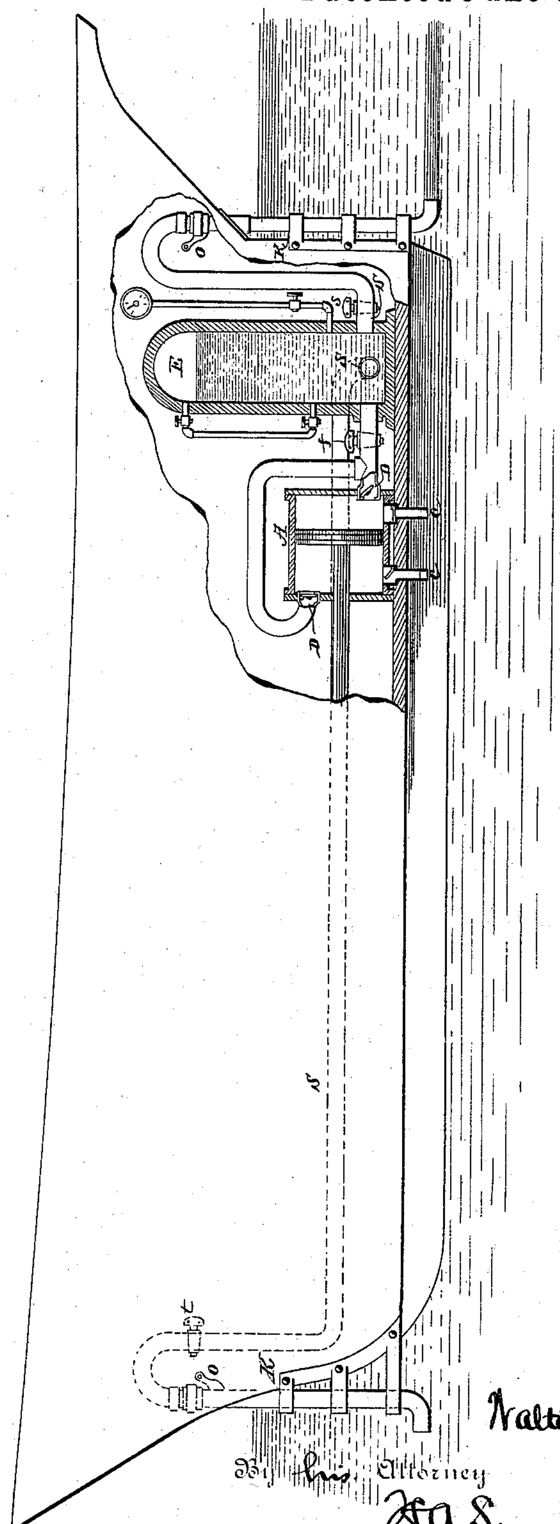
(No Model.)

W. M. JACKSON.

METHOD OF MARINE PROPULSION.

No. 385,184. Patented June 26, 1888.



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METHOD OF MARINE PROPULSION.

SPECIFICATION forming part of Letters Patent No. 385,184, dated June 26, 1888.

Application filed January 6, 1888. Serial No. 259,953. (No model.)

To all whom it may concern:

Be it known that I, WALTER MARSH JACKSON, of New York, in the county of New York and State of New York, have invented certain new and useful Improvements in Marine Propulsion; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

My invention relates to a method of marine propulsion, the object being to provide a novel method for propelling marine vessels, and one which will insure greater speed and economy than can be attained by any heretofore known.

As is well known, when marine vessels are propelled by an artificially-produced force acting on the water of flotation as a fulcrum, a certain quantity of water is driven backward while the vessel is driven forward. The distance this certain quantity of water is driven backward in a unit of time, compared with the distance the vessel is driven forward in the same length of time, is called the "slip." The amount of slip, in methods heretofore applied, depends upon the shape of the propelling agent; on the area of the cross-section of opposing water which is to serve as a fulcrum; upon the rigid nature of the propelling device; upon the velocity of impact with which said propelling agent acts upon said water-fulcrum; upon the loss of primary energy by friction of articulating parts; upon waste work expended in churning the water and causing peripheral currents, and in overcoming the inertia of the machinery. The propelling agent may be an oar, the bucket of a paddle-wheel, the blade of a screw-propeller, the pressure of a discharged jet of gas, air, steam, or the cross section of a column of water issuing in a jet from an orifice in or connected with the vessel. It is only necessary that the propelling agent shall have sufficient rigidity, as in the oar, wheel-bucket, or propeller-blade, or inertia, combined with sufficiently extensive cross-sectional area, as is the case with the water-jet, to transmit reflexly the propelling force back along the line of action.

