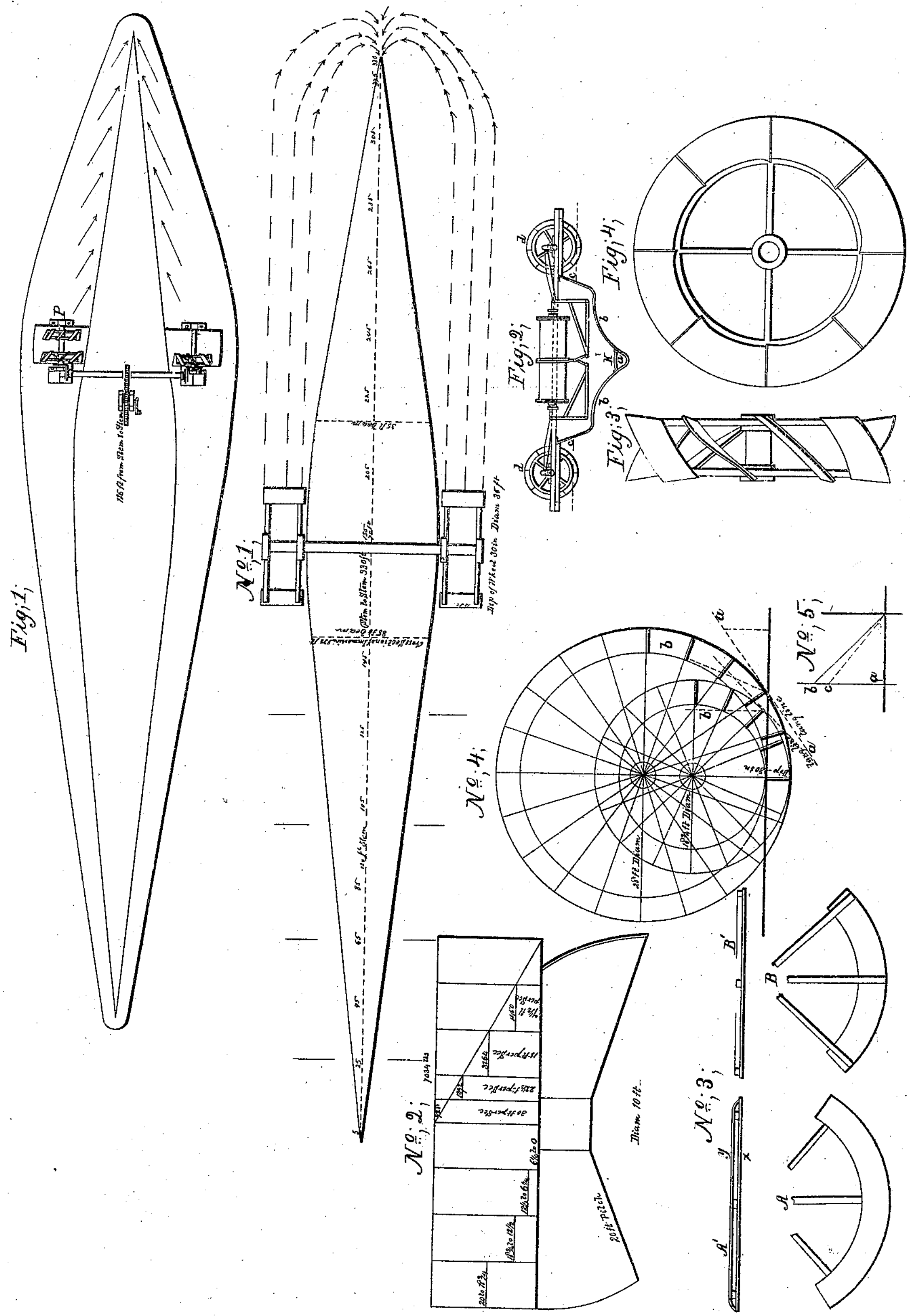
S. J. Gold,

Wheels in Channels.

