Sept. 19, 1950

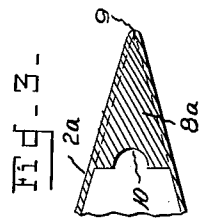
V. ISACCO
SUSTAINING PROPELLER FOR FLYING MACHINES AND PARACHUTES

2,523,216

Filed Nov. 16, 1946

3 Sheets-Sheet 1

Fig. 2.



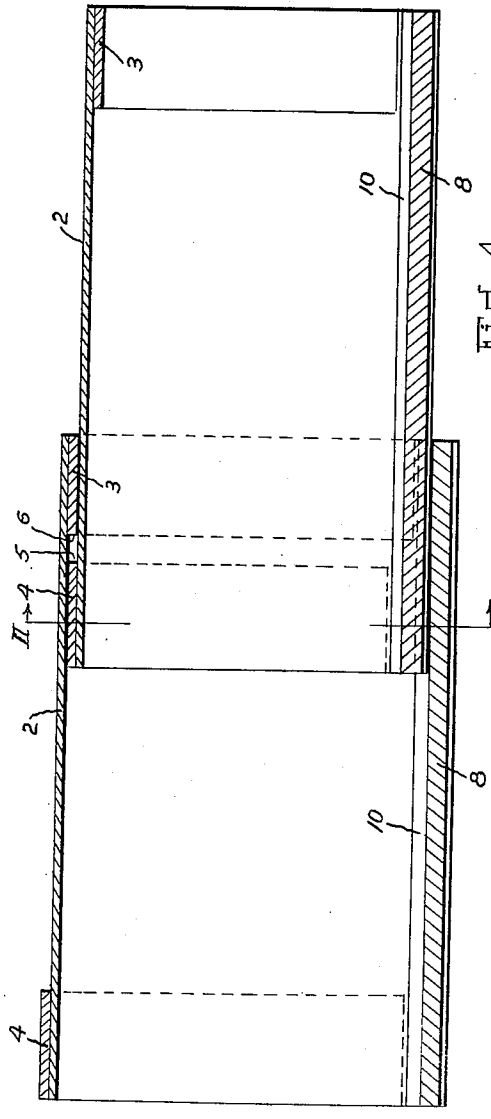
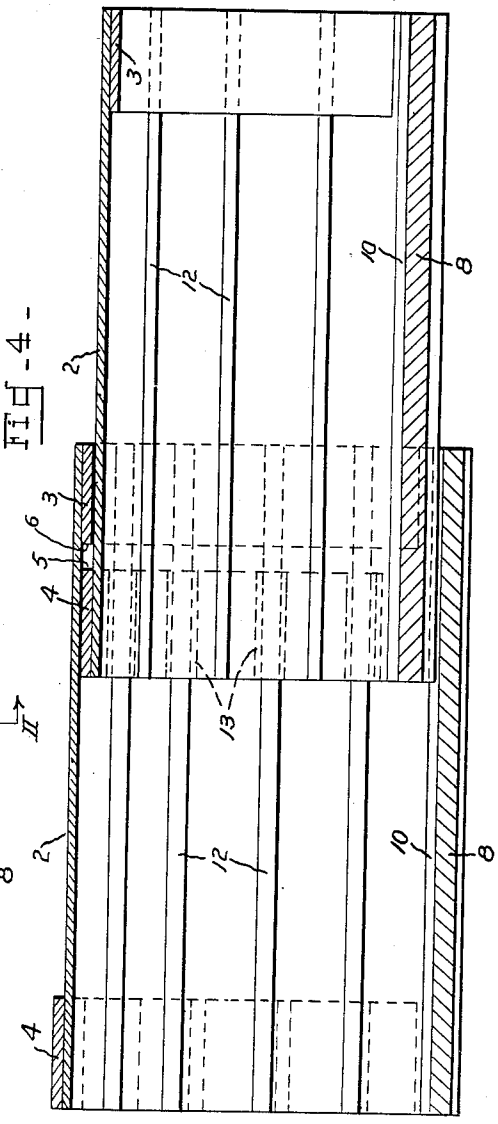


Fig. 1.

