(No Model.)

2 Sheets—Sheet 1.

E. BIERSTADT.
SCREW PROPELLER.

No. 566,292. Patented Aug. 25, 1896.

FIG. 1.

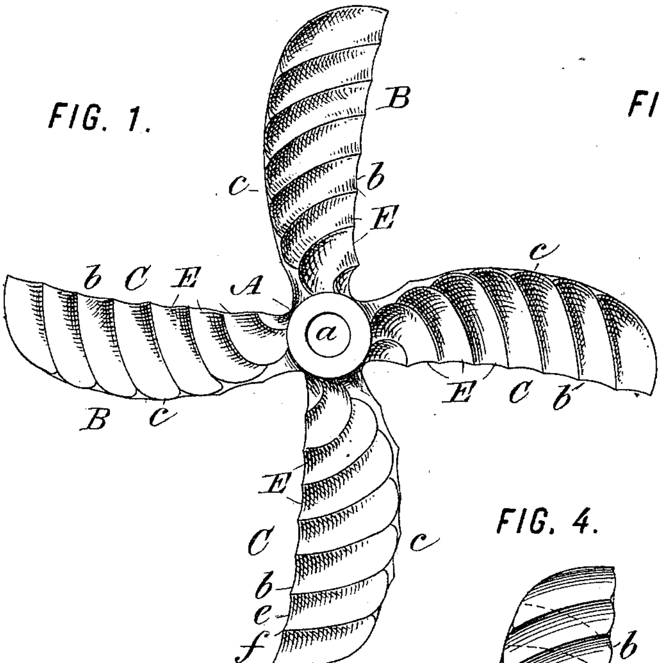


FIG. 2.

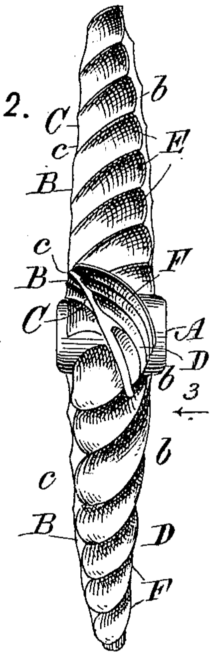
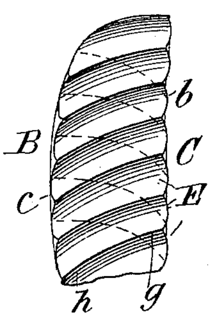


FIG. 4.



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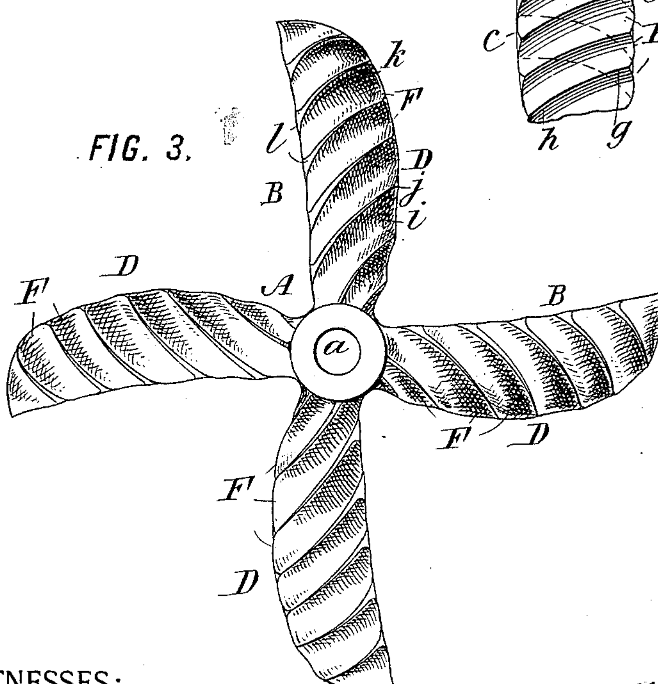
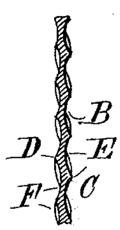


FIG. 5.



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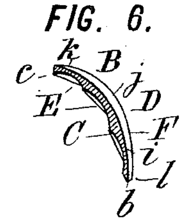

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(No Model.) 2 Sheets—Sheet 2.

E. BIERSTADT.

SCREW PROPELLER.

No. 566,292. Patented Aug. 25, 1896.

FIG. 9.

