April 29, 1924. 1,491,972

M. SCHIESARI

EXTENSIBLE PROPELLER

Filed March 13, 1922 3 Sheets-Sheet 1

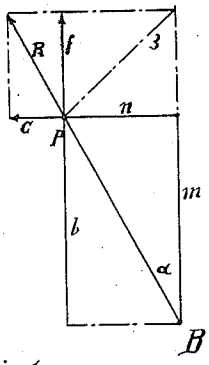



Fig. 1

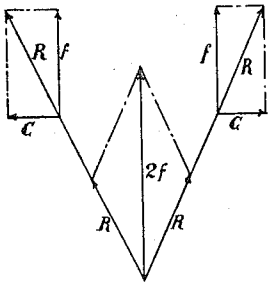



Fig. 2

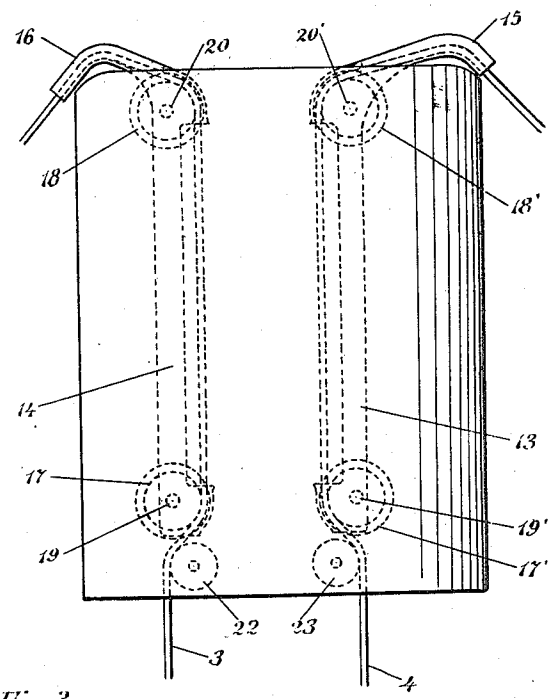



Fig. 3

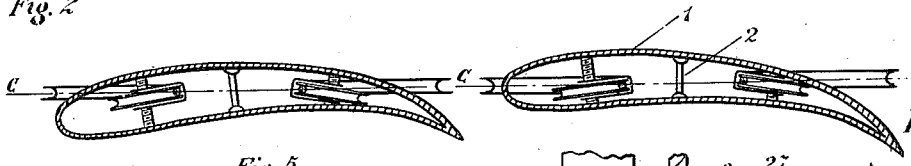



Fig. 4

Fig. 5

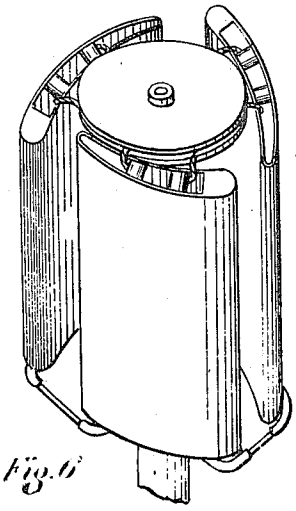


Fig. 6

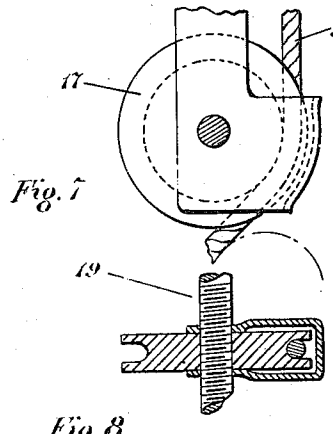



