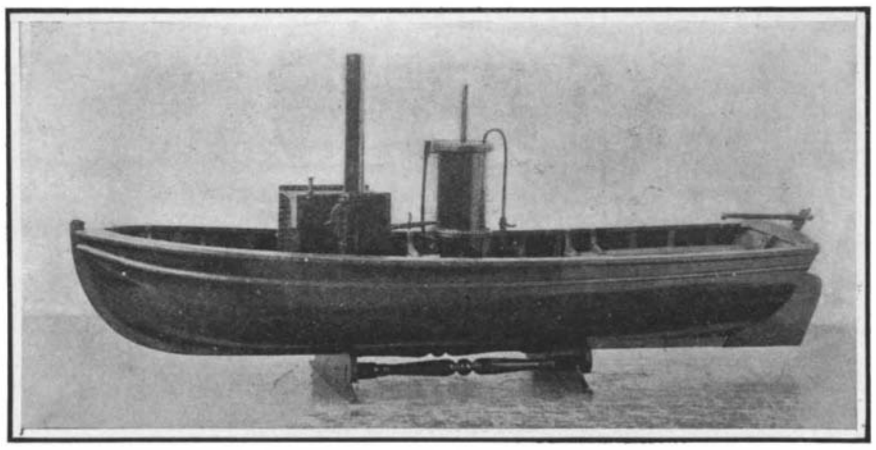
AMERICAN STEAMBOATS PRIOR TO THE "CLERMONT."

It is one of the estimable qualities of Robert Fulton that, in spite of the obvious temptation so to do, consequent upon his brilliant success with the "Clermont," he never claimed the distinction of being the original inventor of the steamboat. He was perfectly familiar with the ingenious work in the development of steam navigation which had been done both in the United States and in Europe during the two decades preceding the successful trip of the "Clermont." He had intimate knowledge of the previous history of the art; he was personally acquainted with the more successful inventors; and, as a guest, had made trips on at least one of the more successful boats. The present celebration, so far as Fulton is concerned, is held in honor of the *successful inauguration of practical commercial steamboat navigation on the Hudson River.* There is glory enough, surely, in this to make a fitting crown for the life work of one man. Were Fulton in our midst to-day, he would be among the first to do justice to the work of his predecessors and contemporaries, in other times and on other waters.

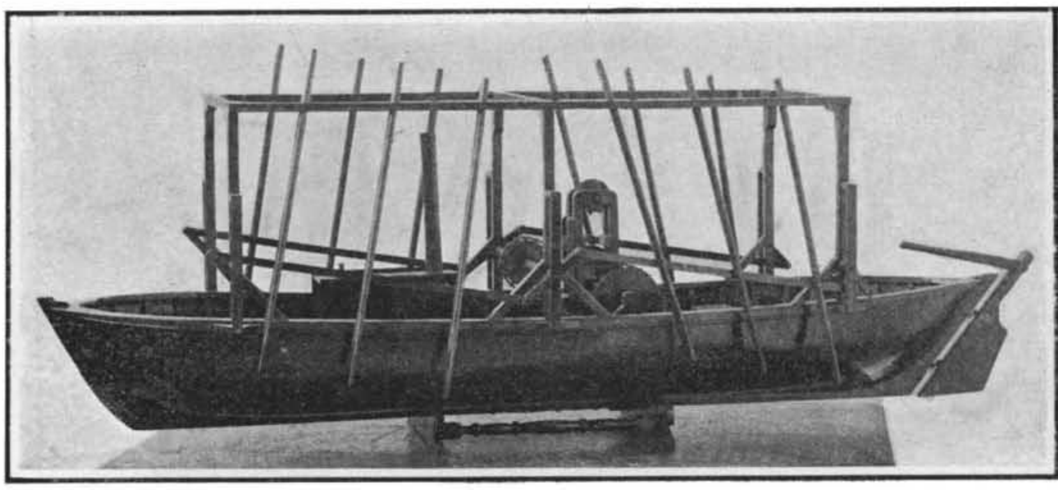
It is impossible, within the limits of the present article, to describe at any length the dozen or more steamboats, big and little, which were built and tried with varying degrees of success in America prior to 1807. We must content ourselves with the following summary (based on Preble's history) of these early efforts, followed by a brief sketch of the remarkable work of Fitch and Stevens.



Rumsey's boat was propelled by a steam engine and pump which drew in water through the bottom and discharged it in a jet at the stern. Made four miles an hour in a short trial on the Potomac; but never reached the stage of practical operation.

(From photograph of the model in the Smithsonian Institution taken especially for the SCIENTIFIC AMERICAN.)

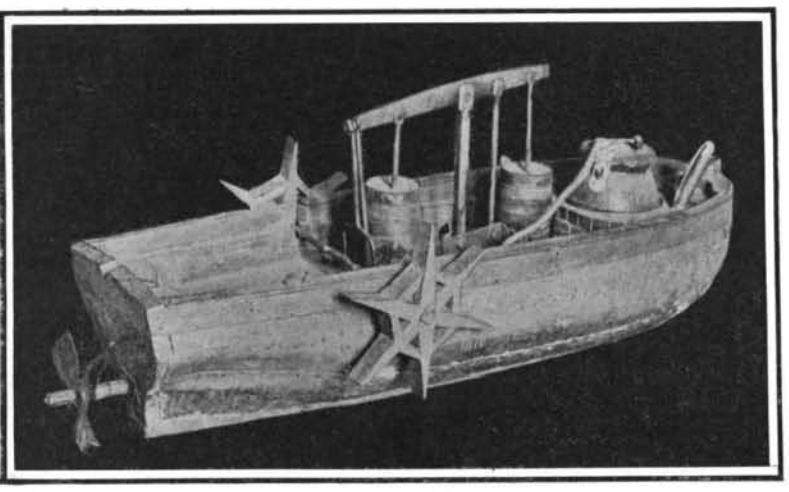
JAMES RUMSEY'S STEAMBOAT OF 1787.



This boat made six miles an hour on the Delaware. It was propelled by vertical paddles, driven in sets of three by side rods operated by a steam engine.

(From photograph of the model in the Smithsonian Institution.)

JOHN FITCH'S STEAMBOAT OF 1787.



This crude model was made from memory in 1852 by a witness of the trials of the boat on the old Collect Pond, New York city.

(From photograph of the model at the New York Historical Society.)

JOHN FITCH'S STEAMBOAT OF 1796.

The first boat successfully propelled by steam in America was one built by John Fitch, which was tried on the Delaware, July 27th, 1786.

The second American steamboat, also built by Fitch, was tried on the Delaware in 1787.

