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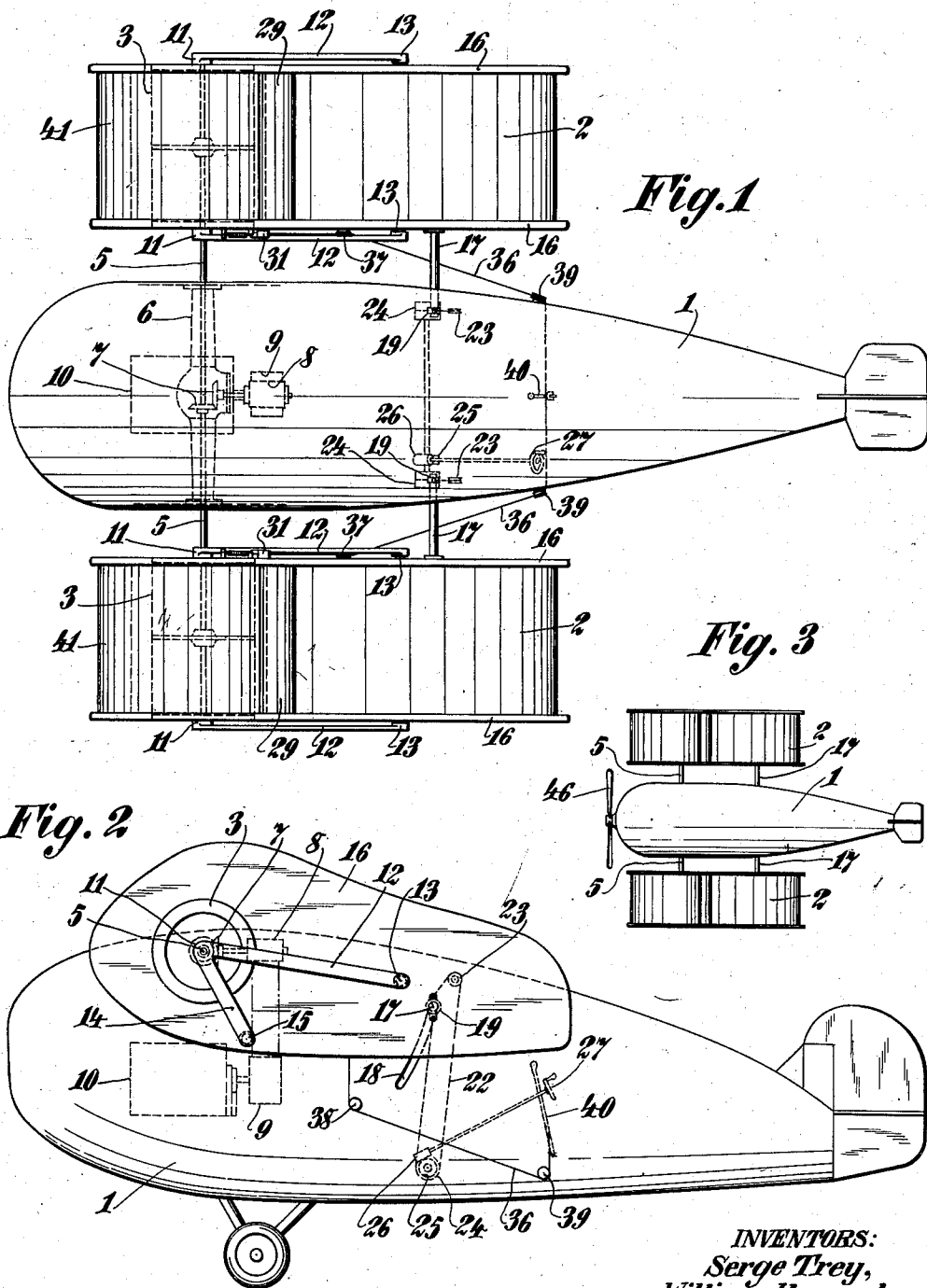
S. TREY ET AL