Fig. 7

Fig. 8

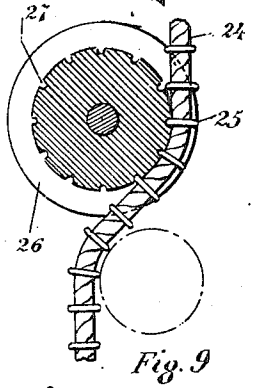



Fig. 9

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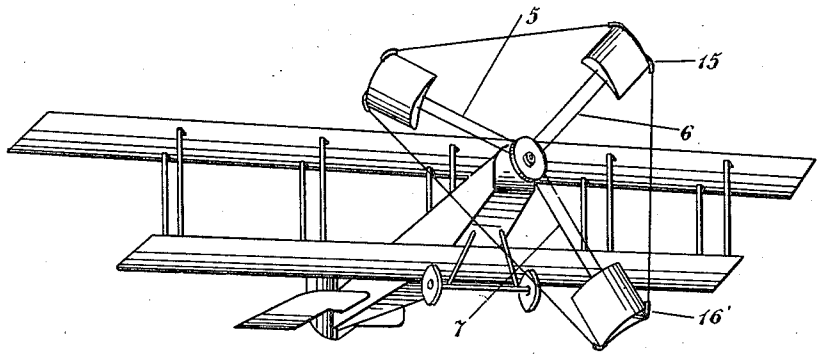



Fig. 10

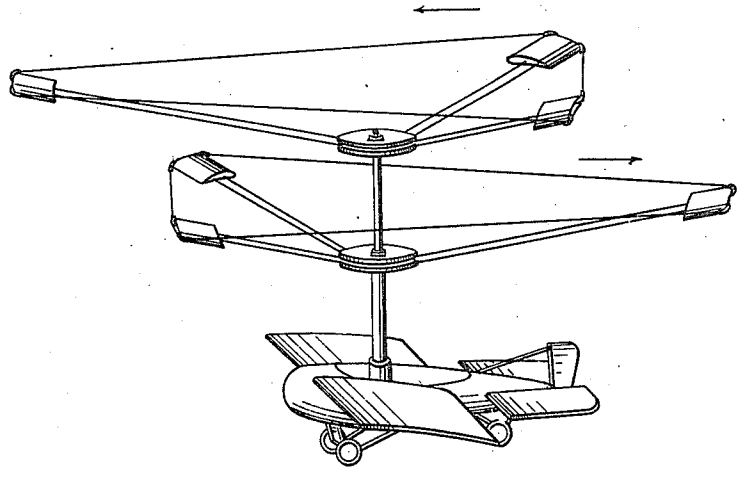


Fig. 11

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EXTENSIBLE PROPELLER

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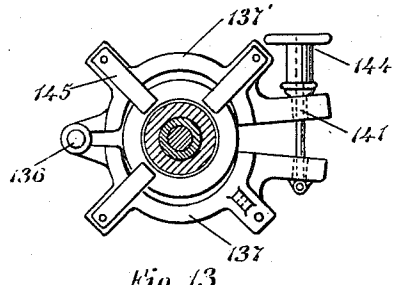