Fig. 4.



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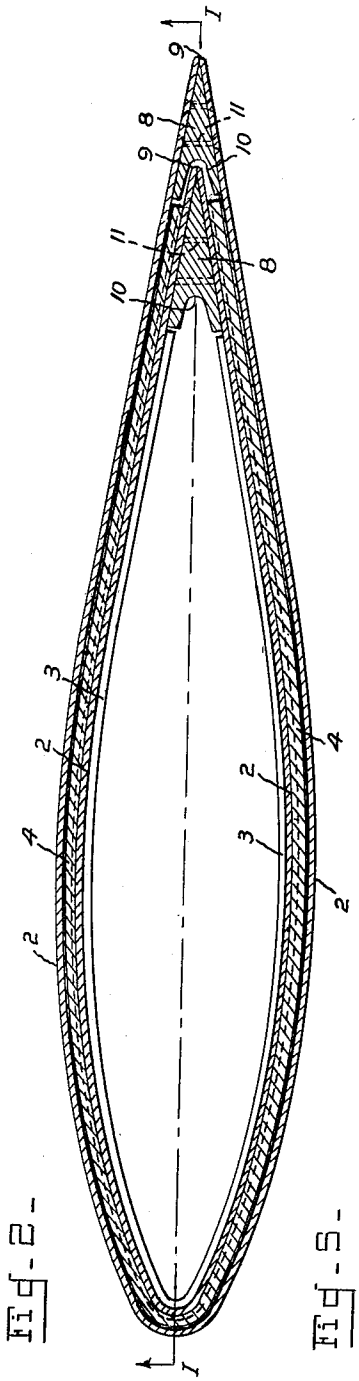


Fig. 2.

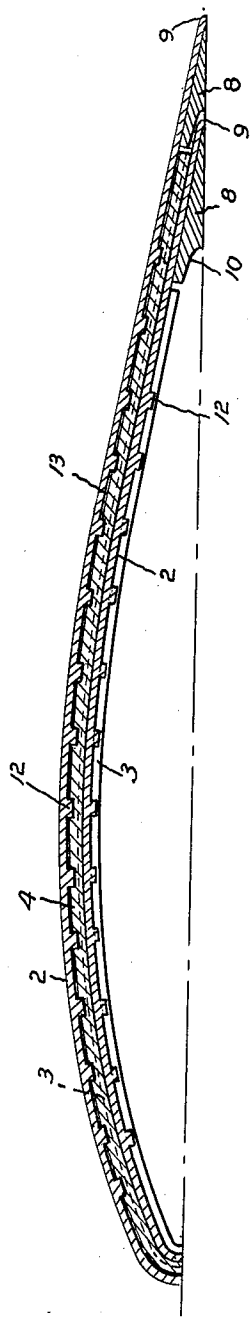


Fig. 5.

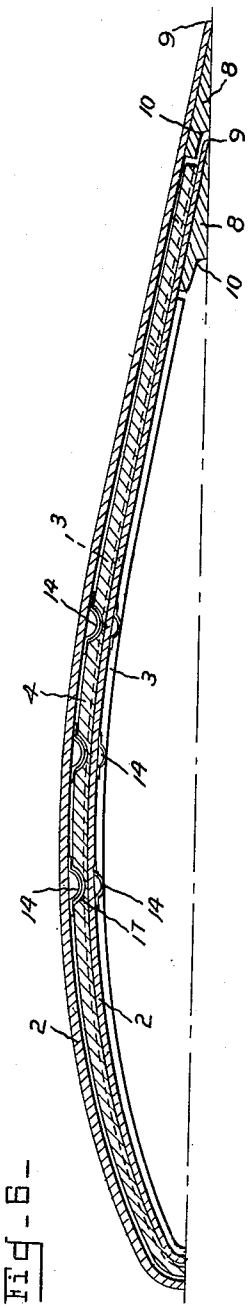


Fig. 6.