2,004,256

AEROFOIL

Filed Nov. 24, 1930

3 Sheets-Sheet 1



INVENTORS:
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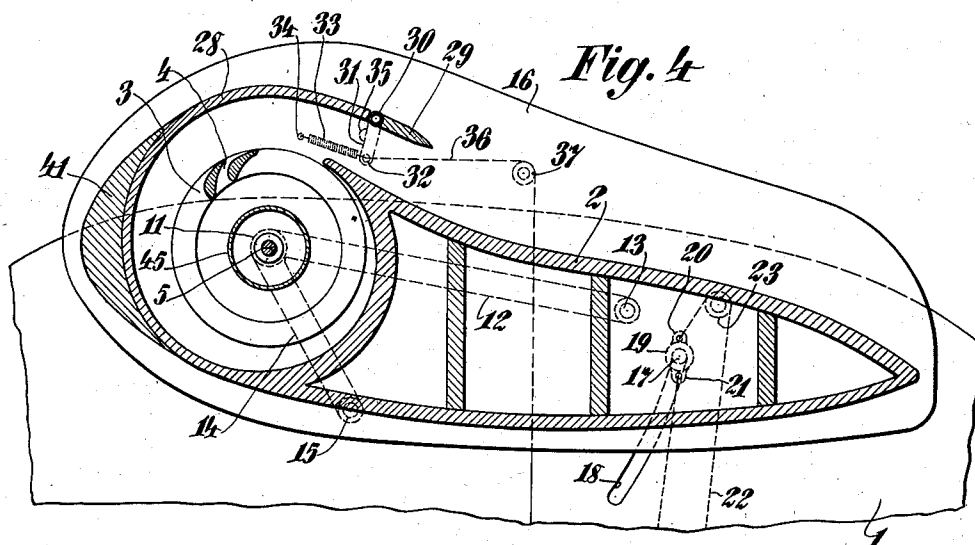
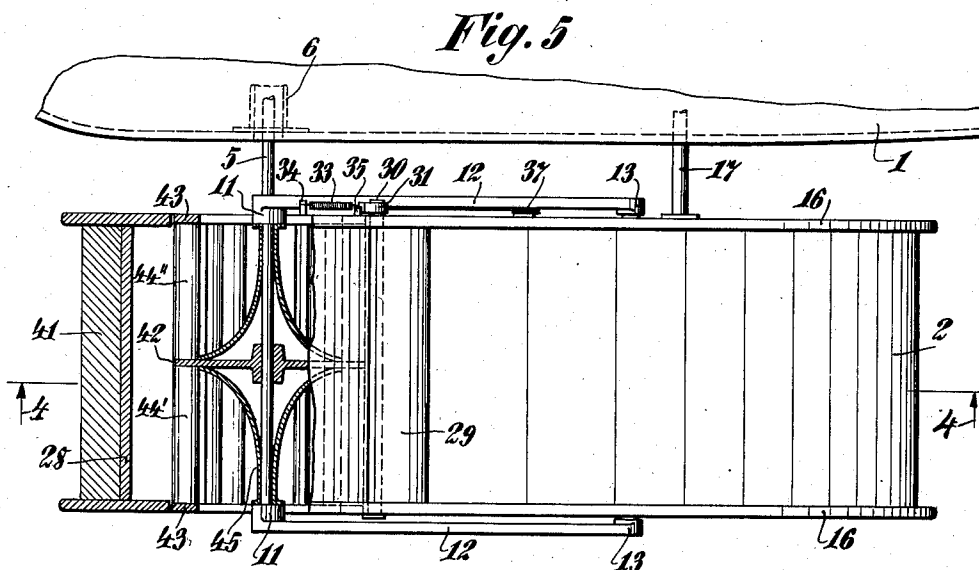
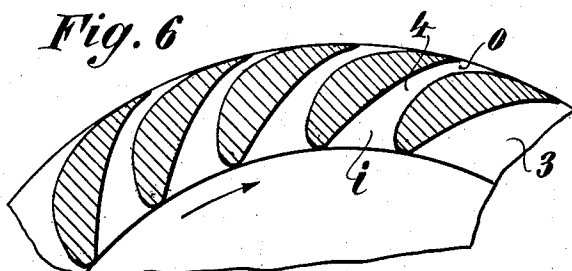
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AEROFOIL