The third boat, built by James Rumsey, and driven by a water jet, was operated at Shepardstown on the Potomac, September 3rd, 1787.

The fourth steamboat, built by Fitch, ran from Philadelphia to Burlington in 1788.

The fifth steamboat, also built by Fitch, made eight miles an hour over a measured course at Philadelphia in 1789, and in 1790 was placed in regular service on the Delaware as a packet, its sailing dates being advertised in the local press.


THE
STEAM BOAT
Sets out to-morrow morning, at ten o'clock, from Arch-street ferry, in order to take Passengers for Burlington, Bristol, Bordentown, and Trenton, and return next day.
Philad. July 26, 1790.

Gray's Garden

Photograph of advertisement in the "Federal Gazette" of Philadelphia, July 26th, 1790.

The sixth steamboat, a stern-wheeler, built by Capt. Samuel Morey of Connecticut, sailed from Hartford to New York, with Chancellor Livingston and others on board, in 1794.

The seventh steamboat, by Fitch, tried on the old Collect Pond, now the site of the Criminal Court building and City Prison, New York, was driven by both paddle wheels and a screw propeller. Chancellor Livingston was aboard on this trip, and a very crude model of the boat, shown in the accompanying illustration, is now in the keeping of the New York Historical Society.

The eighth boat, by Morey, was tried on the Connecticut River in 1797.

The ninth steamboat was built to plans of Chancellor Livingston by a Mr. Nisbet, and tried at De Koven's Bay, south of Tivoli, in March, 1798.

The tenth steamboat was a model side-wheel vessel built by Fitch and tried on the Ohio in 1798.

The eleventh boat, built and designed conjointly by Nicholas Roosevelt, John Stevens, and Chancellor Livingston, had side chain wheels driven by a steam engine. It was tried successfully in October, 1798, and with the Spanish Minister on board as a guest made three miles an hour.

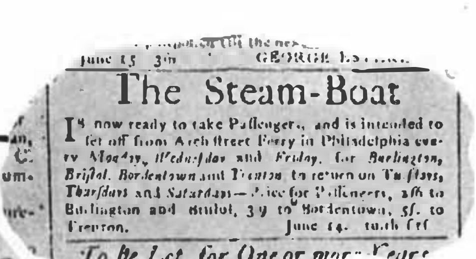
The twelfth steamboat, built by Col. John Stevens, was a 25-foot flat-bottomed boat, which was driven by a screw propeller on the Hudson River at a speed of four miles per hour in 1803 and 1804.

The thirteenth steamboat, built in 1804 by Stevens, was propelled by twin screws at a speed of seven to eight miles per hour, and made several trips on the Hudson River.

The fourteenth steamboat, built by Oliver Evans in 1804, was a large scow, or lighter, driven by a paddle wheel at the stern.

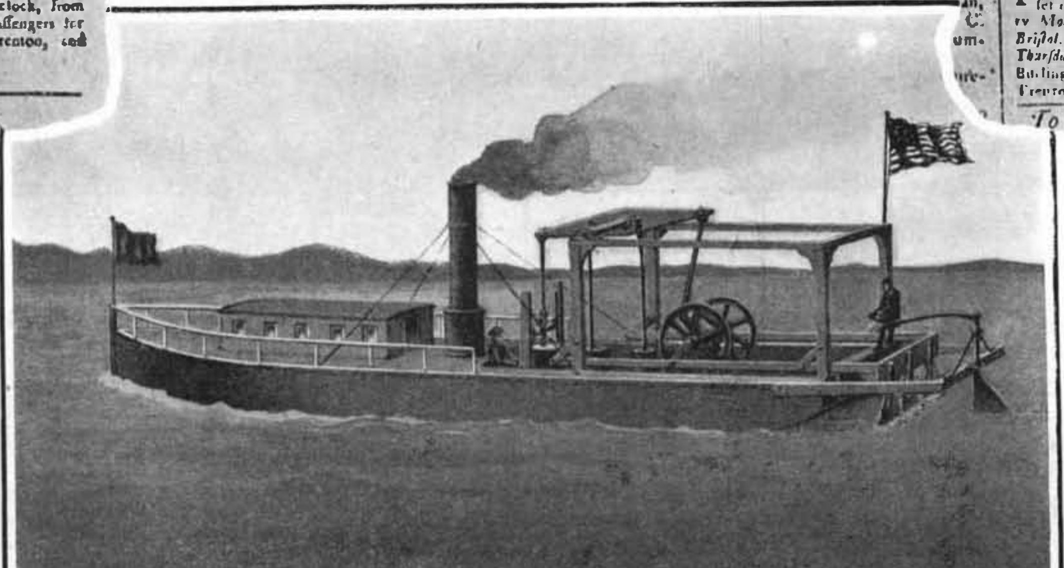
The fifteenth and last steamboat before 1807 to make a trip under her own steam was a large pirouge, with side paddle wheels, called the "Phœnix," built by Stevens in 1806-7, which, being debarred by Fulton's monopoly from navigating on the Hudson, subsequently steamed to Philadelphia by sea, and thus became the first steamship to make an ocean voyage.

It should be understood that although the above enumeration includes vessels that were actually moved by steam, no claim is made that they were all of a practical character. Of the Americans who turned their attention to the development of the steamboat in the pre-"Clermont" period, two men, in our opinion, stand head and shoulders above their competitors, namely, John Fitch and John Stevens; the first, for the reason that as far back as 1790 he placed on the waters of the Delaware a steamboat which ran on a regular schedule, was advertised extensively in the local papers, and carried freight and passengers at specified fares; the latter, because he was the first to apply the screw propeller as the sole means of propelling a boat; that he used tubular boilers and high-pressure steam; and that he was the first to adopt that system of twin propellers which subsequently became the standard method of propulsion throughout the world.


June 15 3in GEORGE
The Steam-Boat
Is now ready to take Passengers, and is intended to set off from Arch Street Ferry in Philadelphia every Monday, Wednesday and Friday, for Burlington, Bristol, Bordentown and Trenton, to return on Tuesdays, Thursdays and Saturdays.—Price for Passengers, 2/6 to Burlington and Bristol, 3/9 to Bordentown, 5s. to Trenton. June 14.

To Be Let, for One or more Years

Photograph of advertisement in the "Pennsylvania Packet" of Philadelphia of June 14th, 1790.



This boat, 60 feet long, driven by an engine with cylinder 18-inch diameter, designed and built by Fitch, was put in regular service, advertised in the Philadelphia papers, and for three months in 1790 sailed according to schedule between Philadelphia, Trenton, and way points. Its average speed was 7 miles an hour. It was propelled by paddles at the stern.

