A DESCRIPTION

OF THE

REVOLVING STEAM ENGINE,

RECENTLY INVENTED

BY SAMUEL MOREY,

AND PATENTED TO HIM ON THE 14TH JULY, 1815,

WITH FOUR ENGRAVINGS.

Communicated for the American Journal of Science and the Arts, &c.

To Professor Silliman.

Sir,

THE successful employment of the steam-engine, in navigating the rivers and inland waters of the United States, and the probable extension of this mode of conveyance of persons and property, makes those improvements desirable which adapt the steam-engine to this purpose with less complication and expense, placing it more within reach of individual enterprise, and rendering it even useful on our small rivers and canals.

The steam-engine, though often seen in operation, is not readily understood by an observer, without an acquaintance with the facts in natural philosophy on which its power depends: and it may elucidate the subject of this communication to advert, for a moment, to the gradations by which this important machine has attained its present perfection.

It will be recollected that as early as 1663, the Marquis of Worcester published some obscure hints of a mechanical power derived from the elastic force of steam.

In 1669, Savary, availing himself of the suggestion, and pursuing the subject more scientifically, invented his engine, consisting of an apparatus to cause a vacuum by the condensation of steam, so that the water to be raised would thereupon, by the external weight of the atmosphere, rise into the chamber of the apparatus, which the steam had occupied.

As caloric becomes latent in the steam which it forms at 212° of Fahrenheit, and the steam thus formed occupies 1800 times the bulk of the water composing it; and as it returns instantly to a state of water on losing its heat, by contact with any thing cold, Savary easily produced his vacuum by the injection of a little cold water.

He also used (though in a very disadvantageous manner) the expansive force of steam to drive the water out of the chamber, through a pipe different from that by which it entered.

It is doubtful whether this kind of engine was ever erected on a scale of any magnitude; for, a few years later, Newcomen and Crawley invented the first engine with a cylinder and piston; and Savary, abandoning his own, united with them in bringing their engine into use.

As steam drives out air, the principle of this engine was to let steam into the cylinder beneath the piston, where (the piston having risen to the top of the cylinder) a jet of cold water* condensed the steam, produced a vacuum, and the piston, working air tight, descended by the pressure of the atmosphere upon it, this pressure being a weight of nearly fifteen pounds to each square inch; so that if the cylinder were two feet diameter, it would amount to a weight of three tons.

This mode of operation prevailed for about fifty years, and though much used to pump water from mines, was found to have great inconveniences and defects; till, in the year 1762, Mr. Watt, being employed to repair a working-model of an engine at the University of Glasgow, was led to direct his mind to the improvement of the machine; and from his experiments sprung the most essential change, viz. the condensation of the steam in the cylinder, by opening a communication with a separate vessel, into which the injection of cold water was made, thus allowing the cylinder to remain hot.

* This jet of cold water being let into the cylinder itself, necessarily cooled it at every stroke; and then it was necessary to heat it again to the boiling point, before the piston would reascend, and thus a vast loss of heat occurred. Editor.

On opening that communication, the steam instantly rushes to the cold, or rather is destroyed by the instant loss or reduction of its heat, and the vacuum thus made allows the piston to descend as before mentioned.

Mr. Watt soon added the air-pump to the condenser, to extract the air extricated from the water in boiling, together with the water injected.

The next step was to close the upper end of the cylinder, the piston-rod working through a tight packing to exclude the air, letting the steam in above, as well as below the piston, by an alternate communication, and then condensing it in both cases alternately, thus producing a double stroke; at the same time deriving some aid from the expansive force of the steam on the side of the piston opposite to the vacuum. This is essentially the form of all the engines in use at the present day. The minor parts devised by Mr. Watt, as the working of the valves, &c. were such as would readily occur to a scientific mechanician.

While he was bringing the engine to its present perfection, and furnishing it for the numerous mines, manufactories, and breweries in Great Britain, variations were devised by Cartwright, by Hornblower, Woolf, and others in England, and more recently by Evans and by Ogden in America, evincing much ingenuity, but (with the exception of Evans's, which is a simple engine of high pressure) making the machine more complex.

Watt and Bolton's engine, as most generally used, being properly an atmospheric engine, or working with steam so low as merely to produce a vacuum in the cylinder, became of enormous dimensions, when the power required was that of an hundred horses: a scale of estimate adapted to the comprehension of those who had before used the labour of that animal, and preferred to substitute the steam-engine.

