No. 697,403. Patented Apr. 8, 1902.

C. GROOMBRIDGE.

PROPELLER FOR AIR SHIPS.

(Application filed Feb. 12, 1901.)

(No Model.) 3 Sheets—Sheet 1.

Fig. 1.

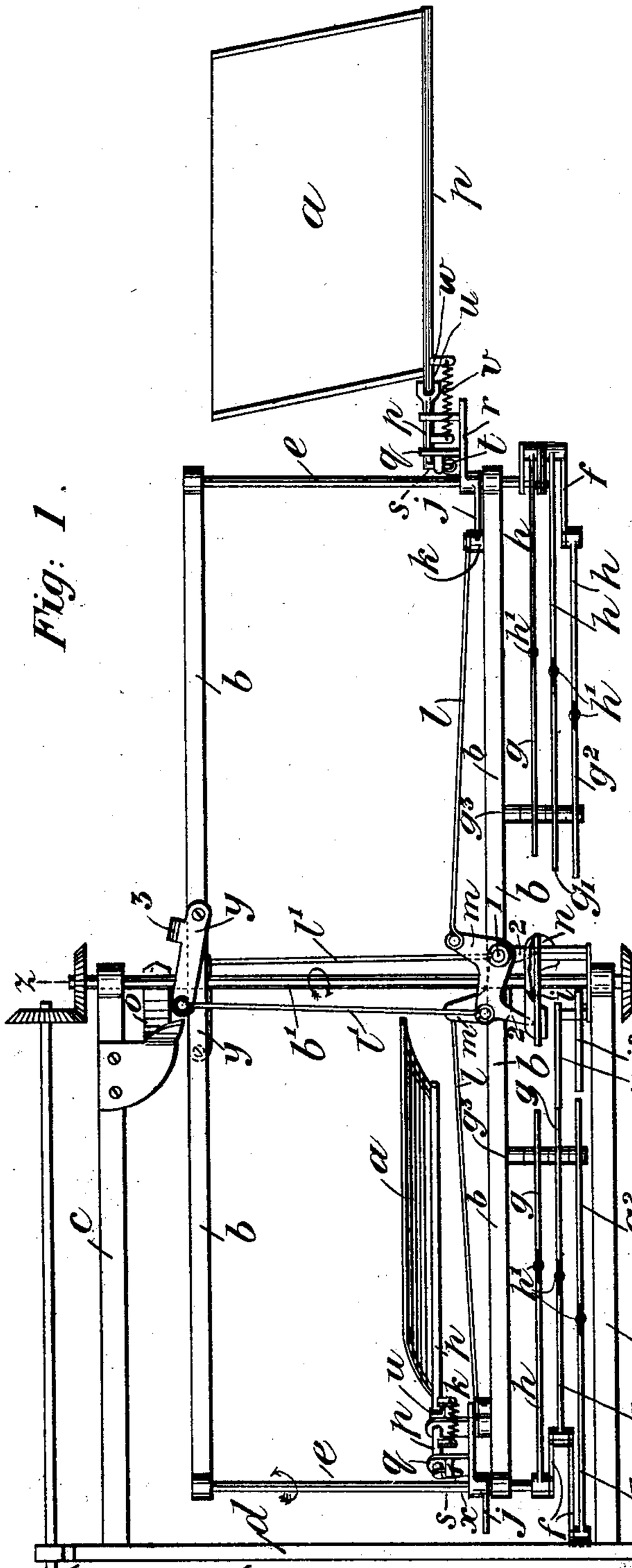
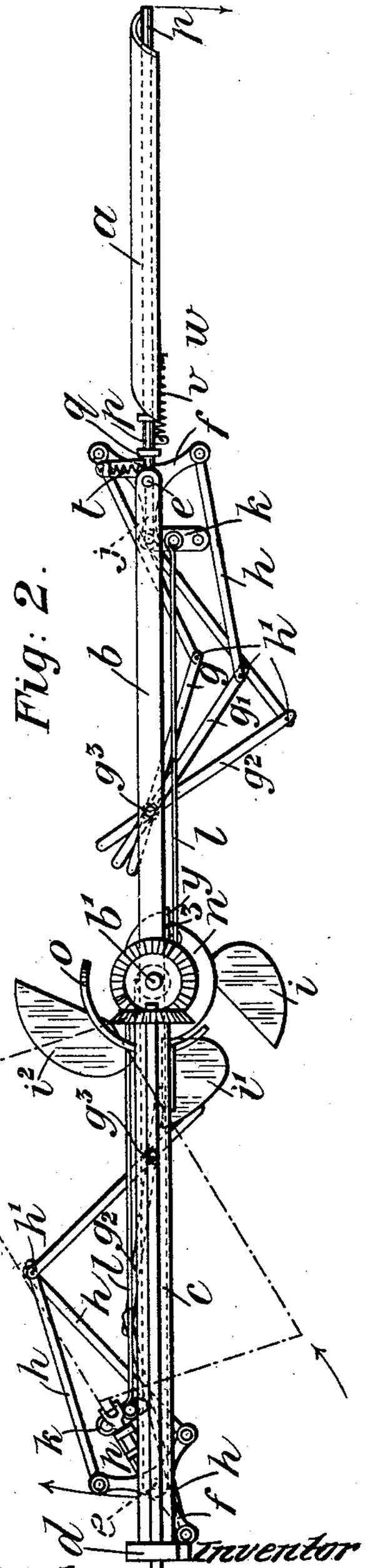