JOHN FITCH'S STEAMBOAT, WHICH SAILED REGULARLY BETWEEN PHILADELPHIA AND TRENTON IN 1790.

JOHN FITCH.

John Fitch stands out as a splendid type of a large class of ingenious, courageous, but poor inventors, who did so much to promote the industrial development of the country during the early years of the young republic. Born at

Windsor, Conn., on the 21st of January, 1743, in moderate circumstances, he learned the trade of clock making, and at twenty-six years of age moved to New Jersey and then to Philadelphia, where he became a strong partisan on the American side in the dispute between the colonies and Great Britain. He was made lieutenant of a company raised at Trenton, but ultimately he found his sphere of usefulness in the gun factory at Trenton. When Washington crossed the Delaware Fitch moved with the Continental troops to Pennsylvania. In 1780 he was appointed a deputy surveyor, and ultimately struck out westward for the purpose of surveying lands lying beyond the Ohio River. In 1781 he started for Fort Pitt, now Pittsburg. Later he was captured by the Indians, endured severe privations, and was finally carried by them to Canada, where he fell into the hands of the British. After his liberation he again took up the work of surveying the unknown lands of the West; and ultimately, in 1785, turned his attention to his great life-work of inventing a boat to travel by the power of steam. Beyond a natural aptitude for mechanics, Fitch was entirely unfurnished for this difficult task. Although steam-engine building was a recognized trade in England, and had been for many years, there were at this time but three steam engines in the whole of America, and the country was absolutely without suitable means for steam-engine manufacture. In his quaint 500-page manuscript autobiography, now in the Philadelphia Library, Fitch writes: "Although it was not to my credit, I did not know that there was a steam engine on earth when I proposed to gain a force by steam." He read up all the scant literature he could obtain on the subject, formulated his plans, and on September 27th, 1785, presented a drawing and model of his boat to the American Philosophical Society at Philadelphia. The model shows the method of propulsion by an endless chain provided with paddle boards. He endeavored to interest Franklin and Gen. Washington in his plans, neither of whom, however, gave him much encouragement. He formed a company, and on March 18th, 1786, secured from the Legislature of New Jersey the exclusive rights for steam navigation in that State. It was at this time that he associated himself with Henry Voight, a clockmaker of unusual mechanical ingenuity and skill. The task which these men had set themselves was Herculean. There were no machine shops nor the necessary tools for the accurate work required; and through the subsequent years of experimentation they had to feel their way, amid a thousand discouragements of poverty and ignorance, to the final success which crowned their efforts five years later. They first built a model steam engine with a cylinder of one inch diameter, which was too small for a demonstration. Then a new model, with a 3-inch cylinder engine, was erected in a small skiff, and a trial was made with Fitch's endless chain paddle-boards, but without success. Then it occurred to Fitch to move the boat by oars or paddles, working on the side, and moved by cranks operated by the engine. This was tried on the skiff with the 3-inch engine, and on the 27th of July, 1786, the first boat propelled by steam in America made its trial trip successfully on the Delaware. Encouraged by the passage of a law by the State of Delaware in 1787, securing Fitch's right to the invention, fresh advances of money were made by the shareholders, and a boat 12 feet wide and 45 feet long was equipped with an engine having a 12-inch cylinder. After much experimental work with the condensers, this boat, on August 22nd, 1787, was propelled on the Delaware in the presence of practically all the members of the Convention who were then sitting in Philadelphia to frame the Federal Constitution. Certificates of perfect success of this trial were given by Gov. Randolph of Virginia, David Rittenhouse the astronomer, and other notable men. An engraving and description of the boat made from the plans were published in the Columbian Magazine for December, 1786.

Col. Stevens built the first successful steamboat driven entirely by the screw propeller; the first twin propeller boat; and the first steamboat to make an ocean voyage.

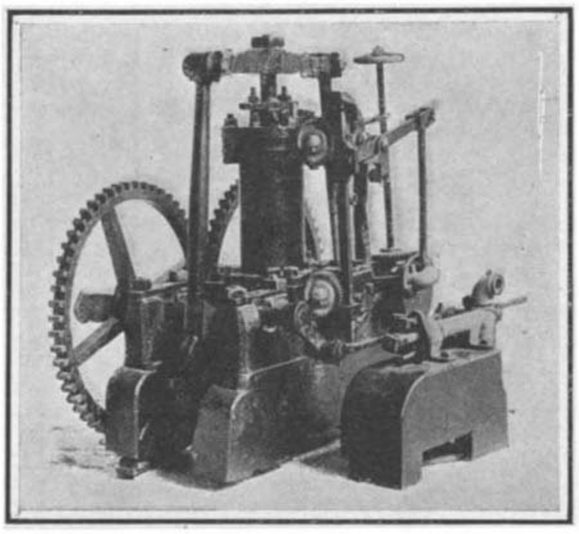
COLONEL JOHN STEVENS; 1749-1838.

The cylinder was double-acting and condensing. Fitch introduced the jet condenser, which he believed to be original with him, although it had been previously invented in Europe. The boat was driven by six pairs of oars, or paddles, which were pivotally connected in sets of three to four horizontal driving bars, operated by cranks on crank disks driven by the engine. Fitch preferred these paddles to the paddle wheel, because he considered that the latter involved a great waste of power, due to the obliquity of the wheels on entering and leaving the water. Fitch's objection to the paddle wheels was theoretically correct; and its inefficiency was not corrected until the invention, half a century later, of the feathering paddle wheel.

The third steamboat built by Fitch was a much larger craft, and was driven by a greatly improved engine. The new boat was 60 feet in length and 8 feet in beam. Its engine, also, had 12-inch cylinder; but as the result of an improved condenser, designed by Fitch, it developed considerably more power than the engine in the preceding boat. Furthermore, it should be mentioned that this was the first steamboat equipped with a tubular boiler, the invention of Voight. The oars, or paddles, were removed from the sides and placed at the stern. Toward the close of July, 1788, she made the trip of twenty miles from Philadelphia to Burlington, and on the 12th of October she made the same trip in three hours and ten minutes with thirty passengers on board. The boat continued in more less experimental operation during 1788 and 1789. The story of the troubles of Fitch and Voight in the endeavor during this time to perfect their engine, as contained in Fitch's autobiography, is of absorbing interest. No less than seven different condensers were tried and rejected. Finally an 18-inch steam cylinder and a jet condenser of Fitch's design were installed, and at last, in the words of Fitch, "On the 16th of April (1790) got our work compleated, and tried our Boat again; and altho the wind blew very fresh at the north east, we reigned Lord High Admirals of the Delaware, and no boat in the River could hold its way with us, but all fell astern, although several sail boats, which were very light, and heavy sails, that brought their gunwales well down to the water, came out to try us."

