H. HIRSCH.

MARINE PROPELLER.

No. 25,197. Patented Aug. 23, 1859.

Fig. V.

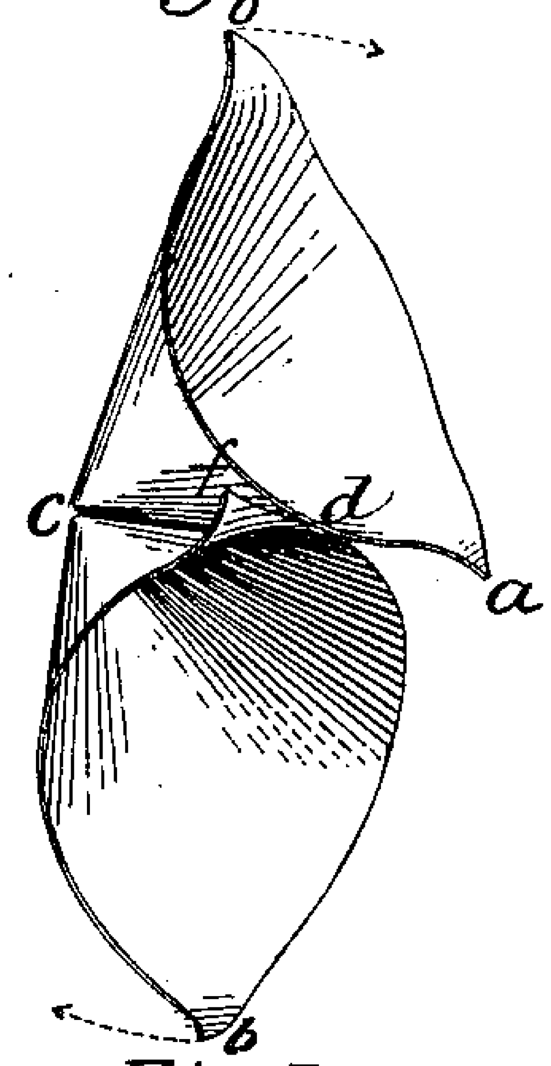


Fig. IV.

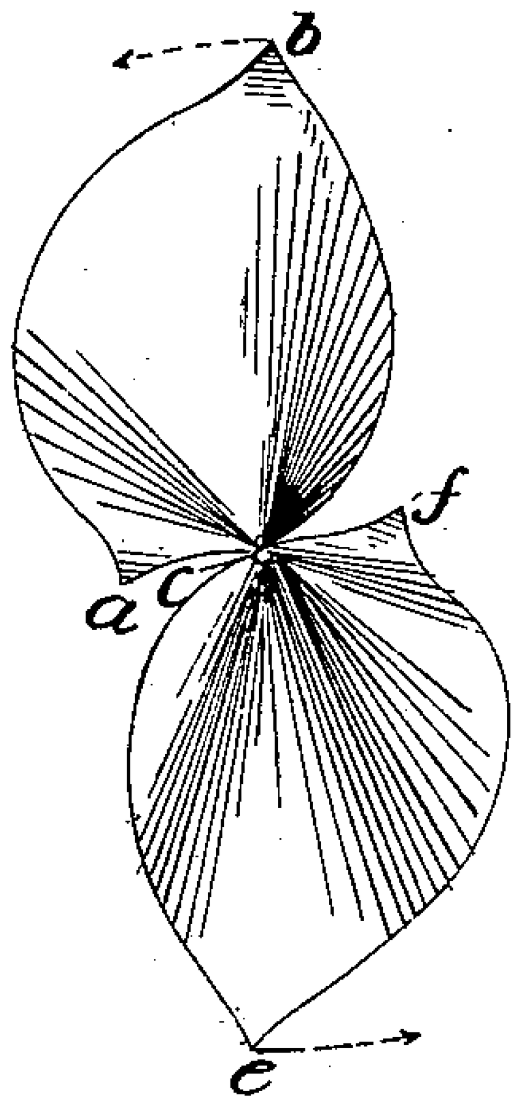


Fig. I.

