

## FULTON AND HIS LIFE WORK.

The forthcoming festivities commemorate the first complete exploration of the Hudson River by Henry Hudson and the inauguration by Robert Fulton of successful commercial steamboat navigation on its waters. Hudson was not the first navigator to see the Hudson River, and neither Robert Fulton himself nor the Commission which has organized and carried through the celebration has ever claimed that Fulton was the original inventor of the steamboat. It is rarely that a complete invention leaps full fledged from the brain of any one man. Almost invariably it is the product of the disconnected labors of separate individuals, each of whom contributes his quota to the ultimate result. Three men above all others—Symington on the Forth and Clyde Canal, Fitch on the Delaware, and Fulton on the Hudson River—will be forever associated with the invention of the steamboat; and it is because Robert Fulton combined with his fine engineering sense a large executive and commercial instinct, and was backed by the financial and political influence of Chancellor Livingston, that he was able, not only to put a practical steamship afloat on the Hudson River, but to establish the infant enterprise as a permanent commercial success.

Fulton was born in Little Britain, Lancaster County, Pennsylvania, in 1765. As a boy he showed a decided gift for drawing and mechanics, to which was joined an unusual facility for mathematical calculations. At seventeen years of age he went to Philadelphia to take up the study of portrait and landscape painting and mechanical drawing. In this he must have shown considerable ability; for at the age of twenty-one he had saved sufficient means to purchase a home for his widowed mother, in Washington County. In the following year he went to England to study art under his distinguished compatriot, Sir Benjamin West, who subsequently, in 1792, was elected president of the Royal Academy. That Fulton was an artist of no small attainment is shown by the character of the work which has survived him, and by the fact that his portraits were exhibited at the Royal Academy and at the Society of Arts in Great Britain. His own portrait, painted by his brush, which now hangs in the rooms of the American Society of Mechanical Engineers in New York, is an excellent piece of work, and shows distinctly the influence of the master under whom he studied.

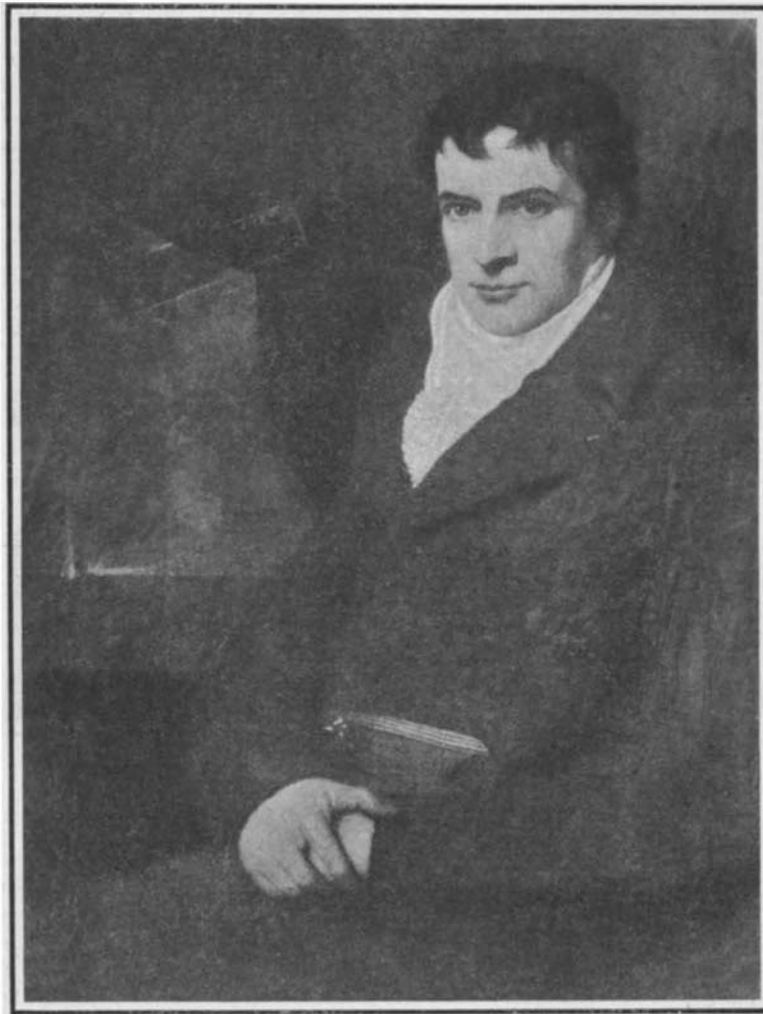
An artist by profession, Fulton was an engineer and inventor at heart. Benjamin West's influence, coupled with his own charm of personality and undoubted social gifts, brought him into touch with many leading men in England, notably the Earl of Stanhope, whose interest in mechanical and physical science is well known. On September 30th, 1793, Fulton wrote to the Earl, offering to make known to him his scheme for moving ships by steam and his plan for an inclined plane for the operation of canals. In the same year, also, he invented a mill for sawing marble and other stone, and actually had one in operation near Torbay, Devonshire. His interest in steam navigation at this time is shown by a letter to Boulton & Watt, dated November 4th, 1794, asking what would be the cost of a steam engine, "which is designed to be placed in a boat." The letter was written from Manchester, where he met young Robert Owen, subsequently known as the distinguished social reformer. Fulton interested Owen in his plans for the more rapid and cheaper excavation of canals, and they became co-partners in his inventions. Meanwhile he was writing a "Treatise on Canal Navigation," which appeared in 1796. In 1797 he went to Paris, where he obtained two French patents for panoramas. A lasting evidence of his work in this direction is to be found in the Rue des Panoramas and the Passage des Panoramas in the French capital. Here he lived with the American Minister, Joel Barlow, of whom he painted an excellent portrait now owned by his descendant, Robert Fulton Ludlow of Claverack, N. Y. It was during his residence in Paris that he began to turn his genius for invention almost exclusively to the field with which his name was to be so honorably associated. His first efforts were directed to the invention of means for prosecuting submarine warfare. He invented a system of torpedoes operated by clockwork, and devised methods of attack which were wonderfully similar to those that were used with such disastrous effect