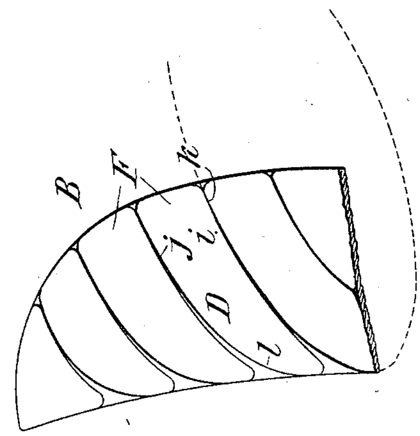


FIG. 8.

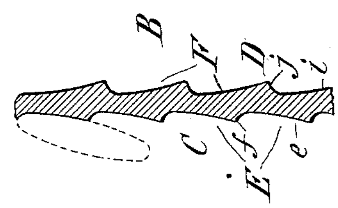
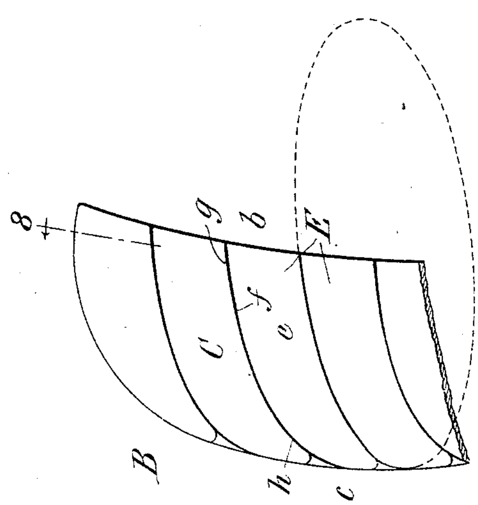


FIG. 7.



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UNITED STATES PATENT OFFICE.

EDWARD BIERSTADT, OF SUMMIT, NEW JERSEY.

SCREW-PROPELLER.

SPECIFICATION forming part of Letters Patent No. 566,292, dated August 25, 1896.

Application filed October 12, 1893. Renewed January 31, 1896. Serial No. 577,634. (No model.)

To all whom it may concern:

Be it known that I, EDWARD BIERSTADT, a citizen of the United States, residing in Summit, in the county of Union and State of New Jersey, have invented certain new and useful Improvements in Screw-Propellers, of which the following is a specification.

This invention relates to screw-propellers for propelling or acting on a fluid, such, for example, as screw-propellers of vessels, or screw-pumps for causing a liquid to flow, or screw fans or blowers.

The invention aims to provide improvements in the construction of such screw-propellers, the improvements being particularly applicable to screw-propellers for vessels and being designed to increase the efficiency of such devices to the end of obtaining a higher rate of actual speed or thrust in return for the energy expended in operating the screw.

Heretofore various constructions of screw-propellers having a plurality of radial or substantially radial blades have beem employed. In these, various expedients have been resorted to to obtain the greatest effective propulsive action on the water, to reduce vibration incident to the operation of the screw, and to overcome the divergent tendency of the water due to the centrifugal force attending the revolution of the screw. Of these constructions that known as the "Hirsch propeller" may be taken as an example. In this propeller the blades are constructed with longitudinally-concaved or backwardly-inclined force-faces, designed by their peculiar contour to produce a tendency in the water which they drive backward to converge to a point, the attempt being to establish a convergent tendency balancing the divergent tendency due to centrifugal force, so that the two forces, being in equilibrium, will cause the water to be projected directly backwardly from the screw. Another feature of this known construction of propeller consists in constructing the force-faces of the blades with a lateral concavity, which is generally accomplished by constructing these faces in the form of a curve of great radius at the taking or advancing edge of the blade and of decreasing radius at the leaving edge of the blade, the advancing edge being of relatively small pitch and the leaving edge of relatively great pitch, whereby as the water is acted on by the successive portions of this force-face the increasing curve or pitch of the face follows the water up in its backward progression and gives a constant action on the water as the blade passes it. These two features of construction have proved very advantageous in practice; but in availing of them it becomes necessary that the reverse faces of the blades be convex both in their longitudinal and lateral contour, and therefore the propeller is almost ineffective when its rotation is reversed for the purpose of stopping or backing a vessel.

My invention is particularly applicable to propellers of the Hirsch type, and is particularly designed as an improvement on such propellers; but it may be advantageously availed of in connection with other types of propellers.