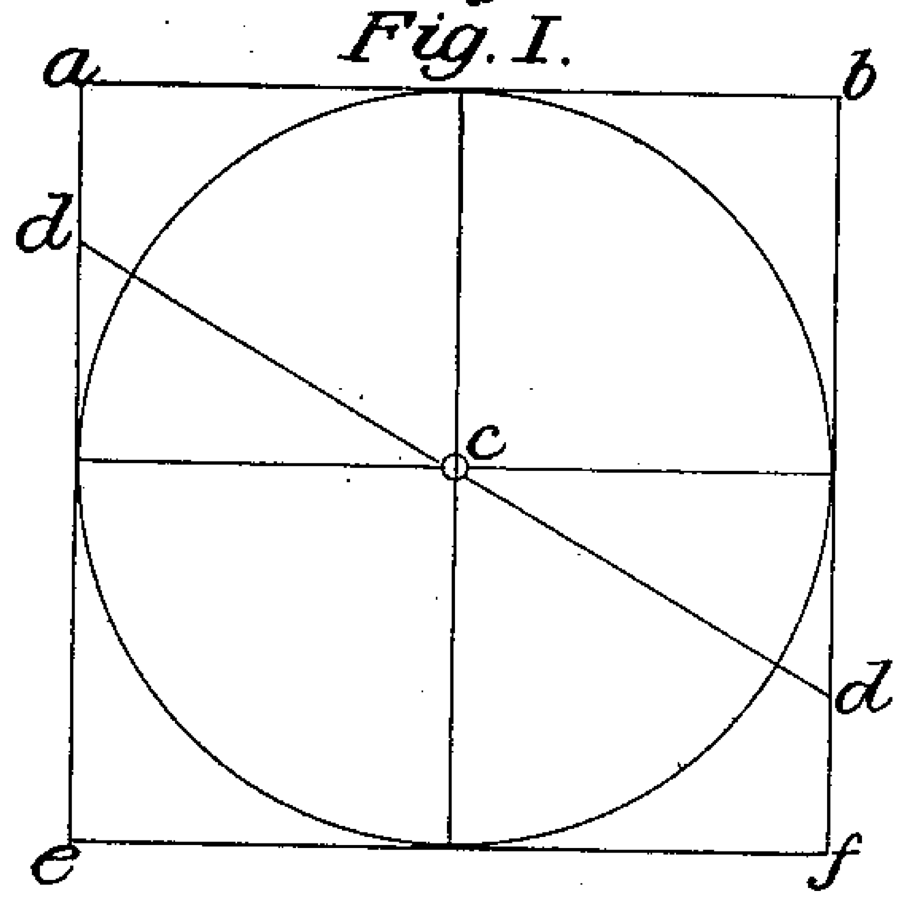


Fig. II.

