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Historical and descriptive anecdotes of steam-engines, and of their inventors and improvers

Stuart, R.

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Chapter twenty-two.

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CHAPTER TWENTY-TWO.

SOON SHALL THY ARM, UNCONQUERED STEAM! AFAR
DRAG THE SLOW BARGE, OR DRIVE THE RAPID CAR;
OR, ON WIDE WAVING WINGS, EXPANDED BEAR
THE FLYING-CHARIOT THROUGH THE FIELDS OF AIR.

Darwin.



THERE is probably no one, whose name is associated with the history of this mechanism, and whose labours have received so large a share of applause, appears to have less claim to notice as an inventor, than Robert Fulton.

His father was a poor Irish labourer, a native of Kilkenny, who emigrated to Pennsylvania, where Robert was born in 1765; and it was his misfortune, when he was little more than three years old, to lose, by the death of his father, even the slender protection which this homely lot in life afforded. In the village school he was taught to read and write a little, and in Philadelphia, he afterwards followed, with varied success, a youthful partiality for drawing and mechanics; in a few years, his perseverance enabled him to rise a little above the humble circumstances of his family, and to earn a livelihood by the sale of his portraits and landscapes. His frugal habits soon enabled him to purchase a small farm in the

neighbourhood of Philadelphia, which he settled upon his family; and coming to London in 1786, he experienced the kindness and patronage of Benjamin West, as his countryman and an artist. Under him he made some progress in design: he was clever, without giving indications of possessing a talent, that would rise above mediocrity; as an artist, he had diligence and perseverance, but he had no taste, and little invention: this was attributed to a divided, and, of course, a desultory application; for mechanics, which had always some share of his attention, soon engrossed the whole.

He spent two years near Exeter, where he became known to the Duke of Bridgewater and to the Earl of Stanhope, with the latter of whom he communicated in 1793, on the subject of applying steam to move boats; and for the following eighteen months he lived at Birmingham, where he matured his scheme for small canals. This project receiving no attention from government, he published it in 1796. The character of this book was that of its author; it contained nothing original, either in matter or manner. But from his acquirements as an artist, the engravings were superior to those usually given in similar books; and, as exhibiting industry, was considered for a young man to be a respectable production*.

* In this treatise he attempts to prove, that small canals, navigable by boats of little burden, were preferable to canals and vessels of the large dimensions then in use; an opinion, of which the ruinous fallacy is confirmed by every day's experience, and the small returns received, in the majority of instances, from the immense sums expended in excavating and preserving some of this species of navigable ditches in England. "To continue traffic over mountainous countries, he proposed inclined planes, upon which vessels and their cargoes, navigating the canal, should be raised or lowered



FULTON.

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He received, in 1794, the thanks of two societies for accounts of various projects, and he had patents for improvements on sawing marble, and making cordage, but they did not turn out productive to those who became his colleagues. In 1796 he went to France, but there his private schemes met with less regard than in England. As he was not wanting in a certain sort of judgment, he revived a project which had been often suggested, and attracted the public eye, by a proposal to blow up ships, by a machine of his invention, which "moved entirely under water, and thus he hoped to deliver France and the whole world from British tyranny and oppression*."

He applied to the Directory for pecuniary assistance: he was referred to the Minister of Marine, who pronounced the project impracticable. Fulton, with his model under his arm, again presented himself to the Directory; and the persons whom they named to inspect it gave an opinion in its favour, but the inexorable Minister of Marine finally rejected it. Three years had thus been wasted, when Fulton offered his model

from one level to another; or by lifting or lowering the boat and her freight perpendicularly, by machinery, which was to be moved by the power of water taken from the superior height, and applied to a water wheel; or by the weight of a body of water received into a coffer, which was to move in a direct line between the higher and lower level, through a perpendicular shaft, or well, made in the earth for that purpose; and, in another place, he proposes to pass over a valley, from one summit to the other, by double inclined planes. In these projects he only claims the perpendicular lift, and the connexion of the inclined planes with machinery, as new ideas."—*Colden's Memoir*, p. 15.