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3 Sheets-Sheet 2



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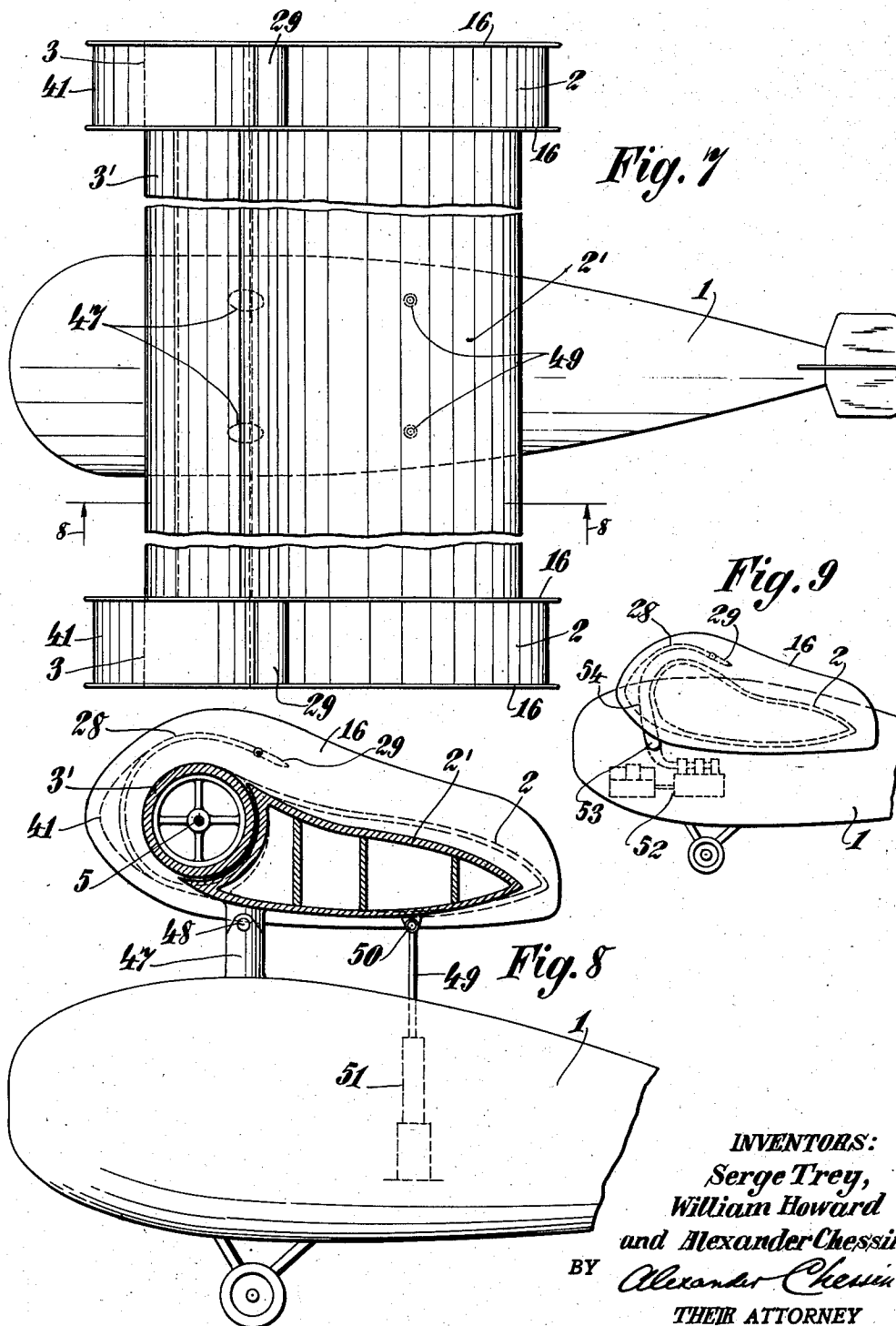
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UNITED STATES PATENT OFFICE

2,004,256

AEROFOIL

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30 Claims. (Cl. 244-18)

Our invention relates to aeroplane wings and, more particularly, to aerofoils having rotors at their leading edges.

The invention has several purposes in view, the principal objects being: increased lifting capacity, a more efficient form of propulsion, avoidance of accidents to the propelling means by confining it within the wing structure, ability to regulate the ratio of lift to drag, possibility of hovering in the air, diminished danger of nose dives and tail spins, and greater over-all efficiency of the plane.