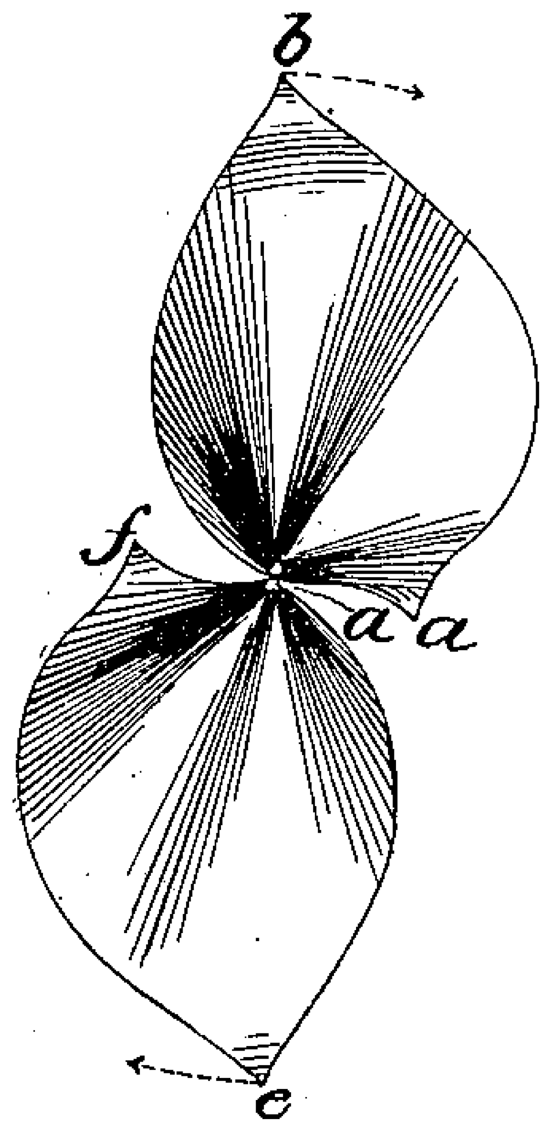
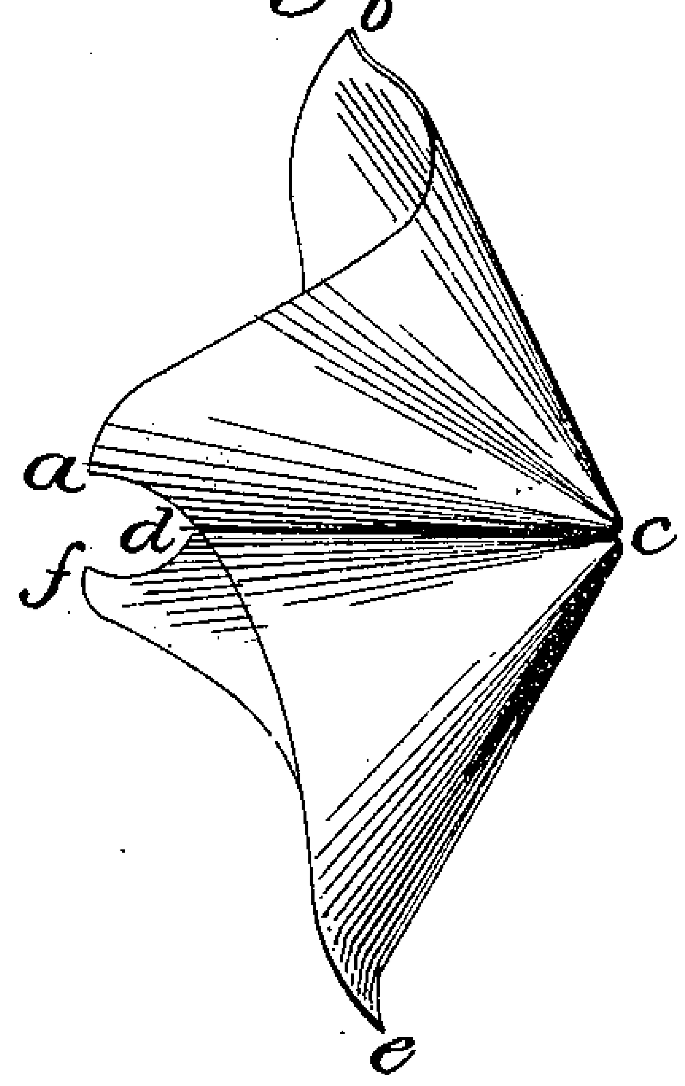


Fig. III.



Witnesses.

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HERMANN HIRSCH, OF BERLIN, GERMANY.

MARINE PROPELLER.

Specification of Letters Patent No. 25,197, dated August 23, 1859.

To all whom it may concern:

Be it known that I, HERMANN HIRSCH, of Berlin, in the Kingdom of Prussia, Germany, have invented a Centrifugal Screw-Propeller; and I do hereby declare that the following is a full, clear, and exact description of the same, reference being had to the annexed sheet of drawings, making a part of the same.

The special peculiarity of this new propeller consists in the coöperation of the centrifugal force obtained by its peculiar construction.

The description of this screw, the comparison with the other forms of screws hitherto in use, and a statement of the peculiar advantages which it offers are the objects of the following:

1. Description.

Figure 1 Plate I represents a plane surface in the form of a square. In this a circle is described having two diameters intersecting each other at right angles, and a third drawn through the circumference and produced to the two sides of the square in the points *d* and *d'*. Two quadrants are thus divided into arcs of 60° and 30°. The square surface is then so bent or curved, that the half of the same on the right hand being curved downward, the point *d* coincides with the point *d'*. The two arms or vanes thus formed are now so compressed that without disturbing the other curvature the two lines *c*, *d*, and *c*, *d'* coincide. On firmly uniting these we have two hollow cones whose bases deviate but slightly from circles and, at the circumference of each, two points are now bent outward. The form of the new propeller is determined by these conditions.

Fig. 2 gives a view of its open or (speaking with reference to the length of the ship) after part. The corresponding points are indicated by the same letters as in the square in Fig. 1; *b* and *a* are the two points of the upper cone bent outward, *f* and *e* those of the lower cone; *d* is the point of junction of the two hollow cones lying on the open side.

Fig. 3 exhibits the propeller, seen from the side and in reference to the ship—the starboard side. The letters for reference are all the same as in Fig. 1. *d c* is the line of junction of the two hollow cones, *b* and *a* are the two points of the upper, *e* and *f* those of the lower cone, bent outward.