in the late Russo-Japanese war. He proposed to float down upon the enemy two such torpedoes tied together by a line, which, being intercepted by an enemy's ship, would swing around, strike her sides, and explode. His most effective work in this field was the construction of a practical submarine or "plunging"

propeller through a man-operated crank wheel, from which power was transmitted through bevel wheels to a propeller shaft running through the center of the boat. The steering, operation of the pump, and the raising and lowering of the sail, were all accomplished from the interior by the methods shown in the accompanying engraving. Fulton made an exhibition on the Seine, descending with one man, remaining twenty minutes below the water, and coming successfully to the surface. At Brest, in June, 1801, he descended with three men to a depth of twenty-five feet, and remained below for one hour, the air being renewed from a reservoir of air under high pressure. On another occasion he attacked a specified boat in the harbor, attached one of his torpedoes, and blew the boat to pieces. This occurred in August, 1801. The significance of these exploits is enhanced when we bear in mind that the experiments above referred to were made to demonstrate to Napoleon I. the value of Fulton's invention for attack upon the English fleet. His plan was to build steamboats which were to act as tugs to tow the vessels containing Napoleon's army of invasion across the English Channel; and while the steamboats were to afford Napoleon an opportunity to strike a blow upon land with his army, Fulton's system of submarines would enable the French navy to strike an equally telling blow by sea. As the French government failed to accept Fulton's submarine and torpedo inventions, he subsequently returned to England and laid his plans before the British government. Mr. Pitt, the Prime Minister, was favorably impressed, and Fulton was given an opportunity to attack a brig which was anchored off Deal in the English Channel. He launched a torpedo, and by completely destroying the vessel demonstrated to naval and military officers and to a large concourse of spectators the success of his invention. The British government, however, for obvious reasons, did not wish to encourage the development of submarine warfare, for they realized its great potentiality. They offered Fulton a considerable reward if he would suppress his plans forever.

This he refused to do, saying to the committee that waited upon him: "I will never consent to let these inventions lie dormant, should my country at any time need them."

