

B. G. COOPER.  
 PROPELLER FOR OPERATING ON FLUIDS.  
 APPLICATION FILED JAN. 30, 1909.

977,068.

Patented Nov. 29, 1910.

2 SHEETS-SHEET 1.

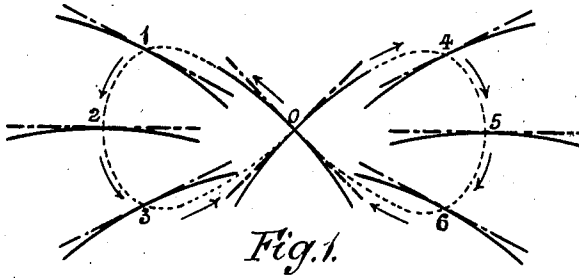


Fig. 1.

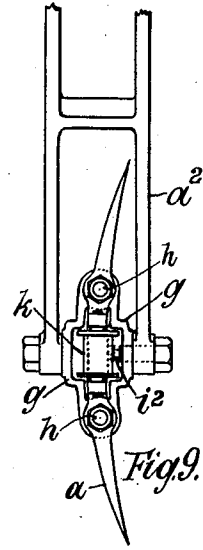


Fig. 9.

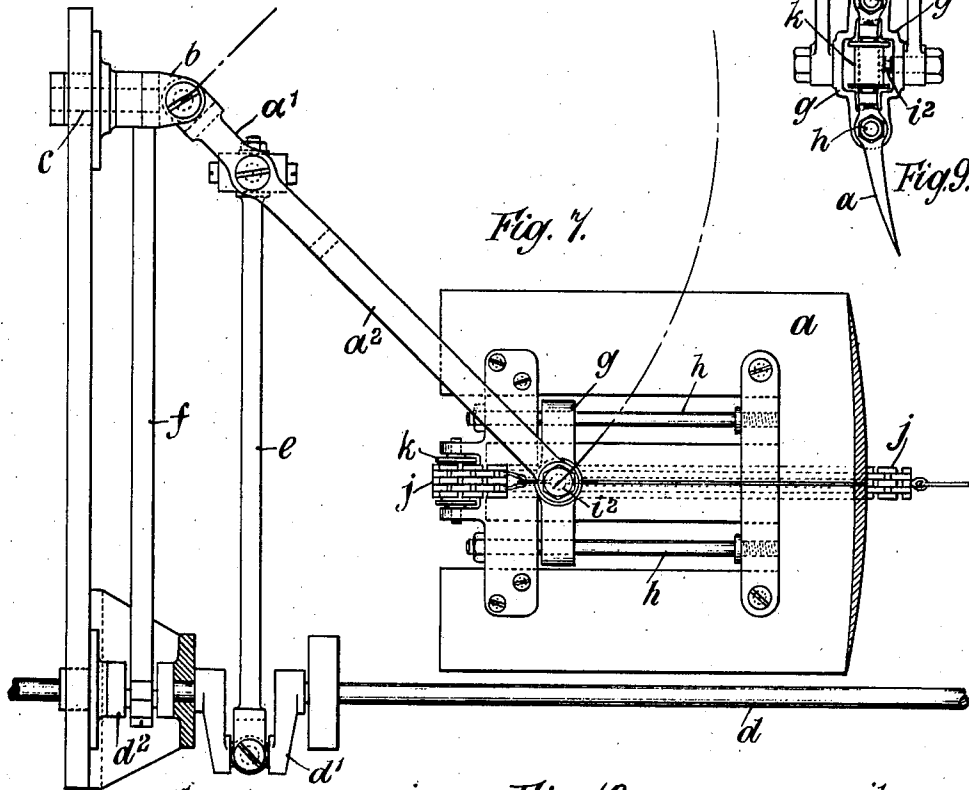


Fig. 7.