In its preferred and most complete form my invention consists in providing on the force-face of the propeller-blade, and preferably on both the front and rear faces thereof, one or more improved grooves disposed in their general direction angularly to the longitudinal axis of the blade in such manner that at the taking edge of the blade they shall be farthest from the axis of revolution of the screw and at the leaving edge of the blade they shall be nearest to said axis. Preferably a series of these grooves are provided on each side of each blade, and each consists of a concave surface or groove which in its lateral concavity is in the form of a curve of relatively great radius at the point of greatest depth of the concavity or the point nearer the axis of the screw and of progressively-increasing curvature or decreasing radius to its extremity or its point farthest from the axis of the screw, at which point it preferably terminates in a point or ridge from which starts the succeeding concavity of the next groove, and in its longitudinal continuation this groove, while corresponding to the general contour of the face of the blade, consists, preferably, of a curve of relatively great radius at the taking edge of the blade, inclined relatively to the longitudinal axis of the blade, and progressing, as it traverses the latter toward its leaving edge, inwardly toward the axis of the screw with a constantly-increasing curvature to the point where it meets the leaving edge. Thus in operation these auxiliary faces each receive and act on the adjacent water as follows: First, the water on striking the concavity of the face at its taking edge will be followed up, under its outward divergent tendency due to centrifugal force, by the increasing curvature of the groove to the leaving point of the latter, in which operation the groove exerts a convergent tendency on the water, and, second, as the groove passes against the water its inward and increasing curvature toward the axis of the screw will cause it to follow up and exert an inward pressure against the water throughout the length of the groove. By reason of the increasing curvature this inward tendency increases in proportion to the increasing tendency of the water under the action of the immediately preceding portion of the same groove. Thus it will be seen that throughout the contact of the groove with the water the latter is being constantly acted on by the former, and that this action is in addition to the usual action due to the contour of the blade as a whole. By proper adjustment of the lateral and longitudinal curvatures of the respective grooves their action on the water may be made uniform throughout its passage across them.

When a plurality of successive grooves are employed, the water diverging under centrifugal force over the one will be caught and acted on by the succeeding one, and each will give a converging tendency to the water, and a correspondingly-increased effective thrust to the screw, additional to that which it would have were the grooves omitted.

Preferably the grooves are applied to both the forward or force and rear or reverse faces of the blades, those at the rear being of reverse inclination to those at the former face, for the reason that, when reversed in its operation, what was formerly the leaving edge becomes the taking edge of the propeller. Thus crossing these grooves causes the ridges between them constituting their leaving points to act as diagonal transverse stays or ribs reinforcing and increasing the general strength of the blade. The application of these improved grooves to the rear sides of the spoon-shaped Hirsch blades gives to them an effective hold on the water in backing, which greatly decreases the slip they would otherwise have in this operation and renders them sufficiently effective for stopping or reversing the motion of the vessel propelled.

In the accompanying drawings, which illustrate the preferred application of my invention in its most complete form, Figure 1 is a front elevation of a Hirsch propeller provided with my improvements. Fig. 2 is a side elevation thereof, looking in the direction of the arrow 2 in Fig. 1. Fig. 3 is a rear elevation thereof, looking in the direction of the arrow 3 in Fig. 2. Fig. 4 is a fragmentary face view of the force-face of one of the blades. Fig. 5 is a fragmentary longitudinal section of one of the blades. Fig. 6 is a cross-section of one of the blades. Fig. 7 is a fragmentary elevation, on a larger scale, of the force-face of a blade. Fig. 8 is a fragmentary longitudinal section thereof on the line 8 and looking in the direction of the arrow, and Fig. 9 is a fragmentary elevation of the reverse face thereof.

Referring to the drawings, let A indicate the hub, and B the blades, of a propeller. The hub A is of the usual cylindrical or bulging construction, having axial-shaft aperture *a*, and the blades B are the usual blades, having inwardly-inclined concave spoon-shaped force-faces C, beginning at taking edges *b* and terminating at leaving edges *c*, and bulging convex reverse faces D. The hub and blades are connected together in any suitable manner in the construction shown by being cast in one integral piece. As usual, the faces C increase in curvature or pitch as their leaving edges *c* are approached, and the corresponding reverse faces D correspondingly decrease in curvature or pitch as their leaving edges, which are the taking edges of the faces C, are approached.