Fulton, again a resident in France, realizing that he had failed to interest either government in his system of submarine warfare, turned to his favorite scheme, and bent his energies to the development of a practical steamboat. He made application to the French government, filing a description and plans of his boat, which have been preserved in the archives of the Conservatoire des Arts et Métiers, Paris. The wide study of what had been done and was then being attempted in the development of the steamboat, with which Fulton prepared himself, is shown in these plans, and the reader is directed to the illustration of the boat, in the chapter on "Steamboats Prior to the Clermont," which appears on page 221. The drawing is especially valuable for the light which it throws upon the "Clermont," of which the original drawings have disappeared. The date of the letter to the French Commission was January 25th, 1803. Fulton built a small boat, in which he placed his boiler and engine; but on the eve of his demonstration before the Commission, during a heavy wind, the craft, unable to carry its burden, broke in two, and the wreck sank to the bottom of the river. The engine, which was presumably the one ordered from Watt, seems to have come through the disaster unharmed; for Fulton immediately built another boat, 66 feet long by 8 feet beam, and in August, 1803, made a fairly successful trial in the presence of members of the Institute and a crowd of onlookers. In spite of this demonstration, Fulton was doomed to disappointment; for the French government failed to take up his invention. But his star was now in the ascendant. The wheel of fortune took a turn in his direction, when Robert R. Livingston was sent to France to act for the United States in the matter of the Louisiana Purchase. This able man, who had himself already given much study to, and made several experiments in, the development of the steamboat, was quick to see the excellence of the Fulton plans, and became from that time on his ardent associate and never-failing backer. "Fulton had genius, and Livingston had the genius to perceive it"; and out of the combination of interests thus formed, there was to emerge four years later that curious but capable little craft, the "Clermont"—practically identical in design, and the lineal descendant of, the boat which steamed successfully on the



From a painting by Benjamin West in possession of Fulton's grandson, Robert Fulton Ludlow, of Claverack, N. Y.

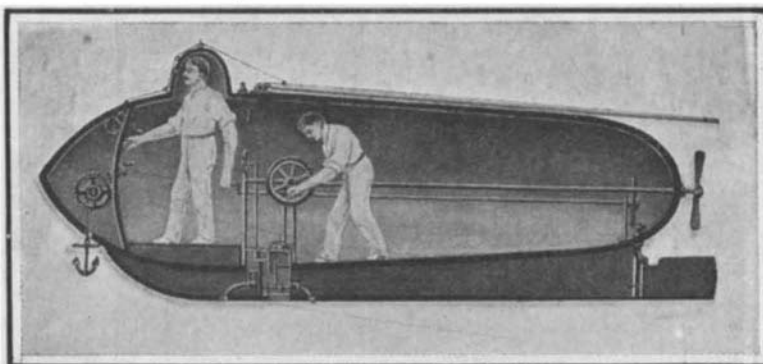
ROBERT FULTON; 1765-1816.

boat, called the "Nautilus." This vessel, 6 feet in diameter and 20 feet long, was built of iron and copper, and in general outline resembled the modern submarine. It was provided with a sail for surface navigation,



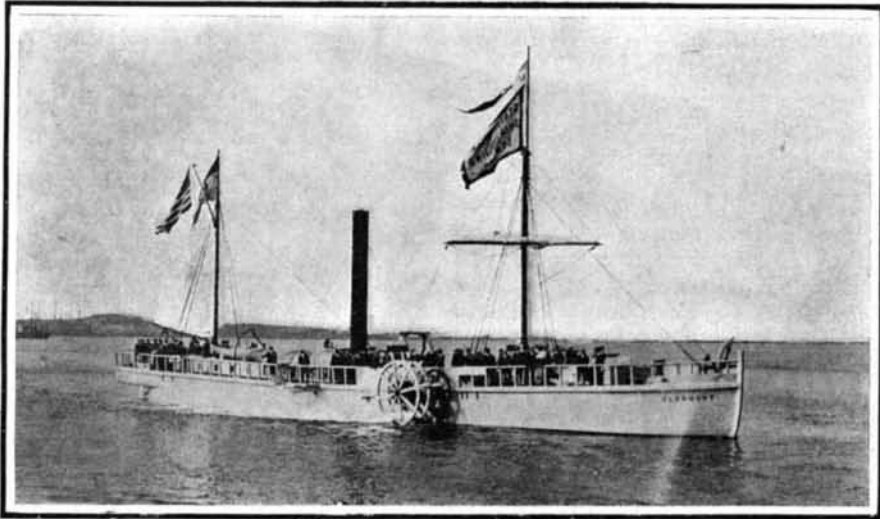
THE BRONZE MEDALLION OF ROBERT FULTON ON HIS MONUMENT IN TRINITY CHURCHYARD.

