Feb. 28, 1939. R. M. STEPHENS 2,148,843

AUTOMATIC VARIABLE PITCH PROPELLER

Filed Dec. 20, 1935 3 Sheets-Sheet 1

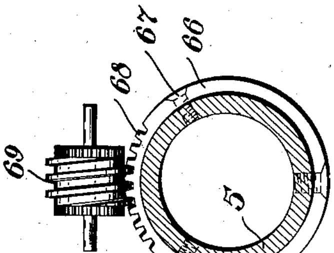

FIG. 4.

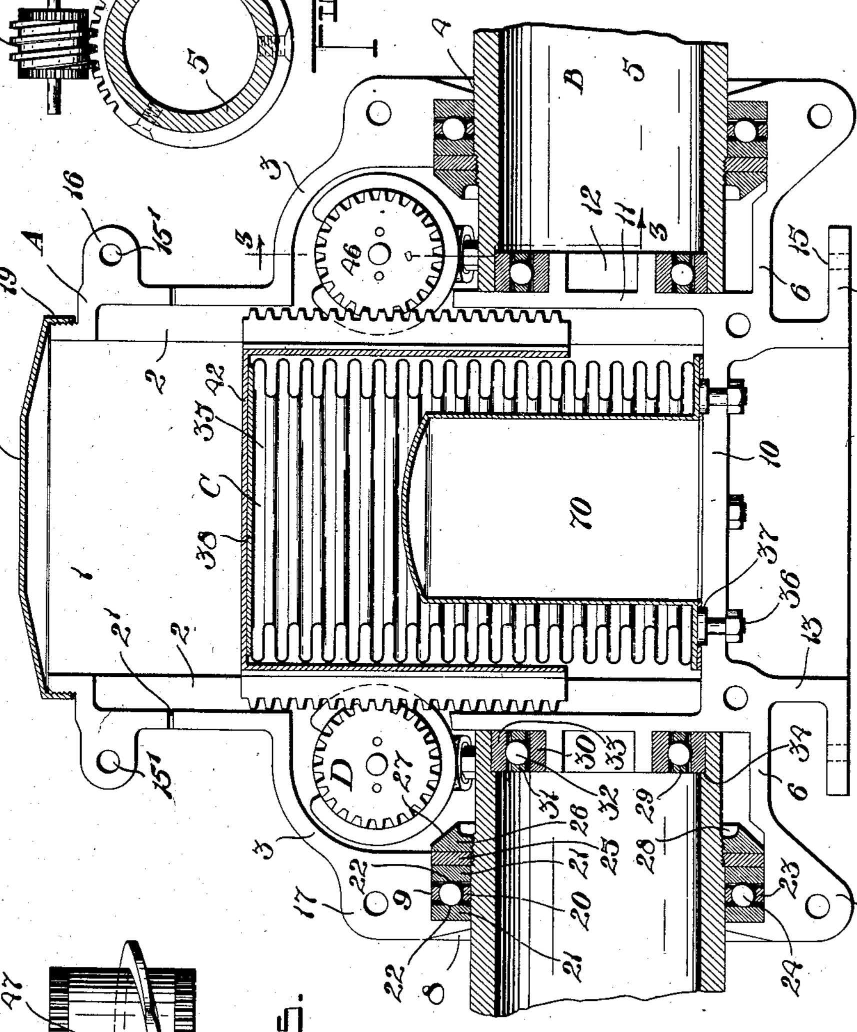

FIG. 1.

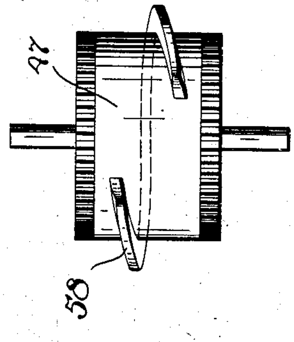

FIG. 5.

INVENTOR
R. M. STEPHENS
BY Fetherstonhaugh & Co.
ATTYS.