According to my invention I provide one or more improved grooves traversing the working faces of the blades in a lateral direction, inclined at their leaving ends inwardly toward the axis of the propeller. Preferably a plurality of succeeding grooves E E are provided on the force-face C of each blade, and a plurality of like grooves F F, crossing diagonally in their direction the direction of the grooves E E, are provided on the reverse face of the blade. Each groove E succeeds the preceding one, and they extend from the outer extremity of the blade to the inner end thereof, the one groove beginning where the other terminates and each starting at the taking edge of the blade, progressing transversely diagonally across the face and terminating at the leaving edge of the blade at a point nearer the axis of the screw than that at which they started. Each groove E preferably consists of a concave groove terminating at its lateral point farthest from the axis of the screw in a ridge or elevation *f*, from which the succeeding like groove begins. The grooves in cross-section are preferably of curved contour, their bottoms at their inner portions *e* being composed of a curve of relatively great radius, and their contour, as their outer ridge *f* is approached, increases continually in curvature, so that at their termination the curvature of their contour is of relatively small radius, as best seen in Fig. 8. In longitudinal direction the grooves are preferably constructed as a continually-increasing curve, having the least curvature or the greatest radius at the taking edge of the blade, the point *g* in Fig. 4, and a continually-increasing curve toward the axis of the propeller as they progress toward the leaving edge *c*, as seen at the point *h* in Fig. 4 and in Fig. 7. The extent of increase in the longitudinal curvature of the grooves depends on the distance of their location from the axis of the screw, those being farthest removed therefrom having the smallest increase in curvature and those being the nearest thereto having the greatest increase in curvature, as in Fig. 1 and Fig. 7.

The grooves on the reverse faces of the screw are preferably formed of grooves *i*, terminating in ridges *j* and in all respects substantially identical with the grooves E and ridges *f*, and likewise having bottoms of a curvature of relatively great radius and as they progress outwardly laterally a curvature of constantly-decreasing radius until the ribs *j* are reached. As is the case with the grooves E, the grooves F have the least curvature at their points *k*, which are their taking edges, and the greatest curvature at their points *l*, which are their leaving edges. The direction of these grooves being the reverse of that of the curves E, their ridges *j* cross transversely and diagonally the ridges *f* of the grooves E, and thereby serve as strengthening-ribs at the opposite faces of the blades.

The grooves E and F are preferably arranged in continuous series, successively, and with increasing curvature from that of the outermost groove to that of the innermost.

The curves employed for the grooves may be any known or suitable curves. Preferably elliptical curves are used.

In operation the grooves E or F, depending upon whether the propeller is being driven forward or backward, will successively act on the water or other fluid in contact with the propeller, and throughout their action thereon will exert a converging and axially-projecting tendency, in addition to that usually obtained from the action of the propeller itself.

It will be seen that my invention provides an improved screw-propeller which can be variously and advantageously availed of, and it will be understood that the invention is not limited to the particular features of construction and adaptation set forth and shown as its preferred form, as these may be modified as circumstances or the judgment of those skilled in the art may dictate without departing from the essential features of the invention.

What I claim is, in screw-propellers, the following-defined novel features and combinations, substantially as hereinbefore set forth, namely:

1. In a screw-propeller, a blade having on its face a groove extending in an elliptical curve transversely of said face and inwardly toward the axis of the propeller from a point near the taking edge of said blade to a point near the leaving edge thereof, whereby the water is drawn inwardly toward the axis of the propeller by the inward curvature of said groove.

2. In a screw-propeller, a blade having a face constructed with a groove extending transversely of said face in a curve of decreasing radius from a point near the taking edge of said face to a point near the leaving edge thereof.

3. In a screw-propeller, a blade having a plurality of grooves traversing transversely its reverse face in a curve of decreasing radius from a point near the taking edge thereof to a point near the leaving edge thereof, and of greater distance from the axis of the propeller at the taking edge than at the leaving edge of said face.

4. In a screw-propeller, a blade having upon its reverse face a concave groove elliptical in its longitudinal curvature and traversing said face transversely and inwardly toward the axis of the propeller from the taking edge of said reverse face to the leaving edge thereof, whereby in backing the water will be drawn inwardly toward the axis of the propeller by said groove, and thereby the effective hold of the propeller on the water in backing will be increased.

5. In a screw-propeller, a blade having force and reverse faces constructed each with grooves, the grooves of the force-face extending transversely thereof and inclined from its taking edge inwardly toward the axis of the propeller as they progress to its leaving edge, and the grooves of the reverse face inclined from its taking edge inwardly toward the axis of the propeller as they progress toward its leaving edge, whereby the grooves of the respective faces of said blade are disposed diagonally relatively to each other.

6. In a screw-propeller, a blade having force and reverse faces constructed each with grooves, those of the force-face extending transversely thereof, and those of the reverse face extending transversely thereof and inclined relatively to those of the force-face, whereby the grooves of the respective faces of said blade are disposed diagonally relatively to each other.

In witness whereof I have hereunto signed my name in the presence of two subscribing witnesses.

EDWARD BIERSTADT.

Witnesses:
GEORGE H. FRASER,
FRED WHITE.