It had not, however, escaped the notice of Mr. Watt, that there existed in steam another source of power besides that of atmospheric pressure. The experiments of his learned friend, Dr. Black, of Glasgow, as well as those of the French chemists, and of Papin, in the instance of his digester, had ascertained the laws of its expansive force, and amongst other interesting facts, those subservient to our present purpose; viz. That after water has reached the boiling point, 212° of Fahrenheit, the caloric which enters it no longer becomes latent, but sensible in the steam, which thereupon acquires expansive force to an unlimited degree: that this force increases geometrically; or, that every accession of about 30° of heat, nearly doubles its power at those stages of progression; that when the pressure at a high temperature is taken off, or the steam allowed to flow, there is an instantaneous and rapid production of steam; a fact which proves there can be no necessity of a large space for the steam to form in above the water, provided it be sufficient to prevent water from issuing with the steam, and, therefore, that boilers of a small cylindrical form are best.

It may be a fair question, why Mr. Watt did not further employ this principle of expansive force? We may readily conceive of several motives to the contrary. Watt and Bolton's engines were in great demand; they gave entire satisfaction, and the work they performed saved so much labour as to afford the purchase at a high price. The public had gained immensely by this better form of the engine, and Mr. Watt enjoyed the benefits of the patent he had obtained; and, at a later period, this preference was increased by an accident which happened to Trevethick's engine, though caused by gross mismanagement, that would have been equally fatal to any other.

From an investigation, by a committee of parliament, into the causes of the several fatal explosions of steam-engine boilers within a few years, published in Tillock's Magazine, vol. 1., it appears that in every instance the accident was fairly attributable to neglect or mismanagement. Many competent persons were summoned to give their opinions; and through the contrariety of their testimony, the prevalent opinion appears to have been, that cast-iron boilers cannot be safe; that as many engines of high steam as of low are now used in England, but that the high are much the most economical in fuel and cost; that they are more safe, if properly constructed; it being argued by some, that boilers for steam of 100 pounds to the inch, are easily made of strength to sustain 500 pounds; this excess being much greater than in those constructed for low steam, makes them comparatively the safest, as the safety valves are less liable to be accidentally prevented from venting the steam.

In the United States, instances are not wanting of the successful operation of high steam; of which the engine at the mint is a conspicuous example. There can, indeed, be no good reason why this great power should not be employed to an extent within the limits of safety, if more economical and convenient. If boilers can bear (as they are usually made of iron) 500 pounds, there can be no danger in using them with fifty; and this gives an increase of power, with a condenser, fourfold, or makes a ten horse power forty. The economy, therefore, of high steam, hardly admits of a question. It seems unphilosophical to neglect a power so great, merely because it is so.

Mr. Watt was desirous of an improvement by which to obtain a direct rotatory motion. His experiments, resembling those of Curtis, at New-York, were not found permanently practicable.

It was probably perceived to be a great object to get rid of a reciprocating movement of large masses, on the well-known mechanical principle, that it consumes power to check momentum, as well as to give it—to drag an inert mass into motion rapidly, in opposite directions. And in engines for navigation this is more disadvantageous than for land uses, as the foundation of the engine cannot be perfectly substantial.

An engine, therefore, that possesses the cylinder and other members of Watt's engine, working with or without a condenser, at pleasure—having a rotatory movement—requiring no ponderous balance-wheel—adapted to high steam—attended by no inconvenience from the rapidity of its stroke or movement—having no inert mass of machinery to move reciprocally—more powerful, proportionately, from its using steam as strong as that in the boiler—of a simple and durable construction, and by a combination of two similar machines attached to the same common intermediate axis, operating so as to give nearly an equal power at every moment of its operation, seems to combine every thing desirable in an engine for the purposes of navigation. Such appears to be the revolving engine invented by Mr. Morey.

When those who are acquainted with steam-engines of the atmospheric kind only, are told that Morey's cylinder revolves, their imaginations may suppose a moving mass as large as the enormous cylinders they have been accustomed to see: but it is not so; the elastic force of steam requires machinery but of comparatively small dimensions.

The revolving engine makes up in activity what in other engines is supplied by magnitude.