Fig. 2.



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(No Model.) 3 Sheets—Sheet 2.

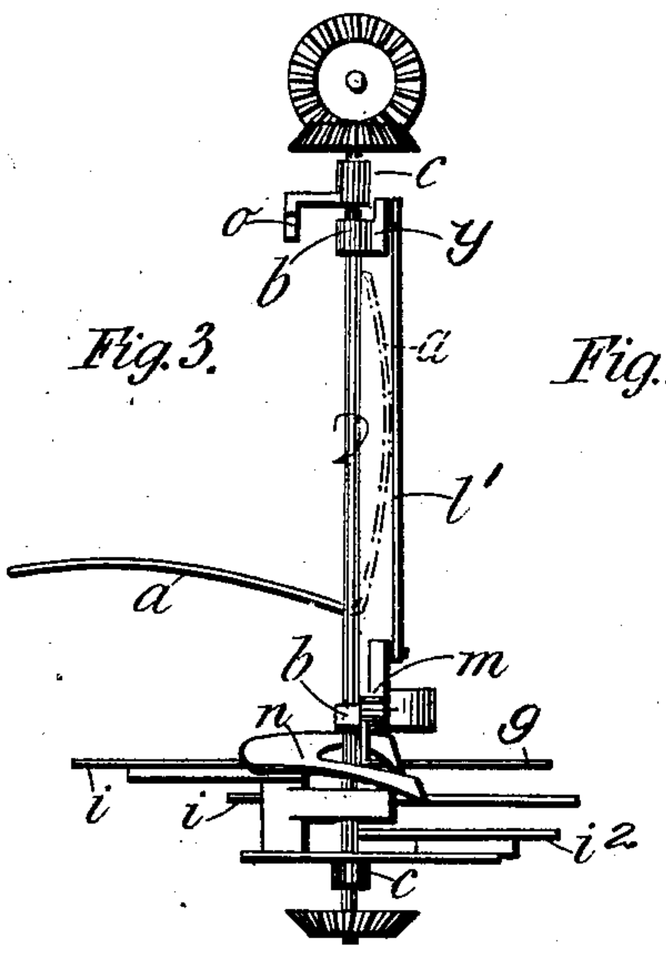

Fig. 3.