Shortly afterward, Rittenhouse the astronomer, Dr. Ewing, Gen. Irvine, and others were favored with the novel experience of a steam voyage; and now, at last, public journals began to give well-deserved notice to the successful efforts of these indefatigable inventors. The following paragraph was published in the Gazette of the United States, May 15th, 1790, and widely recopied throughout the Union: "Burlington, May 11, 1790. The friends of science and the liberal arts will be gratified in hearing that we were favored, on Sunday last, with a visit from the ingenious Mr. Fitch, accompanied by several gentlemen of taste and knowledge in mechanics, in a steamboat constructed on an improved plan. From these gentlemen we learn that they came from Philadelphia in three hours and a quarter, with a head wind, the tide in their favour. On their return, by accurate observations, they proceeded down the river at the rate of upwards of seven miles an hour." Subsequently, on June 16th, Gov. Thomas Mifflin and nine members of the

(Continued on page 222.)

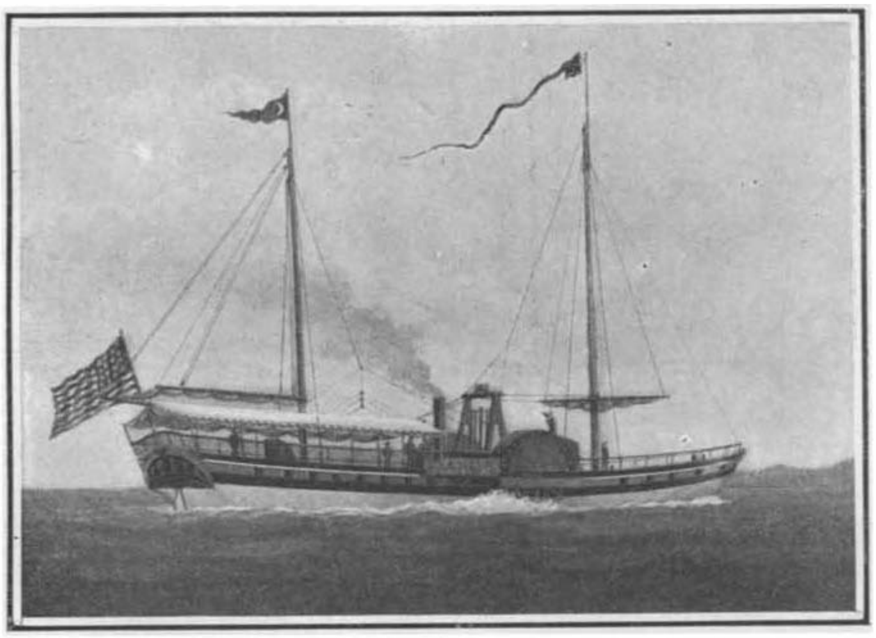


Cylinder, 4½-inch diameter by 9-inch stroke. Two connecting rods to two shafts which are geared together and turn in opposite directions. Valves are two-way cocks, operated by a crank on inboard end of one of the crank shafts.

ENGINES OF STEVENS'S TWIN-SCREW STEAMBOAT OF 1804.

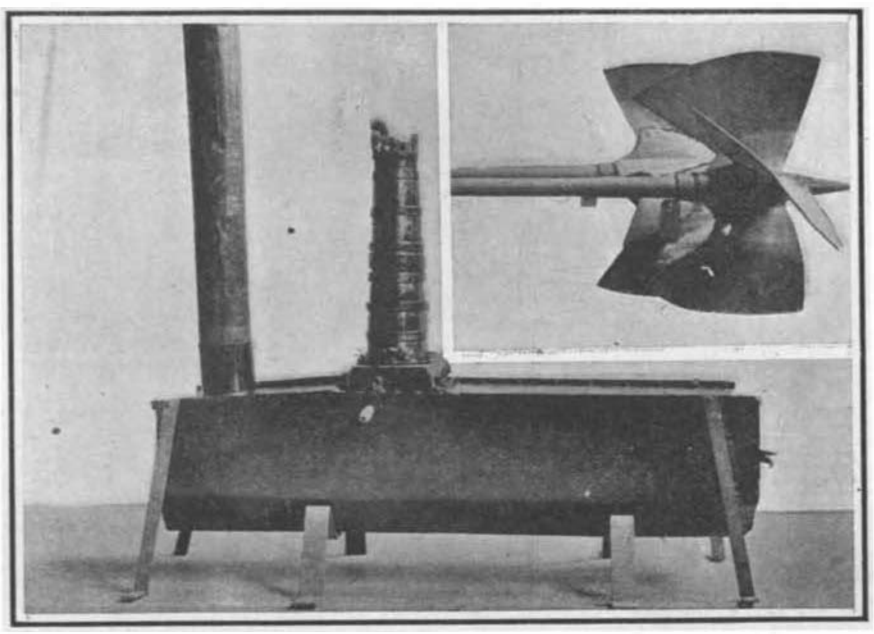
Round shank could be turned in the hub to change pitch.

STEVENS'S ADJUSTABLE PROPELLER BLADES



Debarred by the Livingston-Fulton monopoly from navigating the Hudson, the "Phoenix" went by sea to Philadelphia and was operated on the Delaware. (This was the first steamboat to make an ocean voyage.)

STEVENS'S STEAMBOAT THE "PHOENIX," 1807.



Boiler has 28 tubes 1½-inch diameter and 18 inches long; fourteen projecting from each side of the central rectangular chest. (From photograph by the courtesy of the Smithsonian Institution.)

MULTI-TUBULAR BOILER AND TWIN SCREWS OF THE STEVENS BOAT OF 1804.

EUROPEAN STEAMBOATS PRIOR TO THE "CLERMONT."

As in America, so in Europe, the quarter of a century preceding the successful inauguration of steamboat service on the Hudson River was a period of extraordinary interest among inventors in the possibilities of steamboat navigation, during which a great amount of thought and experimental work was devoted to the development of a successful steam-driven vessel. In the present chapter we shall touch lightly upon those inventors who merely drew up plans, took out patents, and made more or less successful models of steamboats; our attention will be devoted more specifically to the clearly-recorded and well-authenticated instances, in which steamboats of useful size were actually propelled by steam.

Following this plan, we may dismiss at once the oft-asserted claim that a vessel of some 200 tons, built by Blasco de Garray, a native of Biscay, was propelled by steam at Barcelona in Spain in the year 1543. Careful search by investigators has revealed two letters, signed by Garray and dated 1543, describing experiments with different vessels, both of them moved by paddle wheels *turned by men*. There is no mention of the use of steam, or anything to indicate that this motive power was contemplated.