We will take for example the engine working at the glass manufactory in this vicinity, the cylinder of which has one foot stroke and nine inches diameter, and is at least a ten horse power, working with fifty pounds—or, the engine now building for the Hartford boat. This engine will have two cylinders of seventeen inches diameter and eighteen inch stroke; they will revolve fifty times a minute. The area of the piston in each being 227 inches, steam at fifty pounds will give an hundred horse power.

This boat is seventy-seven feet long, twenty-one feet wide, and measures one hundred and thirty-six tons. The engine, with its boilers, will occupy sixteen feet by twelve, or one-eighth only of the boat; the cylinders being hung on the timbers of the deck over the boilers. She is principally intended to tow vessels up the river to Hartford.

In towing, it is of importance that the engine admit of any inferior velocity or power, till some momentum is had. An engine working by atmospheric pressure does not admit of this. And as the boat herself, at the moment of commencing the operation, may have no steerage-way, by placing two blade-rudders at the sides, behind the water-wheel, where a current

is occasioned by them, the boat is kept in her relative position.

The application of the steam-engine to the towing of other vessels was fully appreciated by the late Mr. Fulton, whose conspicuous labours and enterprise in the establishment of steam-boats, the public duly honours. His active mind had conceived of its utility; and he would have obtained a patent, had not the previous employment of steam in this way, and the award of arbitrators on the question been in my favour; which I mention merely in reference to the supposed utility of this mode of operation, in connexion with Morey's engine.

Morey's engine should rather be denominated a revolving engine than a rotatory one, especially as it is essentially different from one so called invented by Mr. Curtis.

Plate I. Fig. 5, represents the arrangement of a double engine for a boat, with its cylinders in different positions. *a a a*, boilers; *b b*, tar-vessel; *c*, valve-box; *d*, cylinders in different positions; *e*, piston-rod; *f*, pitman; *h*, centre-piece; *i i*, shaft; *k*, valve; *l*, steam-pipe; *m*, escape-pipe; *n*, condensers; *t*, water-wheel; *v*, face of the valves; *x*, tar-fire. The frame, holding the cylinder (*d*) is, by its opposite sides, so hung as to revolve. To the end of the axis of one side, extended over the cylinder, is fixed the centre-piece (*h*) resembling a crank, from which the bar or pitman (*f*) communicates to the cross-piece of the piston-rod. On this same axis, but outside the frame, is placed two circular pieces, one of brass, the other of iron, (*k*) which we may call the valves. One is fixed on the axis, the other moves, and accompanies the frame and cylinder in its revolution; from it, at opposite sides, pipes lead the steam to each end of the cylinder. It has a smooth face, which applies, and is kept by springs close to that of its counterpart fixed on the said axis. Steam-pipes lead from the boilers through the counterpart into the moving valve. On the opposite side of the fixed piece the eduction-pipe (*o o*) leads to the condensers.

The condensers (*p*) are upright vessels, two to each cylinder, connected at top by a sliding valve-box, so that the steam enters them alternately. At bottom are two valves, kept closed by weights. A stream of water is injected into the condensers, which escapes by the bottom valves (*p p*) by which also the air is blown out, at every stroke, in the same manner the engine is cleared of air at first.

There are also two cocks and cross-pipes seen, Plate III. Fig. 4, to change the steam from one side to the other of the valve, to give a reversed motion of the engine.

The power is communicated to its object from the opposite side of the frame by the axis attached thereto, and supported on bearings. This axis (*i i*) may be of any length; may terminate in a crank or cog-wheel, or another cylinder (as here represented) may be attached thereto at right angles to the first, to co-operate and produce, at every moment, equal power.

Plate II. Fig. 6. Profile of the above. *a a*, the boiler; *c*, valve; *d e g*, cylinder and frame; *f*, valve; *h h*, cog-wheels; *i*, cog-wheels to move the pumps; *k k*, condensers; *m m*, coverings in; *o o*, gas-fire flue.

Fig. 1. *a*, steam-pipe; *b*, escape-pipe; *c*, fixed valve; *d*, moving valve; *e*, axis; *f*, a washer; *g*, section of frame; *h*, a washer; *i*, centre-piece; *l l*, steam-pipe; *k k*, springs to keep the valves together.

The canal-boat has her wheel in the stern. (See Plate IV.) The motion is given by a cog-wheel upon its axis (*g*) played upon by another, upon a shaft, at right angles, to which the engine communicates motion. The wheel being divided by a space of two or three inches, into two parts, to allow room for this shaft, and for the support of its end.