* "His first experiment, 1797, made on the Seine, (in company with Joel Barlow, with whom he lived for seven years,) was to impart to carcasses of gunpowder a progressive motion under water, and there to explode them. He was disappointed in this machine,"—*Ibid.*, p. 28.

to the Batavian Directory : to the heavy Dutchmen it appeared as impracticable as to their lighter neighbours ; and M. Vanstaphast, an opulent citizen, who had a better opinion of it than his colleagues, after disbursing the expenses of several trials, also gave it up in despair.

From Napoleon Bonaparte, after his elevation to the Consulate, he at last succeeded in obtaining money to make an experiment on a large scale at Havre, in the winter of 1801. And in sailing between that and Brest in the following year, he amused himself by alarming the gunners on some parts of the coast, by plunging his nautilus under water, and then re-appearing at some little distance ; “ but this amusement was all that his patrons had for their money.” At Brest, however, he succeeded in immersing his nautilus to the depths of five, ten, and twenty-five feet, remaining under the surface of the water for an hour *. In another ex-

* “ During this time they were in utter darkness. Afterwards he descended with candles, but found a great disadvantage from their consumption of vital air. He next fitted, near the bow of his boat, an aperture, one inch and a half in diameter, with glass, and he found this admitted light sufficient to enable him to count the minutes on his watch. Finding he could descend to any depth, and rise to the surface with facility, his next object was to try her movements as well on the surface as beneath it. His boat had one mast, a mainsail, and jib. He weighed anchor and hoisted sail, (July, 1801,) there was only a light breeze, and, therefore, she did not move on the surface at more than the rate of two miles an hour ; but it was found she would tack and steer, and sail on a wind, or before it, as well as any common sailing boat. He then struck her mast and sails, and perfectly to prepare the boat for plunging required about two minutes. Having plunged to a certain depth, he placed two men at the engine, which was intended to give her progressive motion, and one at the helm, while he, with a barometer before him, governed the machine, which kept her balanced between the upper and lower waters. He found that with the ex-

periment, he moved about the fifth of a mile under water; and in a subsequent one, accompanied by three other persons, by means of a globe, having about a foot of cubic capacity, and in which he had condensed air under a pressure of two hundred atmospheres, they remained under water for several hours*.

Having acquired some practice in sub-marine navigation, he was allowed to demolish an old brig in Brest Harbour; and during the same summer he anxiously sought to test his art on some English ships, which daily advanced to the Roads, when once, as he was on the point of attaching his "infernal machine" to a man-of-war, "it fortunately changed its position and escaped from the threatened annihilation.

Bonaparte now turned a deaf ear to his applications for further assistance, considering him to be a quack and a sharper, whose enterprises were only means to supply himself with money †. Ful-

ertion of one hand only he could keep her at any depth he pleased; the propelling engine was then put in motion, and on coming to the surface he had moved about five hundred yards; he then again plunged, turned her round while under water, and returned to near the place he began to move from: this he did several days successively. He found that the boat was as obedient to her helm under water, as any boat could be on the surface, and that the magnetic needle traversed as well in the one situation as in the other."—*Colden*, p. 34.

* "He descended to the depth of five feet; at the expiration of an hour and forty minutes he began to take small supplies of *pure* air from his reservoir, and he did so, as he found occasion, for four hours and twenty minutes; he then came to the surface, without having *experienced any inconvenience* from having been so long under water."—*Ibid.*, p. 35.

† "Bonaparte, dont le goût pour les innovations diminuait à mesure que son pouvoir augmentait, avait déjà cessé d'attacher aucun prix aux inventions sous-marines; et il traitait

ton, more fortunate in his appropriations, having made himself acquainted with Panoramas before leaving England, established the first of that kind of exhibition at Paris; in a pecuniary view, this speculation more than answered his expectations.