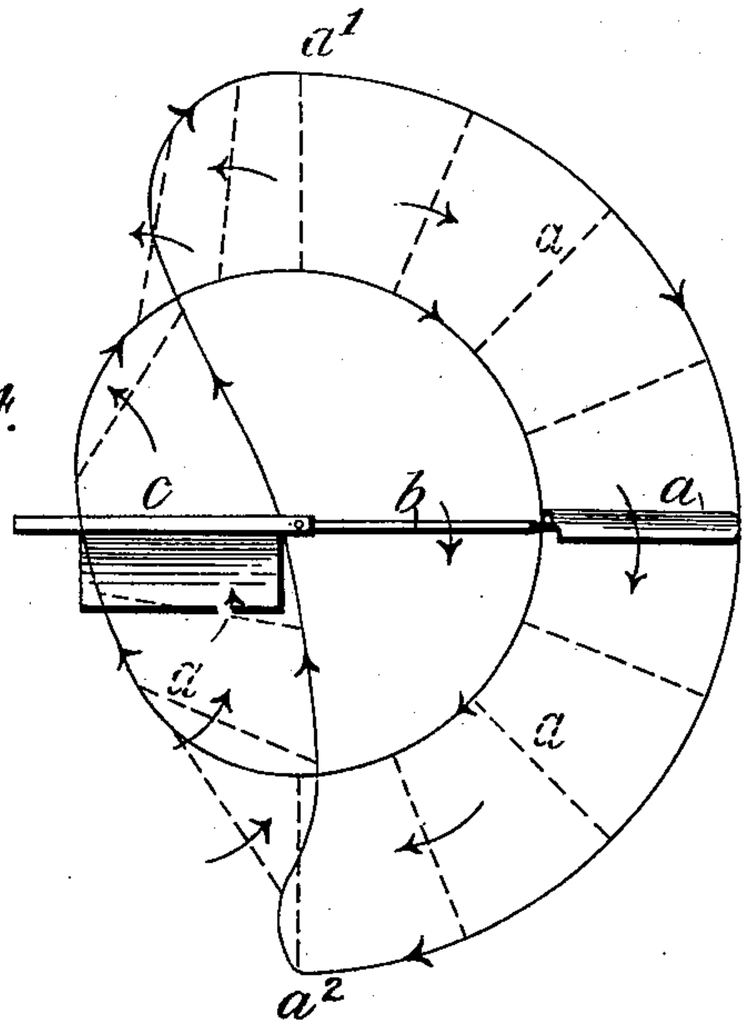

Fig. 4.

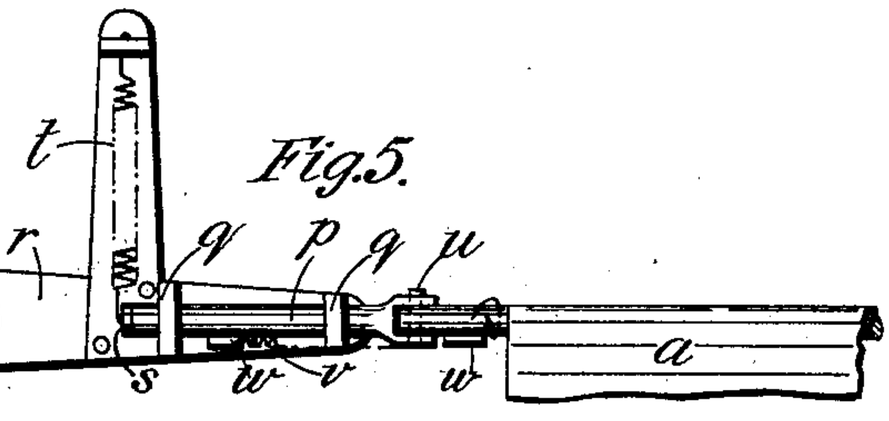

Fig. 5.

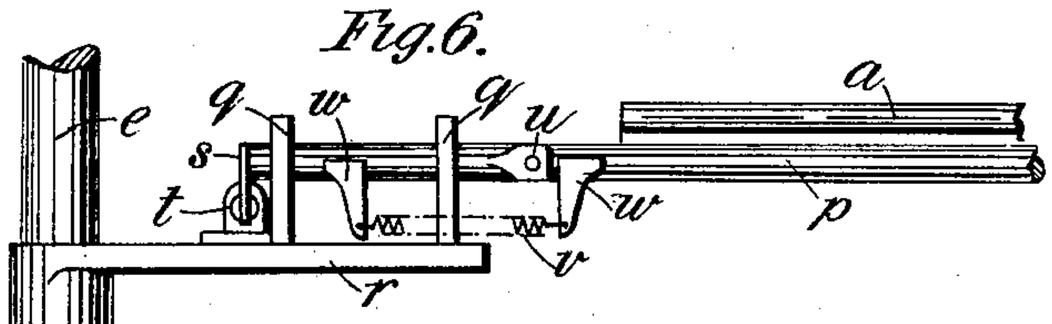

Fig. 6.