Feb. 28, 1939. R. M. STEPHENS 2,148,843

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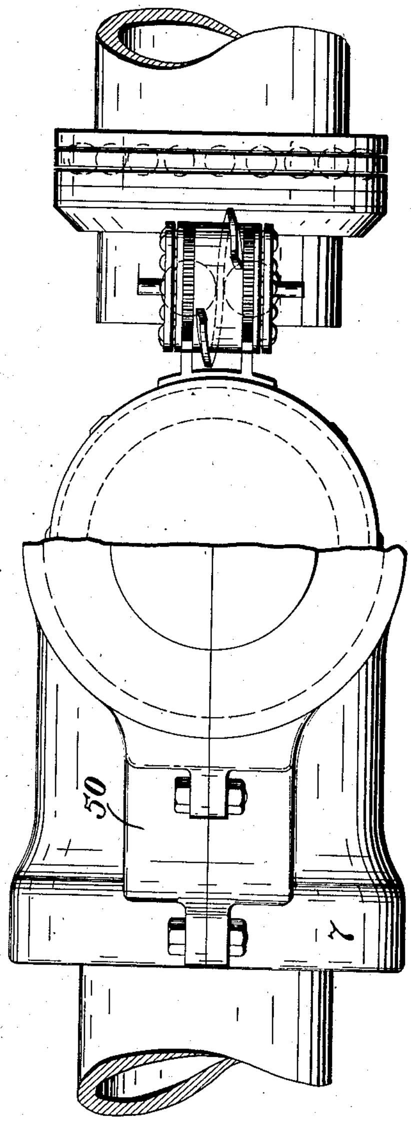
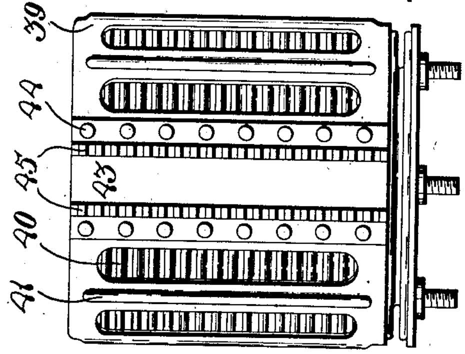


FIG. 2.



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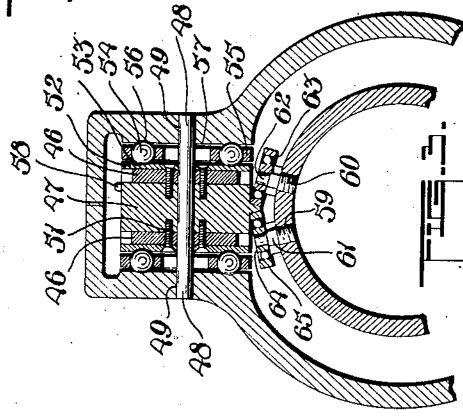

FIG. 3.

INVENTOR
R. M. STEPHENS
BY Fetherstonhaugh & Co.
ATTYS.

Feb. 28, 1939.

R. M. STEPHENS

2,148,843

AUTOMATIC VARIABLE PITCH PROPELLER

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3 Sheets-Sheet 3

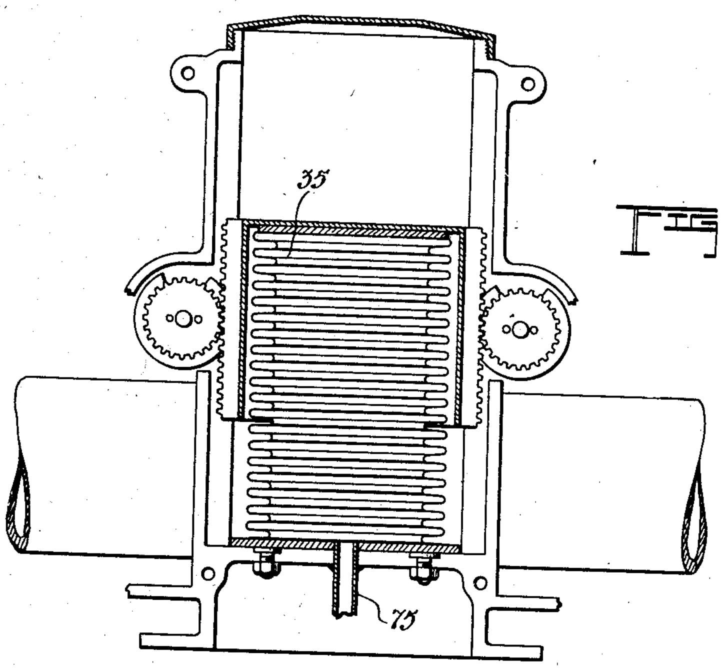

FIG. 7.