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Fig. 7.

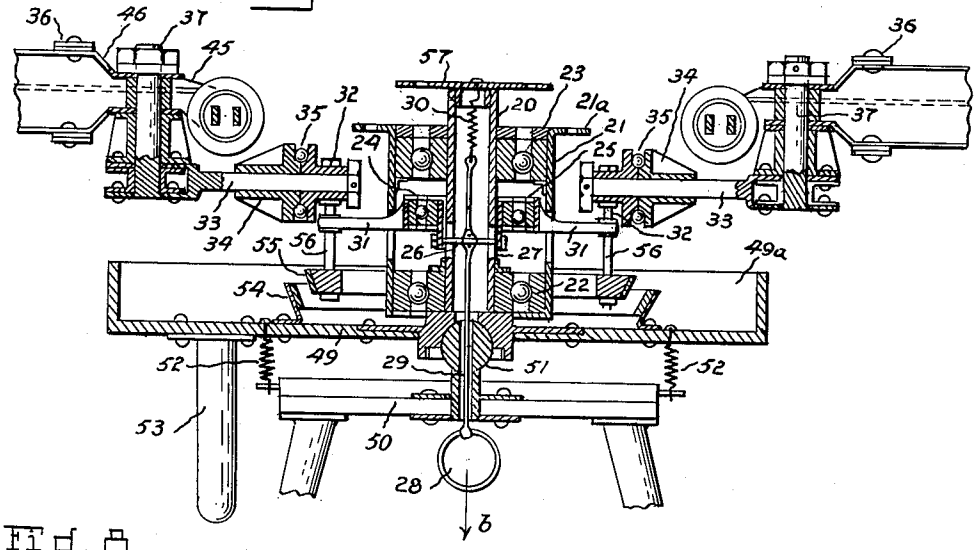
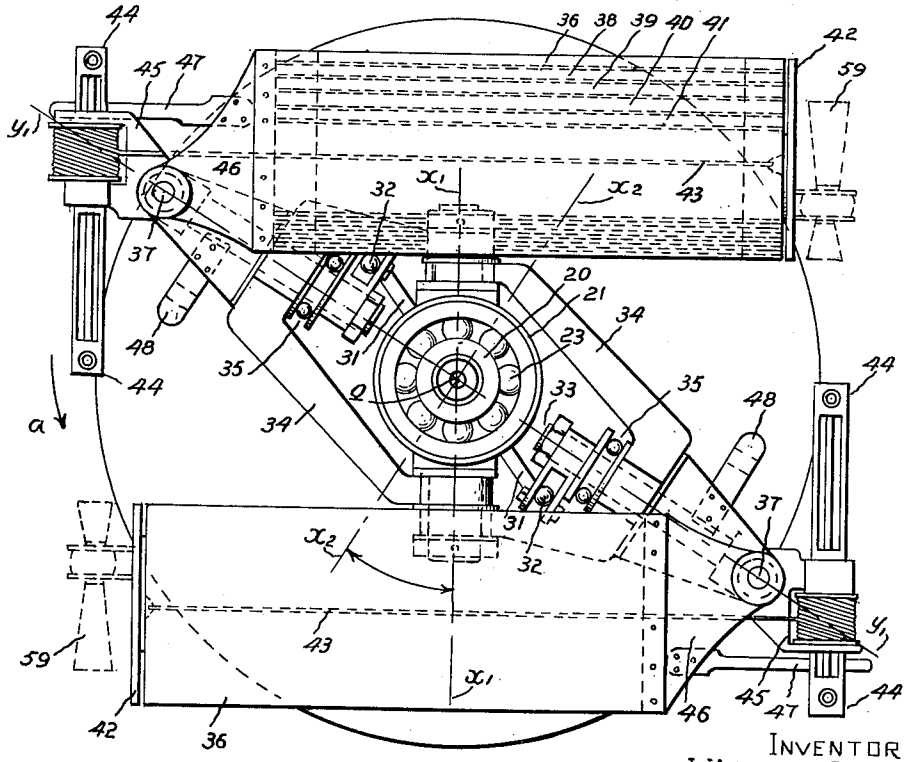


Fig. 8.