It was during his journey from London to Paris, that he was introduced to Doctor Cartwright, then residing in the neighbourhood of Dover. The Doctor explained to him a mechanism to move vessels by steam, and he drew a plan of it, in the presence of some of his family, which he presented to Fulton, expressing his regret, that his circumstances at that time were not so favourable as to enable him to be at the expense of making the experiment. The Doctor's idea was not forgotten, when, during the state of incertitude with regard to his nautilus, Fulton turned his attention to propelling boats by a steam-engine.

Soon after his arrival in Paris, Fulton had formed a friendship with Mr. Robert Livingstone, then minister from the United States to the Court of France. In their conversations, this gentleman communicated to Fulton his opinion on the importance of steam-boats to their common country; informed him of what had been attempted in America, and his resolution to resume the pursuit on his return, and advised Fulton to turn his mind to the subject. It was agreed between them to embark in the enterprise, and immediately to make such experiments as would enable them to determine how far, in spite of former failures, the object was attainable; and to Ful-

leurs auteurs d'extravagans, ou d'imbéciles, et ajoutait, à l'égard de Fulton, que cet Americain était un charlatan, un escroc qui voulait seulement attraper de l'argent."—*Montgery*, p. 241.

ton, says the Chancellor, was left the principal direction of these experiments.

Among the schemes which Fulton thought of, but discarded, was that of Franklin, and those by Fitch, as well as Rumsey. By paddles and duck-foot oars, he saw it was impossible to drive a boat six miles an hour, and he thought it was to such defective applications of power, and not to a want of it in the engine, that all experiments had hitherto failed.

Endless chains, with resisting boards upon them as propellers, appeared to him greatly preferable to any other method which had been tried; and as he was desirous of proving their effect by actual experiment, for which he wished for more retirement than the waters near Paris would afford, he accompanied Mrs. Barlow, who had been ordered by her physicians to Plombieres; and on a little rivulet, which runs through that village, he made a course of experiments with a set of models he had constructed for the purpose: the results of these gave him strong assurances of success.

During the time Fulton was engaged in these experiments, a M. des Blancs, whose boat on the Soane has already been noticed, deposited a model of his apparatus in the Repository of Machines at Paris. In this he used a horizontal cylinder, by which endless chains, with resisting boards upon them, or what he called chaplets, were to be worked from stem to stern alongside of the vessel.

From Fulton's report of his experiments at Plombieres, on models of his own invention, it was understood, says Livingstone, that *he* had developed the true principles upon which steamboats should be built, and for the want of knowing which, all previous experiments had led to no

useful result. But as many things, which were apparently perfect when tried on a small scale, had failed when practised on a large one, they determined to go to the expense of building an "operating boat" upon the Seine.

During the construction of this vessel, Des Blancs called the public attention to Fulton's operations as an invasion of his patent right; "and he also addressed a remonstrance to Fulton himself on the subject. In reply the American explained, that his plan differed materially from Des Blancs', for his boat was to be propelled by wheels, not by chains. He also, at the same time, communicated to Des Blancs his own experiments with the chaplet mechanism and paddle wheels; and informed him, that the result decided him to adopt the latter. Fulton concluded by offering his rival a share in the advantages of the discovery which he had made, if he would bear his proportion of the expense. But no notice was taken of this offer, or even of the letter*.

Livingstone and Fulton's experimental boat was completed early in the spring of 1803—"And they were on the point of making an experiment with her, when one morning as Fulton was rising from a bed, in which anxiety had allowed him but little rest, a messenger from the boat, whose precipitation and apparent consternation announced that he was the bearer of sad tidings, presented himself to him, and exclaimed—"Oh, sir, the boat has broken in pieces, and gone to the bottom!"—For the first time in his life he felt a vivid emotion of despondency, but this was only for a moment. On examination he found that the boat

* *Colden*, p. 159.