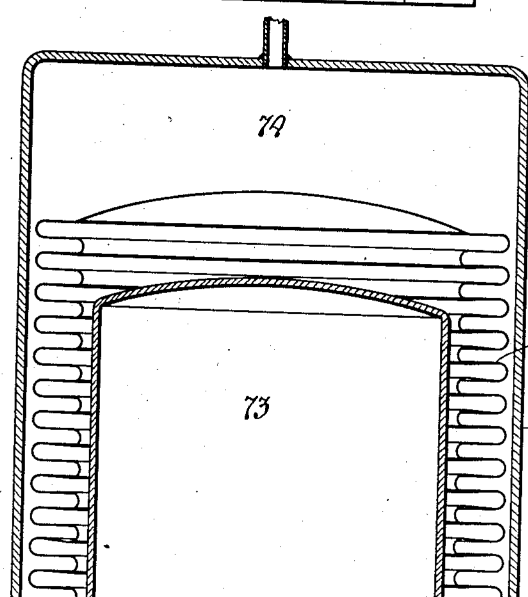

FIG. 8.

INVENTOR
R. M. STEPHENS
BY Fetherstonhaugh & Co.
ATTYS.

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UNITED STATES PATENT OFFICE

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AUTOMATIC VARIABLE PITCH PROPELLER

Robert M. Stephens, Winnipeg, Manitoba, Canada

Application December 20, 1935, Serial No. 55,470

3 Claims. (Cl. 170—162)

My invention relates to improvements in automatic variable pitch propellers and an object of the invention is to provide a device of the character herein described which will change the angular pitch of the propeller blades with a change in air pressure and thereby change in altitude, the pitch angle becoming greater as the pressure decreases.

A further object of my invention is to provide a device of the character herein described which will be entirely automatic in action and requires no attention by the pilot when in flight.

A further object of my invention is to provide a device of the character herein described which will utilize the full power of a supercharged motor at high altitudes.

A further object of my invention is to provide a device of the character herein described in which the energy for varying the pitch of the propeller blades is derived from air pressure surrounding a hermetically sealed bellows.

A further object of my invention is to provide a device of the character herein described which is rugged in construction and will not easily become out of order but yet is positive in action and sensitive to relatively slight variations in air pressure.

A still further object of my invention is to provide a device of the character herein described which is simple to construct, and economical to manufacture.

With the above more important objects in view and such other minor objects as may appear as the specification proceeds, my invention consists essentially in the arrangement and construction of parts all as hereinafter more particularly described, reference being had to the accompanying drawings, in which:

Fig. 1 illustrates a central sectional elevation of my invention, with the racks, pinions and worm gears, however, illustrated in full.

Fig. 2 is a plan view of the invention with the casing partially removed to show the location of the actuating mechanism.

Fig. 3 is a fragmentary sectional elevation taken on the line 3—3 Figure 1.

Fig. 4 is an elevational view of the bellows and cage used with this invention.

Fig. 5 illustrates a detailed view of the helical gear and pinions used in the actuating mechanism of my variable pitch propeller.

Fig. 6 illustrates a sectional elevational view of an alternative method which may be used for rotating the propeller blades on their longitudinal axis.

Figure 7 is a further elevational view of my invention similar in general to Figure 1 but showing a conduit leading to Figure 8.

Figure 8 is a sectional elevation of the cylinder and hermetically sealed bellows provided within the cockpit of an associated plane.

In the drawings like characters of reference indicate corresponding parts in the different figures.

It is commonly known that in internal combustion aeroplane engines in use at the present time, a large percentage of the potential power developed by the engine is lost when the 'plane ascends to high altitudes. This loss of power is due to the decrease in the weight of air taken in by the carburetor in the rarified atmosphere.

In order to overcome this difficulty, the supercharging of engines has been resorted to with very successful results. However, a supercharged engine equipped with a propeller designed for operation at sea level will not be able to develop full power in the upper thin atmosphere. Increasing the pitch of the propeller will overcome this difficulty at great altitudes but will reduce the efficiency of the machine in the low atmosphere. Accordingly, variable pitch propellers have been used in order to obtain the correct pitch angle for the air pressure encountered.