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SUSTAINING PROPELLER FOR FLYING MACHINES AND PARACHUTES

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Application November 16, 1946, Serial No. 710,266
In Great Britain November 27, 1945

5 Claims. (Cl. 170—135.75)

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This invention has reference to improvements in and relating to sustaining propellers for flying machines and rotating wing parachutes as have been described in copending applications Serial Nos. 688,270, filed August 3, 1946; 598,111, which has matured into Patent No. 2,457,376, December 28, 1948; and 598,112, which has matured into Patent No. 2,458,855, January 11, 1949.

According to the invention there is provided a sustaining propeller for helicopters and rotating wing parachutes, said propeller comprising two or more blades each of telescopic form, wherein the telescopic elements of the blades, of substantially precise aerofoil section, are provided internally of their trailing edges with bearers for the trailing edges of the telescopic elements immediately within them, said bearers lying between the trailing edges of the successive elements either for all (or substantially all) or for part of the length of the said elements.

Thus the present telescopic elements differ from those I have described in the said copending applications Nos. 688,270, 598,111 and 598,112, where the increase in the width of one element with respect to the other was the same for both the leading and trailing edges.

Another feature of the invention resides in the method of attachment of these blades to the central rotating hub, which allows for their horizontal articulation axis to be exactly or very near the centre of rotation of the propeller, although there is maintained the hinging vertical axis which allows for their suitable position before use.

Another feature of the invention resides in the simultaneous control of the pitch angle of the blades and also of a brake which allows the pilot to reduce and finally to stop the rotation of the propeller as soon as landing is achieved.

For helicopters and cabin or heavy weight parachutes, where the blade elements are relatively large, specially at and near their roots, a method to increase the rigidity of the skin of the corresponding elements is described in the present invention.

In the telescopic blade elements as I have described in my patent specifications above-mentioned the difference in the width of one element with respect to the other was determined by the respective thickness of the skins and of the shoulders and the play between them. The consecutive aerofoil sections obtained possessed an increasing deformation with respect to the original aerofoil section and consequently the sustaining efficiency of the propeller decreased considerably, while its drag cofficient increased.

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The present invention remedies this defect as the successive elements keep in their integrity the dimensions determined from the standard aerofoil section chosen.

To achieve this result, in the most usual cases the trailing edges of one element with respect to the other must be further apart, the gap being filled-up with a conveniently shaped part (a bearer) fixed to the trailing edges or forming part of them, the shape allowing always an easy sliding of one element with respect to the other.

Also for sufficiently wide elements, the rigidity of the skin elements would not be sufficient in practice. To remedy such cases, the elements are provided in their inside with small ribs cut into the thickness of the sheets constituting the elements, or also with separate ribs fixed to the skin at convenient places. The above-mentioned disposition at the trailing edges of the elements being kept also in this case.

The horizontal articulation of the blades passing through the central axis of rotation, constitutes an improvement for stability purposes, and the control of the blade's incidence, at the will of the pilot, will be particularly useful when landing is achieved.

The same for the brake, which will allow the pilot to stop the rotation of the propeller in a much shorter period of time without damage to the propeller.