In the drawings, Figure 1 is a top view of an aeroplane embodying our invention; Figure 2 is a side elevation of the same device; Figure 3 is a top view of a similar aeroplane but with the addition of a standard propeller; Figure 4 is a vertical cross section taken along the line 4-4 of Figure 5, the latter being a top view of the aerofoil shown in Figures 1 and 2, partly in cross section; Figure 6 is a detail of the rotor forming part of our invention; Figure 7 is a top view of a modified form of our invention; Figure 8 is a cross section taken along the line 8-8 of Figure 7; and Figure 9 is a somewhat schematic drawing illustrating a further modification of our invention.

Referring to the figures in detail, 1 is the fuselage and 2 are the wings of an aeroplane. At the leading edge of the wing or aerofoil 2 is a hollow, cylindrical rotor 3 provided along its peripheral surface with slots 4. The axle 5 of the rotor 3 is mounted in a housing 6 within the fuselage 1 and is rotated by means of a train composed of the beveled gears 7 and pulleys 8 and 9, the latter being rotated by the engine 10. The axle 5 is supported in bearings 11 held by means of braces 12 and 14, the braces 12 and 14 being secured, respectively, at 13 and 15, to the side plates 16 attached to the aerofoil 2. The aerofoils 2 are further connected to the fuselage 1 by means of rods 17 which are fixed, at one end, to the side plates 16. At the other end, the rods 17 pass through slots 18 in the fuselage 1 and are provided with flanges 19 having ears 20 and 21. From the ear 20, a wire 22 passes over a pulley 23 onto the drum 24 upon which it is wound, and thence to the ear 21. To the drum 24 is fixed, coaxially therewith, a worm gear 25 which is rotated by means of the worm 26. The latter is operated by means of the handle 27.

At the leading edge of the aerofoil 2, over the rotor 3, is a scrolled hood 28, at the end of which is an aileron 29 mounted to turn on an axle 30. The inclination of the aileron 29 is controlled in any suitable manner. As an illustration, there is

shown here an arm 31 rigidly affixed, at one end, to the aileron 29, and, at the other, 32, secured to a spring 33 attached to the side plate 16 at 34. From the end 32 of the arm 31, a wire or cord 36 passes over pulleys 37, 38 and 39, to a point of the control stick 40. A nose piece 41 may be added for a proper formation of the leading edge.

The slotted rotor 3, as shown, has a central plate 42 and two end rings 43, to which are attached in any suitable manner, as by riveting or spot welding, or both, the blades, made in two parts, 44' and 44''. The blades 44', 44'', are so curved as to cause the centrifugally expelled air to flow tangentially to the rotor, and they are so spaced as to make the slots 4 wider at the area of intake, marked by the letter *i* in Figure 6, than at the area of outlet, marked by the letter *o*. In speaking of the area of inlet or of outlet, it is to be understood, of course, that the area considered is that of a cross section normal (i. e. perpendicular to the tangent) to the slot boundary surface. The central plate 42 is integral with the axle 5 of the rotor 3 and with the reinforcements 45. The curved conical shape of the reinforcements 45 facilitates the suction of air into the cylinder from its open ends. The side plates 16 are provided with openings conforming to the open ends of the rotor, i. e. they have circular holes of a diameter equal to the internal diameter of the rotor 3, so that the side plates 16 cover the ends of the rotor blades 44', 44''.

A standard propeller 46 may be added in some cases where additional speed is desired (see Figure 3).

Referring more particularly to Figures 7 and 8, a combination of a smooth rotor with a slotted rotor is shown. The portion of the wing having a smooth rotor at its leading edge is in every way similar to the aerofoil disclosed in the copending application of one of the present applicants, Ser. No. 295274. The rotor has a smooth portion 3' in the middle and two slotted portions 3 at the ends. The slotted portions are identical with the rotors shown in Figures 4 and 5. The aerofoil extends over the fuselage, as against the construction shown in Figure 1, with the aerofoils situated on each side of the fuselage. The wing is pivotally connected at 48 to the strut 47, and, at 50, to the rod 49 operated by a hydraulic jack 51. The sections of the wing having slotted rotors are separated from the section having a smooth rotor by side plates 16 similar to the end side plates 16.