gation, which could be folded back upon the boat when diving. To submerge the boat, water was admitted, which was removed by pumping when it was desired to come to the surface. It was driven by means of a

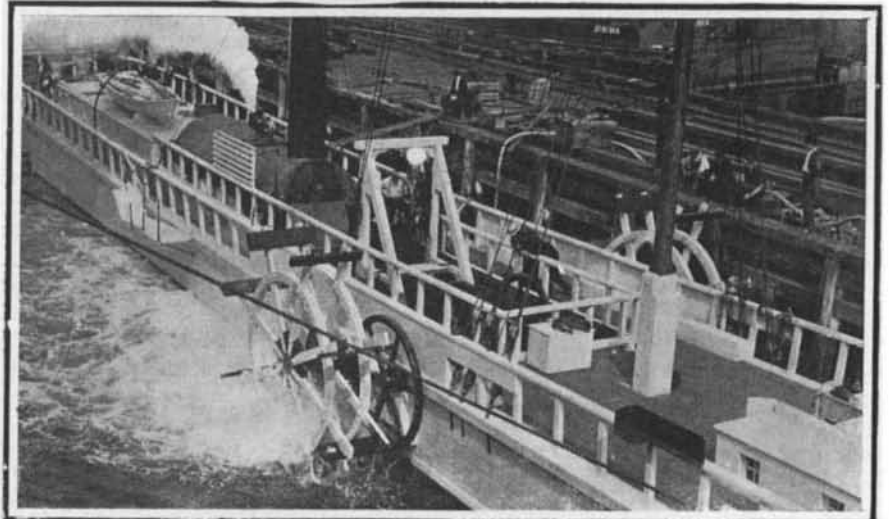


Built of copper and iron; driven by a hand crank and propeller; was submerged by admitting water; air was replenished from a tank of compressed air; remained under water 5 hours with three men aboard. Fulton is the undisputed inventor of the first successful submarine. He antedated the present submarine boat by 100 years and demonstrated by successful tests before officials, first of the French and later of the English navy, the practical character of his vessel.