In the accompanying drawings:

Fig. 1 is a longitudinal sectional plan of two consecutive telescopic elements of a propeller constructed in accordance with the invention, the plane of section being on the line I—I of Fig. 2;

Fig. 2 which is a sectional end elevation of the said elements in the plane indicated by the line II—II of Fig. 1;

Fig. 3 is a fragmentary view in sectional end elevation of a modified construction of the trailing edge of a telescopic element;

Fig. 4 is a plan view of two consecutive elements provided in addition to the bearers at their trailing edges with longitudinal strengthening ribs;

Fig. 5 is a half sectional end elevation of the elements shown in Fig. 4, the plane of section being indicated by the line V—V, Fig. 4;

Fig. 6 is a half-sectional end elevation of a further modification which is comparable with Fig. 5 except the ribs herein are provided by channel shaped metal strips applied to the inner surfaces of the skins of the sections;

Fig. 7 shows a preferred construction of the hub of a propeller according to the invention, the upper part of the parachute, flying machine or

the like on which the propeller is mounted being shown, the assembly being provided with a brake; and

Fig. 8 is a plan view of the assembly shown in Fig. 7, the blades being provided with jet engines as indicated in dotted lines.

The propeller blades 1 shown in Fig. 8 comprise a number of telescopic elements 2. Two of these elements are shown almost fully extended in Figs. 1 and 2 whereas in Fig. 8 all elements are shown nested. Moreover the blades are shown folded in their out of use position in Fig. 8. When they are in use their axes extend radially outwards in opposite directions from the centre of rotation *o* of the propeller and the elements 2 are extended relatively. In order to limit the extent of the outward movement of each element the extension occurring as a result of centrifugal force generated when the propeller is set in rotation in the direction of the arrow *a*, Fig. 8, all elements except the outermost ones are provided with internal fillets 3 (Fig. 1) at their outer ends whilst all elements except the innermost ones are provided with external fillets 4 at their inner ends. The shoulders 5 on the fillets 4 about the shoulders 6 on the fillets 3 when the elements 2 are extended. The fillets may be riveted, welded or otherwise suitably secured to the blade elements. Blades having these characteristics are described in the specifications of copending applications Nos. 688,270, 598,111 and 598,112.

The blade elements 2 are of precise aerofoil section. As a result the outside transverse dimensions of successively thinner elements decrease at a rate faster than do the thicknesses of the successive elements. In accordance with the present invention bearers or guides 8 on which the trailing edges of the inner elements can freely slide are disposed in the gaps which would otherwise lie between the trailing edges of the successive elements. Moreover, the trailing edges of the inner elements are rounded at 9 and the bearers are grooved in complementary manner at 10 to facilitate the said sliding. Owing to the arrangement described any tendency of the elements to wedge one within another is prevented and in practice relative sliding of the elements takes place freely.

The bearers preferably extend the full length of the trailing edges of the elements as shown in Figs. 1 and 4 but may be provided at intervals along the said elements. The bearers may be riveted, welded or otherwise secured to their respective blade elements. In Fig. 2 rivets are indicated at 11. The rivets also hold the adjacent edges of the sheet from which the skin is formed closed, said edges being at the trailing edge of the element.

Instead of making the blade elements of bent sheet metal and riveting or otherwise securing initially separate bearers to them the blade elements and the bearers in them may be integral as shown in Fig. 3, such part of the element as is shown being indicated by 2^a and the bearer by 8^a. The elements with integral bearers may be drawn or moulded, for example, as also may the elements shown in Figs. 1 and 2.

In order to impart added rigidity to the elements longitudinal ribs may be provided inside same, the fillets 3 then being slotted to accommodate the ribs. Two constructions of elements incorporating ribs are shown in Figs. 4 and 5 and Fig. 6.

In Figs. 4 and 5 the longitudinal ribs 12 are either machined out of the material of the skin or are otherwise made integrally therewith by a rolling, drawing or moulding operation. The grooves in the fillets 3 are indicated at 13.

In Fig. 6 the ribs 14, which run longitudinally of the elements are formed by flanged, channel section strips welded, riveted or otherwise secured to the integral surfaces of the skins by means of their flanges 15. The complementary grooves in the internal fillets 3 are indicated by 17.

It will be understood that the ribs 12 and 14 extend from the shoulders 6 to those ends of the elements surrounded by the fillets 4, as also in certain cases along the whole length of the elements as shown in Fig. 4.