Fig. 13

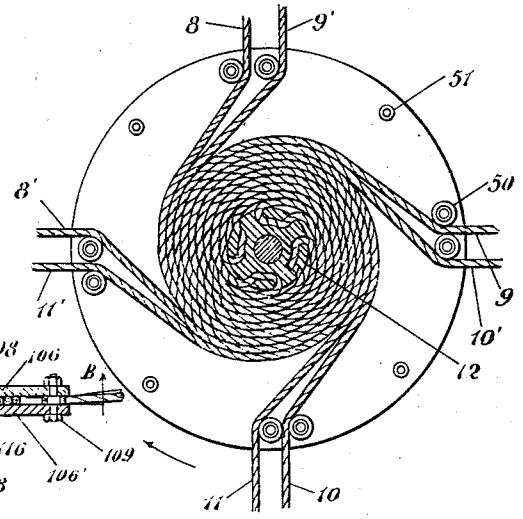



Fig. 14

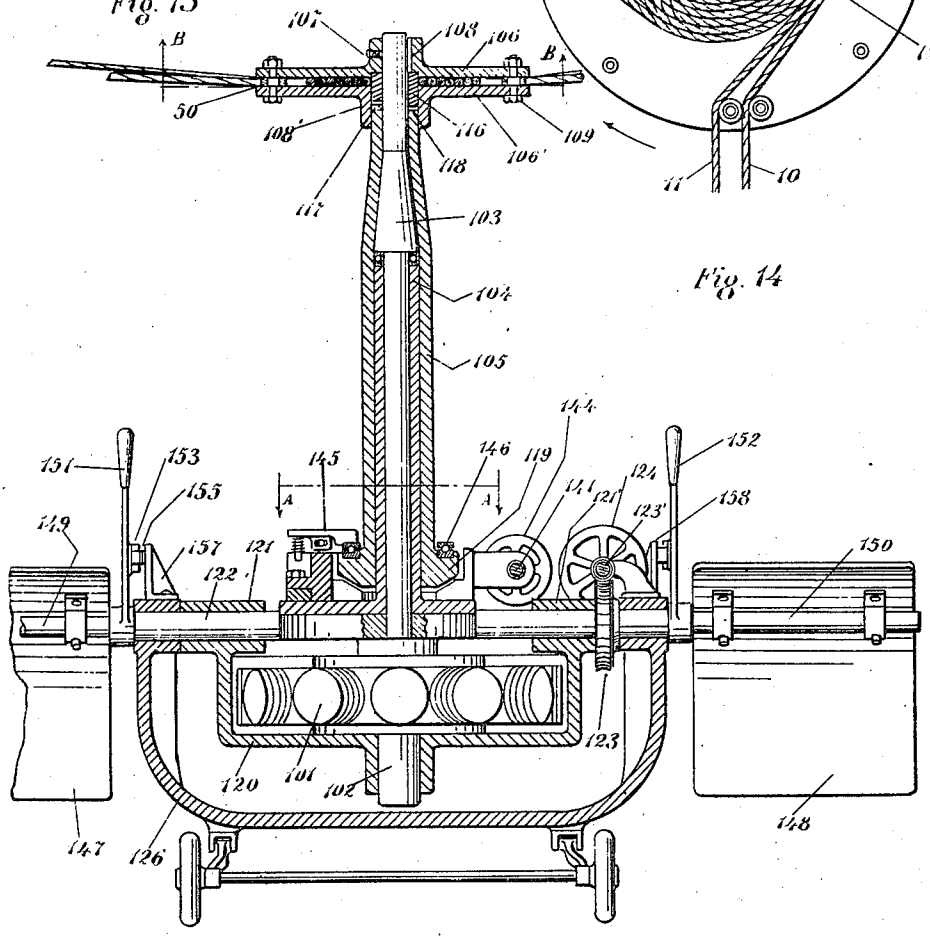



Fig. 12

Inventor
Mario Schiesari

Patented Apr. 29, 1924. 1,491,972

# UNITED STATES PATENT OFFICE.

MARIO SCHIESARI, OF NEW YORK, N. Y.

## EXTENSIBLE PROPELLER.

Application filed March 13, 1922. Serial No. 543,303.

*To all whom it may concern:*

Be it known that I, MARIO SCHIESARI, a citizen of the United States, residing at New York, in the county and State of New York, have invented certain new and useful Improvements in Extensible Propellers, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, forming part of this specification.

This invention relates to extensible propellers consisting of a plurality of inclined planes or blades connected to an axle and to each other by flexible retaining means, and rendered operative through the utilization of centrifugal force, of the type described by me in another application for patent filed by me July 14, 1921, having for title "Method and apparatus for aerial propulsion," Serial No. 484,827; and its main object is to provide a novel method of construction of extensible propeller, whereby the variations of its radius of action are utilized to modify the angle of incidence of its planes, so as to substantially counterbalance the variations in the torque of its axle due to said variations in its radius.

A further object of my invention is to provide a propeller of a novel and improved design, the action of which is based on utilizing the lifting or propelling force obtained through causing inclined planes or blades connected to an axle and to each other by flexible retaining means, to travel in a circular path at a suitable speed; said propeller having a variable radius of action, and also being provided with means whereby the angle of incidence of the planes to their plane of travel may be varied, in order to realize certain advantages in operation, as will hereafter be more fully explained.

A still further object is to provide, in a propeller consisting of a plurality of planes or blades connected to an axle and to each other by flexible retaining means, means whereby the planes or blades may be caused to assume different angles of incidence to their plane of travel.

With these and other objects in view, as will more fully appear as the description proceeds, my invention furthermore consists in certain novel constructions and arrangements of parts as will be hereinafter fully described and claimed in the appended claims.

In my other patent application above referred to, the advantages of this type of propeller have been fully set forth; the same being substantially an adaptation of aerofoil elements in combination with a rotating axle, the lifting or propelling power developed by said aerofoils set at a certain angle of incidence to their plane of travel being made available through a novel method of exploitation of centrifugal force. In order to attain greater efficiency in a propeller, it is desirable to make the same of a large diameter, and low angle of incidence; but with propellers of ordinary design there are sharp limitations imposed by practice in determining these factors of construction.