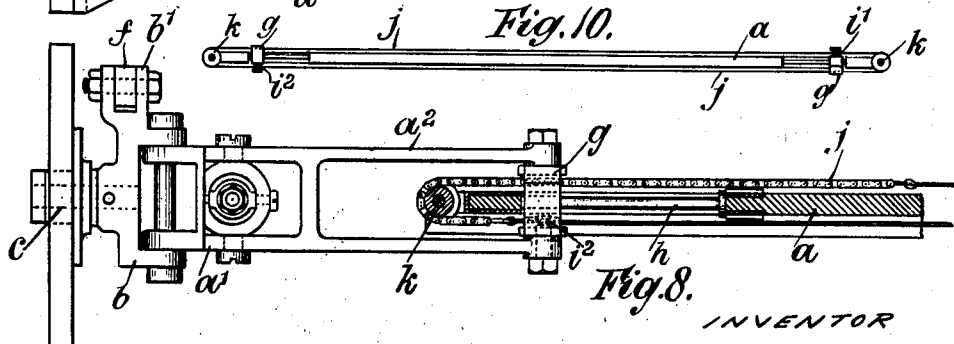


Fig. 10.

Fig. 8.

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2 SHEETS—SHEET 2.

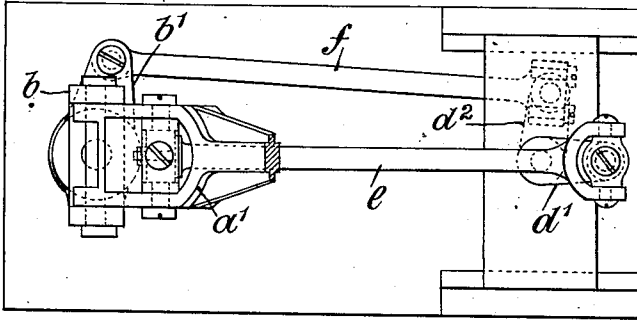


Fig. 3.

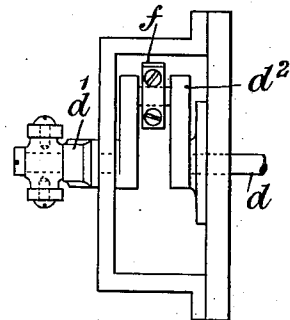


Fig. 4.

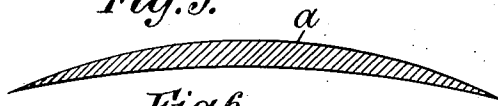


Fig. 6.