Heretofore innumerable attempts have been made to revolutionize the accustomed mode of propulsion known as "screw" and "paddle-wheel" propulsion. Such attempts have resulted in the use of air, gas, steam, steam and water mixed, air and water mixed, gas or the products of combustion and water mixed, ejected from the vessel above or below the water-line into the water or into the air, the motion of the vessel in each case proceeding from the inertia of the discharge on the one hand and the inertia of the resistance on the other. Thus it was a question of relative specific gravity of the material discharged and that discharged against in estimating the difference between the outward thrust and reaction. Power cannot be transmitted effectively through a shaft which has torsional, lateral, and direct flexibility, and as such a shaft is an indifferent transmitter, so, too, must it be equally inefficient as a conductor of reaction. It can only be rendered semi efficient or approximately effective when it is made so large that its component particles stiffen it by their collective inertia. Therefore the theory of action heretofore has been with all jets to secure great cross-sectional areas to press against and cover such areas by equally extensive cross-sectional areas of discharge. Thus the sole cause of action and reaction applied by an indifferent conductor of both was inertia. It requires the application of a highly-concentrated power to start a heavy body from a state of rest into rapid motion; hence the heavy body makes an exceedingly good fulcrum. Now, if the body be solid, like iron, steel, or stone, the fulcrum is much increased. If it be soft and yielding, like the atmosphere or water, its bulk must be proportionately increased to offer similar resistance, specific gravity governing the size of fulcrum relative to value for reflex action. If we push from a vessel with a column of air the cross sectional area of which is equivalent to one square foot against the atmosphere, we shall press against a cross-sectional area of fulcrum exactly one square foot, and as a cubic foot of air weighs only five hundred and thirty-five grains, we should have a resisting-fulcrum so ethereal that the reaction against the vessel would do nothing toward overcoming the resistance of the water of flotation to her progress. If we pushed against the air with a column of water our fulcrum would be the same, therefore our reaction the same. The same would be true of steam thrown against the air, or anything else employed as the active agent against such a fulcrum. Therefore it will be seen that to secure a fulcrum for reaction and a shaft for conducting both action and reaction in air we would require enormous cross-sectional areas, for thus only could we provide the necessary inertia to secure that rigidity which is necessary to gain a fair proportion of our power for actual duty. Since air weighs five hundred and thirty grains to the cubic foot, and salt-water sixty-four pounds, therefore an air-fulcrum and a water thrust or shaft would require cross sectional areas equivalent to the difference in weight. In other words, the cross-sectional areas of water, shafts, or thrusts need be but about one nine hundredth part of that required for air to produce the same inertia and consequent action and reaction. Entertaining this view, I abandon any attempt at an air-fulcrum. Now, permit me to reverse the order of attack and supply an air shaft or thrust acting against a water-fulcrum—in other words, operating an air-jet submerged. As air is about nine hundred times lighter than the water, the shaft or medium through which we conduct the energy to the fulcrum, and from the fulcrum reflexly to drive the vessel, has an inertia represented by 1, while the water is represented by 900. Therefore, to render the shaft as rigid by inertia as the fulcrum, its cross-sectional area should be nine hundred times greater. Such a vast cross-sectional area of the air-shaft would involve the egress of an enormous quantity of air to press against a water-fulcrum of sufficient size to insure inertia in the fulcrum, and the engines for supplying such air would be many times larger than the vessel herself. The same philosophy will apply to shafts or thrusts of gas or steam, or any mixture of such, the difference being determined by relative specific gravity.

This brings us to an analysis of water against water. It has been laid down as a fixed fact, and so stated by many expert marine engineers, that the greater the area of the discharge-nozzle and consequent quantity and weight or inertia of the discharged water the better the result. Why? Because a vast volume of water has more inertia than a small volume and necessarily creates a fulcrum in the water of flotation equivalent to the outward-thrust area. Thus the fulcrum and shaft are both stiffened by a vast grouping of particles and rendered more efficient as transmitters of action and reaction. In pursuing this theory, which is undoubtedly correct, we reach for the greatest percentage of reflex thrust or available propulsive power, and as we go on enlarging the cross-sectional area of our jet it dawns upon us that in order to reach the efficiency of the screw and paddle we must construct our outlets so large and handle such immense volumes and weights of water that our vessel is not large enough to afford to carry the water passing through and at the same time give space for such huge mechanism as would be required. If we enlarge the vessel we have so much more to drive, and so the two are relative with the power, and its adjuncts always behind.