It is obvious that one of the elements determining the pull exerted by a propeller being its circumferential speed, this factor may be increased by increasing the diameter of a propeller, or else it may be maintained by increasing the diameter and proportionately reducing the speed of the axle; in the first case increasing the pull exerted, and in the second case realizing better working conditions for the engine. The improved propeller forming the object of my other patent application above referred to, permits of realizing these advantages, on account of its diameter being variable and under the control of the operator; and if the engine is operated at a uniform speed, as the diameter of the propeller is increased, so is its pull proportionately increased, with slight variations in efficiency due to changed conditions.

With this type of propeller, however, it is obvious that the angle of incidence of the planes or blades must be such as to exert a sufficient pull even when the diameter of the propeller is small; with the result that when the diameter is increased it may be necessary to cut down the speed of the engine in order to avoid considerable overloads. The torque on the axle however, will increase with the increasing of the diameter of the propeller, and is not affected by variations in speed; and this condition therefore constitutes in practice a serious limitation to the diameters attainable, and to reductions in the size of the axle.

In order to realize conditions whereby the engine may be run at a substantially uniform speed, and the torque exerted on the axle maintained within reasonable limits, I have sought to modify another one of the factors concurring in the determina-

tion of these conditions, viz, the angle of incidence of the planes to their plane of travel; since by decreasing the said angle of incidence as the diameter of the propeller increases, not only is the pull considered in relation to the circumferential speed decreased, but a higher efficiency for the device as a whole is attained.

I have therefore devised a novel and improved construction of extensible propeller having a variable angle of incidence of its planes or blades, said angle decreasing as the diameter of the propeller is caused to increase, and vice versa; the radial travel of the planes or blades themselves being used in order to cause corresponding variations in their angle of incidence.

For purposes of illustration, in the drawings I show one of the ways of carrying my invention into practice, and a few applications, and, for the sake of clarity, also the general mode of operation of my type of propeller as a whole. Referring to the same:

Figs. 1 and 2 are diagrammatic views of the composition of centrifugal and lifting forces taking place in the operation of my propeller;

Fig. 3 is a plan view of one of the aerofoil type planes entering into the construction of my propeller;

Fig. 4 is a cross sectional view in elevation of the same;

Fig. 5 is a cross sectional view in elevation of the same, tilted at a different angle of incidence to the plane of travel;

Fig. 6 is a view in perspective of a complete propeller in a retracted position;

Fig. 7 is a detail plan view of one of the sheaves controlling the operation of the planes;

Fig. 8 is a detail cross sectional view in elevation of the same;

Fig. 9 is a detail plan sectional view showing a modified type of sheave and cable;

Fig. 10 is a view in perspective of an aeroplane fitted with my improved propeller;

Fig. 11 is a view in perspective of a flying machine of the helicopter type fitted with two propellers rotating in opposite directions;

Fig. 12 is a cross sectional view in elevation of an aeroplane illustrating one of the ways of controlling the operation of my propeller;

Fig. 13 is a detail plan sectional view of same through line A—A of Fig. 12; and

Fig. 14 is a plan sectional view of the same through line B—B of Fig. 12.

In order to facilitate a thorough understanding of the present invention, in Figs. 1 and 2 I show in a diagrammatic form the composition of forces governing the operation of my improved propeller. Let us assume that the flexible member B P, inclined at an angle $\alpha$ to the vertical and carrying a weight at P, be revolving at such an angular velocity about the fixed point B as to develop at P a centrifugal force C. Evidently, if the force C was the only force acting on the system, the member B P could not be in equilibrium. If we apply at P another force $f$ of such a magnitude that the resultant R, obtained by compounding it with C, will be in alinement with B P, the moment of said resultant about the fixed point B will be zero, and the system will consequently be in equilibrium.

Considering the moments of the component forces about B we find.

$$cm = fn \quad (1)$$

$$\frac{c}{f} = \frac{n}{m} \quad (2)$$

equation (2) giving the complete solution of the dynamic problem.

From it, if two elements of the system are assumed all the other elements will immediately be found. In practice, the magnitude of the centrifugal will be greater than the magnitude of the lifting force, therefore, the flexible member B P will be only slightly inclined upwardly in respect to the horizontal.

In Fig. 2, I show how two lifting (aerofoils) forces acting simultaneously will compound themselves in a double lifting force axially directed.