Fig. 3, represents the arrangement of the machinery, occupying the after-part of the boat. An engine of twenty horse power may thus occupy half a canal-boat, can tow a number of others at such rate as may be proper on canals.* *b b*, the boilers; *c*, tar-vessel; *d*, the cylinder; *f* water-wheel.

* But it is not necessary (as in the plate) to crowd the engine into the after-part of the boat, the boilers may be placed forward, and near them, or over them, *the cylinder*, &c. The power is then communicated to the stern-wheel by a long shaft, supported on, or immediately under, the deck. This arrangement gives room for loading both behind and before the boilers and engine, and equalizes the burden. This is the actual arrangement of the Merrimack boat.

The supply of water to the boilers is either by a pump, in usual form, or by the *supply-chamber* of my invention, (Plate III. Fig. 2.) which consists simply of a pipe having two stop-cocks, one end in a reservoir, the other opening into the boiler at top, sloping downward for a foot or two. The cocks are in the sloping point. The operation commences, by opening the cock nearest the boiler, the steam drives the air out of the pipe through the water into the reservoir; shut the cock, and the water rises from the reservoir to fill it; shut the second cock, and open the first, the water discharges from the chamber into the boiler; repeated by a movement from the engine, when in motion, the supply continues with more certainty than by a pump, because it is difficult to pump hot water, on account of the elasticity of the steam arising from it, which obstructs the operation of the valves. And it is important not to have to pump against the pressure of high steam.*

Plate III. Fig. 4. The mode of changing the passage of the steam to the opposite sides of the valves, in order to get a reversed motion of the engine. *a a*, the fixed part, or valves; *c d*, the pipes; *f g*, the cross pipes; *e e*, the cocks, which are represented open, to pipes *c* and *d*—turn them half round, they close *c* and *d*, and open *f* and *g*. Fig. 1 shows the side-rudders, *d*, *e*, &c.

To this engine is conveniently applied the gas-fire, in the following manner.

The boilers being cylindrical, with an inside flue for fuel, two or three are placed close together, and set in the following manner: First, cross-bars of iron are laid on the timbers, a platform of sheet-iron is laid on these bars, coated over with clay mortar, or cemented, to keep out the air. Upon the sheet-iron, and over the bars below, are placed cast-iron blocks in shape to fit the curve of the boiler, so as to raise it three or four inches above the platform. The sheet-iron is continued up the outsides of the outer boilers, so as to

* It is found with very high steam that the source of supply must be above the *chamber*, or a small quantity of cold water introduced to condense the steam therein.

enclose them; and at one end, between the boilers, there are small grates for coal or other fuel.

The tar vessel or vessels, as the case may be, are lodged in the space between and upon the boilers, and a small fire may be made under them, if necessary. A pipe leads steam in at one end, two pipes at the other; one near the bottom, and one near the top, lead out the tar and steam. These pipes unite below; the steam and tar, thus mingled in suitable proportions, flow to the main fire, or the flues of the boilers, as well as to the coal-fire below, where the gas and tar are ignited. The fireman judges of the proportion of each, by the effect; the object being to produce a nearly white flame without appearance of tar. Thus flame is applied to the greatest possible surface, and the apparatus adds very little to the cost of the engine.

There are also two improvements in the boiler, which I deem it important to mention. First, the lining or covering of the flue within with sheet-iron or copper, *perforated with small holes*, reaching down its sides, nearly to the bottom. Plate III. Fig. 2. *a* the boiler; *b* the flue; *d* the grate; *c c* the lining.

This causes the water to circulate rapidly between them to the top of the flue, and protects it from being run dry, or heated red hot, when the water gets, by accident, too low. The lining also *causes the steam to form much faster*, *in consequence of this circulation.*

The other is the interior boiler. A vessel occupying the back part of the flue. Plate II. Fig. 8. (*d*) communicating downwards with the water, and upwards with the steam of the main boiler. The fire acts upon it very forcibly, surrounding it on all sides.

I have said there is no reciprocating movement in Morey's engine. Should it be objected that the piston moves in the cylinder as usual, it must be apparent that it also moves circularly; it is in fact the cylinder that moves, carrying the piston with it, which gives and keeps up the motion, by drawing and pressing on the centre-piece, and communicating

the resistance thence to the *guides* of the cross-piece on the insides of the frame, which thus receives its motion.