To understand my invention, the first thing in preparation is to discard the cross sectional theory entirely and proceed to a contemplation of the true generical reason why the thrust is reflected upon the vessel at all. Let us see if we can transmit propulsive energy to a vessel by two different devices. "Reflex thrust or reaction" and "thrust and action" are synonymous or convertible terms. It is a well-accepted fact that action and reaction are equal; but the terms of statement should be qualified, otherwise they are misleading. Action and reaction are equal—that is, the sum of the reaction is equal to the sum of the action—but while the action may be transmitted in a straight line the reaction may be so deflected that almost its entire energy may fail to return over the line of action. Still the collective value of the reaction, taken in all its directions, would be equal to the action. For the purpose of propelling a vessel economically and effectively the reaction must be returned over the line of action. There are but two conditions of perfect action and reaction: first, a rigid conductor; second, a rigid point of contact or fulcrum, which the action cannot pass through or around. I can conceive of but two ways to secure this condition—one by stiffening the conductor and fulcrum by a great mass of material, thus securing the result by inertia; the other by stiffening the same by great concentration of energy, and thus getting the value of inertia by impact, or the suddenness of the blow. In the first case we deal with great spaces and volumes, and consequently great friction; in the second contracted and easily-encompassed dimensions with less friction and giving promise of a much better proportion of the primary power expended being returned for work. To illustrate the two methods I will give the following examples: We provide the stern-post of our vessel with a metallic thrust-block, and against this block we place a bar of steel having a diameter of one inch. Therefore its contact-surface is but one inch. We now apply in a direct line with the bar thousands of pounds static pressure, and the vessel readily moves, and following her up with the bar and pressure she goes on increasing her speed until the resistance of the displaced water and the atmosphere equals the thrust, and this establishes her maximum velocity for the power applied. The action and reaction are complete, through an absolutely-rigid shaft and fulcrum, and the area of concentrated thrust is but one square inch. We might make the area an eighth or a sixteenth of an inch and still apply the action and reaction as well. Therefore the fact is plain that cross-sectional areas of great dimensions are unnecessary if we apply the power properly. The illustration is one extreme of the problem. Now the other extreme consists in building the vessel's stern of immense cross-sectional area and covering the entire stern—say fifty feet in diameter—with a column of putty, and by now distributing the same power over the immense area of putty the column becomes stiff and rigid as the little steel bar, and the power is applied to the propulsion of the vessel in the same ratio as before with the bar. The first is an example of concentrated energy acting within a small space; the other diffused energy scattered over a proportionate space, both containing the necessary elements for the successful conduct of action and reaction, but reached by very different methods.

So thoroughly have the philosophers in marine propulsion digested matters that they have pronounced the fact that there is nothing to be gained by discharging the water at any greater speed than attained by the vessel. Thus it is proved that the putty column cannot be constructed any wider than the vessel's stern. Practically I admit this to be true, upon the theory of great nozzles and vast quantities of water. A rigid action exerted against a mobile fulcrum must exert its force upon an area in proportion to its rigidity; therefore, if the propelling agent be stiff and unyielding, it must cover a surface the inertia of which is equal in rigidity to the propelling agent, otherwise the reaction to propel the vessel will always be less than the action. It is not necessary that the reactionary surface or fulcrum be parallel with the area of the thrust. We have been in a habit of associating an ideal fulcrum, its area standing at a right angle to the direction of the outward thrust; and it is by establishing an area parallel as well as at right angles to the thrust that I secure that rigidity which is necessary to an effective fulcrum.

The line of my discovery is precisely opposed to what has previously been known in the art. I have found certain propelling agents—such as a jet of water—preferably water or of any liquid of about the same specific gravity as the water of flotation, to lend itself most advantageously to my method, and the use of such I shall specifically claim, but it is in no wise necessary to the application of the discovery itself, which consists, broadly, in the method of causing the propelling agent, of whatsoever nature, within the above limitations as to weight and rigidity, to act upon the fulcrum furnished by the water of flotation at a high velocity—a velocity many times that represented by the full speed attained by the vessel in the opposite direction.