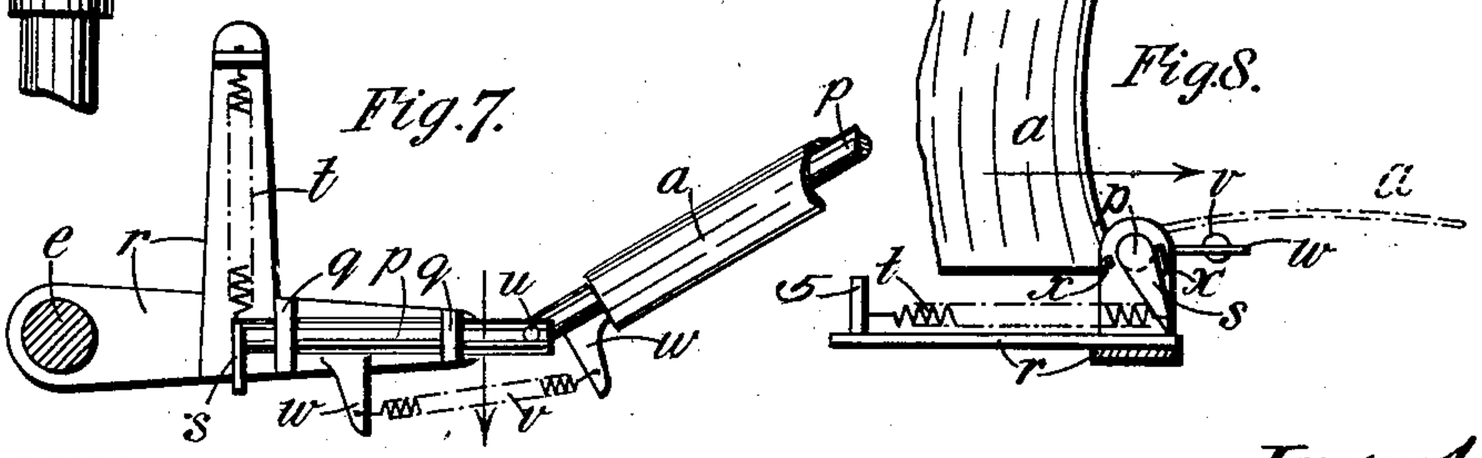

Fig. 7.

Fig. 8.

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(No Model.) 3 Sheets—Sheet 3.

Fig. 9.

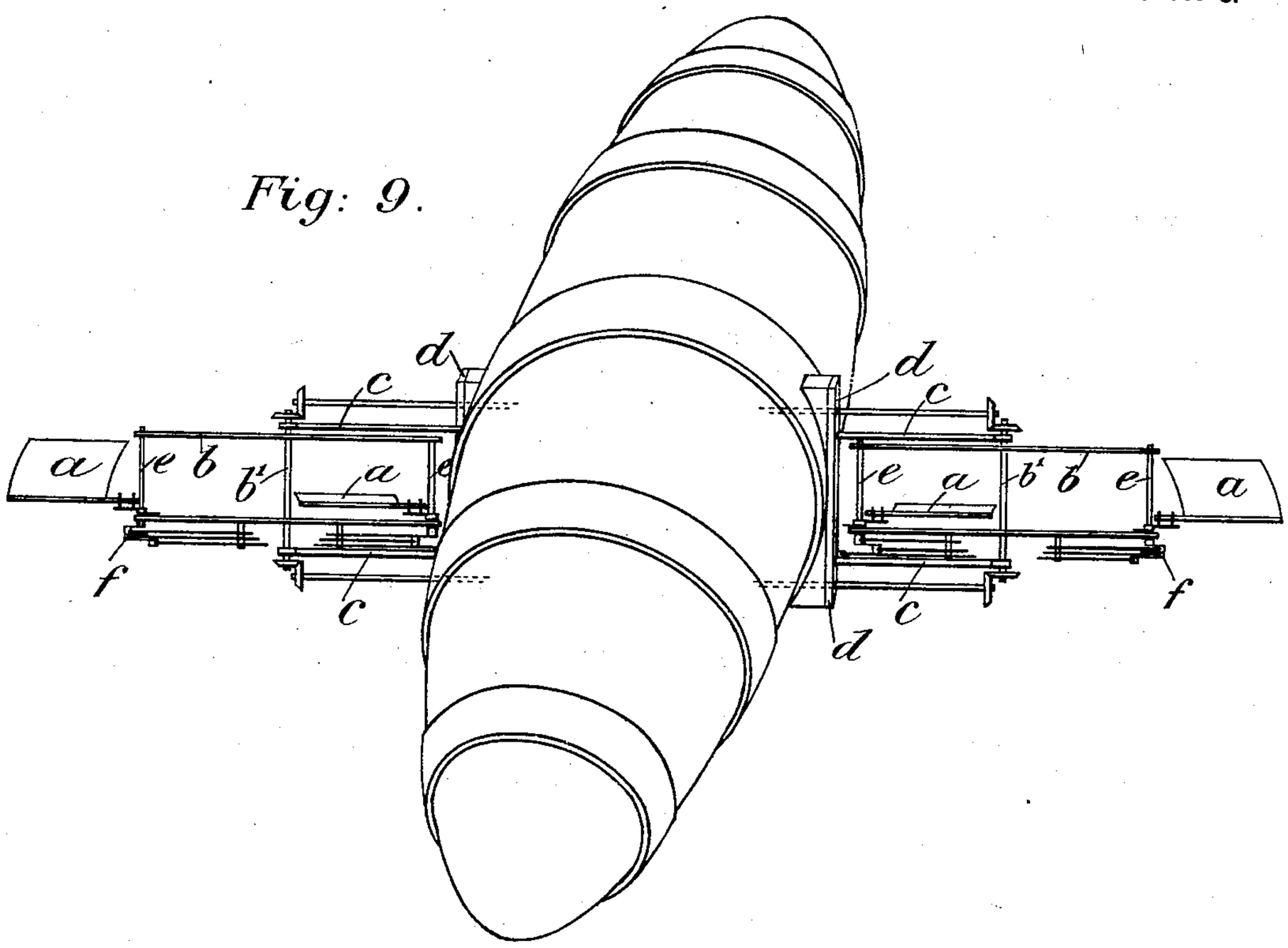


Fig. 10.