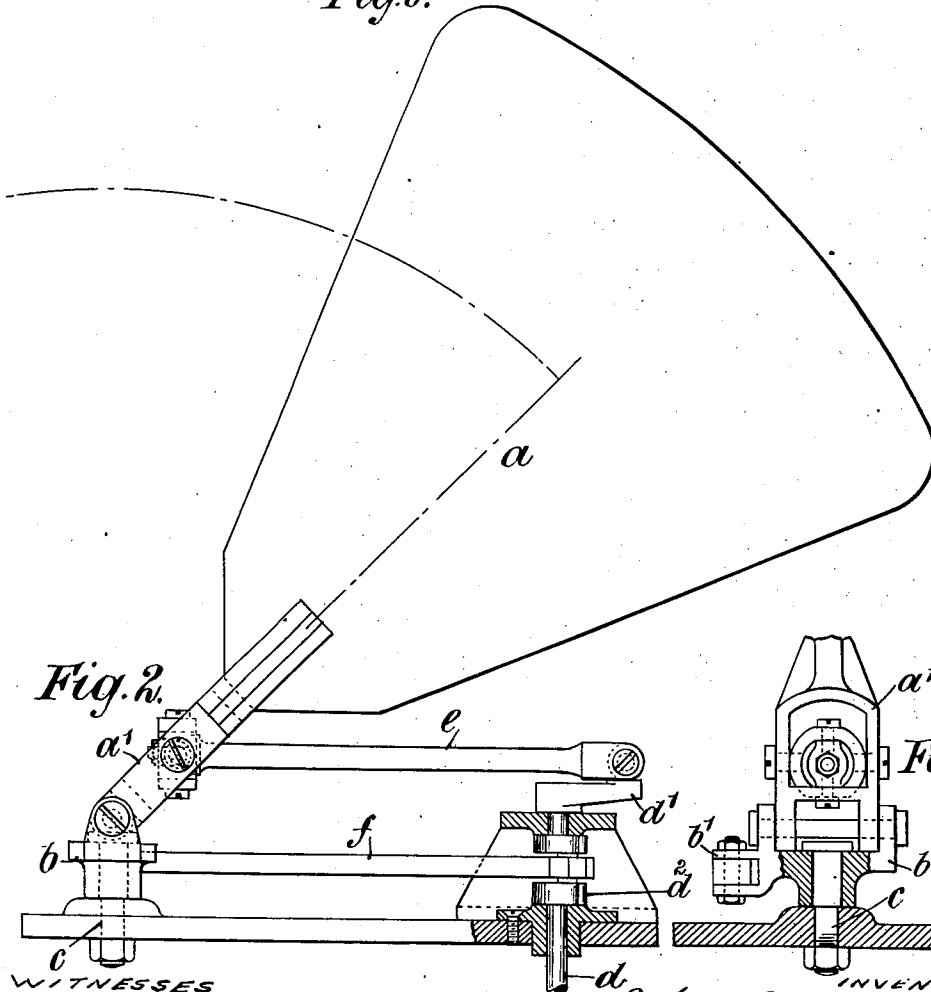


Fig. 2.

Fig. 5.

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# UNITED STATES PATENT OFFICE.

BERTRAM GEORGE COOPER, OF SURBITON, ENGLAND.

## PROPELLER FOR OPERATING ON FLUIDS.

977,068.

Specification of Letters Patent. Patented Nov. 29, 1910.

Application filed January 30, 1909. Serial No. 475,265.

*To all whom it may concern:*

Be it known that I, BERTRAM GEORGE COOPER, a subject of the King of Great Britain, residing at 30 Brighton road, Surbiton, in the county of Surrey, England, have invented an Improved Propeller for Operating on Fluids, of which the following is a specification.

This invention relates to a propeller which operates on fluids in an entirely novel manner for the purpose of obtaining a re-active propelling force therefrom or, alternatively, to effect a circulation of the fluid, which may be either liquid or gaseous, the chief purpose of the invention being the provision of a more effective propeller than those now available for aerostats or aerodromes.

The distinctive feature of the invention consists in the provision of means whereby a propeller blade is caused to move relatively to a carrier thereof in a figure of 8 orbit during two forward portions of which its operative surface is situated more or less exactly normal to the direction of motion, each of such movements being alternated by an obliquely directed backward movement along a crossing branch of the figure of 8 orbit, during which backward movement the blade is so inclined relatively to the direction of motion that a re-active force is exerted on the same operative surface of the blade, which force has a component in the same direction as that derived from the forward movement of the blade during which it is presented normally to the direction of motion.

The principle of action of the propeller will be explained more specifically by reference to the accompanying drawings which comprise two examples of mechanism adapted to constrain the movement of a propeller blade in a manner to cause it to perform the above described function.

In these drawings:—Figure 1 is a diagram showing a plane projection of a representative form of a figure of 8 orbit which is traversed by the center of area of the operative surface of a propeller blade which is actuated in accordance with the present invention. Fig. 2 is an elevation of one form of construction of mechanism as viewed in the direction of the required propelling force, the figure of 8 path of the center of area of the operative surface of the blade lying on the surface of a sphere with the long dimensions of the figure horizontal,

the dash-dot curve on Fig. 2 showing the projection of a portion of the orbit on a vertical plane. Fig. 3 is a plan view of the mechanism, the blade being broken off near the root to avoid obscuring the mechanism. Fig. 4 is an elevation viewed from right to left. Fig. 5 is an elevation viewed from left to right with the blade inclined as in Fig. 2. Fig. 6 shows a section of the blade. Figs. 7-10 show how two mechanisms, like that shown in Figs. 2-6, may be employed to actuate a single blade, one such mechanism and one end of the blade only being shown. Fig. 7 being an elevation, as viewed in the direction of the propelling force. Fig. 8 is a plan. Fig. 9 is an end elevation of the blade, and:—Fig. 10 is a diagram showing the connection of the two blade carriers.