These propellers, however, have the disadvantage of necessitating the addition of an extra control in the cockpit of the plane and the pilot has difficulty in adjusting the propeller to obtain the maximum efficiency from his engine.

Applicant has accordingly developed a variable pitch propeller which is entirely automatic in its action and which changes the pitch of the propeller blades with changes in air pressure.

The following description relates to an automatic variable pitch propeller having two blades but it will be evident after a perusal of the description that exactly the same principle may be used in connection with propellers possessing any number of blades.

The invention consists of a socketed casing A into either side of which are inserted the roots B of the propeller blades. A longitudinally expansible bellows C is provided within the casing and gear mechanism D co-acts between the bellows and the blade roots to transmit movement of the bellows to the blades.

The upper part of the casing A is in the form of a short cylinder 1 having opposed longitudinally extending and diametrically opposed recesses 2 therein having pin holes 2' passing through the walls thereof. These recesses expand laterally into the gear housing 3 and immediately subjacent thereto are the opposed sockets 4 for the reception of the roots 5 of the propeller blades.

The sockets consist of cylinders 6 made integral with the casing and are provided with encircling flanges 7 around the outer ends thereof. These flanges are inwardly bevelled as at 8. The inner portion of the socket immediately behind the bevel 8 of the flanges is reamed as at 9 for a purpose presently to be explained.

A circular base plate 10, also integral with the casing, extends between the sockets and closes the lower end of an upstanding cylinder 11 which is in alignment with the aforementioned cylinder 1. Integral annular flanges 12 are provided on the outer face of the cylinder 11, the longitudinal axes of which are coincident with those of the roots 5 of the propeller blades within which they extend. Beneath the plate 10, a further short cylinder 13 extends downwardly and is furnished at its extremity with an encircling hub flange 14 provided with a plurality of apertures 15 therein for attachment to the companion crank shaft flange of the aeroplane engine.

The casing, it should be noted, is constructed in two identical halves which are fastened together by passing bolts through orifices 15′ within lugs 16 situated on either side of the longitudinal recesses 2 and also through lugs 17 and 17′ on opposing sides of the encircling socket flanges 7. Further orifices are drilled within the casing between the cylinder 13 and the plate 10 and bolts are passed therethrough to aid in firmly holding the two halves of the casing in integral relationship. The upper end of the cylinder 1 is externally threaded and provided with a cap 18 having an encircling internally threaded flange 19, the threads of which engage with those upon the cylinder 1.

Within the reamed portion 9 in the root sockets is placed a ball thrust bearing 20 consisting of rings 21 having opposed ball races 22 cut in the faces thereof and interposed between these rings is placed the ball cage 23 carrying the ball bearings 24 therein which engage within the ball races 22.

In order to prevent this bearing 20 from slipping off the roots of the blade, an internally threaded collar 25 is screwed upon the root against the bearing and a further collar 26 having an inwardly converging face 27 is tightened against the collar 25 and constitutes a lock nut to hold that collar firmly in place.

An encircling channel 28 is cut within the collar 26 facing the central axis of the propeller, this channel being provided for the purpose of catching and retaining oil which otherwise would be thrown out past the bearings and along the blade of the propeller by the centrifugal force of the rapidly rotating device. When the propeller stops, the oil which has been retained within the channel is immediately released and serves to aid lubrication of the device when the engine is restarted.

Further bearings 29 are furnished to facilitate the rotative movement of the propeller blades on their longitudinal axis. Annuli 30, carrying on their outer peripheries the inner ball race, are firmly attached over the flanges 12. The customary ball cage 31, carrying the ball bearings 32, is inserted between the annuli 30 and further annuli 33 which are inserted in the ends of the roots of the propeller blades by reaming out a portion of the said blades and pressing the annuli home to engagement with shoulders 34 produced by the reaming.

It should here be mentioned that the upstanding cylinder 11 acts as a stop to prevent the blades from moving towards the central axis of the device and thus disengaging the thrust bearing 20 when the propeller is in a stationary condition.