had been too weakly framed to bear the great weight of the machinery, and in consequence of an agitation by the wind on the preceding night, what the messenger had represented had literally happened. By great exertions the parts were raised from the bottom, and the greater part of the boat was rebuilt. Her length was sixty-six feet, and her width eight feet. Fulton's experiment drew a great concourse of spectators, in August, 1803; the wheels and other machinery acted according to his expectations, although her speed was not so great as he calculated upon her machinery producing *. Such entire confidence

* "Blasco de Garay, a sea captain, exhibited to the Emperor and King Charles V., in the year 1543, an engine by which ships and vessels of the largest size could be propelled, even in a calm, without the aid of oars or sails.

"Notwithstanding the opposition which this project encountered, the Emperor resolved that an experiment should be made, as in fact it was, with success, in the harbour of Barcelona, on the 17th of June, 1543."

"Garay never publicly exposed the construction of his engine, but it was observed at the time of his experiment, that it consisted of a large caldron or vessel of boiling water, and a moveable wheel attached to each side of the ship.

"The experiment was made on a ship of 209 tons, arrived from Calibre, to discharge a cargo of wheat at Barcelona; it was called the Trinity, and the captain's name was Peter de Scarza.

"By order of Charles V. and the Prince Philip the Second, his son, there were present at the time, Henry de Toledo, the governor, Peter Cardona, the treasurer, Ravago, the vice-chancellor, Francis Gralla, and many other persons of rank, both Castilians and Catalonians; and among others, several sea captains witnessed the operation, some in the vessel, and others on the shore.

"The Emperor and Prince, and others with them, applauded the engine, and especially the expertness with which the ship could be tacked. The treasurer Ravago, an enemy to the project, said it would move two leagues in three hours. It was very complicated and expensive, and exposed to the constant danger of bursting the boiler. The other commissioners affirmed, that the vessel could be tacked twice as

did he and his associate acquire from this trial, that he writ instructions to Watt and Bolton, to prepare a steam-engine for him, and which was to be sent to New York, to which place he prepared to return, in order to introduce his invention on the American waters*; and soon afterwards Livingstone succeeded, by means of his friends at New York, in having his privilege of navigating all the waters of that State by steam, which had

quick as a galley, served by the common method, and that at its slowest rate it would move a league in an hour.

"The exhibition being finished, Garay took from the ship his engine, and having deposited the wood work in the arsenal of Barcelona, kept the rest to himself.

"Notwithstanding the difficulties and opposition thrown in the way by Ravago, the invention was approved; and if the expedition in which Charles V. was then engaged, had not failed, it would undoubtedly have been favoured by him. As it was, he raised Garay to a higher station, gave him a sum of money (200,000 maravedies) as a present, ordered all the expenses of the experiment to be paid out of the general treasury, and conferred upon him other rewards.

"Such are the facts collected from the original registers preserved in the Royal archives at Samancas, and among the public papers of Catalonia, and those of the Secretary at War, for the year 1543."

This remarkable statement appears as a note in the first volume of original papers relating to the voyages of Columbus, lately published in Spain, by one of the Secretaries of the King, and printed at the Royal Press, was communicated to the author, in a letter from Thomas Gonzales, dated at Salamanca, 27th August, 1825; and it would seem he had recently consulted the public records to which he refers. The editor of the *Franklin Journal*, from whom this extract has been made, observes, "when the 'Public Records' shall appear in an *authentic form*, their evidence must be admitted; *until then* he should not be inclined to commence the history of the invention of the steam-boat, so far back as 1543. For circumstantial as the account is, it seems to have been written since the days of Fulton."

* "It is said, that the shore of the Mississippi, and of the rivers which flow into it that are navigable for steam-boats, are equal to an extent of fifty thousand miles."

become obsolete, re-granted to Fulton and himself, for a period of twenty years.