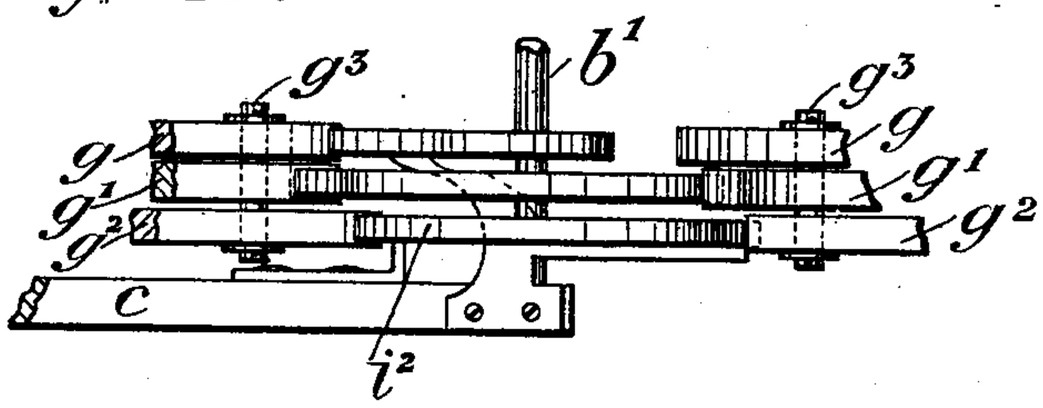
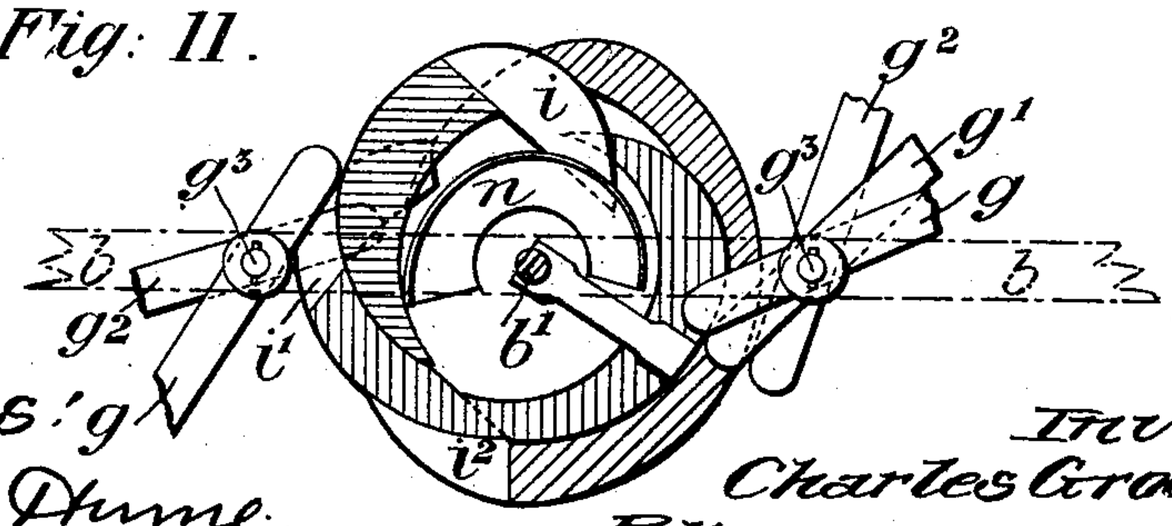


Fig. 11.



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UNITED STATES PATENT OFFICE.

CHARLES GROOMBRIDGE, OF LONDON, ENGLAND, ASSIGNOR OF ONE-HALF TO WILLIAM ALFRED SOUTH, OF LONDON, ENGLAND.

PROPELLER FOR AIR-SHIPS.

SPECIFICATION forming part of Letters Patent No. 697,403, dated April 8, 1902.

Application filed February 12, 1901. Serial No. 47,034. (No model.)

To all whom it may concern:

Be it known that I, CHARLES GROOMBRIDGE, a subject of the King of Great Britain and Ireland, residing at London, in the county of Middlesex, England, have invented a new and useful Propeller for Flying-Machines, Air-Ships, Balloons, and the Like, of which the following is a specification.