Within the aligned cylinders 2 and 11, I provide a cylindrical metallic bellows 35 composed of brass or other suitable material. This bellows is securely attached to the plate 10 by means of a plurality of bolts 36 fastened to the lower edges thereof, the heads of the bolts being countersunk in circular recesses 37. These bolts, it should be noted, are tightened sufficiently to hermetically seal the bellows and prevent any entrance of air thereinto or discharge therefrom.

The upper end of the bellows is closed and sealed by a substantial metallic disc 38 and over the bellows and attached to the disc 38 is placed a light yet strong cylindrical cage 39. Longitudinally extending apertures 40 are cut around the sides of the cage and between these apertures are provided ridges 41. When the cage is within the cylinders 11 and 1, these ridges just bear against the sides thereof and so reduce the friction between the cage and the cylinders. The upper end of the cage is closed by a disc 42 which is attached as before mentioned to the companion disc upon the upper end of the bellows 35.

Diametrically opposed on either side of the cage 39, are attached rack plates 43 by means of rivets 44 passing through orifices therein and also through aligned orifices within the cage. Upon each rack plate integral therewith are provided a pair of spaced parallel longitudinally extending racks 45. The racks 45 are designed to engage with pinions 46 attached to either side of a short cylinder 47 through which is passed a shaft 48 journalled within bearings 49 within either side of the gear casing 50. On the outer sides of the pinions 46 are fastened by means of bolts 51, ball race plates 52 provided with ball races 53 therein to engage with ball bearings 54 carried within bearing cages. The ball bearings 54 are designed to rotate within a further ball race 56 machined within the inner opposed faces 57 of the gear casing 50.

It will be noted that around the cylinder 47 is placed a single helical rib 58. This rib does not extend completely around the cylinder and the side walls of the rib are twisted with respect to the longitudinal surface of the cylinder in order that the rib may mesh correctly at all times between bearings immediately to be described.

Threadably attached within orifices 59 in the roots 5 of the propeller blades are a pair of adjacent pins 60 provided with lock nuts 61 to prevent them from becoming accidentally disengaged from the orifices 59. Stub shafts 62 project through the lock nuts 61 and upon these shafts are placed ball bearings 63 having the usual inner and outer annuli 64 and 65 respectively carrying opposed ball races and the ball bearings inserted therebetween. The outer surfaces of the annuli 65 are designed to engage against either side of the helical rib 58 so that rotative movement of the pinions 46 will cause a slight angular displacement of the roots of the propeller blades.

It has already been mentioned that the side walls of the helical rib 58 are obliquely disposed with respect to the surface of the cylinder 47, the reason for this being that as the cylinder rotates in a clockwise or anti-clockwise direction from the point where the central portion of the rib is in bearing contact with the bearing 63, these bearings are moved together with the root of the blade to right or to left so that when either end or any point between the center of the rib and the end thereof is in engagement with the bearing surfaces of the bearings 63, the V formed thereby is offset either to right or left which means that one or other of the bearing faces of the bearings 63 will be approaching the vertical while the other will be more or less inclined to the horizontal.

For this reason, it may be clearly seen that in order that the bearing faces of the bearings 63 may always lie parallel and against the side walls of the rib 58 at each point upon the length thereof, the rib must be machined to an increasing obliquity towards each end.

If so desired, instead of using the pins 60 provided with the bearings thereon and the single helical rib 58, I may make use of the embodiment shown in Figure 6 of the drawings accompanying this application which consists of metallic rings 66 circumscribing the inner end of the blade roots 5 and being attached thereto by a plurality of countersunk screws 67 passing through the rings 66 into the blade root.

Upon the upper surface of this ring are cut a number of teeth 68 to engage with a worm gear 69 substituted in place of the cylinder 47 and tooth 58 described in the first embodiment.

It will be noted that within the bellows 35, extends an upwardly disposed sealed dome 70. This dome is by no means an essential part of the apparatus and may be dispensed with if necessary and its function will be shortly described.

The structure of my improved type of automatic variable pitch propeller having now been described, its mode of operation will be herewith presented.