Fulton, whose nautilus had never risen fairly to the surface, found means of communicating his experiments to the Earl of Stanhope; and coming to England, through his lordship's influence, Fulton, received permission from the government to turn the scheme Bonaparte so much despised, against himself. Fulton was sent to the fleet stationed off Boulogne, and had there an opportunity of making an experiment on two French gun-boats, but the nautilus exploding before the proper time, did not even frighten those whom it was sent to destroy. Although the impression against the scheme was decisive, yet, by the influence of his noble patron, he was permitted, a fortnight afterwards, to make another experiment on an old vessel lying in Walmer Roads," and with the assistance of Sir Home Popham, and two boats' crews, succeeded, after an unresisted attack of two days, in blowing up this poor old carcass *."

This failure again left him at leisure to attend to his steam-boat project, for which Bolton and Watt had nearly constructed an engine on their peculiar principle, but with some modifications to adapt it to propel a vessel; during its progress, he visited Scotland, and inspected Symington's steam-boat on the Forth and Clyde Canal.

Fulton remained in England until October; and, on his arrival at New York, in December, 1806, he commenced his operations to perfect his torpedoes, or submarine bombs, and to build his steam-boat; but finding, when erecting her, that the expenses would greatly exceed his

* On our side of the water, mechanics had not been idle; for Lord Stanhope had invented a submarine machine to destroy the nautilus!!

calculation, he endeavoured to lessen the pressure on his finances, by offering a third share of his exclusive right, to navigate steam-boats in the State of New York, to some individuals, for a proportionate contribution to the expense of this experiment; but he found no one willing to aid him in this enterprise.

In the spring of 1807, notwithstanding the pecuniary and mechanical obstacles opposed to his project, Fulton had completed the vessel, and it was soon after launched on the East River. The engine which had been sent from Watt and Bolton, by this time had arrived, and with the assistance of the working engineers, who had accompanied it from Soho, it was fixed in the boat; and in August, 1807, Fulton had the satisfaction of seeing this celebrated vessel moved by her machinery from her birth-place to the Jersey shore. On this occasion Livingstone and Fulton had invited many of their friends to attend the first trial; "and nothing," says Colden, "could exceed the surprise and admiration of all who witnessed the experiment. The minds of the most incredulous were changed in a few minutes—before the boat had made the progress of a quarter of a mile, the greatest unbeliever must have been converted. The man, who, while he looked on the expensive machine, thanked his stars that he had more wisdom than to waste his money on such idle schemes, changed the expression of his features as the boat moved from the wharf and gained her speed: his complacent smile gradually stiffened into an expression of wonder—the jeers of the ignorant, who had neither sense nor feeling enough to repress their contemptuous ridicule and rude jokes, were silenced for the moment by a vulgar astonishment, which deprived them of the power

of utterance, till the triumph of Genius extorted from the incredulous multitude, which crowded the shores, shouts and acclamations of congratulations and applause." Though her performance far exceeded the expectations of his friends, Fulton perceived that there was an error in the construction of her water-wheels—he lessened their diameter, so that they did not dip so deep into the water, and it was manifest that the alteration had tended to increase the speed.

"This famed vessel, which was named the *Clermont*, soon after sailed for Albany; and, on her first voyage, arrived at her destination without any accident. She excited the astonishment of the inhabitants of the shores of the Hudson, many of whom had not heard even of an engine, much less of a steam-boat. There were many descriptions of the effects of her first appearance upon the people of the banks of the river. Some of them were ridiculous, but some of them were of such a character as nothing but an object of real grandeur could have excited. She was described by some, who had indistinctly seen her passing in the night, to those who had not a view of her, as a monster moving on the waters, defying the winds and tide, and breathing flames and smoke."