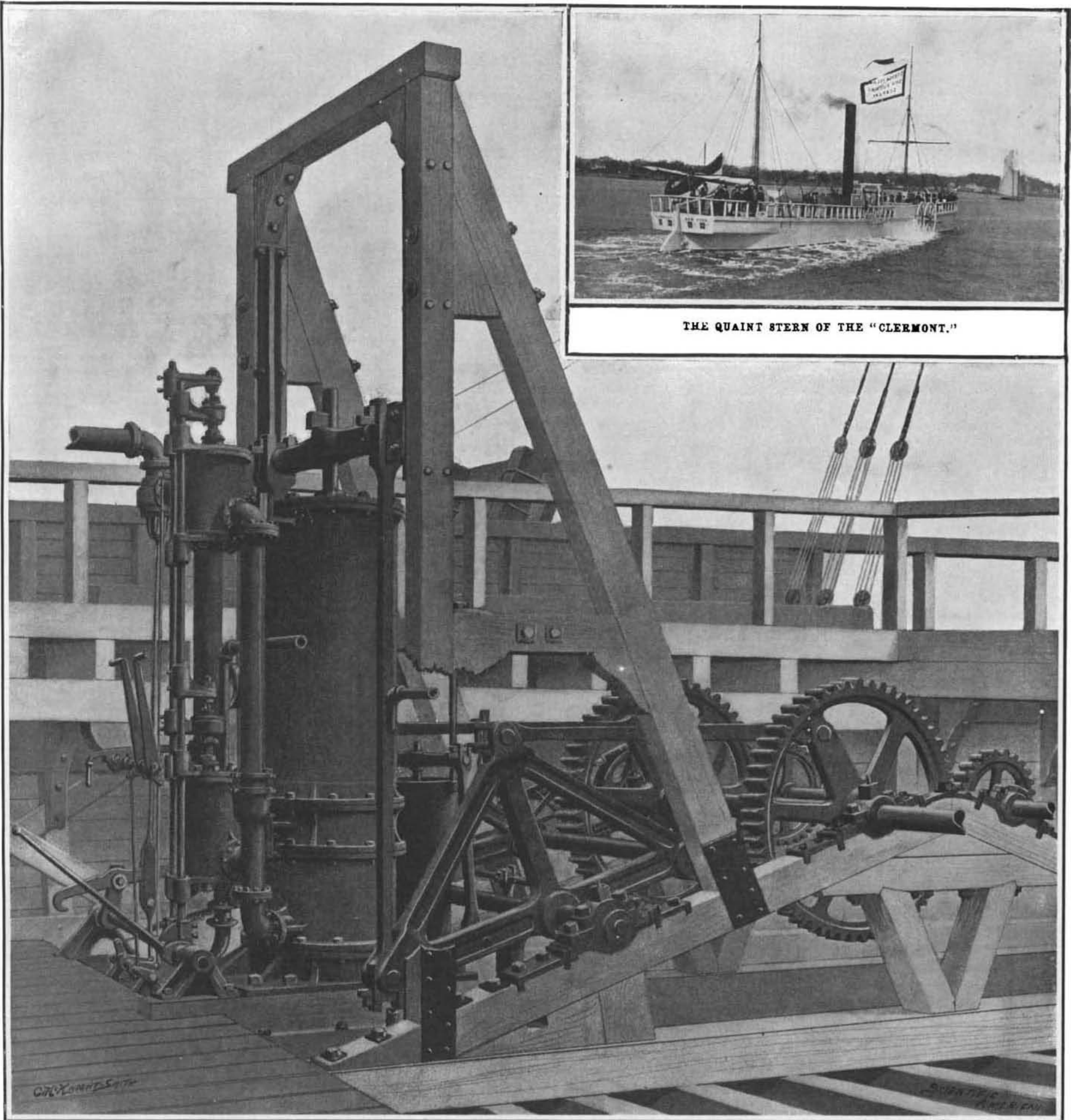
FULTON'S SUBMARINE THE "NAUTILUS."



THE "CLERMONT'S" TRIAL TRIP: SEPTEMBER 14TH, 1909.



DECK VIEW, SHOWING FLYWHEELS OUTSIDE HULL.



THE QUAIN STERN OF THE "CLERMONT."

With the exception of the eccentric, valve gear, and starting and stopping mechanism, which were modernized in accordance with government requirements to ensure safe handling during the water parades, this replica is an exact copy of the original of 1807.

The main parts of the engine were built by Watt in England in accordance with Fulton's order of August 6, 1803, which called for "a cylinder of 24-horse-power double effect, the piston making a 4-foot stroke, the valves and movements for opening and shutting them, the air-pump piston and rod, the condenser with its communications to the cylinder, and air pump." The A frame and guides; the cross-head; the bell-crank lever with its connecting rods to cross-head and crank wheels; the crank wheels, paddle wheels and shaft, and the flywheels and shaft with gear for driving the same, were all Fulton's own design; and the arrangement was well adapted for keeping the weight low in his very narrow boat with its small margin of stability. In the original engine the valves were probably operated by a vertical reciprocating rod, carrying pins which engaged the valve-tripping devices.

(Drawn on board the replica of the "Clermont" by the artist of the SCIENTIFIC AMERICAN.)

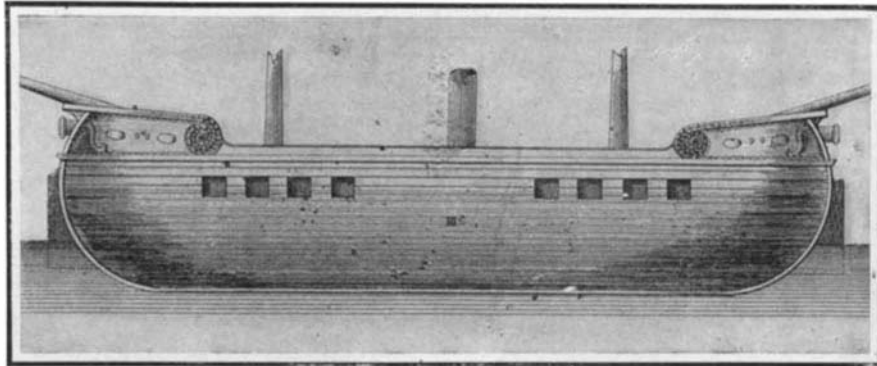
THE ENGINE OF THE "CLERMONT"