In Figs. 3, 4, 7 and 8, I show an aeroform design of propeller plane, which must be properly built with suitable materials in order to secure the necessary lightness and strength. In the same, 1 designates the plane, proper, reinforced by aluminum partitions 2. 3, 4, designate the retaining cables, each forming a closed circuit between two adjacent planes and the hub, as will be clearly seen by referring to Figs. 10, 14. The number of cables used is equal to the number of planes entering into the construction of the propeller, so that in the propeller shown in Fig. 10, comprising three planes, three cables 5, 6, 7, are employed, while in the propeller the hub of which is shown in Fig. 14, comprising four planes, four cables 8—8′, 9—9′, 10—10′, and 11—11′ are employed.

In said Fig. 14, it is seen that all the cables are inserted through, and retained by the hub 12, the two strands of each cable thus obtained being wound spirally around said hub in a flat spiral; so that if the hub is rotated in the direction of the arrow, all the cables are simultaneously unwound of the same quantity, while the reverse happens if the hub is rotated in the

opposite direction. Means for controlling the operation of the hub for winding or unwinding will be described later; but assuming that the relative position of the cables and the hub be rendered stationary it will be seen that if the propeller thus formed is rotated at considerable speed the effect of the centrifugal force exerted on the planes will be to keep the same under tension both radially and peripherically. In order to create in the plane elements a tendency to axial movement however, it is necessary to maintain the active surfaces of said planes at an angle of incidence in relation to the plane of rotation; and this is obtained by making guide members 13, 14 for the cables, with a bent portion 15, 16 sufficiently long, and bent at the right angle so as to maintain the peripherical strands of the cables in the right position. In other words, the rearward bent portion 15 of one plane must be directed towards the forward bent portion 16′ of the adjacent plane.

The action of the air against the plane surfaces will be the same for all the planes of a propeller, and will constantly create a tendency in the rear part of a plane and the front part of the adjacent plane to move away from each other. This will obviously be prevented by the peripherical strand connecting said two portions of adjacent planes, and therefore the angle of incidence will be maintained throughout. For each plane we have, therefore, created the condition diagrammatically illustrated in Fig. 1, C representing the centrifugal force tending to cause the planes to move in a radial direction and F representing the reaction of the air striking the inclined surfaces of the planes and causing the same to move in an axial direction, the resultant force R having the effect of maintaining the retaining cables under tension at an upwardly inclined angle. A propeller being formed of a plurality of symmetrically arranged elements, counter-balancing each other, a system will have been created such as diagrammatically illustrated in Fig. 2 where the ultimate resultant force is axially directed, same as in a propeller of ordinary construction.

The general mode of operation of the propeller forming the object of the present invention, is therefore essentially the same as in the case of the propeller described and claimed in my previous patent application above referred to; with the difference that in the present instance I have provided means whereby the angle of incidence of the planes may be varied, and will automatically become smaller as the diameter of the propeller increases.

As explained above, through this improvement an equalizing effect will be obtained on the torque of the axle on which the propeller is mounted, and it is made possible to use propellers with a larger diameter and smaller angular speed, realizing a better efficiency for the propeller and better working conditions for the engine.

The operation of my device is based on the fact that as the propeller expands, the strands of cable connecting adjacent planes become longer; and therefore an outward movement of said cables relative to said planes must take place. Instead of causing the relative position of the planes and the cables passing therethrough permanently set at a given angle, therefore, I cause the said relative position to change from a high angle to a low angle as the diameter of the propeller is gradually increased. To this end, I provide the planes with adjustable guiding means for the cable strands, the relative position of which to the planes is adapted to change as the strands are caused to travel in one or the other direction; and these relative movements being such that when the rear portion of a plane is moved upwardly so as to diminish its angle of incidence, its front portion is moved downwardly, so as to achieve the same effect; so that the cumulative effect on the plane will be a tilting movement of the same around an imaginary intermediate longitudinal axis. This movement will take place so as to diminish the angle of incidence as the propeller is expanded, and in the opposite sense as the propeller is contracted.

This action of the propeller planes may easily be conceived, by imagining the path of travel of the cables to be permanently set on a plane normal to the axis of the propeller, and by imagining a gradual change in the angle between said plane and the surfaces of the propeller planes.