The Marquis of Worcester published a book in 1663, in which mention is made of an engine, and of the ability of the inventor to make the vessel which carried it "go against the stream which the more rapid it is the faster it shall advance." His patent, however, contains no suggestion that he had any idea of using steam.

Although the name of no inventor in the early part of the eighteenth century is more closely associated with the design of the steamboat than that of Jonathan Hulls, there is no proof that he ever built and operated one. At the same time, Hulls was a man of unusual intelligence and of considerable mechanical skill. His patent, taken out in 1736, describes the invention as "a machine for carrying ships and vessels out of, or into, any harbor or river against wind and tide." The following year he published a pamphlet in London describing his invention; and it is curious that, like many early experimentalists, he considered that its greatest usefulness would be found in the towing of vessels. The illustration of his boat, given on page 220, was drawn from his very complete description of the mechanism of the boat, and Admiral Preble, of the United States navy, in his work "On the Origin and Development of Steam Navigation," says that "there can be no doubt of his having been the first inventor of an ingenious and practicable mechanism for propelling vessels by a condensing steam engine and by paddle wheels"; and this, be it remembered, was as far back as 1736. Writing over a quarter of a century ago, again the same author says: "The following doggerel is still the burden of a common street ditty among the boys of Campden of Gloucestershire, Hulls's native place:

'Jonathan Hulls,
With his patent skulls,
Invented a machine
To go against wind and stream;
But he, being an ass,
Couldn't bring it to pass,
And so he was ashamed to be seen.'"

Truly, a prophet is not without honor save in his own country.

It is a disputed point whether to Denis Papin, the great French engineer and professor of mathematics at the University of Marburg, is due the credit of being the first to make a steamboat run upon a public waterway. Preble, however, is of the opinion that his correspondence with Leibnitz, which was brought to light during the latter part of the nineteenth century, fully proves that Papin actually constructed a steamboat which he ran upon the river Fulda in 1707. It is certain that he met with the seemingly inevitable ridicule and abuse. Disgusted with the conduct of the Hessians, he determined to go to London in his steam vessel, and descended the Fulda as far as Munden, where the boatmen laid violent hands upon him, and destroyed his little craft.

Next to Papin comes the Marquis de Jouffroy, who in 1781 built a steam vessel 150 feet in length and 15 feet in beam, which, according to a document now in Paris, was propelled by steam for fifteen minutes against the stream.

WILLIAM SYMINGTON.

The credit for the invention and construction of the first steamboat to be successfully applied in Europe to useful navigation is due a Scotch engineer, William Symington, who attacked the problem on original lines, and produced a vessel, the "Charlotte Dundas," which in many respects was half a century in advance of the state of the art. Symington was born in Scotland in 1764. Educated for the church, his taste for mechanical philosophy, he tells us, led him to direct his studies to the exercise of the profession of a civil engineer. He obtained patents for several improvements in the steam engine, and designed a steam carriage, which in 1786 he submitted to several learned and scientific men in Edinburgh. Here he met Patrick Miller of Dalswinton, a wealthy banker, who informed Symington that he had "spent much time in making experiments as to the propelling of vessels upon water by using wheels in place of sails or oars. These wheels he had put in motion, applying the strength of men to the turning of a handle or winch." Symington told Miller that he believed a steam engine might be constructed for the purpose, and he proposed that favorite method with early steamboat inventors, of communicating a rotary motion to the paddle by the alternate action of ratchet wheels. The first experiment was made with a two-cylinder engine, the cylinders being of 4 inches diameter and 18-inch stroke. It was installed on a double-keel vessel, and tried on the Dalswinton estate in 1788, with satisfactory results. The next experiment was upon a larger boat, 60 feet in length, belonging to Miller, which was already equipped with man-operated paddle wheels. In this vessel Symington placed a two-cylinder engine, each cylinder being of 18 inches diameter and 3-foot stroke; and in October, 1789, with Miller and several prominent business men and engineers on board, the boat was driven at a rate of five miles an hour in still water. The engraving on page 220 is based on the original plans of this boat, as given by Symington. At this point, Miller retired from business to devote himself to his estate at Dalswinton; but in the year 1800, Lord Dundas, one of the principal owners of the Clyde Canal, requested Symington to take up his experiments with the steamboat, and spent about $35,000 in this work. With sufficient capital assured to give him a free hand, Symington designed an entirely new boat and engine, called the "Charlotte Dundas." An examination of the drawings of the vessel, as shown on pages 220 and 221 of this issue, proves that Symington was an engineer of decidedly original genius. Even at that early day, his mechanical sense objected to the cumbersome overhead working beam, and in a letter at that period he criticises the cylinder erected in a vertical position and the heavy working beam, and other heavy and complicated apparatus of the old steam engine, and explains how, by changing the position of the cylinder and "by coupling to the end of the piston rod a crank and arm," he "reproduced a rotary motion without the intervention of a lever or beam." In other words, Symington in the engine of the "Charlotte Dundas" originated the modern horizontal reciprocating engine, which was destined to become the predominant type for steamboat, locomotive, and stationary engines, and continued to be such throughout the middle period of the history of the steam engine. The cylinder was double acting, 22 inches in diameter and with a stroke of 4 feet. It was direct-connected to the crankshaft of a paddle wheel at the stern of the boat. The account of the experiment, as given in his own narrative, which has been confirmed by others, is as follows:

"Having previously made various experiments, in March, 1802, at Lock Twenty-two, Lord Dundas, the great patron and steamboat promoter, along with Archibald Spiers, Esq., of Elderslee, and several gentlemen of their acquaintance being on board, the steamboat took in drag two loaded vessels, the 'Active' and 'Euphemia,' of Grangemouth, Gow and Elspine, masters, each upwards of *seventy tons* burden, and with great ease carried them through the long reach of the Forth and Clyde Canal at Port Dundas, a distance of nineteen and a half miles, in six hours, although the whole time it blew a very strong breeze right ahead of us; so much that no other vessel could move to windward in the canal that day but those we had in tow."

Since the object of Lord Dundas in employing Symington was to have him devise some cheaper means of towing canalboats than the existing method by horses, it would look as though the future of the steamboat was assured; but, unfortunately, the other proprietors of the canal objected to the use of steamboats, urging that the waves set up would wash away the canal banks. Therefore, nothing further was done. Subsequently, Symington was introduced by Lord Dundas to the Duke of Bridgewater, who was responsible for the introduction of canals into England. Symington impressed him so favorably that he gave him an order to build eight boats similar to the "Charlotte Dundas" for service on his canals, but the death of the Duke shortly afterward led to the canceling of the order.