The object of this method of acting upon the water of flotation with such high velocity is to create an elongated fulcrum, closed at its extreme limit, like a *cul de sac*, the fulcrum being filled by the ejected water running at such high speed that the surface of the stream produces violent frictional contact with the surrounding water, thus establishing a rigid horizontal elongated resistance, the length of the fulcrum so established increasing or diminishing as the speed of the water is greater or less. Thus, if I thrust with five hundred pounds pressure to the square inch and secure a stream speed of five hundred feet per second, my fulcrum will be of stated length, and if I increase the speed to one thousand feet a second by doubling my pressure my fulcrum will be half as long again and proportionately more rigid. If I commence an experiment upon a pressure of twenty pounds to the square inch and test the reactionary power of the jet, I will find it capable of sustaining a given dead-weight one inch high. If I double the pressure to forty pounds it is capable of sustaining the same weight six inches high. Now, to prove that the elongated fulcrum is fully equal to a solid cross-sectional fulcrum, I place a board or block of wood directly in the path of the stream an eighth of an inch, or any distance from the nozzle, and the reaction is not increased one atom. Therefore a perfectly rigid fulcrum opposed to a stream which is not as rigid returns the same reaction for propelling purposes that the water-fulcrum does. Now as we increase the speed and pressure of the discharged water we increase the rigidity and transmitting power of the stream or water-shaft; so, too, we render the fulcrum proportionately more resisting by its elongation and frictional activity. Thus we may increase the hydraulic pressure and consequent speed of the discharged current to almost the full return in reaction of the primary power expended. The more rigid we make the stream the faster it goes, the harder it pushes, the more rigid and long it makes the fulcrum, and the better does it transmit the thrust outward to the fulcrum, and the better it conducts the reflex thrust or reaction or propelling purposes.

I have found the above to be true by absolute tests, and I have propelled a vessel fifty feet long by my method faster than she could have been driven by the screw with same power, her hydraulic pressure being twelve hundred pounds to the square inch and her discharge-outlet being one quarter of an inch in diameter.

I am the first, so far as I know, to reach toward the extreme of small cross-sectional areas of discharge and exceedingly high velocities. There is nothing in the books or in the records of marine societies recording or advising the application of such a method. No vessel now afloat other than mine is propelled by such method. That the foregoing explanation of my method is true I have proved by many and careful experiences; that it is novel in conception and practice is proven by the entire absence of any mention of it in the whole literature of marine propulsion and the patent records of all countries. I find certain agents and apparatus to work advantageously, one of which I will describe as follows:

The accompanying drawing represents a vessel in longitudinal section showing one form of apparatus for carrying out my method.

A represents a steam-pump of any approved form, which in the present instance is connected directly to suction-pipes *c c*, leading through the bottom of the vessel and opening into the water on one or both sides of the vessel's keel, the said suction-pipes being provided with check-valves.

D is the pump-outlet communicating with a high-service receiver, E, a stop-cock, *f*, being placed between the receiver and pump for the purpose of shutting off communication to the former. This stop-cock is not necessary, but might prove convenient. The high-service receiver E is of any suitable material and of great strength, and has an outlet, S, leading to the stern, and another one, S, if desired, leading to the bow, both outlet-pipes being provided with suitable valves, *st*, which latter are adapted to be operated from the pilot-house or other convenient place for the purpose of stopping, starting, or maneuvering the vessel or increasing or diminishing her speed.

Communicating with the interior of the receiver, or at other convenient point, is a pressure-indicator, *e*, for indicating the hydraulic pressure. The pipes K having the discharge-outlets are connected in a water-tight manner to the pipes S, and are provided with levers O, to which chains, rods, or ropes leading from the pilot-house or other parts of the vessel, for the purpose of rotating or changing the direction of the opening in the outlet-pipes, are connected.

The operation is as follows: After having raised steam to a pressure of, say, two hundred pounds to the square inch, the pump is started, the water taken into the pump is forced into the receiver, and as the propulsion-outlet is of smaller capacity than the inlet the water becomes accumulative. Now if the steam-piston has an area five times greater than the pump-piston, then two hundred pounds of steam are capable of pumping against a reflex pressure of one thousand pounds hydraulic. As water is not compressible there is no elasticity, and to store the water in the receiver in such manner that dynamic value will result we must put the water in a dynamic condition of compression, and this is accomplished by providing a receiver closed at the top to prevent the escape of any air, and as the water is packed in under the column of air the air is more and more compressed, reflecting its own elasticity upon the water and thus bringing the water into a dynamic state of compression. My object in providing this dynamic compression of water is, first, to soften the movements of the machinery; second, to store power; third, to even the pulsations of the steam and pump pistons; fourth, to secure a steady uniform flow of water through the outlet-pipes; fifth, to make the receiver its own governor of the pump and steam pistons without danger of sudden stoppage of said pistons, and, sixth, to provide a high steady pressure.