No. 5,000. Patented Mar. 6, 1847.



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UNITED STATES PATENT OFFICE.

STEPHEN J. GOLD, OF CORNWALL, CONNECTICUT.

IMPROVEMENT IN PROPELLERS FOR VESSELS.

Specification forming part of Letters Patent No. **5,000**, dated March 6, 1847.

To all whom it may concern:

Be it known that I, STEPHEN J. GOLD, of Cornwall, in the county of Litchfield and State of Connecticut, have invented new and useful Improvements in Steamboats and Propellers Therefor; and I do hereby declare that the following is a full, clear, and exact description of the principle or character which distinguishes them from all other things before known, and of the manner of making, constructing, and using the same, reference being had to the accompanying drawings, making part of this specification, in which—

Figure 1 is a plan of my boat, and Fig. 2 a cross-section of the same.

The same letters indicate like parts in all the figures.

In all the various modes heretofore adopted for propelling boats an excessive power has been required above what was known to be sufficient for forcing the boat through the water. To illustrate this I will take the approximate dimensions of a well-known boat of great speed, as shown by Diagram No. 1. The area of her cross-section of immersion is one hundred and seventy-five square feet nearly, and her velocity through the water is thirty feet per second. This, if presented as an obstacle to propulsion, would require a power of one hundred and sixty-two thousand four hundred pounds nearly; but the bow being wedge-shaped causes the water to part laterally with a velocity of three feet per second, which requires a force of sixteen hundred and fifty pounds only at the same velocity—*i. e.*, the surface of the wedge formed by the bow being three hundred feet by five feet, or an area of fifteen hundred square feet, on each of which there is a pressure of about ten pounds at three feet per second, (at a velocity of two and one-half feet per second water presses with a force of seven and one-fourth pounds, at five feet per second is twenty-nine pounds,) the power increasing four to one. Boats on the Erie canal, known as "Lake boats," displace in their cross-section of immersion at least fifty-six square feet. They are nearly square at the bow, and are drawn at a regular speed of two and one-half miles per hour by two horses, in the narrow parts of the canal; but in the enlarged parts, such as Tonawanda creek, they frequently for short distances attain a speed of six miles per hour with a power less, of course, than twice the steam horse-power. These boats, it will be seen, require more propelling-power than our largest boats of good model, yet, taking them for a type, it is obvious that the power of eight horses would draw them twelve miles per hour, and with thirty-two horses we should attain the enormous speed of twenty-four miles. By this it will be seen how small a power comparatively it will take to propel the largest boat. To propel the boat above named we have therefore to overcome that force of sixteen hundred and fifty pounds. This is done by two side wheels, the paddles of which are each thirty feet area, making sixty feet in all, which is moved with a velocity not exceeding five feet per second, having a resistance of seventeen hundred and forty pounds, a superabundance for the purpose required. The power actually expended on the piston of this boat is two hundred and ten thousand pounds, which with her proportions gives on the periphery of the wheel at that velocity seventy thousand pounds, all of which, except seventeen hundred and forty pounds required in propulsion, is wasted. A portion of this power is expended by the wheel in passing through the air, which at the same initial velocity would at the top of the wheel cause the paddle to pass through the air sixty-five feet per second, producing a resistance of sixteen pounds to the square foot, or nine hundred and sixty pounds on each paddle at that point. If there were twenty paddles out of water at once, they would present an area of twelve hundred square feet, with an average resistance of four pounds upon each square foot, or four thousand eight hundred pounds in all. The paddle striking the water at thirty-seven degrees throws away about a third of its effective force in indirect action, and on leaving the water the same result is produced, making a waste of forty-five thousand pounds. The balance is expended in friction and concussion, which latter is a source of great waste, as may be known from its effects, producing the vibration upon the machinery and boat that is so injurious to both.