Among the many methods of applying the power of the engine to propel the boat that were tried by the early inventors, one of the most popular was to use an endless chain of paddle boards, traveling over wheels or pulleys at each end of the boat, the paddles being submerged as they passed toward the stern, and being carried clear of the water as they returned toward the bow. Of this type was Desblanc's steamboat, which was tried on the river Doubs in 1802. The arrangement of the engine and the chain of paddles is shown very clearly in the engraving on pages 220 and 221. The engine was horizontal, and the reciprocating motion of the piston was converted into rotary motion by means of a ratchet gear acting upon a spur wheel upon the main driving axle.

AMERICAN STEAMBOATS PRIOR TO THE "CLERMONT."

(*Concluded from page 219.*)

Council, after a trip on the Delaware, were so greatly pleased as to present Fitch with a suit of colors for his boat.

The new venture was now ready for commercial exploitation. A schedule of sailing dates and fares was drawn up, and during the following three months there appeared in the local papers twenty-three advertisements announcing the times of sailing. The routes covered were to Trenton, thirty miles; to Burlington, twenty; to Chester, fifteen; and to Wilmington, thirty miles. During these three months "The Steamboat," as she was popularly called, ran in regular passenger service for a total distance of between 2,000 and 3,000 miles. Limitations of space prevent any further quotation of the certificates and eulogies given by prominent men of the day. We present engravings of two of the advertisements of 1790, photographed for the Scientific American from the files of the Pennsylvania Packet and the Federal Gazette, by the courtesy of Mr. Abbott, the curator of the Philadelphia Library.

In view of this crowning success to the labors of Fitch and his associates, the story of the rest of his life is truly tragical. His attempt to build another and larger vessel failed for want of financial support. Had some influential, wealthy, and far-sighted patron come to Fitch's assistance at this time, there can be little doubt that the advent of successful commercial steamboat navigation would have been hastened by twenty years. But it was not to be. Discouraged and embittered by failure to secure recognition and support, Fitch, after an abortive trip to France, wrote an account of his life and experimental work, which he delivered to the librarian of the Philadelphia Library, with instructions that it be not opened for thirty years; and then, retiring to Bardstown, Ky., he ended his unfortunate life by committing suicide.

JOHN STEVENS.

The claim of Col. John Stevens to a foremost position among those who contributed to the early development of the steamboat is based upon his recognition of the value of the screw propeller, of the multitubular boiler, and of high-pressure steam. Like Fitch, Stevens was possessed of great mechanical ability; and to this was added the advantage of wealth and education. His claim to have built the first steam screw propeller boat to navigate the waters of any country we consider to be indisputable.

After some preliminary experiments, as recorded earlier in the present chapter, Mr. Stevens designed an entirely new engine and boiler, differing from anything that had yet been attempted either here or in Europe, and erected it in a 28-foot boat, which made many successful trips at speeds of between seven to eight miles an hour on the Hudson River. The twin screws, engine, and the boiler are still in existence, and are now at the Smithsonian Institution, Washington. The accompanying illustrations are reproductions from photographs of this exhibit made especially for the Scientific American by the courtesy of the curator. The cylinder was of 4½ inches diameter and 9 inches stroke. Motion was transmitted from the overhead crosshead by two connecting rods to a pair of cranks, one on each propeller shaft. The cranks turned in opposite directions (to overcome the tendency of a single propeller to rotate the boat) and the cranks were maintained in their proper rotating position relatively to each other by means of two gear wheels on the propeller shafts. The reaction of the connecting rods against each other served the purpose of a parallel motion and maintained the piston rod in alignment. The valves consisted of two-way cocks, and they were driven by a crank on one of the propeller shafts, through the intermediary of a vertical rack and gear wheels on the spindles of the two-way cocks. The boiler is one form of the multitubular type invented by Col. Stevens. It has 28 copper tubes, 14 projecting from each side of a center rectangular chest.

Contemporary testimony to the successful operation of this boat is given in Stewart's "Anecdotes of the Steam Engine," published in 1829, and in an article by Dr. James Renwick contributed to Tredgold's "Treatise on the Steam Engine," published in London in 1838.

That John Stevens and his son, Robert L. Stevens, are to be credited with having built the first ocean-going steamship is proved by the well-authenticated voyage made by the "Phœnix" from New York to Philadelphia. The engines of the "Phœnix" were designed and built by Stevens. The accompanying illustration of this historic vessel is from a photograph of an old painting at the family home, Castle Point, Hoboken, N. J. Alluding to the above voyage, the late Mr. J. Scott Russell, the builder of the "Great Eastern," said that Mr. Robert L. Stevens was "undoubtedly the pioneer of steam navigation in the open sea."

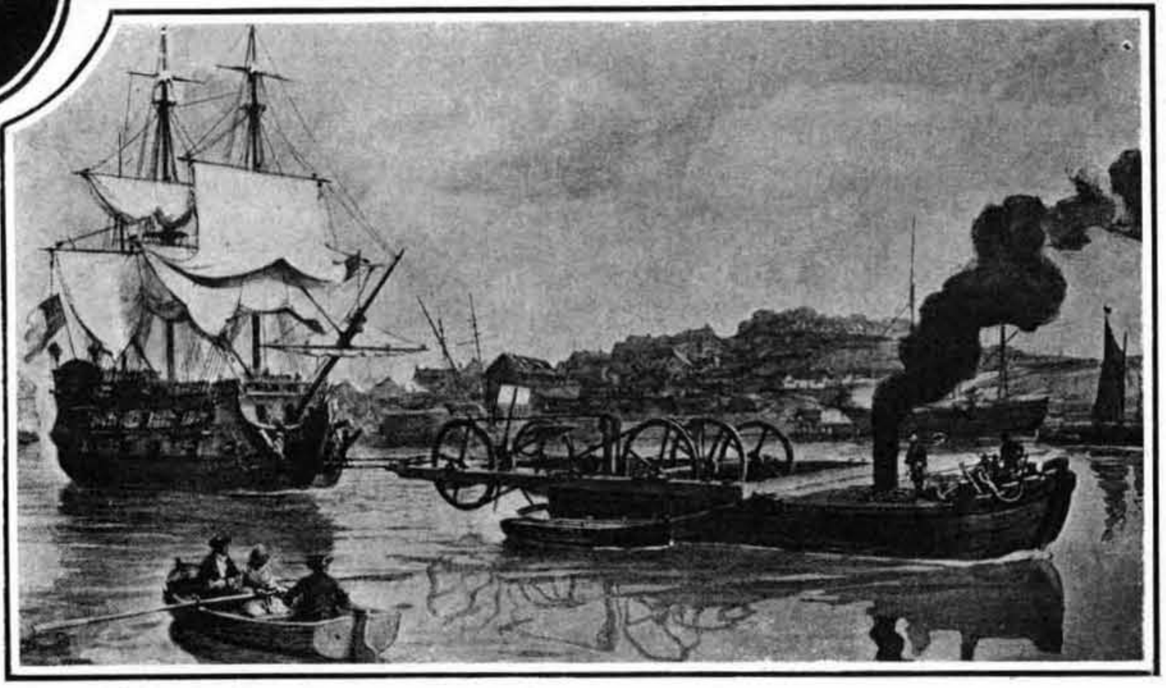


Fig. 1.—JONATHAN HULLS'S PROPOSED BUT NEVER BUILT STEAM TUG. 1737.