The bellows 35 is sealed with air at sea level pressure, namely 14.7 pounds per square inch while contracted to its greatest degree, the lower end of the cage 39 resting upon the upper surface of the plate 10. In this position, the propeller blades possess their minimum angular pitch. However, if the device is now moved to a higher altitude where the air becomes rarified, the pressure on the upper surface of the bellows will decrease and consequently the air therein will expand and tend to open the bellows. This will cause an upward movement of the cage 39 and a consequent turning of the pinions 46 by the racks 45. The rotation of the helical tooth 58 engaging between the bearings 63 will cause a longitudinal turning effect of the propeller blades to take place and the device is so adjusted that this turning effect will increase the angle of pitch of the blades.

Consequently, the greater the altitude of the engine to which this device is attached, the greater will be the expansion of the bellows and the greater the pitch angle of the propeller blades, this being the condition which it is desired to produce.

In the case of an ascent to extremely high altitudes, the decrease of pressure on the bellows would cause an abnormal expansion thereof, thereby requiring an excessively long cylinder. To keep the length of the cylinder within desired limits, the above mentioned dome 70 may be placed within the bellows to displace a certain amount of air which is thus unable to expand within the bellows. For this reason, it cannot extend as rapidly as if the dome was absent, thereby decreasing the ultimate length of the bellows under reduced external pressure.

In cases where it may be necessary to increase the amount of energy delivered by the bellows 35, I would, of course, increase the diameter of the bellows, thereby increasing the cross sectional area thereof and obtaining a greater amount of pressure therefrom. However, increasing the size of the bellows might require that the hub of the propeller be made abnormally large and in order to overcome this difficulty, I use an auxiliary bellows in the following manner.

Within the cockpit of the plane or in any other convenient location, is placed a rigid metal cylinder 71 closed at either end, which is provided with an hermetically sealed bellows 72 therein similar to the bellows 35 within the hub of the propeller but having a larger diameter to deliver a greater amount of energy. Within this bellows, I may also place a dome 73 similar to the dome 70 within the propeller.

The space 74 between the outside of the auxiliary bellows and the rigid casing is filled with oil or other non-compressible fluid and a tube 75 leads from this oil chamber to the inside of the bellows 35 within the propeller hub which is likewise filled with oil. It will now be apparent that if the pressure around the bellows 35 should decrease, a corresponding decrease in pressure would occur within the bellows 35 which would be transmitted through the oil tube 75 to the oil chamber 74 around the auxiliary bellows. Thus the bellows 72 would expand and it will be noted that it possesses a greater diameter than the bellows within the hub of the plane, this expansion would deliver more power to the bellows within the hub than if this bellows was air filled and operated independently.

From the foregoing, it will now be evident that I have devised a simple, yet rugged type of variable pitch propeller which has the great advantage of being entirely automatic in operation, will not easily become out of order and will move the propeller blades to the correct pitch angle for the air pressure to which the device is subjected.

Since various modifications can be made in the above invention, and many apparently widely different embodiments of same, made within the scope of the claims without departing from the spirit and scope thereof, it is intended that all matter contained in the accompanying specification shall be interpreted as illustrative only and not in a limiting sense and I desire only such limitations placed thereon as are specifically expressed in the accompanying claims.

What I claim as my invention is:

1. Improvements in variable pitch propellers comprising a casing, a cylinder within said casing, bellows within said cylinder, a cage upon said bellows, twin racks upon the sides of said cage, pinions meshing with said racks, a cylinder mounted between each pair of said pinions, a helical rib extending around said cylinders, a plurality of rotatable blades extending within sockets provided in said casing, bearings mounted upon said blades, said helical rib passing between said bearings and means for attaching said propeller to an aero engine.

2. Improvements in variable pitch propellers comprising a casing, a cylindrical portion within said casing provided with longitudinal recesses extending down the sides thereof, outwardly opening sockets upon the sides of said cylindrical portion and a hub flange attached to said casing,

an expansible and contractible cylindrical bellows within said cylindrical portion, a cage upon said bellows, twin racks upon the sides of said cage, twin pinions engaging with said racks, cylinders interposed between each pair of said twin pinions, helical ribs extending around said cylinders, rotatable propeller blades extending within said sockets and mounted upon thrust and radial bearings, an oil retaining collar encompassing the roots of said blades, secondary bearings mounted upon said blades, said ribs passing between said bearings to transmit rotative movement of said ribs to said blades.

3. The device as claimed in claim 2 in which an air displacing dome is positioned within said bellows.

ROBERT M. STEPHENS.