river Seine. Preliminary to our description of the "Clermont," it is well to make it clear that Robert Fulton is entirely free from any charge of plagiarism. It has been asserted that, because Fulton inspected the work both of Symington on the Clyde and Fitch on the Delaware, and was familiar with Fitch's plans as left in charge of Aaron Vail, U. S. consul at L'Orient, France, it was from these sources that he derived the design of the "Clermont." Now, while it is true that Fulton was in touch with these men and their work, and probably saw their steamboats in operation, there is nothing in the design of the "Clermont" to indicate that her hull and the general arrangement of her engine were not the design of Fulton himself. On the contrary, there is abundant written evidence that the form of the boat and the connections from the cylinder to the paddle wheels were Fulton's. This is said with due appreciation of the fact that Fulton went to Boulton & Watt at Birmingham, England, for the essential parts of his engine. They were the foremost engine builders of their day; and it was a wise step on Fulton's part to order the cylinder, condenser, and air-pump from a first-class firm. Both Fitch and Symington, it is true, designed and built their own engines throughout; but this fact does not invalidate Fulton's claim to be considered as the naval architect of the "Clermont"—a boat which was quite unlike any other that had been built, and that was so well designed as to prove a thorough commercial success.

While Fulton was yet in Paris and a few days before the trial of his boat on the Seine, he again wrote to Boulton & Watt, asking them to build him an engine, which he no doubt intended for the boat that he had in mind to build on his forthcoming return to America. On the date of August 6th, 1803, his letter says: "Will you be so good as to make me a cylinder of a 24-horse-power double effect, piston making a 4-foot stroke? Also the piston and piston rod, the Valves and movements for opening and shutting them, the air pump piston and rod, the condenser with its communications to the cylinder and air pump. The bottom of the cylinder cast in form as in the drawing and the dispositions of the parts as near as possible as they stand in the drawing. The other parts can be made at New York. . . . The situation for which this engine is designed and the machinery to be combined with it, will not admit of placing the Condenser under the cylinder as usual." The drawing which accompanied this letter showed the condenser placed forward of the cylinder, and not underneath it, as was the practice in the Boulton & Watt engines. Mr. H. H. Suplee, who has probably given a more thorough study to this phase of the subject than any other investigator, is of the opinion that Fulton wished to place his cylinder directly upon the floor of the boat, in order to keep its weight as low as possible.

from the original plans, in order to comply with the requirements of the government inspectors and secure a reliable boat, suitable for the purposes of the Commission. Hence, in the interests of historical accuracy, it is advisable to note that the motive power departs in some respects from Fulton's original design, although in the main it is a faithful reproduction. This is particularly true of the eccentric, valve gear, cut-off, and starting and stopping devices; and it takes only a glance at our drawing to see that these parts belong to a later period, and are practically similar to those now in use on walking-beam engines. In the drawings of the boat on the Seine, the valve gear and the air pump are shown to have been operated by levers and quadrants. Probably Fulton used the "tappets and tappet rod," which were current practice for working the valves in Boulton & Watt engines. Another change is in the boiler, which in the original "Clermont" was built of copper, and carried a pressure of probably not more than three to five



Designed by Fulton for the United States Navy; launched in 1814 and completed shortly after his death. Length, 156 feet; beam, 56 feet; depth, 20 feet; paddle wheel, 16 feet diameter; engine cylinder, 4 feet diameter, 4 feet stroke; speed, 4½ knots.

