat until the load had passed, then fall down into the hollow channel left behind. In a shallow canal in Scotland, where the "carrier wave" only traveled at the rate of seven miles per hour, he had compelled a boat to move at the rate of ten miles, and he found that the water not only rose up, but lifted the boat with it, so that it drew less water than before, and it actually went easier at the rate of ten miles than five per hour. Had not railways then dawned upon the world, England would soon have been dotted with long troughs, and people would have traveled on the tops of these waves in an easier and cheaper mode than by any other means then known.

The "wave bow" of a ship does not interfere with the form of its midship section, nor does it tie down a nautical architect to any proportion of depth to breadth; it could be applied to any general form of ship whatever. The wave line, however, prescribes the exact length of a ship for every speed. To go six miles per hour a vessel must be at least 30 feet long; eight miles, 50 feet; ten miles, 70 feet; twelve miles, 100 feet; fifteen miles, 150 feet; eighteen miles, 200 feet; twenty miles, 300 feet; twenty-five miles, 400 feet; and for thirty miles, 500 feet. He had tried to obtain higher velocities than these with shorter vessels, and had got them, but at a fearful waste of power and it would be folly not to lengthen vessels for the purpose of economy. The wave-line theory makes the length of a bow to that of a vessel's run as 3 to 2. The lines of the *Great Eastern* are an exact copy of the wave lines; the length of the bow is 330 feet; length of run 226 feet; there is also 120 feet of parallel body put into her amidships. It is a valuable conclusion for practical shipbuilders that proportionate length and breadth are not necessary for a fast vessel. It is not necessary that a fast vessel should be narrow, thin and long. Mr. Russell had taken vessels 200 feet long, and made them of every variety of breadth; but whenever they were 200 feet long, and had lines for 16 miles per hour, they moved at that velocity with a given power. There is, however, considerable resistance experienced by water adhering to the surface of a vessel; the greater the amount of surface, the greater is the resistance. Mr. Russell did not claim to be the inventor of hollow bows—they had existed as far back as he could trace steam navigation; but he had discovered what he believed to be the principles of nature which related to the subject. He had been surprised that treatises on naval architecture had not told us to make vessels with hollow bows exclusively. In England, steamships built on the wave-line principle were now common, and their number is constantly on the increase.

THE CATTLE DISEASE.

The Boston *Journal* has just published a letter from an individual who has lately arrived at Boston from the Cape of Good Hope, from which we condense the following facts.

The writer believes that the cattle disease now producing so much alarm in Massachusetts, is the same that has lately proved so destructive to horned cattle in South Africa. The disease at the Cape is called the *lung sickness*; it was introduced about seven years ago by the importation of two Dutch bulls, and spread before its destructive character was fully understood. Attempts were made to isolate the infected stock, and to confine the disease to certain limits, but it was all in vain. All transportation and much of the travel is performed by oxen, who scattered the disease everywhere. Various remedies were tried without success, until *inoculation* was adopted, which proved successful, as it did in the small-pox. The writer thus describes the process of inoculation:—"Inoculation is performed as follows:—Kill a diseased beast not too far gone, and take as muca of the lung as you require for the number of cattle you intend to operate upon; throw them down one by one, or otherwise make them fast, cut the hair short off about nine inches from the tip of the tail, make an incision through the skin an inch long, insert a bit of the lung the size of a bean, or rather larger, bandage it properly, and in three days the virus ought to take, and within the week the bandage should be taken off, when the wound appears swollen. Many of the cattle lose their tails by inoculation, and some even die when proper attention has not been given, but so far as I have had experience, few cattle have died of this sickness after being inoculated." The disease has been very destructive in South Africa—a part of the world where cattle are more valued than anywhere else. The price of draught oxen has risen from $15 to $50 since the existence of the plague. The writer thinks the disease is contagious and not an epidemic. We leave that point for the doctors to settle.

Our Boston cotemporary further states that, in view of the alarming extension of the cattle disease, and the need of increased appropriations, Governor Banks has decided that it is expedient to convoke an extra session of the Legislature.