Fig. 4 presents an external view of the propeller or speaking in reference to the length of the ship a view of its fore part; *b* and *a* are the points of the upper hollow cone, *e* and *f* those of the lower cone, *c* is the point of junction of the hollow cones on the closed side.

2. Comparison of the new propeller with those hitherto in use.

In the case of the propellers which have hitherto been employed, the normal pressure of the water on the vane may be divided into two elements of which one is taken up by the force of the wave in producing the revolution, and the other is imparted to the ship by means of the wave urging it forward. Hence the angle of elevation formed by the line of the screw with a perpendicular drawn through the axis of the wave is very decided. In this sense however there is no such angle in the propeller now described. On examining Fig. 3 Plate I it will be seen that each hollow cone may be divided into two readily distinguishable parts; in the upper cone for instance the front and strongly shaded part and that lying on the side which is turned away, and of which a portion of the edge is to be seen.

The direction which the propeller must assume during the progress of the ship, is indicated by the arrows in Fig. 2, and also in Fig. 4, which gives a view of the closed after-part of the propeller, and where the arrows have therefore assumed an opposite position. If we imagine this revolution to commence at the point shown in Fig. 3, and if we regard that water only on the exterior of the upper cone, then the curved side *a*, must first strike the water, but almost simultaneously with it the most curved portion of the forwardmost surface lying in the direction of *c* does the same. The incision proceeding from the side *a* and the curvature reduce the resistance of the water to a minimum. At the same time a portion of the water is driven along the indentation in the direction from *c* toward *a*. The portion of the internal surface which protrudes at *l* resists the pressure of the water, first by means of its own outward flexure, secondly by means of the edge which there intersects it nearly at right angles and finally by the most curved edge of the curvature of the cone there situated.

If in the ordinary propeller we indicate the force of the axis by R, the force of the revolution by P, the corresponding expenditure of labor by L, the average velocity of the wave by c, the angle of elevation by α the density of the water by γ, the superficial content of both vanes by F, the impulsive coefficients by ζ and the dimension 0.016, as usual by $\frac{1}{2}\, g$, we obtain the three equations:

$$R=\zeta_1 \frac{(c.\ \sin.\ \alpha - v.\ \cos.\ \alpha)^2}{2g} \cos.\ \alpha\, F_1 \gamma;$$

$$P=\zeta_1 \frac{(c.\ \sin.\ \alpha - v.\ \cos.\ \alpha)^2}{2g} \sin.\ \alpha\, F_1 \gamma;$$

$$L=Pc=\zeta_1 \frac{(c.\ \sin.\ \alpha - v.\ \cos.\ \alpha)^2}{2g}\, c.\ \sin.\ \alpha\, F_1 \gamma;$$

where v represents the velocity of the ship and thus the axis of the propeller. It will at once be seen from what has been said that only $2g$, γ and c can retain the original value; but α, F and ζ, must be replaced by other magnitudes and v also obtains a fresh value. F, is found to consist of four different elements of which two compose each hollow cone. One of these is the surface with such compound curvature situated in the front of Fig. 3. The other is the surface, likewise having numerous volutions, of the interior surface in the direction of b. The peculiar form of these two parts and the different degree of pressure of water dependent thereon render a complicated calculation necessary which must be reserved for a separate treatise. As has been observed, the angle of elevation α does not occur at all, but this is partially replaced by the magnitude of the centrifugal force which is shortly to be mentioned and which is determined by the rapidity of the revolution. The coefficient of impulsive force ζ, on account of the minimum of pressure of the water, acquires a perfectly new value. The magnitude v, which represents the velocity of the ship and therefore that of the axis of the propeller also in this direction has, in the screws hitherto in use, the value:

$$v=1+\sqrt{\frac{\zeta F}{\zeta_1 F_1 (\cos.\ \alpha)^3}}$$

where F represents the principal transverse section of the ship and ζ the coefficients of the resistance. The dependence of v upon the angle of elevation and also upon the proportion which the section of the surface bears to the principal transverse section and the whole content of the surface of the vanes is now evident. As has been already observed, α does not occur in the new propeller at all. The proportion between the two contents of the respective surfaces still continues to be of importance but much less than in the screws hitherto in use, a totally different factor appearing in the numerator, dependent upon the centrifugal force. Besides what has just been mentioned, the influence of v on the determination of the respective values of R, P and L is by no means so negative as in the ordinary screw; for the greater the velocity with which the ship proceeds the greater is the ease with which each cone falls and discharges itself, thus increasing and not retarding the centrifugal force.