This improved propeller for flying-machines, air-ships, balloons, and the like is designed to exert a greater propulsive force for a given motive power than those hitherto proposed, which only disturb the air and cause it to rebound from the vanes.

According to my invention the vanes are so arranged as to rebound from the air, and thus aid the effective propulsion of the flying-machine or the like. Said propeller (while being driven by mechanical means) is, moreover, designed to cause the alternate adjustment of its vanes into their effective and feathering positions to be effected automatically by the pressure of the air upon said vanes instead of by means of mechanism, as has heretofore been the case.

For the purpose of the invention the vane, which pivots about a vertical axis at the end of a revolving frame, is adapted to swing out and travel in a wide radius during approximately one half-revolution when propelling and to turn inward or backward and travel in a lesser radius in the remaining portion of the revolution—that is, when feathering or out of action. Said vane is further arranged in such a manner that during its propelling stroke it is vertical; but on completing such stroke it is in its backward revolution caused to rotate in the reverse direction and by the pressure of the air upon it to lie down in a nearly-feathering or nearly-horizontal position and then to gradually rise again until it is about to commence the next propelling stroke, when it has then become restored to its effective or vertical position also by the pressure of the air. The vane is carried by a bar which is provided with means to render it resilient and enable it to yield, so causing the vane to come into action gradually without loss of power and without sudden shock.

The invention will be readily understood by reference to the accompanying drawings, in which—

Figure 1 is a side view, and Fig. 2 a plan, showing the general arrangement of the improved propeller. Fig. 3 is an end view of the left-hand portion thereof on the line *z z* of Fig. 1. Fig. 4 is a diagram showing the form of the path which the vane describes and the different positions it takes up at each one-sixteenth of a revolution. Figs. 5 to 8 are detail views of the jointing arrangement of the vane bar or holder. Fig. 9 is a perspective view of an air-ship, showing one arrangement of the propellers (one on each side) constructed according to my invention. Fig. 10 shows in elevation, and Fig. 11 in plan, a modified construction of the cams which may be made use of with this propeller.

For convenience of description, as each vane and its connections are identical, only one set will be described, although two are shown in the drawings.

Referring mainly to Figs. 1 and 2, the vane *a* is carried by a revolving frame *b*, which is fast on an axle *b'*, driven, as shown, by bevel or other gear from the motor of the flying-machine. This frame is supported in turn in a stationary frame *c*, secured to a convenient portion *d* of the flying-machine and suitably stayed. The vane *a* is held in a bar *p*, which is mounted in a bearing-bracket *r*, fixed on a vertical axle *e*, which is rotatably mounted in the end of the frame *b*. This axle *e* has at one end a three-throw crank *f*, coupled by connecting-rods *h* to three corresponding levers $g\ g'\ g^2$, articulated at *h'* to the rods *h* and pivoted at g^3 to the frame *b*, said rods and levers being arranged at different levels, as shown.

$i\ i'\ i^2$ are cams supported upon the stationary frame *c*. These cams are of such shape and fixed in such positions as to be wiped in succession by the free ends of the levers $g\ g'\ g^2$ (*g* wiping cam *i*, *g'* wiping cam *i'*, and g^2 wiping cam i^2) during the rotation of the frame *b*, and they are, further, so set as to commence to operate the said levers just after the cranks *f* have passed their dead-centers. These cams $i\ i'\ i^2$, acting in conjunction with the levers $g\ g'\ g^2$, serve to impart to the vane

a pivoting motion about the axle *e*, to some extent independent of that of the frame *b* and in the reverse direction, thus turning the vane inward or backward on the completion of its propelling stroke and restoring it to its outward position, ready for the next stroke, as hereinafter more fully explained.

The vane-bar is held rigid when in its extended position by means of a catch *j*, fast on the axle *e*, which catch engages a stop *k*, pivoted to the frame *b*, throughout the propelling stroke, and so locks the vane-axle *e*. This stop *k* is alternately thrown in the path of the catch *j* just prior to the commencement of a stroke and withdrawn therefrom at the completion of the same by means of a bell-crank *m*, pivoted at 1 to the frame *b* and connected by a rod *l* with the stop *k*, said bell-crank having a projection or finger 2, which rides on a stationary inclined track *n*, adapted to turn the bell-crank on its pivot and so cause, through the intervention of the rod *l*, the desired movements of the stop. The bell-crank is also connected by a rod *l'* with a pivoted arm *y*, which bears against or brushes, by means of the beveled projection 3, a semicircular horizontal track *o*, fixed to the frame *c* and adapted to keep the arm *y* down horizontal during the feathering stroke, and consequently through the intervention of the rod *l'* and bell-crank *m* hold the stop *k* out of the path of the catch *j*.