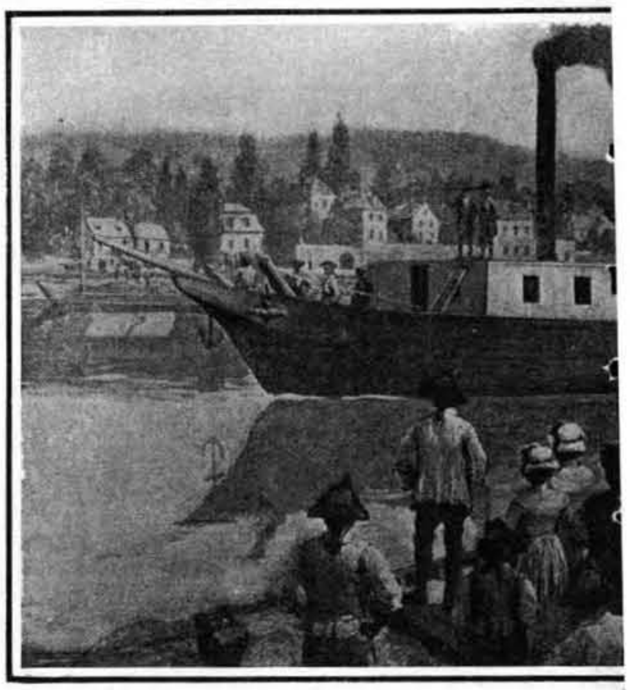


Fig. 2.—THE MARQUIS DE JOUFFROY'S PADDLE STE

FIG. 1.—In 1736 Jonathan Hulls, yeoman, of Campden, Gloucestershire, patented and published a complete description of a practical steam-tug. The tug had a single-acting steam-cylinder, 30 inches in diameter, which in its inward stroke lifted a weight equal to one-half of its effective pull. The energy of this weight in its descent during the return stroke gave the engine a double action and the reciprocating motion of the piston gave continuous rotation by a ratchet gear to a paddle-wheel at the stern.

FIG. 2.—The drawing is based on a sketch at South Kensington Museum taken from a French print published in 1816. In Paris there exists a document declaring that on July 15, 1783, the vessel was propelled by steam for fifteen minutes against the current of the Saone. The boat was 150 feet long with 15 feet beam and 3 feet 2 inches draft. It had two paddle-wheels, turned by a single horizontal steam-cylinder, driving through a ratchet mechanism.

FIG. 3.—Patrick Miller, a wealthy Scotch banker, built a double-hulled boat which he propelled by a paddle-wheel, placed in the channelway between the hulls and operated by men by means of cranks and winches. Symington subsequently (Fig. 5) substituted steam for man power.

FIG. 4.—This vessel, designed by Symington for the Forth and Clyde canal, in March, 1802, towed two 70-ton barges for 19½ miles against a hard wind at the rate of 3½ miles an hour. The horizontal engine, direct-connected from cross-head to paddle-wheel shaft, was many decades ahead of its time. It embodies all the essential features of the modern horizontal engine, and mechanically was a great advance upon the Watt beam engines of that day.

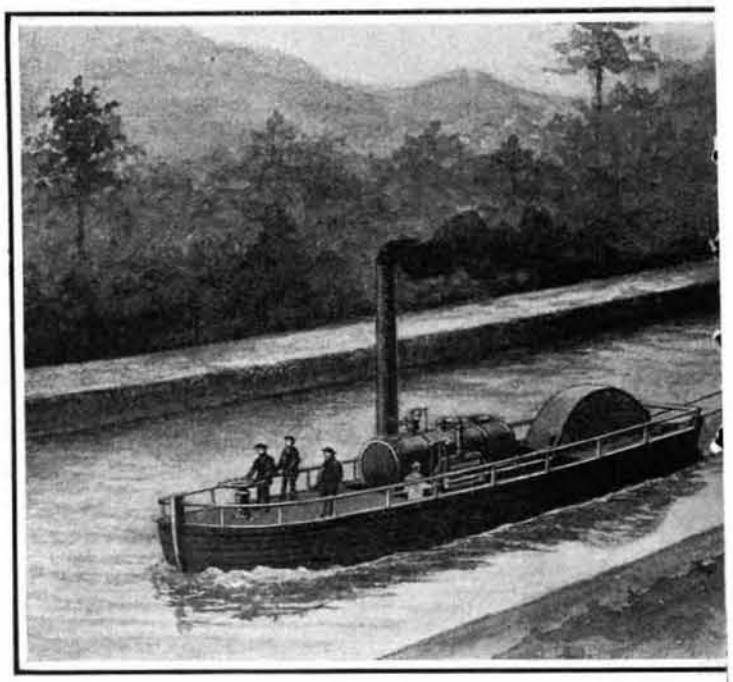


Fig. 4.—WILLIAM SYMINGTON'S STEAMBOAT "CHARLOTTE DUNDA

Fig. 5.—SYMINGTON AND MILLER'S DOUBLE-HULLED STEAM VESSEL. 1788.

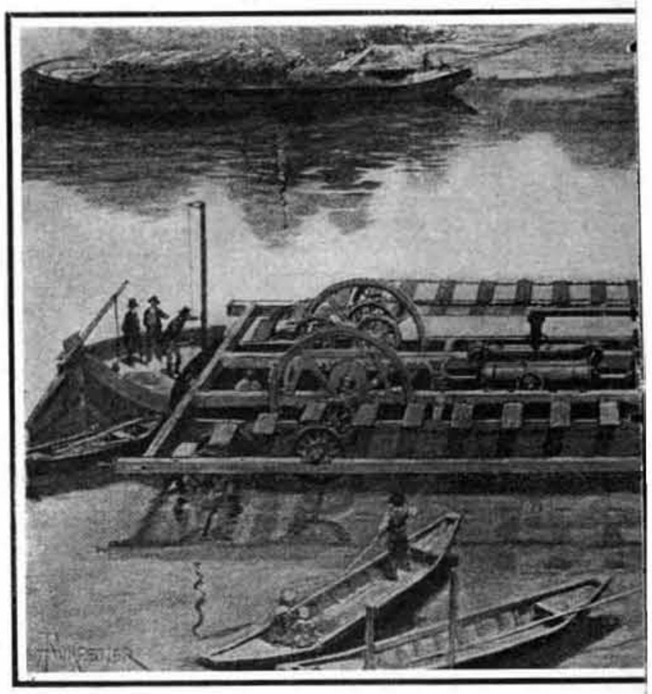


Fig. 6.—DESBLANCS' STEAMBOAT TRIED

EUROPEAN STEAMBOATS PRIO

Figs. 4 and 7 by our own artist; the others by the

AMBOAT ON THE SAONE. JULY 15TH, 1783.