Referring first to Fig. 1. At salient points numbered 0 to 6 in the dotted figure of 8 are shown, in dash-dot lines, the respective positions of the center line of a section of a plane blade and in full lines the center lines of a section of a curved blade, the blade being caused to move in the direction of the arrows for forward propulsion. From this figure it will be seen that during the portions of the orbit between the points 1 and 3, and also between the points 4 and 6, the blade surface will be presented nearly broadside to the direction of motion so that a direct thrust will be exerted on the fluid almost exactly in the line of the propelling force whereby, for the area of the blade employed, a maximum propelling force will be created. Also inasmuch as the path of direct thrust from 4 to 6 is laterally at a considerable distance out of the line of that of the path 1 to 3, the disturbance of the fluid effected by one of those efforts will not effect any appreciable disturbing movement of the fluid which will subsequently be operated on in the succeeding direct thrust thus a relatively large volume of fluid being within reach of the blade there is a second cause whereby a given area of blade will be able to create a maximum propelling force. In the crossing movements from 3 to 4 and 6 to 1 the operative surface of the blade will be so presented, relatively to the direction of motion, that the oblique impact of the fluid on the blade surface will create a reactive force on the blade which has a component in the same direction as that derived from the direct thrust so that throughout the entire orbit the blade will be actively engaged in creating a propelling

force. With respect to the consideration of the ratio of the propelling force to the power expended in its creation, it may be observed that, for the reason above explained, the stream of fluid set in motion has, relatively to the operative area of the blade, a considerable transverse section, on which account it will be feasible to get a sufficient propulsive thrust-creating momentum in the stream without requiring it to possess an unduly large amount of kinetic energy, this being the major condition on which the efficiency of the operation will depend.

Referring to Figs. 2-5 a blade  $a$  secured to or formed in one with a forked shank  $a^1$  is mounted in a fork  $b$  in a manner to enable it to vibrate about a horizontal axis, which axis is adapted to be angularly displaced in a horizontal plane by the mounting of the fork  $b$  on a pivot  $c$  which has a vertical axis. The blade is actuated by a motor-rotated shaft  $d$  provided with two cranks  $d^1$  and  $d^2$  approximately at right-angles to each other. The crank  $d^1$  serves to periodically swing the blade about the horizontal pivot of the fork  $b$  through the medium of a connecting-rod  $e$  which is universally jointed at one end to the pin of the crank  $d^1$  and at the other end is universally jointed to the forked shank  $a^1$  of the blade  $a$ , the crank  $d^2$  serving to periodically swing the fork  $b$  about its vertical pivot through the medium of a connecting-rod  $f$  which is articulated to the crank-pin of  $d^2$  at one end and at the other end is articulated to a lever-arm  $b^1$  whose radial length is greater than that of the crank  $d^2$ . In the following claims, what is there denoted the "first pivot" is the pivot  $c$ ,  $b^1$  being what is called the "blade-inclining lever" and  $a^1$  the "blade-carrying lever," the said two levers being connected by the so-called "second pivot." It will be readily seen that, by such a mechanism the center of area of the blade will be constrained to move in a figure of 8 orbit as before described, making for each revolution of the motor driven shaft  $d$  a single to-and-fro swing in the direction of the length of the figure of 8 and a double to-and-fro swing in a direction at right-angles thereto. It is obvious that the same orbital motion of the center of area of the blade would be derived if, alternatively to connecting the pin of a crank  $d^1$  to the shank of the blade at a point between the center of area of the blade and the horizontal pivot carried by the fork  $b$  as shown, the shank  $a^1$  were extended beyond the pivot carried by the fork  $b$  and the connection were similarly made between a point on the extension and a crank on the shaft correspondingly altered in position.

Fig. 6 shows a form of section of blade suitable for a propeller which is chiefly employed in creating a propulsive force in one

direction. With such a blade, although a reversed propulsive force will be available it will be less effective than the forward acting force.

Figs. 7-10 show how a pair of mechanisms, constructed as above described, may be employed to actuate a single blade and cause its center of area to move in a plane orbit of the figure of 8.

In these figures corresponding parts to those in the above described figures are similarly lettered.