While I prefer to employ the receiver for storing the water under pressure, yet the increased pressure greatly in excess of the steam-pressure in the boiler can be secured without the use of a receiver. For instance, I can employ a pump having a compound double steam-piston of, say, six inches diameter, while the pump pistons—two in number—are two inches in diameter, thus giving them together an area of 6.2832 square inches, while the steam-pistons would together have an area of 56.548 square inches, or about nine times the area of the pump-pistons. Now, supposing a pressure of eighty pounds per square inch be exerted from the boiler upon these steam-pistons alternately, to even the flow of pumped water, then the entire pressure on the steam-pistons (56.548 square inches) would be 4,523.84 pounds, while the pump pistons, having an area of but 6.2832 square inches, would receive the entire pressure, amounting to (719.98) nearly seven hundred and twenty pounds to the square inch, so that if the submerged outlets were closed the water would be under this pressure, and when open, the orifice being so exceedingly small, the water-pressure upon them would be nearly the whole seven hundred and twenty pounds to the square inch; or, in other words, the difference between seven hundred and twenty pounds and the loss of pressure from friction and depth of submersion by the escape through the submerged orifice or orifices, according to size and number.

If desired, a pump such as described can be used alone or in connection with a receiver, or water-forcing devices may be driven by other powers than those furnished by steam.

Heretofore the pressure of the ejected water, as it appears from an exhaustive search of the records of experiments in this line, has never exceeded a boiler-pressure of forty pounds to the square inch, while by my own experiments I find the value of impact barely to commence at three hundred pounds to the square inch and it rapidly increases from that point up. With an increased pressure of from five hundred to one thousand pounds my vessel nearly doubled her speed, and with an increase of pressure up to two thousand or more pounds surprising results will be attained.

The secret of propelling vessels effectively and economically by throwing a jet of water against the water consists in the intensity of contact, the impact or suddenness of the blow, and if the blow be continuous and the water-shaft or outward thrust rigid the reflex thrust is nearly the full power of the primary expenditure of force. Water alone is practically and chemically non-interstitial in composition, its very slight compressibility being due to the mechanical admixture of air; therefore if we experiment with a wooden plank upon its surface by striking violently the suddenness of the impact causes a simultaneous concentration of energy at the point of contact, and, the water being non-compressible, the plank does not penetrate, but is broken by the reaction, while if a soft and graduated blow be given the water will calmly recede under its law of mobility and the sum of the energy displayed will be radiated in all directions, the power being consumed by the time and ease of the resistance.

A stream of water discharged through a nozzle five-eighths of an inch in diameter under two thousand pounds pressure to the square inch would involve a required quantity of one thousand gallons per minute, and the muzzle speed of the water would be one thousand and forty feet per second, equal to the initial velocity of a rifle-ball. It would hardly be possible to revolve a screw or paddle fast enough to reach even an extreme peripheral speed like this. It would be shattered to pieces long before the speed was reached, and, again, no engine could stand or give the required piston-speed.

A stream of water cannot be broken or damaged, no matter what its speed may be, and the water-forcing device may have as slow a piston-speed as you please. The discharged water, at the frightful velocity of over one thousand feet a second, becomes practically a continuous gun, and the impact created against the water of flotation as a fulcrum is instantaneous and constant, following the vessel, no matter how fast she may go. If she ran forty miles an hour, her speed would be only sixty feet a second against the discharged one thousand and forty, thus reducing the primary value of impact only sixty in one thousand and forty. The nozzle or aperture of discharge should be of the least area of any portion of the hydraulic conduit.

Such apparatus, or equivalent thereof, has so far proved most available; but I do not in this application claim such apparatus, nor do I claim any method or means for the generation of power or of transmitting power to the propelling agent.

I make no claim in this application to the apparatus herein shown and described for carrying my improved method of marine propulsion into effect, as such subject-matter is claimed in pending application, No. 258,015, filed by me December 15, 1887.

Having fully described my invention, what I claim as new, and desire to secure by Letters Patent, is—

The herein-described method of marine propulsion, which consists in developing a pressure exceeding the boiler-pressure by means located between the boiler and water-exit, subjecting water received into the vessel to such increased pressure, and then discharging said water in the form of one or more submerged jets against the water of flotation.

In testimony whereof I have signed this specification in the presence of two subscribing witnesses.

WALTER MARSH JACKSON.

Witnesses:
EDWARD B. JACKSON,
GEO. T. GADEN.