In Figs. 7 and 8, 20 represents the central shaft of the propeller on which shaft the hub 21 is mounted in freely rotatable manner by means of the ball-bearings 22 and 23.

The ball-bearing control member 24 is freely slidable along the shaft and the outer hub portion 25 thereof is freely rotatable with respect to the shaft. A diametral pin 26 passes through a longitudinal slot 27 in the shaft 20 and is controlled by the pilot by pulling, according to arrow *b*, on the ring or the like 28 and hence on the wire 29 attached to the said ring and pin. A spring 30 raises the ball-bearing member 24.

The incidence of the blades is changed by movement of ball-bearing control member 24 which is freely slidable along the shaft 20. By pulling on ring 28 and wire 29, the inner ring of the ball-bearing 24 is slid downwards by the action on the diametral pin 26 which is solid with the inner ring of the ball-bearing 24, said diametral pin 26 passing through longitudinal slots 27 in the shaft 20.

When the ring 28 is released by the pilot, the spring 30 raises the ball-bearing member 24 and reverses the blade's incidence. The outer ring 25 of the ball-bearing member 24 is extended by radial legs 31 passing through slots of the rotating hub 21, these legs being connected to levers 32 which are fixed to rods 33 attached to the roots of the blades. The rods 33 bear against supporting forks 34 by means of a thrust bearing 35. It is thus clear that the action on the ring 28 will result in a change of the blade's incidence.

The outer elements 36 of the blades are hinged around vertical axles 37 rigid with the rods 33, and the forks 34 are hinged around an axis x_1x_1 which is inclined at an angle a towards the leading edge with relation to the axis x_2x_2, the latter axis being perpendicular to the longitudinal axis y_1y_1 of the blades when they are in position of flight.

The various elements of the blades 36, 38, 39, 40 and 41 (five only shown in the drawing) are seen in their collapsed position of rest (Fig. 8). To the innermost element 41 of each blade is attached a plate 42 to which is fixed a wire or the like 43 wound around the retractive device 44. This device has already been described in the specification of copending application No. 598,112. The devices are secured by means of brackets 45 to the fittings 46 at the root ends of the blade elements 36 so that they can act in any position of their respective blades during the hinging movements of the blades around their axles 37.

The locking means is analogous to the locking means described in the specifications of my

aforementioned patent applications. The legs **47** are fixed to the fittings **46** of the elements **36** and the catches **48** are fixed to the rods **33**. In this way they both participate in any oscillation of the blades around the horizontal axis x_1x_1.

To the lower part of the central shaft **20** is attached a plate **49** and the said shaft is attached to the upper part **50** of the machine or of the parachute, by means of a spherical joint **51**, in much the same way as is explained in the specifications of copending applications Nos. 598,112 and 649,674, now Patent No. 2,506,873, issued May 9, 1950.

Between the plate **49** and the plate **50** are fitted the springs **52** which damp any rapid movement of the propeller when the control lever **53** is acted upon in order to incline the axis of the propeller and direct the machine or the parachute in the required direction.

The brake is constituted in the example of two conic parts. The first part **54** is solid with the plate **49** and the second part **55** is solid with the rotating hub **21** owing to its attachment to the legs **31** by means of the rods **56**. Part **55** when lowered comes into contact with parts **54** and is normally held out of contact with the said part **55** by the spring **30**.

Both the brake and the ball-bearing system for the variation of the pitch angle of the blades are acted on by the same control, in the example the control is represented by the ring **28**, the wire **29** and the pin **26**, but on account of the necessary play left between parts **54** and **55** of the brake system, the braking action takes place only when the general pitch angle has been sufficiently operated.

The starting of the blades into rotation is effected by means of any of the methods described in the specifications of my previously mentioned patent applications.

For the parachutes, starting can be effected by means of an internal starting device constituted by an elastic or spring motor, which is located in the interior of the hollow **49***a* of the plate **49** substantially as described in the specification of copending application No. 598,111. In the case when the starting of the blades is realised by the fall of the body itself as described in the specification of copending application No. 598,112, the gearing device and the starting wire and pulley are respectively attached to the upper part **21***a* of the hub **21** and to the upper part **57** of the control shaft.