#### THE "DEMOLOGOS"; THE FIRST STEAM WARSHIP.

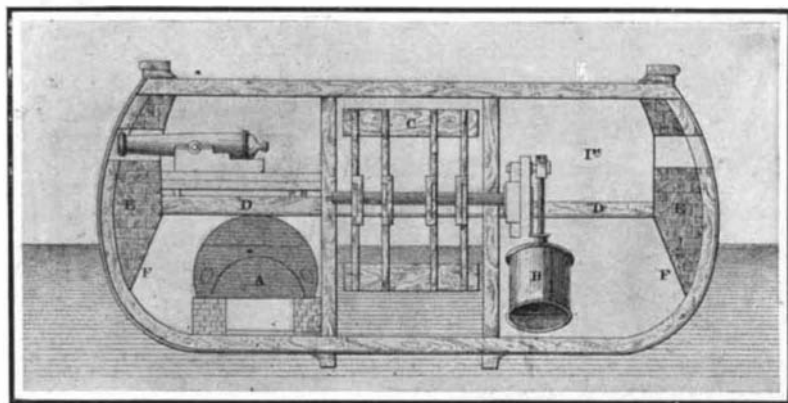
pounds above the atmosphere. In the "Clermont" of 1807, the boiler, in order to meet the government requirements, is built of steel, and carries twenty pounds pressure. With these exceptions in mind, the visitor to the "Clermont" may be satisfied, both as regards the hull and the engines, that she looks very much as she did on her first memorable trip up the Hudson. Fulton's design, if we consider the crude condition of the art in those days, is creditable, and it is a noteworthy fact that if we raise the bell-crank lever above the cylinder, we have an engine which is remarkably like the walking-beam engine of the present day. Fulton, however, wished to keep his weights low in the boat; and the plan adopted is admirable for this purpose. Two connecting rods from the crosshead are coupled to a bell-crank A-shaped pair of levers, from the top of each of which a connecting rod transmits the motion to a pair of crank spur wheels upon the inboard ends of the paddle-wheel shafts. In order to carry the engines over the dead centers, Fulton provided a pair of fly-wheels, which were carried upon separate counter-

V-shaped at and below the waterline, but above the water was carried out with a square overhang. This form was decided upon by Fulton as the result of towing experiments with models which he carried out himself; and he seems to have been of the decided opinion that this was the best form to secure the desired speed. She was provided with a limited amount of sail, of which, at least on her first trip, she seems to have made but little, if any, use. The paddle wheels, 15 feet in diameter, were uncovered, and consequently, if any breeze were blowing, the passengers were pretty well drenched with water.

Let it not for a moment be imagined that the public of that day had the least appreciation either of the genius of Fulton or the momentous character of the work he was doing. When, on Monday, August 17th, the little craft cast loose from her moorings near the old State's Prison, which stood on the square now bounded by Washington, West 10th, West, and Charles Streets, many of the thousands that lined the shore of the river had come to deride "Fulton's Folly"; and he made his preparations for the start to the accompaniment of jeers and catcalls. At 1 o'clock the hawser was drawn in, the throttle was opened, and then, amid the curious hush which immediately fell upon the multitude, the side wheels began to turn, and with Fulton at the helm the "Clermont" moved slowly out into midstream and headed north for Albany. Skepticism gave way to approbation and delight, and amid thunders of applause the "Clermont" moved slowly up the river, and was finally lost to sight in the upper reaches of the river. At 1 o'clock on Tuesday the little vessel tied up at Clermont Dock, the landing for Chancellor Livingston's place, having covered the 110 miles from

New York against the wind at an average speed of 4.6 miles an hour. Resuming the journey at 9 o'clock on Wednesday morning, the "Clermont" reached Albany, 40 miles distant, at 5 P. M., the running time for the whole distance having been 32 hours, which gave an average speed of a little over 4½ miles per hour.

We have shown in another chapter how phenomenal was the development of steam navigation on the Hudson River as inaugurated by this eventful trip, a development in which Fulton took a leading part. In 1812 he put his first ferryboat in commission, although to Stevens must be given the credit for having started a ferry to Hoboken in the previous year. The boat, which was double-hulled, made her landings at a hinged, floating bridge, to which she was guided by lines of piling. Fulton was thus the originator of our present system of ferryboats. In 1810 we find him before President Madison explaining his models and plans for torpedo warfare. In March, 1814, Congress authorized the construction of a steam war vessel to be built from Fulton's plans. This, the first steam warship in the world, was constructed with a double



This view shows the engine *B*, driving paddle wheel *C* in a central waterway; the boiler *A*; and the massive wooden side protection *D*, 5 feet in thickness.