In fact, this form of the engine seems divested of all the usual drawbacks on its power, and leaves it to act freely with any velocity, according to the strength of the steam in the boilers.

Such it appears in principle, and such thus far in practise. I have therefore preferred it for the purposes of navigation, and have purchased the patent right. But, though interested to recommend it, I cannot expect it to be preferred by the intelligent, if there is not merit in the invention, and great economy in its use. It may be considered the most direct application of the power, and the most unexceptionable mode of using the expansive force of high steam. And from the nature of its movement the most applicable to boats and vessels.

Your Journal being the intended medium of information to promote the useful arts, I hope it may be consistent with this object to explain the manner in which these improvements may be made extensively useful.

It being necessary to supply the engines at a reasonable rate, I have established a manufactory for this kind only.

The great expense of steam-boats hitherto, has confined their use too exclusively to the accommodation of passengers. There is a wide field opening for their use, in freighting, on all our waters; and it is often of importance to a community, when great savings can be made, that large capitalists should be induced to engage that such savings may be greater. Where companies are formed for an extensive operation, the legislature may, with propriety, grant an extension of the time for patents to run, that such persons may be duly remunerated for their enterprise, by the duration of the service.

Our laws do not yet make a proper distinction between patents of a large and expensive kind and those requiring little or no capital to go into operation. The period of fourteen years remunerates the inventor of those improvements only that require no capital, and involve no risk.

On this ground several of the State legislatures have, with good policy, given encouragement to this kind of enterprise. They suspend the free use of the invention a few years, rather than loose its immediate operation on a large scale of public benefit.

The constitutionality of the measure plainly appears by its not interfering with the laws of the United States. It is not an act exclusive of, or in opposition to, patents, but acknowledging and confirming them. It is furthering and giving effect to the intentions of the general government, in the encouragement of useful inventions. For their own particular section of the union, a State legislature may thus provide for the protection of capital, engaged in enterprise of uncommon risk, as well as of uncommon usefulness, without excluding other and better inventions, should they arise.

I shall ask leave to communicate, for some future Number, the results of experiments, now making, with the gas fire applied to engines.

I am your most respectful humble servant,

JOHN L. SULLIVAN.

Pl. I.