Finally the starting of the propeller can be effected by means of jets, or compressed air and gases, or powder, or any system giving the required thrust, these being mounted at the tips of the blades as shown in Fig. 8 where small jets **59** are indicated in dotted lines.

In the case of helicopter flying machines, the jets are mounted in a similar way, and the methods utilised for the feeding of these engines **59** has been described in the specification of copending application No. 688,270.

It is evident that the invention is not limited to the devices described, and that several alternative solutions can be applied which, however, do not alter the principles of the invention.

(1) The position and constitution and type of the brake can be altogether different.

(2) The control of the brake can be made separate from the control of the pitch angle control system.

(3) The controls of the brake and the pitch angle control system can be made either by double wire without the retracting spring or by a convenient rod or rods.

(4) The horizontal hinging axis of the blades can be fitted on a plate solid with the central hub, instead of being fitted direct on the said hub.

(5) The automatic locking device can be of an altogether different way of realisation.

(6) The method of the blades attachment to the vertical hinging axis can be different and can also be below the horizontal hinging axis, instead of being above it as shown in the drawings.

(7) The elements of the blades can be made advantageously of any convenient plastic material, instead of metal.

(8) According to the requirements of the aerofoil section, it may eventually become necessary to fit or otherwise provide inside the leading edges similar parts to that of the bearers at the trailing edges, but the relative width of one element with respect to the other will be greater in any case at the trailing edges.

What I claim is:

1. A sustaining propeller comprising a plurality of blades and each blade comprising a plurality of interfitting telescopic sections each of substantially precise areofoil form and each embodying internal strengthening ribs, bearers internally of the trailing edges of said sections to engage the trailing edges of the telescopic sections immediately within them and shoulders to limit the extension of said sections, said shoulders being grooved to accommodate the ribs.

2. A sustaining propeller comprising a plurality of blades and each blade comprising a plurality of interfitting telescopic sections each of substantially precise aerofoil form and each having a drawn or moulded skin, and bearers internally of the trailing edges of said sections to engage the trailing edges of the telescopic sections immediately within them, said bearers lying between the trailing edges of the successive sections for substantially the whole length of the said sections and being integral with the drawn or moulded skin.

3. A sustaining propeller, comprising a plurality of blades, each comprising interfitting telescopic sections, all of substantially precise aerofoil section, and each embodying internal strengthening ribs, and a filler member filling the space between the trailing edge of one nesting section and the section within it, said filler member being grooved longitudinally on the inner side to act as a bearer engaging the outer trailing edge of the section located within it.

4. A sustaining propeller, comprising a plurality of blades, each comprising interfitting telescopic sections, all of substantially precise aerofoil section, and a filler member filling the space between the trailing edge of one nesting section and the section within it, said filler member being grooved longitudinally on the inner side to act as a bearer engaging the outer trailing edge of the section located within it, a central rotating hub, forks at the root ends of said blades and pivotally mounted on said hub for permitting vertical reciprocation of said blades, a hollow member cooperative with said forks, means to permit the blades to hinge around a vertical axis at the outer end of the hollow member, and means to lock said blades after turning about said axis from a position of rest, said locking means including a part solid with the attach-

ment of said blade to the said vertical axis and another part solid with the fork connecting the end of the blade to the said hub.

5. A sustaining propeller, comprising a plurality of blades, each comprising interfitting telescopic sections, all of substantially precise aerofoil section, and a filler member filling the space between the trailing edge of one nesting section and the section within it, said filler member being grooved longitudinally on the inner side to act as a bearer engaging the outer trailing edge of the section located within it, means to control the general pitch angle of the blade, a brake to slow down and stop the rotation of the propeller and a common control for said pitch angle control means and for said brake whereby the brake becomes effective after the pitch angle has been appropriately modified.

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