In order to permit of the rising and falling movements of the vane during propelling and feathering, respectively, and also to permit it to yield (be pressed backward) to a certain extent under the pressure of the air in front of it during the propelling stroke, I employ the devices shown on an enlarged scale in Figs. 5 to 8, to which reference will now be made.

The vane is mounted on a bar *p*, which is carried in bearings *q* on a bracket *r*, fast on the vane-axle *e*. This bar has at its rear end a crank-arm *s*, controlled by a tension-spring *t*, whose sole object is to prevent the vane being brought into the vertical position with too sudden a jerk or jar. One end of the spring is connected to the arm *s* and the other to a fixed projection 5 on the bracket *r*. Thus it tends to hold the vane in its feathering position, and consequently resists the turning of said bar in the opposite direction. Projecting from one of the bearings *q* are two stops *x*, which serve to limit to the vertical and feathering positions the turning movement of the vane-bar *p* in its bearings, and therefore that of the vane, these movements being eased by the spring *t*. The said bar *p* is formed in two parts hinged together at *u*, which are normally kept in alinement by a tension-spring *v*, connected to two lugs *w*, one on each part of the bar, thus permitting the bar to yield to a certain extent in a backward direction (see Fig. 7) when the vane is vertical. As long as the vane is at rest the spring *t* keeps the bar *p* turned, so that the vane is in the feathering position, and the spring *v* keeps the two parts of the bar in alinement.

The action of the propeller is as follows: At the commencement of a stroke the vanes are in the position indicated by *a' a²*, Fig. 4, the vane which is about to do the propelling being at, say, *a'* and the other at *a²*. In these positions the vane-bar of the one about to propel rests at a slight angle to the frame *b*, while the vane-bar of the other vane rests in true alinement with the said frame. The action of the propelling-vane only will be now followed, it being understood that the other one at each stage will be in diametrically opposite phase. On rotary motion being imparted to the frame *b* the vane *a* assumes the vertical position, turning in the bearings *q* against the action of the spring *t* under the pressure of the air in front of it. The vane is arrested at the vertical position by the crank-arm *s* coming against one of the stops *x* on the bracket *r*, and simultaneously the stop *k* is brought into the path of the catch *j* and locks the vane-axle, thus holding the bracket *r*, and consequently the part of the vane-bar within it, rigid. While being thus carried around with a positive drive the vane can, nevertheless, yield under the pressure of the air in a backward direction to a certain extent by turning on the joint at *u*, and thus enabling the vane to rebound from the air, as desired. When the vane reaches the position *a²*, Fig. 4, the stop *k* is pulled out of the path of the catch *j* by reason of the finger 2 having arrived at the bottom of the inclined track *n*. The lever *g* now commences to wipe the cam *i*, thereby causing, through the intervention of its connecting-rod *h* and crank *f*, the axle *e*, together with the vane-bar and vane, to rotate in a backward direction to that of the travel of the frame *b*. The cams *i* and *i²* are then wiped in succession by the levers *g'* and *g²*, respectively, each carrying the vane farther around. Lever *g*, acting on cam *i*, carries the vane-bar out of alinement with the frame *b* to an angle of about thirty degrees with the axle *e*. The lever *g'*, acting on cam *i'*, carries the bar thence through the frame *b* to a similar position on the opposite side, and lever *g²*, acting on cam *i²*, carries the bar thence back to its initial position. During the wiping of the cams by the levers the bevel projection 3 on the pivoted arm *y* brushes the under side of the horizontal track *o* and so keeps the stop *k* of the feathering-vane withdrawn from the path of the catch *j*, while at the same time the other stop is being gradually replaced by reason of the finger 2 on the other bell-crank rising up the incline *n*, which is permitted owing to the bevel projection 3 of the corresponding arm *y* being free of the track *o*, and consequently allowing the arm to rise. This cycle of actions is repeated during the driving of the

frame *b*. Simultaneously with the turning in the backward direction of the vane-axle *e* and bar *p* the vane becomes depressed by the pressure of the air into the feathering or nearly-horizontal position, as seen to the left of Figs. 1 and 2 and in Fig. 3, so that it presents a minimum of resistance to the air until it has passed through the frame *b*, when it again commences to rise, and while being carried around is gradually raised by the pressure of the air into the vertical position, which, as above stated, it assumes when it has arrived at the extended position in alinement with the frame *b*. Thus during the feathering stroke the vane-axle *e* continues to move in a practically circular path, whereas the free end of the vane follows the inner or wave-like line, owing to its independent movement, which causes it to swing through the frame *b* and then to gradually assume its extended position.