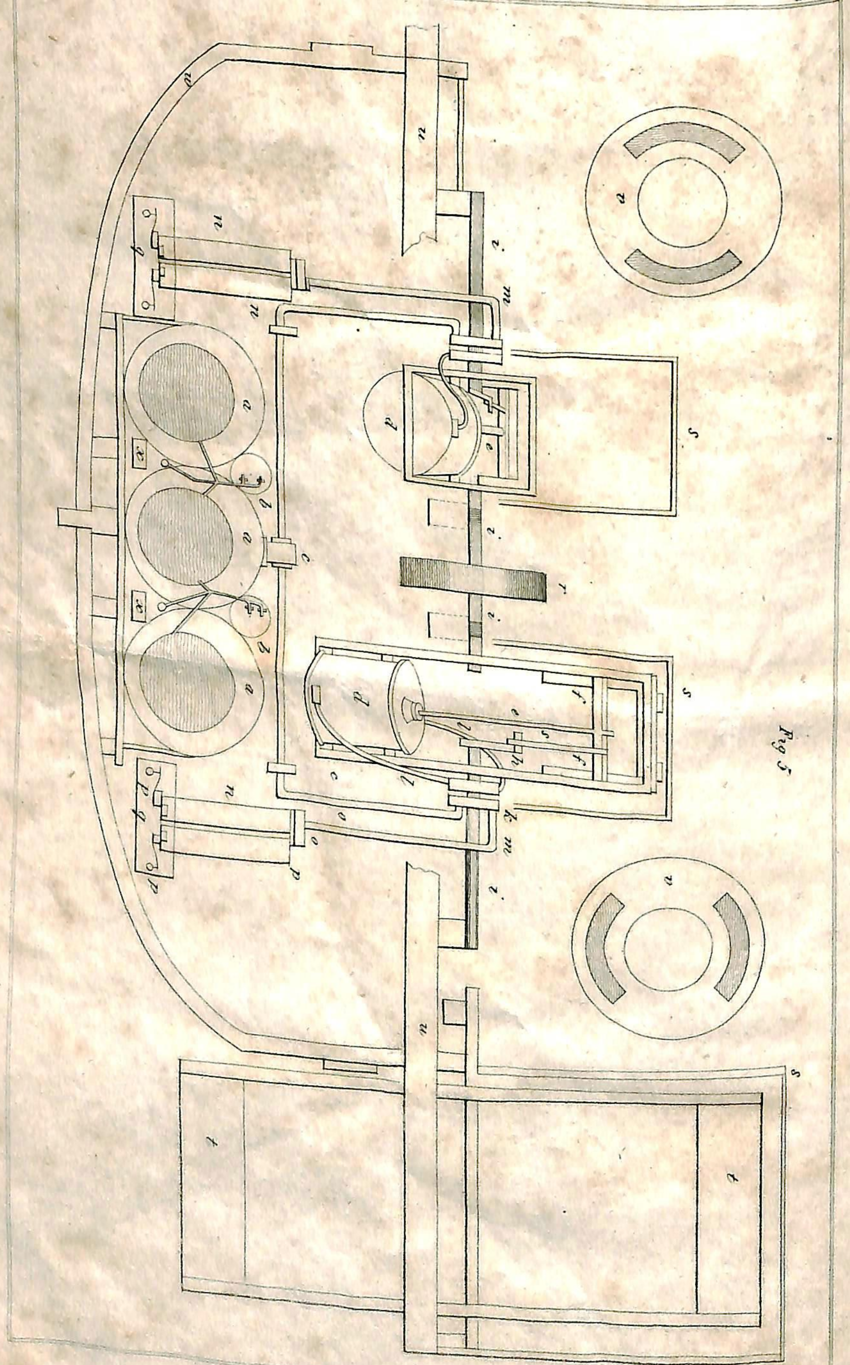
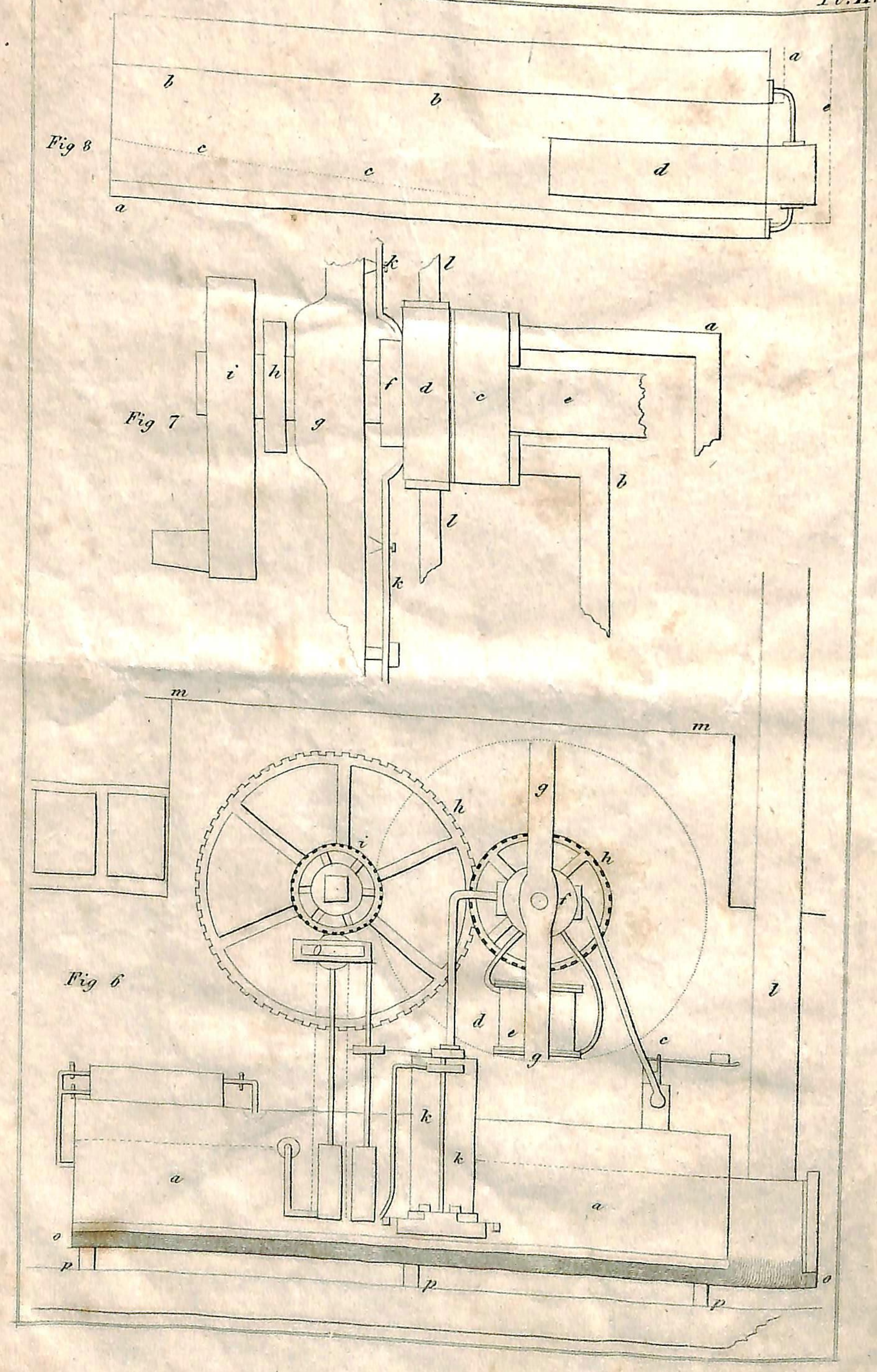