"She had the most terrific appearance from other vessels, which were navigating the river when she was making her passage. The first steam-boats, as others yet do, used dry pine wood for fuel, which sends forth a column of ignited vapour, many feet above the flue, and whenever the fire is stirred, a galaxy of sparks fly off, which in the night have an airy, brilliant, and beautiful appearance. This uncommon light first attracted the attention of the crews of other vessels. Not-

withstanding the wind and tide were adverse to its approach, they saw with astonishment that it was rapidly coming towards them; and when it came so near, as that the noise of the machinery and the paddles were heard, the crews, in some instances, shrunk beneath their decks from the terrific sight; and others left their vessels to go on shore, while others prostrated themselves, and besought Providence to protect them from the approach of the horrible monster which was marching on the tides, and lighting its path by the fires which it vomited*.”

In this first voyage the distance run was about one hundred and fifty miles, which was accomplished in thirty-two hours, giving a speed of about five miles an hour. The voyage back was made in the same time; and both going and returning, the wind (a light breeze) being a-head, the whole was performed by the steam-engine and wheels. The voyagers overtook many sloops and schooners beating to windward, and parted with them as if they had been at anchor.

This triumphant experiment established Fulton's reputation; and, soon after, this fine vessel plied between New York and Albany, as a passage-boat, and her success raised Fulton to a well-merited independence.

“It would have been an extraordinary circumstance if her machinery had been like the men of Cadmus, perfect at its birth; and it would have been quite as extraordinary, if its effects could not have been produced by an arrangement or combination of its parts, not precisely that adopted by Fulton †.”

* Colden, p. 173.

† The dimensions of the CLERMONT were—length of boat, 123 feet; depth, 7 feet; breadth, 18 feet. The boiler was

Yet the men who refused to share in his chances of gain, when he offered them for sale, were greedy of his profits, and envious of his fame, after he had established, by an experiment of an immense cost, the practicability of the invention, and seizing upon some obvious and trivial defects, for which they proposed a remedy, or suggested some slight variations in the arrangement of the machinery, on these grounds contested his right as an inventor, and put forth claims to a share in his hard-earned emoluments. Another source of annoyance arose from the prejudices of those who considered the introduction of steam-boats on the American waters destructive to the interests of the common navigators: by these Fulton was spoken of as if he had introduced some project baneful to society; and the Clermont became the object towards which their hostility was directed. She was often intentionally run foul off to produce damage; and this spirit of hostility had shown itself so openly, that the Legislature passed a law to punish, by fine and imprisonment, all those who made wilful attempts to destroy her*. But notwithstanding

20 feet long, 7 feet deep, and 8 feet broad. The *steam-cylinder* 2 feet in diameter: and the *piston* made a stroke of 4 feet. The diameter of the *water-wheels* was 15 feet, the bucket 4 feet long, and dipped 2 feet into the water. The burden 160 tons. Built 1806.

The CAR OF NEPTUNE, built in 1807, carrying 295 tons, was 175 feet long, 8 feet deep, and 24 feet wider. The boiler 18 feet long, 8 feet deep, 9 feet broad. *Steam-cylinder* 33 inches in diameter: the *piston* had a stroke of 54 inches; the *water-wheels* 14 feet in diameter; 4 feet long buckets, which were immersed 2 feet 4 inches in water.

* The Legislature of New York were so fully convinced of the great utility of the invention, and of the interest the public had in its encouragement, that they made a new contract (1808) with Livingstone and Fulton, by which the term

these demonstrations of animosity, the confidence of the public in her performances was increasing, and the *Clermont* continued to run, loaded with passengers, for the remainder of the summer. To provide accommodation for an anticipated increase of voyagers, she was enlarged in her dimensions in the winter of 1808.

Fulton again renewed his experiments with his nautilus and torpedoes, but the opinion of his countrymen was as decidedly against them, as that of those persons who had witnessed his trials in France and England.

