4 Sheets—Sheet 1.

R. H. ARMIT.
Screw-Propeller.

No. 210.982. **Patented Dec. 17, 1878.**

Fig. 1.

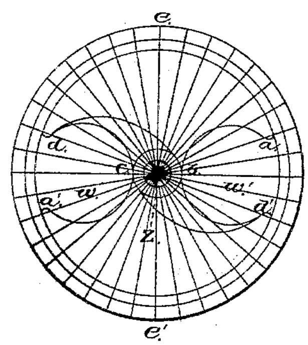


Fig. 2.

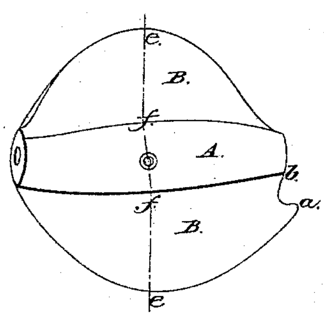


Fig. 3.

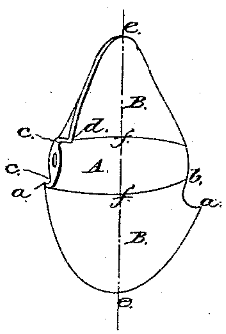


Fig. 4.

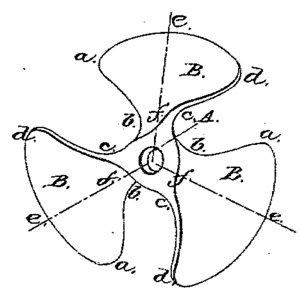
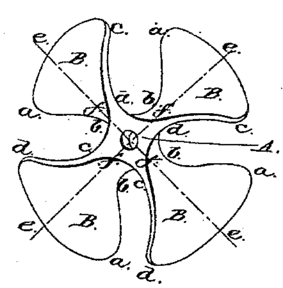


Fig. 5.



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Screw-Propeller.

No. 210,982. **Patented Dec. 17, 1878.**

Fig. 6

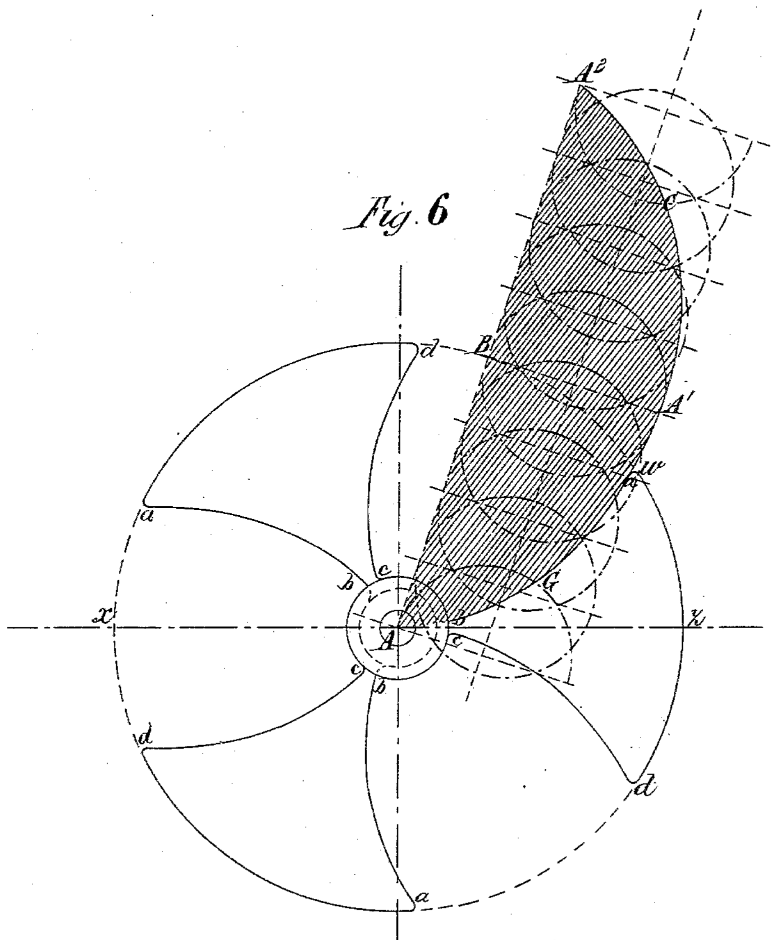
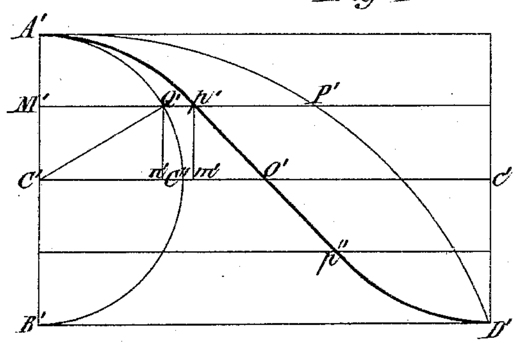