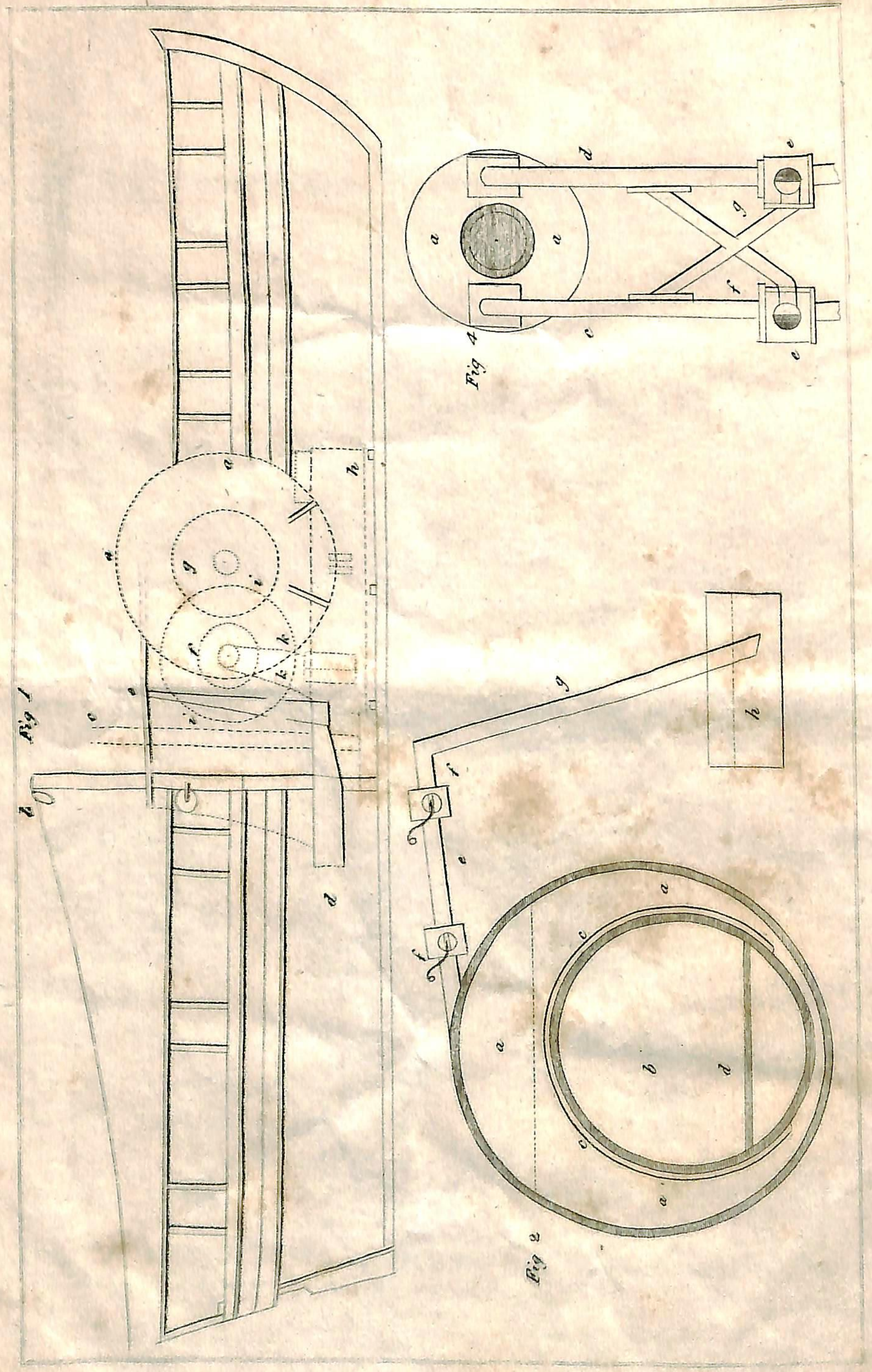


