

of the fire, exposing the structure as a whole to much less strain than befalls a fire-tube boiler. A water-tube boiler has also a much larger draft area than its rival. The sole reason why a fire-tube boiler retains its hold of the market is that it is simpler and cheaper to manufacture than its vastly more efficient competitor.

As remarkable as this adoption and improvement of the sectional boiler, was John Stevens' modification of the screw propeller. He thus describes it in addressing Robert Hare, Junior, of Philadelphia, on November 16, 1805:

"... To the extremity of an axis passing nearly in a horizontal direction through the stem of the boat, are fixed a number of arms with wings like those of a windmill or smokejack. These arms may be readily adjusted, so that the most advantageous obliquity of their angle may be attained after a few trials. The principle of an oblique stroke is the same as in the scull—but the continuity of movement in the wings gives them greatly the advantage over the alternation in the sculls, both in the loss of time and in the resistance of the fluid to change of motion. Besides that, this change of motion must give to the boat a wriggling movement, with a tendency to lift and lower, by turns, the stern of the boat. The sculls would also be liable to be affected by the swells in rough water, and, like the paddles I had thought of using, would be an awkward appendage to the stern of a boat. The consideration which determined me, when I saw you last, to try the paddles was merely to avoid the necessity of giving the boat a draught of water too great for passing the overslough near Albany, but this objection to the use of wheels I expect to obviate by an increase in their number and a consequent diminution of their diameter. Indeed, it is absolutely necessary to have at least two revolving in opposite directions to prevent the tendency to rotation which a single wheel gives to a boat.

"Since you were here I have made a fair experiment on the wheel compared with oars. Two men were placed at two cranks by which a wheel in the stern of the boat was turned; with a stopwatch the time of passing over a given distance was precisely ascertained. After making a suffi-