In the drawings I show one of the ways of carrying my invention into practice, and in the same, Figs. 3, 4, 7, 8, it is seen that for each strand of cable 3, 4, I provide in the plane a set of two guiding sheaves 17, 18, 17′, 18′, mounted on screws 19, 20, 19′, 20′, and adapted therefore to axially travel thereon as said sheaves are being rotated. Referring to Fig. 3 it is seen that when both strands travel outwardly, sheaves 17′, 18′ are caused to rotate clockwise, and sheaves 17, 18, are caused to rotate in the opposite direction. All the screws being with a right hand thread it follows, by referring to Fig. 4, that sheaves 17′, 18′ will travel downwardly on their screws, and sheaves 17, 18 will move upwardly, so that the plane will gradually come to assume the position shown in Fig. 4 where the angle of incidence to the plane of travel C C, has become less. The reverse will obviously take place when the propeller is contracted, and the cables will travel inwardly instead of outwardly.

During their travel, the sheaves will carry

guide members 13, 14, which are also inserted on the screws, and which are provided, as hereinbefore stated, with bent portions 15, 16. In order to assure an intimate contact between the cables and the sheaves, I prefer to increase the angle of contact between them by means of idle rollers 22, 23. The contact between cables and sheaves however, is purely frictional, and if a more positive relation of movements between these factors should be necessary, a modification on the order of the one shown in Fig. 9 may be adopted.

In the same the cable 24 is shown provided with equidistant rings 25, causing the same to act like a chain in mesh with sheave 26, the groove of which is provided with notches 27. The driving action will thus be absolutely positive, and all danger of lost motion through slippage eliminated.

It is obvious that all parts can be so proportioned, and the thread of the screws so cut that the gradual change in the angle of incidence of the planes will take place between a maximum and a minimum which can be predetermined by the designer. Similarly, the screws of one set may have a different pitch from those of the other set, or the sheaves may have different diameter, so that if desired the axial travel of one set of sheaves may be different from the one of the other set. Also it is obvious that different means from those shown may be used in order to change the angle of incidence of the planes by utilizing the travel of the cables, the device described being mainly for purposes of illustration.

My propeller may be used singly, as shown in the aeroplane in Fig. 10, or may be used in connection with another turning in an opposite direction in order to prevent spinning of the machine about its axis in flying machines of the helicopter type, such as shown in Fig. 11. The manner of control of the expansion and retraction of the propeller does not form a part of the present invention; but for the sake of clarity, and in order to assist in understanding its operation, in Figs. 12, 13, 14 I have illustrated, and I will here describe, a mechanism which may be used for the control of a propeller of the single type.

In the same, 101 designates a rotatable frame motor integral with an axle 102 which is formed with a tapered portion 103.

On said axle is inserted a sleeve 104 mounted on the horizontal shaft 122 pivotally mounted on an aeroplane body or fuselage 126. 120 designates a frame in which the motor is mounted fixed on shaft 122 by means of lugs 121—121′. Said shaft 122 may be rotated around its axis by means of a worm wheel 123 operated by worm 123′, which is controlled by a hand wheel 124, so that axle 102 may be caused to assume a horizontal position toward the front of the machine.

On axle 102 is also mounted another sleeve 105 having a tapering portion supported by the tapered portion 103 of axle 102 and becoming integral therewith on account of the wedging action taking place; said sleeve 105 however, is capable of axial motion on said axle so that it may be detached from close contact with tapered portion 103 and rendered loose on said axle. The upper part of said sleeve is formed with teeth 117, 118, constantly in mesh with similar teeth provided on the lower face of a core 116 to which are fixed the flexible elements as shown in Fig. 14, and which is loosely mounted near the end of axle 102. Said core 116 is locked against axial motion by two blades or flanges 106, 106′ forming a reel or housing for the flexible elements. Flange 106 is rendered integral to axle 102 by means of set screw 107 and key 108; while flange 106′ is secured to the same by means of bolts 109, and is provided with a collar portion 108′ which fits loosely around the top portion of sleeve 105 and the lower portion of core 116.

For the operation and control of the flexible elements in the manner which will be hereinafter described means are provided for causing the slight axial motion of sleeve 105 necessary to attach or detach the same through intimate contact with tapered portion 103 of axle 102, or for exerting a braking action on the same. For this purpose sleeve 105 is formed integral with a flange 119 having its lower surface inclined downwardly. Around the lower portion of sleeve 105 is mounted a collapsible collar formed by two members 137, 137′, pivotally mounted on fulcrum pin 136 and having their lower internal edge abutting against the lower inclined surface 119′ of flange 119.