Fig 5

Pl. II.



Pl. III.



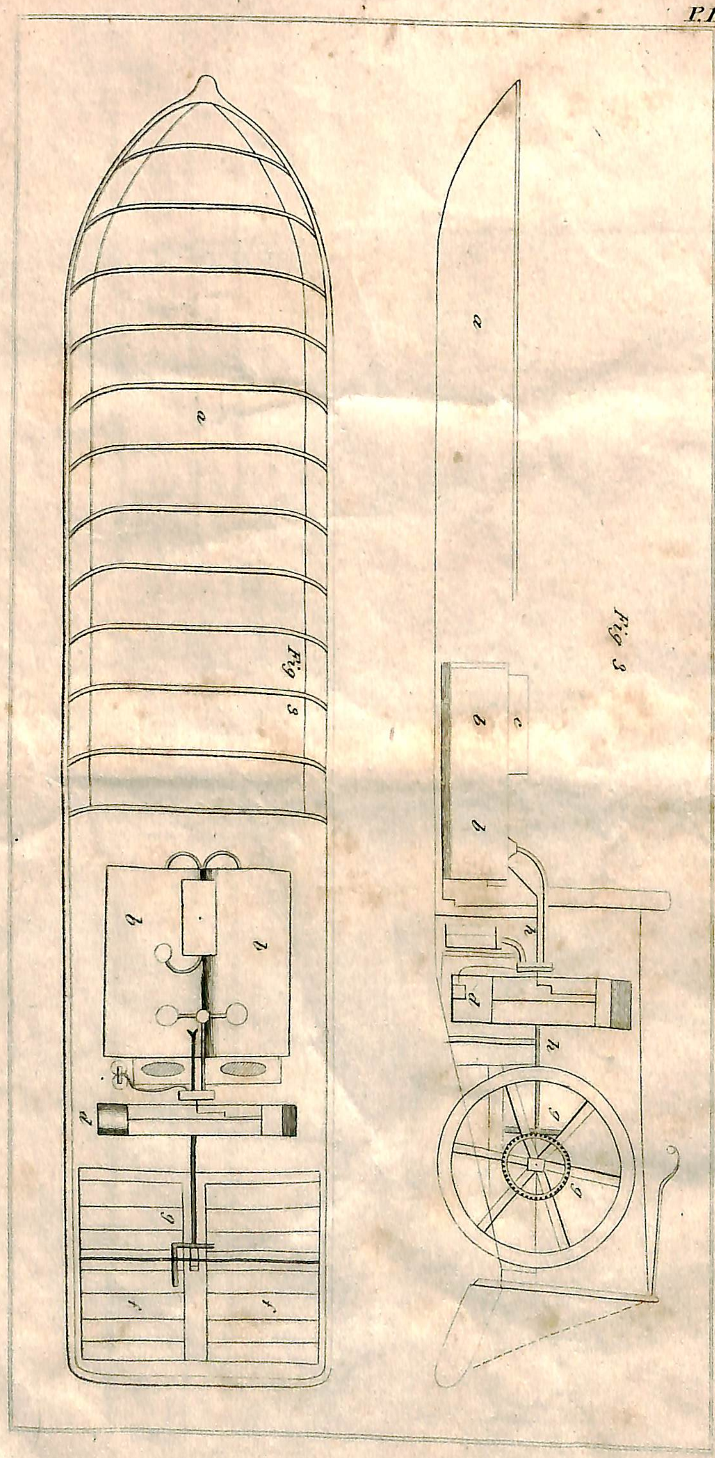


Fig 3
Fig 3