The degree of ease with which the vane-bar *e* may be turned in its bearings *q* against the action of the spring *t* and also on the joint at *u* against the action of the spring *v* may be regulated either by suitably proportioning the said springs for a given rate of speed to be imparted to the revolving frame *b* or by adjusting the tension of these springs according to the speed at the moment. This latter may be effected automatically by any suitable arrangement connected with the speed-governor of the driving-motor, so that the tension shall be greatest when the speed is highest.

Instead of employing the catch *j* and pivoted stop *k* to keep the vane-bar extended in the manner above described this might be effected by means of the levers $g\ g'\ g^2$ if the cams $i\ i'\ i^2$ were so extended that one or other of the said levers would always be resting against some portion of them and so be prevented from turning on their pivots during the propelling stroke. Such an arrangement is shown in Figs. 10 and 11, wherein $i\ i'\ i^2$ are the cams, and the shaded portions are the extensions thereof. It should be mentioned that the arrangement here shown is designed for the frame to rotate in the reverse direction, and hence the cams and levers are in the reverse direction to those seen in Figs. 1 and 2; but otherwise the construction and position of the parts are the same.

Although the propeller shown in Figs. 1 and 2 has a pair of vanes, one of which is always propelling when the other is feathering, yet in some cases the propeller might have only one vane, or two or more vanes might be superposed on the same vertical axle.

It will be readily seen and understood on reference to Fig. 9 that one or more of the propellers is placed on each side of the flying-machine.

Although I have described and shown the propeller as arranged horizontally, yet it is obvious that it can be arranged vertically.

Having now described my invention, what I claim is—

1. In a propeller for flying-machines, airships, balloons, and the like, having a revolving vane-carrying frame and a vane-axle pivoting therein, the combination of a vane carried by a radius-bar fast on said axle, and which bar is constructed in two parts flexibly united in such a manner as to permit of the vane being turned into the propelling and feathering positions automatically by the pressure of the air.

2. In a propeller for flying-machines, airships, balloons, and the like, the combination of a revolving vane-carrying frame having a vane-axle pivoting therein, a vane carried by a radius-bar fast on said axle, the said bar constructed in two parts flexibly united in such manner as to permit of the vane being turned into the propelling and feathering positions automatically by the pressure of the air, and means for automatically rotating the vane backward at a certain point in its revolution.

3. In a propeller for flying-machines, airships, balloons, and the like, the combination of a rotating vane-carrying frame having a vane-axle pivoting therein and a vane carried by a flexible radius-bar fast on said axle, with a three-throw crank fast on the vane-axle, a series of jointed levers connected at one end to said crank, and pivoted to the frame near their other end, and stationary cams adapted to operate said levers for the purpose of turning the vane backward, during feathering.

4. In a propeller for flying-machines, airships, balloons, and the like, the combination with a vane of the vane-carrying radius-bar formed in two parts flexibly united in alinement and rotatably mounted in bearings upon a support fast on the vane-axle, and means adapted to offer resistance to the turning of said bar in its bearings, thereby permitting the vane to rise and fall and to yield under the pressure of the air during the propelling and feathering strokes respectively.

5. In a propeller for flying-machines, airships, balloons, and the like, the combination with a vane of the vane-carrying radius-bar (formed in two parts hinged together in alinement), a lug on each part and a tension-spring coupling the lugs, said bar being rotatably mounted in bearings upon a support fast on the vane-axle and having a cranked arm at the rear end connected by a tension-spring to a fixed support, and which spring is adapted to offer resistance to the turning of the bar on its own axis.

6. In a propeller for flying-machines, airships, balloons, and the like, the combination of the revolving frame, the vane-axle pivoting therein, the vane carried by a radius-bar fast on said axle, and means for automatically turning the vane inward at the commencement of feathering, with a catch fast on the vane-axle, a stop on the revolving

frame adapted to engage said catch and lock the vane-axle during the propelling stroke, and means for automatically engaging and releasing said stop from said catch.

7. The combination with the revolving vane-carrying frame, of levers and rods connecting the vane-axle crank with an inclined plane fast on the axle of the revolving frame, to effect the engagement and disengagement of the catch and stop for locking and releasing the vane.

8. A propeller for flying-machines, airships, balloons, and the like, comprising a revolving frame, a vane carried by a radius-bar adapted to permit the vane to be turned into the propelling and feathering positions automatically by the pressure of the air, means for rotating the vane backwardly at the commencement of feathering, means for automatically locking and releasing the vane-axle to hold and set free the vane, and means for driving the whole vane-carrying frame around, whereby the vane is caused to fly out and travel in a wide radius during the propelling stroke, and to turn backward and travel in a lesser radius during feathering.

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

CHARLES GROOMBRIDGE.

Witnesses:
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W. M. HARRIS.