In this form of the construction the blade  $a$  is not rigidly secured to the forked-shank  $a^1$ , but the forked-shank is prolonged to a length equal to the radial distance of the center of area of the blade from the axis of the horizontal pivot carried by  $b$  and to the free extremity of the forked-lever  $a^2$  thus formed, a carrier  $g$  is articulated the carrier being so mounted on the blade  $a$ , near one end thereof, as to be adapted to slide to-and-fro in the direction of the length of the blade. A like mechanism is employed to support the other end of the blade, this second mechanism being omitted from the drawing, and the same motor-driven shaft  $d$  is employed to actuate both mechanisms.

The arrangement of the mechanism is such that the axis of the blade is horizontal and every point of the axis performs a figure of 8 orbit in a vertical plane at right-angles to the axis of the blade.

The sliding movement between the carrier  $g$  and the end of the blade on which it is mounted is required to be sufficient to compensate for the varying distance from a vertical line of the extremity of the lever-arm  $a^2$  which travels in a circular arc. A convenient construction whereby the required sliding motion can be provided is shown as comprising a pair of parallel bars  $h$  secured to the blade  $a$ , on which bars the carrier  $g$  is slidably mounted. To insure an equal amount of sliding of the carriers relatively to both ends of the blade a flexible connection is made between one of the carriers at  $i^1$  (Fig. 10), on the concave side of the blade and the other carrier at  $i^2$  on the convex side of the blade, the flexible connection being continuous and consisting in parts of chains  $j$  which are led around pulleys  $k$  mounted at the ends of the blade.

I claim.

1. A propeller for operating on fluids, comprising a blade, a carrier thereof and mechanism for effecting a cycle of operations on the blade by causing it to move forward and alternately recede, relatively to the carrier, in such a manner as to impart to the fluid a motion the resultant re-active force of which, due to the receding motion, is in the same direction as the resultant re-active force due to the forward motion.

2. A propeller for operating on fluids,

comprising a blade, a carrier thereof and mechanism for causing the blade to perform a figure of 8 orbit relatively to the carrier and, throughout the entire orbit, exert a propelling force in a direction which is at right angles to the height of the figure of 8 and in the average plane of the orbit.

3. A propeller for operating on fluids, comprising a blade, a carrier thereof and mechanism for causing the blade to perform a figure of 8 orbit relatively to the carrier, the average plane of the blade during the portions of the orbit which cross one another deviating only a little from the line of motion of the blade and being, at the extremities of the orbit, approximately normal to the line of motion.

4. A mechanism for actuating the blade of a propeller in a figure of 8 orbit comprising a carrier, one element of a first pivot secured to the carrier, a second pivot whose axis is at right angles to that of the first, a blade-inclining lever formed with an element of each of the two said pivots, a blade-carrying lever formed with the other element of the second pivot and means for imparting to the blade-inclining lever a single to-and-fro swing about the first pivot while to the blade-carrying lever is imparted, during the same period, a single to-and-fro swing about the second pivot.

5. A mechanism for actuating the blade of a propeller in a figure of 8 orbit, comprising a carrier, one element of a first pivot secured to the carrier, a second pivot whose axis is at right angles to that of the first, a blade-inclining lever formed with an element of each of the two said pivots, a blade-

carrying lever formed with the other element of the second pivot and a motor-actuated crank-shaft for imparting to the blade-inclining lever a single to-and-fro swing about the first pivot while to the blade-carrying lever is imparted, during the same period, a single to-and-fro swing about the second pivot.

6. A mechanism for actuating the blade of a propeller in a figure of 8 orbit, comprising a carrier, one element of a first pivot secured to the carrier, a second pivot whose axis is at right angles to that of the first, a blade-inclining lever formed with an element of each of the two said pivots, a blade-carrying lever formed with the other element of the second pivot and a motor-actuated crank-shaft formed with two cranks approximately at right angles to one another, for imparting to the blade-inclining lever a single to-and-fro swing about the first pivot while to the blade-carrying lever is imparted, during the same period, a single to-and-fro swing about the second pivot.

7. In combination with a propeller blade, of means for actuating each of the two ends of the propeller blade so as to constrain each point of its axis to move in a figure of 8 orbit in a plane at right angles to the axis of the blade.

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

BERTRAM GEORGE COOPER.

Witnesses:

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R. F. WILLIAMS.