Divesting his labours, of all the claim he makes for them, of being undertaken with a patriotic motive, when compared with his countryman Oliver Evans, a labourer also in the same vineyard, he falls greatly below him in practical knowledge, as well as in the power of invention. There was great perseverance in both. Neither hesitated to talk of themselves and their works, in terms which had been used in a better taste by their friends or admirers. But Evans, viewed as one whose ingenuity will probably be less considered than the success of his enterprising contemporary, had a sturdy ingenuousness, which it was one of the greatest blemishes in Fulton's character that he did not possess. But yet Fulton's merit is still of no ordinary kind. Under circumstances where others had given way to despondency, and had sunk under their repeated failures, he persevered in experiment until he produced a successful result; and the splendid

(originally twenty years from 1807) of their exclusive right to the profit of all steam-boats on this peculiar plan, which should navigate the waters of that State, should be extended five years for every additional boat they should build, provided the whole term did not exceed thirty years.

effects which have arisen from his practical introduction of steam-navigation has given him a well-merited claim to rank foremost with those whose enterprise has conferred a lasting benefit on his country.

It is not clear whether it was after the erection of this vessel, that Fulton had some correspondence on the subject of steam-boats, with an individual whom we have already mentioned with approbation. "Fulton," says Mr. Bell, "had occasion to write to me about some plans of machinery in this country, and begged the favour of me to call on Mr. Miller of Dalswinton, and see how he had succeeded in his steam-boat scheme; and if it answered the end, I was to send him a drawing and full description of it, along with my machinery. This led me to have a conversation with Mr. Miller, and he gave me every information I could wish for at the time. I told him where, in my opinion, he had erred, or was misled by his engineer, and at the same time, I told him that I intended to give Fulton my opinion on steam-boats. Two years thereafter, I had a letter from Fulton, letting me know that he had constructed a steam-boat, from the different drawings of machinery that I had sent out, which was likely to answer the end, but required some improvement upon it*."

Rumsey's plan of propelling a vessel by means of the re-action of a stream of water †, was again

* *Caledonian Mercury*, 1816.

† "Mr. Watt informed Buchanan that he tried a pump similar to Linaker's, to propel a vessel for Rumsey, but its effect in moving a boat was very small. Watt, however, justly observed, that Rumsey applied the power to great disadvantage, because he forced the water through a very small

made the subject of experiment by Mr. William Linaker, master shipwright in Portsmouth Dock-yard. From some memorandums, found among his papers after his death, it appears that as early as 1793, he had made a set of experiments on propelling a vessel by machinery, but it was not until 1808 that he applied for a patent. Linaker had two plans, one was to work pistons horizontally, in pumps drawing water in at the bow, and discharging it at the stern of the vessel: the other was to work a vertical pump in the middle of the vessel, also drawing the water in at the bow, and expelling it at the stern. This idea he proceeded to put into practice on a scale of some magnitude, and had a steam-engine constructed by Murray and Wood. "But, I am uncertain," says Buchanan, "whether he lived to try it on board his boat." When the second plan was tried, the motion of the vessel was far from being uniform, and it went by jerks at each stroke of the pump; this irregularity Buchanan thought might have been remedied by attaching air-vessels to the pumps, and the stream of water would, by their aid, have been made continuous. It was the opinion of the same excellent mechanic, that if the pumping

pipe, and that the pipe should have been as large as the pump barrel."

"From one of Linaker's papers without a date, it would appear, that he had tried a boat on this plan. It was a heavy boat, 31 feet long, 6 feet wide; and although it had but one trunk, which was much against the uniformity of its motion, it moved nearly 4 miles an hour, with 8 men working 30 strokes per minute; 6 men working 25 strokes per minute, moved it at the rate of 3 miles an hour; the length of the bucket stroke was 6 feet, inside of trunk 5 inches by 15 inches: when the valve was open, the water passage was very free, the metal being cast thin; the trunk had its sides parallel from end to end." BUCHANAN on *Steam-Boats*, p. 55.

principle were as effective as paddle wheels, it would be a preferable mode in rough water.

After Linaker's death, a partial but imperfect trial of a similar apparatus was made on the Thames. The steam-engine had no piston, but drew in the water, and expelled it on the principle of Savery's engine; an application, by the way, of this form of machine which of all others appears the most injudicious.



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