In all of the figures, the profile of the aerofoil is in accordance with the construction disclosed in the aforesaid application Ser. No. 295274, i. e.,

the upper surface of the wing has a concave portion adjacent the rotor followed by a convex portion ending at the trailing edge. The lower surface of the aerofoil, as shown, has a convex camber which is one of the forms specified in the above mentioned application although not illustrated therein.

It will be noted that, in the case of the combination slotted and smooth rotors, the profiles of the sections 2 and 2' of the aerofoil have the same general characteristics and conform to the construction disclosed in the aforesaid application Ser. No. 295274, but they need not be identical in shape, or of the same dimensions.

It should, further, be noted that the form of the profile of the wing does not constitute a part of the present invention which is independent of the profile and may be combined with a wing of any shape, although it is preferred to have the aerofoil profile as shown, i. e. with an upper surface having a concave portion adjacent the rotor, followed by a convex portion ending at the trailing edge, and an under surface having a convex camber, because of the higher efficiency of such a profile when an aerofoil is provided with a rotor at its leading edge.

While a centrifugal blower has been shown here, located at the leading edge of the aerofoil, it should be understood that we do not mean to limit ourselves to this particular embodiment of our invention. The means for creating the air stream over the top surface of the aerofoil need not be located at the leading edge, so long as the created stream is made to emanate from under the hood and is directed over the top surface of the aerofoil. To illustrate this point, we have shown, in Figure 9, somewhat schematically, an arrangement wherein the stream of air is created elsewhere than at the leading edge. As shown in Figure 9, the air stream is created by a compressor 52 within the fuselage 1 and is led into the aerofoil by means of the manifold 53, whence it passes through the channel 54, at the leading edge of the aerofoil, under the hood 23 and over the top surface of the aerofoil 2. However, the centrifugal blower at the leading edge, and, more particularly, the slotted cylindrical rotor, appears to be the most efficient and, therefore, preferable form of the means for creating the air flow over the top surface of the aerofoil.

The main objects of our invention have been mentioned in the preamble. Experiments in our tunnel, in the city of New York, have shown that the lifting capacity of an aerofoil embodying our invention is far in excess of that obtainable in wings of standard construction. This is due, for the most part, to the scientifically correct aerodynamic conditions. The greatly increased air velocity over the top wing surface is accomplished without any burbling or vortices. The propulsion is more effective, also, because the displacement of air is where it produces the maximum results. When a standard propeller is used, the displacement of the air is cylindrical, whereas, in the aerofoil embodying our invention, the displacement is in sheet form over the top surface of the wing. Besides, by confining the propelling means within the wing structure, the danger of accidents to a propeller is eliminated. Another safety feature is the greatly diminished chance of a nose dive or tail spin. This is due to the fact that, in a wing embodying our invention, the center of pressure does not materially change its position when the angle of incidence is changed. In the standard wings of today, the center of pressure

moves in a direction such as to enhance the tendency developed by the plane, i. e. the center of pressure moves forward when the tail of the wing dips, and it moves backward when the nose of the plane dips; in other words, the center of pressure moves in a direction such as to destabilize the plane. In a wing embodying our invention, the center of pressure either remains stationary or, if it moves at all, it does so in a direction towards stabilization of the plane.

Among the objects of the invention was mentioned the ability to regulate the ratio of lift to drag. This is accomplished by the arrangement shown in the drawings whereby the wing may be inclined relatively to the fuselage. In this arrangement, the fuselage remains horizontal, if so desired. As the angle between the wing and the fuselage increases, the lift increases, while the drag decreases. At a certain angle, which depends on the specific structural features and dimensions of the plane, there will be no propulsion at all, only lift, i. e. the plane will hover in the air. For an experimental wing built in connection with the above mentioned tunnel experiments, the hovering angle was about 37°.

The propulsion is effected without a propeller, properly speaking, by developing a negative drag. However, there is nothing to prevent one from adding a standard propeller to the device, as is illustrated in Figure 3, as, for instance, in the case where additional speed is desired.