A practical illustration has recently been furnished on the Hudson river of how much power can be thrown away by the bad angles of a common side wheel with radial paddles. Two boats having their lines similar and drawing the same amount of water have been running as day boats to Albany and in their continual strife have clearly shown the disadvantages of bad angles in propelling. One of these boats had a wheel of twenty-eight feet diameter with a dip of thirty inches. The other was about eighteen and three-fourths feet diameter with the same dip and area of paddle. When the peripheries of these wheels were going at the same velocity the boats moved at the same speed; but to do this the large wheel was connected with an engine of the following capacity: The cylinders were about forty-four inches diameter and ten-feet stroke with steam not exceeding thirty pounds to the square inch, the travel of the piston four hundred and forty feet per minute, while to make the small wheel turn as fast as its periphery it required engines the cylinders of which were sixty inches diameter and five feet stroke of piston, which moved with a velocity of three hundred and thirty feet per minute with a pressure of sixty pounds to the square inch, making the power on the small wheel nearly double that used on the large one. To illustrate the expenditure of the forces on both, I refer to the accompanying Diagram No. 4, in which the effect of the two wheels in striking the water is shown. If the angle at which the paddle strikes the water is forty-five degrees, there is no tendency to propel, the reflection of the force being perpendicular to the line of progression. If the angle is less than forty-five degrees, it will tend to retard progress, and if more it has a proportionate tendency to aid in propelling, all of which is represented by the diagram, a being the tangent line or line of force and b being the line of reflection. This in part accounts for the enormous waste of power in propelling with the side wheel, which, together with the resistance of the air and other causes, makes up the sum total of the difference between the power required to propel the boat and that expended.

In the submerged screw-propeller the action may be illustrated by the Diagram No. 2, in which I omit the boat, as that has already been calculated as above. The size taken is a diameter of ten feet, a screw of twenty-feet pitch. The hub is one foot and travels at thirty feet per second, as above, having a resistance of nine hundred and twenty-eight pounds to its progress. This pressure, or resistance to the progress of the wheel to the water in the line of progression, gradually decreases with its angle, as seen in the diagram, and its collective resistance amounts to about seven thousand and thirty-four pounds, which is four times as great as the actual power required to propel the boat if properly applied.

It will be clearly seen from the above that by the present modes of applying the power of an engine to propelling boats an enormous amount of it is wasted without in the least advancing the object, and my improvements are intended to obviate the difficulty of the other modes now in use and to apply all the power, or nearly so, to the purpose of forcing the boat forward. The water, if acted on with a sufficient velocity, being non-elastic, will resist with a force equal to a solid, or nearly so, and of this I avail myself as far as practicable mechanically. To do this I employ side wheels d, Fig. 1, having their shafts parallel with the line of motion of the boat and their floats or paddles on an angle with their face. These wheels may be placed at the junction of the midship and stern lines. The hubs and arms are formed in the ordinary way and should have a diagonal bracing formed according to the requirements of the wheel, determined by the judgment of the constructer; but all the bracing must be above the water-line, as hereinafter more particularly described. The paddles or wings are set an angle of forty-five degrees, more or less, and should be constructed like a short section of the thread of a screw A, No. 3, of which A′ shows the edge of the paddle as made, so as to prevent the least possible obstacle to entering the water, the edges being made sharp and the arms flush with their surface. I prefer constructing these buckets of two thicknesses of sheet-iron, flat on the face-plate x, and with the back plate y sufficiently curved to cover the arms, which extend down to the periphery between them, or there may be one flat plate for the face, and the back between the arms may be filled out flush with wood, as at B′, No. 3. If the arms were not inclosed and if they exposed a projection of one foot of surface, that alone would present a resistance of three thousand seven hundred and twelve pounds. This projection of the arms from the face of the paddle is shown at B in Diagram No. 3. The wheels are so placed as to dip the width of their paddles only into the water, and no part of the bracing should be allowed to strike the water in its revolution, as it would retard the engines without propelling. The angle of the stern lines of the boat and the angle of the paddles should be so constructed as to cause any water thrown by the slip of the wheel inward with sufficient velocity to close behind the stern and prevent a drag or backwater, as shown by the arrows in No. 1.