Fig. 7



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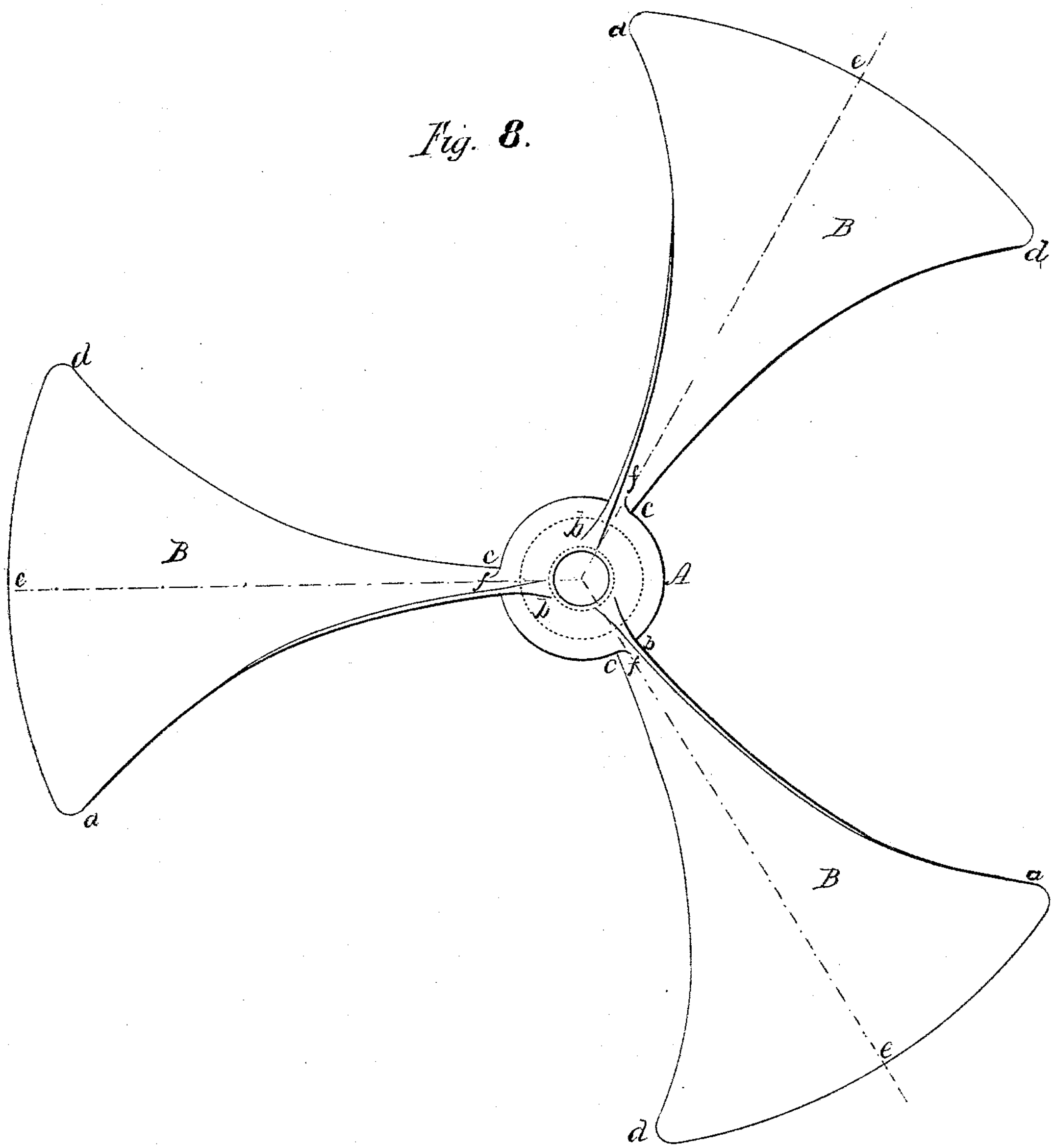
Screw-Propeller.

No. 210,982. Patented Dec. 17, 1878.

Fig. 8.