Having fully described our invention and illustrated it in several embodiments thereof, with the understanding that these illustrations are in no sense intended to be considered otherwise than illustrations, and that numerous modifications within the scope of the invention may be made by those skilled in the art, we claim:

1. An aerofoil comprising means at and within the leading edge thereof for creating a stream of air, a hood extending from said leading edge for directing said stream over the top surface of said aerofoil, and an aileron on the end of said hood.
2. An aerofoil comprising means at and within the leading edge thereof for creating a stream of air, a hood extending from said leading edge for directing said stream over the top surface of said aerofoil, an aileron at the end of said hood, and means for changing the inclination of said aileron.
3. An aerofoil comprising means at and within the leading edge thereof for creating a stream of air, a hood extending from said leading edge for directing said stream over the top surface of said aerofoil, and side plates on said aerofoil projecting beyond its surface and extending at least as far as the surface of said hood.
4. An aerofoil comprising a centrifugal blower at its leading edge, a hood over said blower for directing the air actuated by said blower over the top surface of said aerofoil, and an aileron at the end of said hood.
5. An aerofoil comprising a centrifugal blower at its leading edge, a hood over said blower for directing the air actuated by said blower over the top surface of said aerofoil, and side plates on said aerofoil projecting beyond its surface and extending at least as far as the surface of said hood.
6. An aerofoil comprising, at its leading edge, a rotor open at its ends for the admission of air thereinto and provided with openings along its peripheral surface for the passage of said air, and a hood over said rotor for directing said air

from said peripheral openings over the top surface of said aerofoil.

7. An aerofoil comprising, at its leading edge, a rotor open at its ends for the admission of air therinto and provided with openings along its peripheral surface for the passage of said air, a hood over said rotor for directing said air from said peripheral openings over the top surface of said aerofoil, an aileron at the end of said hood, and means for changing the inclination of said aileron.

8. An aerofoil comprising, at its leading edge, a rotor open at its ends for the admission of air therinto and provided with openings along its peripheral surface for the passage of said air, a hood over said rotor for directing said air from said peripheral openings over the top surface of said aerofoil, and side plates on said aerofoil projecting beyond its surface and extending at least as far as the surface of said hood, said plates being provided with openings conforming with the open ends of said rotor.

9. An aerofoil comprising, at its leading edge, a rotor open at its ends for the admission of air therinto and provided with openings along its peripheral surface for the passage of said air, a scrolled hood over said rotor for directing said air from said peripheral openings over the top surface of said aerofoil, an aileron at the end of said hood, means for changing the inclination of said aileron, and side plates on said aerofoil projecting beyond its surface and extending at least as far as the surface of said hood, said plates being provided with openings conforming to the open ends of said rotor.

10. An aerofoil comprising, at its leading edge, an open end, hollow, cylindrical rotor provided with slots along its peripheral surface, and a hood over said rotor.

11. An aerofoil comprising, at its leading edge, an open end, hollow, cylindrical rotor provided with slots along its peripheral surface, a scrolled hood over said rotor, and an aileron at the end of said hood.

12. An aerofoil comprising, at its leading edge, an open end, hollow, cylindrical rotor provided with slots along its peripheral surface, a scrolled hood over said rotor, and side plates on said aerofoil projecting beyond its surface and extending at least as far as the surface of said hood, said plates having openings conforming to the open ends of said rotor.

13. An aerofoil comprising, at its leading edge, an open end, hollow, cylindrical rotor provided with slots along its peripheral surface, a scrolled hood over said rotor, an aileron at the end of said hood, side plates on said aerofoil projecting beyond its surface and extending at least as far as the surface of said hood, said plates having openings conforming to the open ends of said rotor, and means for changing the inclination of said aileron.

14. An aerofoil comprising, at its leading edge, an open end, hollow, cylindrical rotor provided with slots along its peripheral surface, the areas of the transverse sections of said slots being greater at the intake end than at the outlet end.

15. An aerofoil comprising, at its leading edge, an open end, hollow, cylindrical rotor provided with curved slots along its peripheral surface, the transverse sections of said slots gradually diminishing in area from the intake end to the outlet end.

16. An aerofoil comprising, at its leading edge,

an open end, hollow, cylindrical rotor provided with blades along its peripheral surface, parallel to the axis of said rotor and having curved transverse sections, the curvature of said blades being such as to direct air tangentially to said rotor, and said blades being so spaced as to be nearer one another at the discharge end than at the ingress end.

17. An aerofoil comprising, at its leading edge, an open end cylindrical rotor provided with blades along its peripheral surface, parallel to the axis of said rotor and having curved transverse sections, the curvature of said blades being such as to direct air tangentially to said rotor, and said blades being so spaced as to be nearer one another at the discharge end than at the ingress end, and means for directing air from the open ends of said rotor into the space between said blades.