Fig. 3.—PATRICK MILLER'S DOUBLE-HULLED PADDLE BOAT DRIVEN BY MAN POWER. 1786.

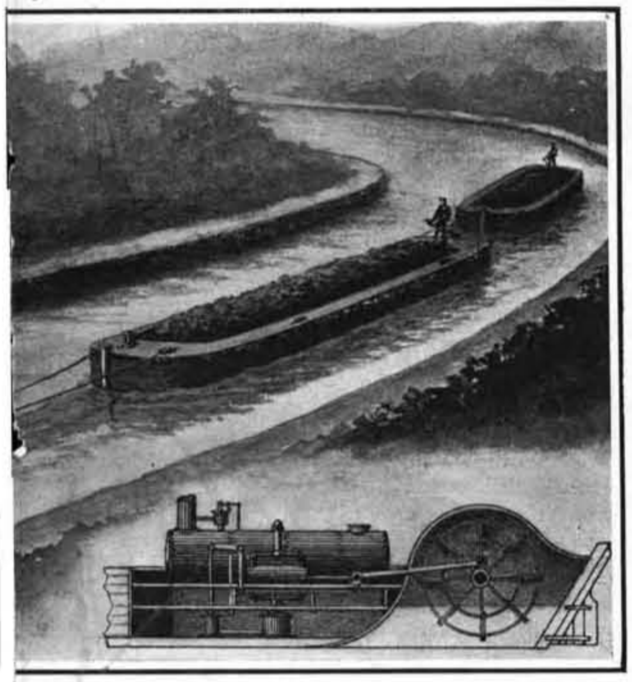
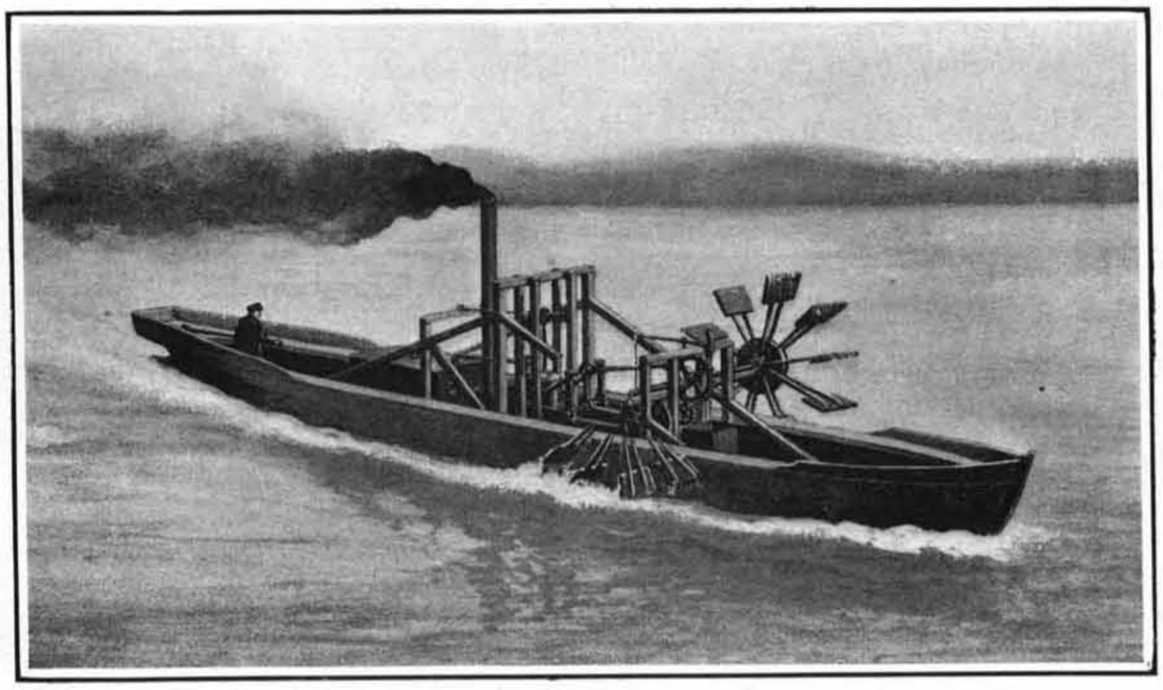


FIG. 5.—The engine for this boat was built in 1788 by William Symington for Patrick Miller. It was placed on one deck of a double-hulled pleasure-boat, and the boiler was put on the other deck. The boat ran on Dalswinton Loch at the rate of five miles an hour. The engine had two vertical open-topped cylinders with pistons connected by two chains with a drum turning in opposite directions alternately. Chains from the central drum turned two pulleys attached to the horizontal paddle-shafts, with ratchet teeth round their inner flanges, and these drove the paddle-wheel continuously in one direction.

FIG. 6.—The hull of the vessel was built like a barge. The horizontal motion of the cylinders was converted into circular motion by a ratchet gear acting upon the axle of the fly-wheels. The floats of the paddle were arranged on parallel chains, and traveled like the buckets of a dredger. As the floats of the paddle came out of the water they feathered like an oar.

FIG. 7.—This illustration, drawn from plans filed by Fulton with the French Commission appointed by Napoleon I. to investigate his invention, possesses special interest, because it undoubtedly formed the model on which the engines of the "Clermont" were designed. The engine consisted of an upright cylinder, cross-head, vertical side rods connecting to a bell-crank lever, from which the paddle-wheel crank-shaft was driven by a connecting rod. It made 3½ miles on its trial trip.

S" TOWING ON THE FORTH AND CLYDE CANAL. 1802.



ON THE RIVER DOUBS. 1802

Fig. 7.—FULTON'S STEAMBOAT BUILT AND TRIED ON THE SEINE AT PARIS. JULY, 1803.

R TO THE "CLERMONT."

[SEE PAGE 222.]

ourtesy of the Illustrated London News.