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Screw-Propeller.

No. 210,982. Patented Dec. 17, 1878.

Fig. 9.

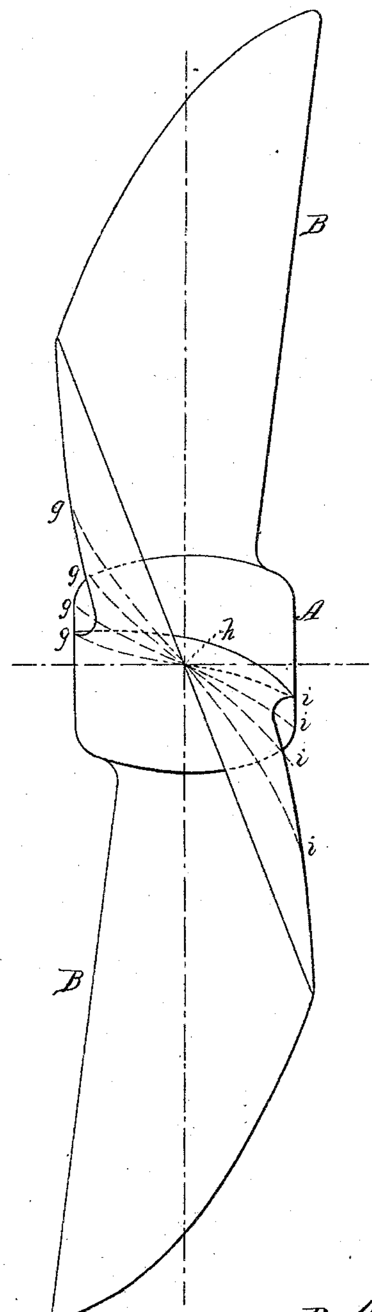

Fig. 10.

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UNITED STATES PATENT OFFICE.

ROBERT HENRY ARMIT, OF LONDON, ENGLAND, ASSIGNOR TO WILLIAM CHARLES HALLETT, OF SAME PLACE.

IMPROVEMENT IN SCREW-PROPELLERS.

Specification forming part of Letters Patent No. **210,982**, dated December 17, 1878; application filed June 4, 1878; patented in England, September 15, 1876.

To all whom it may concern:

Be it known that I, ROBERT HENRY ARMIT, of London, England, have invented new and useful Improvements in the Construction of Ships' Propellers and other like articles with helical surfaces, of which the following is a specification, reference being had to the accompanying drawings.

My invention relates to an improvement in the form of the blades of screw-propellers, its object being to increase the speed and steadiness of vessels using screws, and decrease the liability of the screw to break in racing.

In constructing a propeller-screw according to my invention the lines of the blades are traced on cycloidal curves, the leading edge of each blade being preferably concave or curved laterally with respect to its boss in the direction of the screw's rotation, while the trailing edge curves in the opposite direction, so that both leading and trailing edges terminate in points at the periphery, where the surface area is greatest, contrary to the ordinary style of constructing screws.

The surfaces between the leading and trailing edges are curved longitudinally or from front to rear, on lines determined by the curve of sines, as shown in Figure 9, and by this means I give the leading driving quadrant of the blade a surface curving rearwardly from the leading edge toward the middle radius of the blade, which is a straight line from the center of the boss, and the following quadrant a surface curving in the opposite direction from the radius to the trailing edge.

The blade thus formed acts upon the water by means of a hollow surface, which gripes the water and throws it aft upon the convex surface of the following quadrant, off of which it glides with the least possible resistance.

In addition to the powerful manner in which a screw of this character takes the water and the facility with which it leaves it, there is another advantage in the blade curved from front to rear on the line of sines—viz., its non-liability to break in racing.

When the ordinary flat blade, in racing, strikes the water with a heavy blow, it is very liable to be broken; but my cycloidal blade strikes the water with a curved surface and a cutting-edge, which enter with a minimum resistance and create no perceptible vibration or jar in the vessel to which attached.

In backing, the screw takes and leaves the water in precisely the same manner as when going ahead.

In the drawings, Figs. 1 to 5 illustrate the formation of screw-propellers with cycloidal blades. Figs. 6 and 7 are diagrams, illustrating the mode of tracing the lines of the blades. Fig. 8 is a face, and Fig. 9 a side, view of a three-blade propeller-screw constructed according to my invention. Fig. 10 is a section through one of the blades on a line extending from the boss to the periphery of said blade.

The several blades should, of course, be of the same shape and stand in similar positions equidistant apart upon the boss.