The operation of wheels constructed and arranged substantially as above described is as follows: The water is parted with a velocity due to the speed at which the boat is propelled from the bow-lines to the greatest breadth of beam, where it is struck obliquely by the paddles that revolve with great rapidity. I intend sometimes when large wheels are used to place them near the bows of the boat, in which case they will be made to turn outward, so as to throw the water from the bows instead of closing it in at the stern. This will be found to have a somewhat similar effect to that above described. These paddles should be made to dip and leave the water so quick as not to set it in motion, or, in other words, to slip as little as is practicable. To increase the power the wheels can be multiplied on the shaft, as shown at P in Fig. 1, each succeeding one increasing the lead; but the length of the paddle should not exceed two feet and a half on the square, as a greater length would tend to move the water, and it should be sufficiently wide to take hold on the water. The paddles come over with the momentum of a balance-wheel, strike into the water, and then instantly leave it, the propelling force being made continuous by having the paddles lap a little, so that before one paddle leaves the water the next shall strike it. As no part of the wheel but the paddle is thrown through the water, all the force applied to do that reacts upon the boat in the line of its progress, causing it to move with a speed commensurate with the progressive speed of the wheel.

To illustrate the action of my wheel, I will assume the following proportions: the wheel being ten feet in diameter and two and one-half feet face, the length of the paddle four and one-half feet, placed diagonally on the face at an angle of forty-five degrees on the square, the depth of the paddle is twenty-two inches, which is also the dip of the wheel or a little more. This will require, to revolve it one hundred times per minute, a constant power of eight thousand pounds, and the result is, by experiments, twenty-four miles per hour for the speed of the boat, which by calculation (as in that of the diagram of the side wheel) offers a resistance of about four thousand pounds, the balance of power being used up in friction and the imperfections of the machinery, for if the wheel revolves with a velocity sufficient to describe the hypotenuse of a triangle of the same angle as its paddles in the same time the boat describes the perpendicular, it is obvious there will be no force required to turn it beyond what is used up in friction, and if the velocity with which the wheel revolves is sufficient to pass the paddle-blade through the water before the water can be put in motion it is equal to passing it through a groove in a solid; but if there is a "slip," as it is called, then in like proportion is the line of progress diminished; but at the same time the angle of the paddle is also diminished; or, in other words, as you reduce the perpendicular of the triangle you shorten the hypotenuse. This is illustrated in the Diagram No. 5, where a is the line of progression, b the angle of the paddle, and c the slip, which is here represented at one-eighth.

Having thus fully described my improvements, I wish it to be understood that I do not claim placing propellers at the sides of a boat when said propellers are formed with the propelling-surface extending into the axle, or nearly so, whether said propeller be a true helix, a parabolic, or other curve, as that has been before essayed; but in that case the propeller was either wholly submerged or submerged nearly to its shaft, which brings its connections with the motive power down to the water-line; but

What I do claim as my invention, and desire to secure by Letters Patent, is—

1. The employment of side wheels having their shafts parallel with the line of motion, with narrow short paddles in an oblique position on the periphery of the wheel and all the radial lines of which are perpendicular to the shaft, constructed substantially as herein set forth, and so arranged as to dip the paddle only into the water in the manner and for the purpose described, the paddles being made to enter and leave the water without obstruction and with sufficient velocity to prevent putting it in motion before leaving it enough to impede the progress of the boat, as above specified.

2. Placing two or more wheels on the same shaft, constructed as above set forth, the lead or angle of the paddles of the rear wheels being increased, as herein described.

3. Forming the wheel with two or more arms projecting down to the periphery of each of the stationary paddles, said arms being embraced by the paddles, which are made in two parts for that purpose, so as to present no obstruction to their passage through the water, while the strength and lightness of construction are fully preserved and the paddles are perfectly braced.

STEPHEN J. GOLD.

Witnesses:
A. P. Browne,
G. Stone.