18. An aerofoil comprising, at its leading edge, an open end cylindrical rotor provided with slots along its peripheral surface, and a scrolled hood over said rotor, the upper surface of said aerofoil having a concave portion adjacent said rotor followed by a convex portion ending at the trailing edge.

19. An aerofoil comprising, at its leading edge, an open end cylindrical rotor provided with slots along its peripheral surface, a scrolled hood over said rotor, an aileron at the end of said hood, means for changing the inclination of said aileron, and side plates on said aerofoil projecting beyond its surface and extending at least as far as the surface of said hood, said plates being provided with openings conforming to the open ends of said rotor, the upper surface of said aerofoil having a concave portion adjacent said rotor followed by a convex portion ending at the trailing edge, and the lower surface of said aerofoil having a convex camber.

20. An aerofoil comprising, at its leading edge, a rotor open at its ends for the admission of air therinto and provided with openings along a portion of its peripheral surface for the passage of said air, and a scrolled hood over the portion of said rotor having said peripheral openings for directing the air from said peripheral openings over the top surface of said aerofoil.

21. An aerofoil comprising, at its leading edge, a rotor open at its ends for the admission of air therinto and provided with openings along the end portions of its peripheral surface for the passage of said air, and scrolled hoods over said end portions of the rotor for directing the air from said peripheral openings over the top surface of said aerofoil.

22. An aerofoil comprising, at its leading edge, a rotor open at its ends for the admission of air therinto and provided with openings along the end portions of its peripheral surface for the passage of said air, scrolled hoods over said end portions of the rotor, side plates on said aerofoil, and plates separating the portions of said aerofoil corresponding to the end portions of said rotor from the remaining portion of said aerofoil, all of said plates projecting beyond the surface of said aerofoil and extending at least as far as the surfaces of said hoods, said plates being provided with openings conforming with the open ends of said rotor.

23. An aerofoil comprising, at its leading edge, a rotor open at the ends for the admission of air therinto and provided with openings along a portion of its peripheral surface for the passage of said air, a scrolled hood over the portion of said rotor having said peripheral openings, an aileron

at the end of said hood, and side plates separating the portion of said aerofoil corresponding to the portion of said rotor having said peripheral openings from the remaining portion of said aerofoil, said plates projecting beyond the surface of said aerofoil and extending at least as far as the surface of said hood, and having openings conforming to the open ends of said rotor.

24. The combination with a fuselage, of an aerofoil in variable angular relation thereto, comprising means for creating a stream of air at its leading edge, a hood extending from said leading edge for directing said stream over the top surface of said aerofoil, and means for changing the direction of said stream by varying the inclination of said aerofoil relatively to said fuselage.

25. The combination with a fuselage, of an aerofoil in variable angular relation thereto and comprising, at its leading edge, a centrifugal blower, a hood over said blower for directing air from said blower over the top surface of said aerofoil, and means for changing the direction of flow of said air by varying the inclination of said aerofoil relatively to said fuselage.

26. The combination with a fuselage, of an aerofoil in variable angular relation thereto and comprising, at its leading edge, an open end cylindrical rotor provided with slots along its peripheral surface, a scrolled hood over said rotor for directing air from said slots over the top surface of said

aerofoil, and means for changing the direction of flow of said air by varying the inclination of said aerofoil relatively to said fuselage.

27. An aerofoil comprising means for creating a stream of air at the leading edge thereof, said air being admitted at the outer ends of said leading edge, and a hood over said leading edge for directing said stream over the top surface of said aerofoil.

28. An aerofoil comprising a centrifugal blower at its leading edge provided with means for admitting air at the outer ends of said leading edge, and a hood over said blower for directing the air actuated by said blower over the top surface of said aerofoil.

29. An aerofoil comprising mechanical means at and within the leading edge thereof for creating a stream of air, said air being admitted at the outer ends of said leading edge, and a hood over said leading edge for directing said stream over the top surface of said aerofoil.

30. An aerofoil comprising a centrifugal blower, at and within its leading edge, provided with means for admitting air at the outer ends of said leading edge, and a hood over said blower for directing the air actuated by the blower over the top surface of said aerofoil.

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