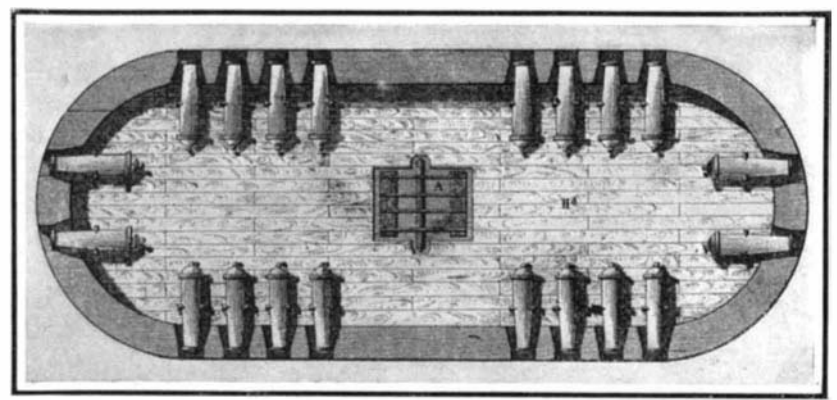
#### MIDSHIP SECTION OF THE "DEMOLOGOS."

We are inclined to agree with him; for the original beam of the "Clermont," which was only 13 feet, rendered her laterally very unstable. Furthermore, the boat on the Seine, which doubtless formed the basis of the design of the "Clermont," shows the condenser separate from the cylinder. There can be no doubt, after reading the Boulton & Watt letter, that Fulton had the outlines of the "Clermont" engine clearly in his mind, and its general similarity to the engine of the boat on the Seine is strong evidence that the "Clermont's" engines were, at least as to their general plan and connections, original with Fulton. On the other hand, the drawings which accompanied Fulton's patent of 1809 show the condenser placed beneath the cylinder, a construction which has been followed in the replica of the engine.

In drawing the plans, it was found that, since the replica of the "Clermont" would have a considerable number of people aboard during the festivities, parades, etc., it would be necessary to depart somewhat

shafts, rotated by means of pinions secured at their inboard ends. The air pump and feed pump are operated through connections from the bell-crank levers, as shown.

About the correctness of the design of the replica of the hull of the "Clermont," there can be no doubt whatever. The plans, drawn by Frank E. Kirby and J. W. Millard, are based upon a letter of Fulton's, which reads: "My first steamboat on the Hudson River was 150 feet long, 13 feet wide, drawing 2 feet of water, bow and stern 60 degrees"; and upon the second enrollment of the "Clermont," on file in the New York Custom House, which describes the vessel as having "one deck, and two masts," and gives her dimensions as 149 feet length, 17 feet 11 inches breadth, and 7 feet depth. The enlargement in beam is due to later changes which were found necessary to increase the vessel's stability. The "Clermont," as originally designed, had therefore a long narrow hull, with parallel sides; a V-shaped bow; and a stern which was



The armament consisted of twenty 32-pounder guns. The plans provided also for two 100-pound submarine guns for attacking the enemy below the water-line.

#### GUN DECK OF THE "DEMOLOGOS."

hull. Its dimensions were: Length 156 feet, breadth 56 feet, depth 20 feet. The paddle wheel, 16 feet in diameter, was driven by an engine, whose cylinder was 48 inches in diameter by 5 feet stroke. As will be seen from our drawing, the sides of the "Demologos," as she was called, were strengthened by massing heavy timbers, until a thickness of five feet was reached. She mounted twenty 32-pounder guns on the gun deck. Fulton, who was present at the launching of the vessel on October 29th, 1814, did not live to see her completed; indeed, it was his devotion to the work of her construction, which led him to spend many hours on her deck in the winter time, when he was troubled with a heavy cold, that brought about his death, which occurred February 23rd, 1815, at his home in what is now Battery Place. He was buried in the Livingston vault on the south side of Trinity Church, and to the northwest of the monument and tablet erected to his memory by the American Society of Mechanical Engineers in 1901.