3. Special advantage of the new propeller.

Many of these special advantages have become evident in the course of what has been said above; but they hardly appear in their full value until they are considered in connection with the most remarkable and chief advantage offered by the new construction viz, the coöperation which the centrifugal force is made to afford. The two hollow cones Fig. 2 Plate I become filled with water which in consequence of the motion of the propeller is thrown into rotation and thus exerts centrifugal force.

Let G represent the weight of the water contained, the mass of which will then be

$$M=\frac{G}{g};$$

let the semidiameter of the circle of revolution *i. e.* nearly the semi-diameter of the circle described in the square Fig. $1=r$, and the velocity of revolution $=c$, we have the following value for the centrifugal force K:

$$K=\frac{Mc^2}{r}=\frac{Gc^2}{gr}=2.\frac{c^2}{2g}\cdot\frac{G}{r}$$

and therefore

$$K=G=2.\frac{c^2}{2g}:r$$

i. e. the centrifugal force is to the weight of the water in the hollow cones as double the extreme of velocity is to the semi-diameter of revolution. The motion being uniform, the velocity can be expressed by the time of revolution, calling this t we have

$$c=\frac{2\pi r}{t}$$

and hence for the centrifugal force:

$$K=\left(\frac{2\pi r}{t}\right)^2\frac{M}{r}=\frac{4\pi^2}{t^2}\cdot Mr=\frac{4\pi^2}{gt^2}\cdot Gr.$$

If the number of revolutions in a minute be represented by u, we have

$$t=\frac{60''}{u}.$$

Again

$$\frac{2\pi}{t}$$

is the angular velocity *w;* therefore

$$K = w.^2 Mr.$$

Hence it follows that, the periods of revolution, and therefore the angular velocities, being equal, the centrifugal force must increase as the product of mass and semi-diameter of revolution, and that the centrifugal force,—*ceteris paribus*,—stands in inverse proportion to the squares of the periods of revolution or to the squares of the number of revolutions, and therefore in direct proportion to the squares of the angular velocities.

Without at present entering into the more extended calculations referring to the content of the two cones and showing that the revolution takes place around the axis *c d*, it may yet be seen what a new and important force is thus imparted to the action of the screws. This action proceeds in two special directions. Firstly, the water lying near the edge in each cone is flung with great violence against the water abaft the ship, and in such a manner as that, at a certain degree of velocity, one hollow cone composed of jets of water continually presses on the water abaft. In the mean time fresh water forces itself into hollow space of this cone of water flowing along the indentation shown in Fig. 3 at *b c*. This occurs with a rapidity increasing with the velocity of the ship. Secondly, the water in the two cones which has not yet reached to the edges acts there by its centrifugal force, in such a manner that the lateral pressure of the water, already much diminished by the curved exterior of the propeller, becomes still more reduced. The proposed form then, renders three advantages apparent. Firstly, the two cones Fig. 2 are so shaped that the parts of the upper one lying in the direction toward *a* and in the lower toward *f* (thus in both cones) in which direction the revolution for producing progression is effected, consist of curves of larger arcs, and therefore their content of water allows of a greater activity in reducing the lateral pressure. Secondly, the bending of the points *b*, *a*, *e*, *f* does not merely admit of a more rapid passage through the water, but it also imparts to the water flowing out in a spiral form, a less and more periphery-like boundary. Thirdly, the volution at *d*, *c* Fig. 3 not only offers an open canal from the outside for the entrance of the water flowing into the hollow cone, but the indentation presents a quiet passage for the water at this part of the cone, which is less affected by the rotation of the mass of water there.

This description, comparison and account of the advantages in question will be sufficient to give the new invention a right, as well to be received among the most important improvements in steam navigation (a subject which is now of such great importance), as to be regarded as a reform, especially in respect of the saving of time and fuel rendered possible by the introduction of the centrifugal force, considerations which become of daily increasing necessity, with the daily increasing magnitude of steam navigation.

Table I is completed by the addition of Fig. 5 for further elucidation. It represents the position of the screw seen partially from forward partially from aft.

Having now described the nature of my said invention and in what manner the same can or may be performed, I wish it to be distinctly understood, that I do claim as my invention,

The peculiar form and construction substantially as herein described of a propeller, whereby the centrifugal force obtained is made to coöperate with and increase the effect of the screw.

HERMANN HIRSCH.

Witnesses:
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C. LEHMANN.