In the several figures, the letter A indicates the boss, and B the blades, of a screw-propeller. The letters *a b* indicate the leading edge of the blade, and *c d* the trailing edge. These two edges spring from opposite ends of the boss, and are curved laterally with respect to the boss in opposite directions, each being traced on a cycloidal curve from the root to the periphery of the blade.

The dotted line *e f* indicates the middle radius of the blade, and *g h i* indicate the reversed curve on which the surface of the blade is formed, as before explained.

On the screw being made to revolve in the direction of the arrow, the point *a* cleaves the water, which is then thrown by the surface *a e f b* back onto the surface *c f e d*, the letter *f* indicating the foot of the radius or straight line which divides the leading from its following quadrant.

In some cases I flange or partly flange the leading driving periphery or outer edge of the blades.

Fig. 2 is a side view of a cycloidal screw-propeller with two blades constructed according to my said invention, whose length of boss should equal, but not exceed, the diameter of the screw.

Fig. 3 is a side view of the cycloidal screw-propeller constructed according to my said invention, whose length of boss is shown to be equal to one-half part of the diameter of the screw-propeller, but may be more or less, according to the requirements of the vessel to which it is attached.

Fig. 4 is an end view of a three-bladed cycloidal propeller constructed according to my said invention, whose length of boss is shown to be equal to one-third part of the diameter thereof, but may be more or less, as required.

Fig. 5 is an end view of a four-bladed cycloidal screw-propeller constructed according to my said invention, whose length of boss is equal to one-fourth part of the diameter thereof, but may be more or less, as required.

The blades may have their leading driving quadrants convex and their following quadrants concave.

Fig. 1 is a diagram given to illustrate a method of setting out my screw-propeller. In this figure, *z* is the center of the shaft or boss, from the face of which spring the cycloidal arcs *a b* and *c d* on the one side, and *c a'* and *b d'* on the other side. *a e* and *d e* join at the point *e* to form the cycloidal arc *a e d*. In like manner I construct the other blade, and I thus set out a two-bladed screw-propeller having water-way *w w'* to allow free discharge of the water through which the propeller is made to pass.

The manufacture of screw-propellers with the blades shaped as above described is attended with certain difficulties, which I obviate as follows:

It is well known to all familiar with the making of screw-propellers that the ordinary and most convenient manner of forming the molds of the propeller-blades previous to casting them is by a process termed "sweeping;" but the shape of the blades of the cycloidal screw, as above described, can only be produced in this manner with difficulty, such blades requiring the use of special patterns. Therefore I have designed the following method of forming my improved cycloidal propellers, whereby I obviate these difficulties without sacrificing any of the advantages of the cycloidal form of the blades, and which I will now proceed to explain.

In the construction of the propellers above described I use only a "right cycloid," which is developed in the following manner:

Referring to the diagram, Fig. 6 shows the face of one of my improved propellers. If the circumference of a circle (hereinafter termed the "generating-circle") be rolled upon a right line until the point A in that circumference in contact with the said line passes entirely around the circle and comes again in contact with it, that point will describe a curve, A G A^1 C A^2, termed a "cycloid." The line A B A^2, on which the generating-circle rolls, and which may equal in length the diameter of the screw, is the base of the cycloid, which starts from the axis or center of the screw, and the diameter B A^1 of the said circle, drawn perpendicularly to this base at the center or middle point of the latter, is the axis of the cycloid. Taking the said axis A of the screw as a center, a circle, B *x z*, is drawn around the same, whose radius equals the distance from the said center A of the screw to the middle point of the base of the cycloid, and this circle will represent the diameter of the propeller. The width of the blade is the chord of an arc, *w z d*, or part of the said circle representing the diameter of the screw, and this width being determined the shape of the edges *w* A and *d* A of the blade are delineated by the cycloid in the plane of the face of the propeller-boss, or extending beyond this plane, as may be required, The external points or corners of the said blades may be curved or rounded, as shown at *w* and *d*.

In the operation of "sweeping" my improved cycloidal propeller it will be understood that I commence, in the usual manner, by using iron or other suitable plates, and complete the formation of the propeller by means of templets. One templet is placed on a right or straight line in the center of the blade extending from the boss to the periphery of the propeller, and vertical to the axis of its rotation.

The templets for the remaining portions of the blades will be developed by or form from the natural curves assumed by the blade in consequence of its having been delineated by a cycloid in the plane of the faces of the boss or outside of this plane.

The position of the straight line on the blade above mentioned may vary, according to circumstances and the form of blade required.