The expansion or contraction of said collar is controlled by a screw 141 operated by hand wheel 144; and it will be easily understood that if said screw 141 is operated so as to close the collar the action of the same against the inclined surface of flange 119 will be to force sleeve 105 in an axial direction out of contact with tapered portion 103, while if the two collar portions are further drawn together the same will exert a brake band action against the lower part of sleeve 105, said action being adjustable at will. In the first case, that is, when sleeve 105 is detached from tapered portion 103, the sleeve becomes loose on the axle 102, and may, therefore, rotate independently of said axle, allowing the cables to extend under the action of the centrifugal force. By again opening the two collar members 137, 137′, if axle 102 is in a vertical position, sleeve 105 will, by the action of its own weight fall back into

contact with tapered portion 103; and in this position, therefore, will again assume the same speed as axle 102, and will, therefore, maintain the cables in their now extended position.

If axle 102, however, should be inclined or horizontal, the action of its weight might not be sufficient to cause sleeve 105 to fall back into contact with tapered portion 103. I have therefore added a system of four spring operated fingers 145, pivotally mounted on collar members 137, 137′, and exerting pressure against a thrust ball bearing 146 mounted on flange 119. The pressure exerted by said fingers will, therefore, cause sleeve 105 to move inwardly into contact with tapered portion 103 when collar members 137, 137′ resume their open position. In order to rewind the cables on the reel, handwheel 144 is operated like in the previous case to close collar members 137, 137′; this will first cause sleeve 105 to become detached from tapered portion 103, and then as handwheel 144 is further rotated collar members 137, 137′ will gradually exert a braking action against said sleeve causing the same to assume a speed lower than the speed of axle 102 and of reel 106—106′ mounted thereon. The four double strand cables held between the reel flanges, therefore, which are guided by rollers 50, as shown in Fig. 14, will be caused to wind again around core 116 by the reel itself; since the reel, as stated, rotates at a speed which is higher than the speed of the core, the core being integral with sleeve 105; the cables will thus be gradually retracted and the radius of action of the propeller become smaller until through the operation of handwheel 144 sleeve 105 is again caused to resume its intimate contact with tapered portion 103.

From the foregoing it is seen that I have devised a novel method of constructing aeroplane propellers having a variable diameter, whereby the angle of incidence of the elements of which the propeller is composed may also be made correspondingly variable; and that by the same I cause the various factors entering into the operation of a propeller to be automatically regulated so as to make for increased efficiency in operation of the device. It is obvious that once the principle is established, many ways besides the one shown and described may be devised in order to carry my invention into practice; and it is therefore understood that I reserve myself the right to modify the details of construction of my invention in such manners as may be suggested by engineering practice in various cases, and as may fairly enter into the scope of the appended claims.

I claim:

1. In a device of the class described, and in combination with a shaft, a plurality of extensible carriers attached thereto, and wings or plane elements adapted to be mounted on said carriers, adjustable means for mounting said elements on said carriers for controlling their angle of incidence to their plane of travel, the operation of said adjustable means being controlled by the expansion or retraction of said carriers.

2. In a device of the class described, the combination of a shaft, a plurality of extensible carriers attached thereto, wings or plane elements adapted to be mounted on said carriers, and adjustable means for mounting said elements on said carriers operated by the expansion or retraction of said carriers for controlling the angle of incidence of said elements to their plane of travel.

3. In a device of the class described, the combination with a shaft, carriers radially extending therefrom, and wings or plane elements adapted to be mounted on said carriers, of rotatable means for mounting said elements on said carriers, said rotatable means being movable transversely to said plane elements.

4. In a device of the class described, the combination of a shaft, carriers radially extending therefrom, wings or plane elements adapted to be mounted on said carriers, and rotatable means for mounting said elements on said carriers, the axes of said rotatable means being at right angles to the axes of said carriers.

5. In a device of the class described, the combination of a shaft, carriers radially extending therefrom, wings or plane elements adapted to be mounted on said carriers, and rotatable means, movable transversely to said elements, for mounting the same on said carriers.

6. In a device of the class described, the combination with a shaft, carriers radially extending therefrom, and wings or plane elements adapted to be mounted on said carriers, of rotatable means transversely movable in relation to said plane elements and controlling the angle of incidence of said elements to their plane of travel.

MARIO SCHIESARI.

Witnesses:
MARIE ZELLER,
ROSE GISBERT.