One very important feature of this invention is that I now make use of both the "prolate" and "curtate" cycloids, as also of the "epicycloid" and "hypocycloid," according to the shape I desire my blades to assume. I am therefore able to impart cycloidal curves to any shaped blade, and to gain from ten to fifteen per cent. on screws formed on the principle of the Archimedean curve or screw-thread. Thus the spiral of Archimedes may be regarded as an epitrochoid.

The curve traced out by a point retaining a fixed position with respect to a straight line which rolls without sliding on a circle in the same plane as line and point may be regarded as an epitrochoid, whose generating-circle has an infinite radius. Archimedes defines this curve as "the curve traversed by a point moving uniformly along a straight line which revolves uniformly around a center," and the difference between these spirals, when applied to mechanical purposes, is that the cycloidal screw-thread, as hereinbefore described and illustrated, reverses the curves of the Archimedean thread or spiral—that is to say, that where the Archimedean thread is concave the cycloidal thread is convex, and vice versa, forming a true "line of sines" or "companion to the cycloid."

Fig. 8 is a face view, and Fig. 9 is a side view, illustrating the form of a propeller constructed in the manner set forth in the diagram, Fig. 7. Fig. 10 is a section through one of the blades on a line extending from the boss to the periphery of the said propeller.

I wish it understood that I may use any desired number of blades of any form or shape governed by the cycloidal principle on my improved propellers, and these blades may be cast or otherwise formed separately from the boss, and attached thereto by screws or other suitable means, so that in case of fracture or injury of a blade the same may be readily removed and replaced by a new blade, if necessary; or the blades may be cast solidly with the shaft without any boss whatever. The blades may also be made to incline aft or forward.

The boss may be of any shape or form; but the smaller the boss, consistent with strength and safety, the more efficient will be the propeller.

The pitch of cycloidal blades may vary. The diameter, length, and pitch of cycloidal screw-propellers must depend on the weight of the vessel and the available horse-power of the engines.

Moreover, I wish it understood that I do not bind myself to any particular orthographic projection of the blades, as my cycloidal screw-thread enables me to take such portion thereof as I may deem necessary and to shape it or cut it down until I have left such area of blade as I may require in each individual instance.

The companion to the cycloid or curve of sines, whose hollow surface, as a rule, forms the leading driving-surface of the leading quadrant of my blades, is obtained as follows:

Referring to Fig. 7, which is a diagram illustrating this method of forming the blades, let $A' B'$ be a fixed diameter of a circle, $A' Q' B'$, and through any point, Q', on $A' Q' B'$ draw $M' Q' p'$, perpendicular to $A' C' B'$, and equal to the arc $A' Q'$. The locus of this point p' is the companion to the cycloid $A' P' D'$, having $A' B'$ as axis. If $C' O' c'$ (the line of centers of semi-cycloid $A' P' D'$) be bisected in O', the curve passes through O', because $C' O' =$ quadrant $A' Q' C''$. Drawing $p' m' Q' n'$ perpendicular to $C' O' c'$, I have $m' O' = C'' O' - C'' m' = A' C'' - A' Q' =$ arc $Q' C''$; then $p' m' : O' m' :: Q' n' :$ arc $Q' C'' ::$ sin. $Q' C' C'' : -$ circumferential measurement of $Q' C' C''$. Hence the part $A' p' O'$ of the companion to the cycloid is a curve of sines, and when produced to $O' p'' D'$ this latter will be found to bear precisely the same relation to the line $O' c'$ which the part $A' p' O'$ bears to $O' C'$. Thus the entire curve is a curve of sines, of which the central point, O', is to be found in the center of my blades, at which point a straight-edge will lie flat along the blade, but not at any other point. A straight-edge, when applied to a cycloidal blade at the point O', will lie flat along the surface of the said blade, either from boss to periphery or from edge to edge, according to the construction and form of the said cycloidal blade. The curve of sines or companion to the cycloid may be used to delineate both the leading and the trailing edges of the blades of a screw-propeller. Any portion of the cycloid may also be used. In each case the horizontal section of the blade parallel to the axis of rotation will form a curve of sines or companion to the cycloid.

What I claim is—

1. A propeller-screw or similar article having longitudinal curved blades, the leading or trailing edges, or both, of which are formed on cycloidal curves, substantially as described.

2. A propeller-screw or similar article having blades which are curved longitudinally on reverse curves, determined by the line of sines, and the leading or trailing edges, or both, of which are formed on cycloidal curves, substantially as described.

3. A screw-propeller blade curved longitudinally on a line of sines, substantially as set forth.

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