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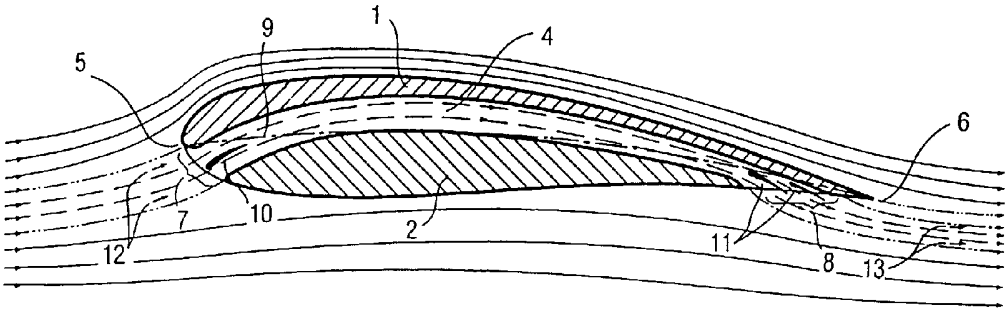
(54) **Title:** WING ABLE TO ENHANCE LIFT BY INTERNAL AIR FLOW



(57) **Abstract:** Wing able to enhance lift power by inner air flow, is solution of wing that results in increased and changeable lift power, with lesser increase of aerodynamic resistance than with conventional wings. In the invention basic embodiment, the wing is provided with free aerodynamic air-flow through a specially designed tunnel (4) running from the opening below the wing front edge (5) to the wing exit edge (6). Turning of the blades (11) enables adjusting of angle of the air flow (13) exiting from the tunnel (4), and their synchronous turning with the gate (15) enables partial or complete closing of the tunnel (4) and turning of the wing into a l conventional wing with closed profile contour. The principle of this technical solution is applicable, with adequate adjustments, to glider-paraglider and kite wings, made of fabrics, and to wind-generator rotor wings.

WO 03/039949 A2

WING ABLE TO ENHANCE LIFT BY INTERNAL AIR FLOW

INVENTION DESCRIPTION

1. FIELD OF APPLICATION

The invention relates to wing with specially designed internal tunnel whose aerodynamic profile enables internal flow of air, this resulting in additional lifting power at the wing.
It is classified in the International Patent Classification as Class B 64 C: Aeroplanes; Helicopters – group 3/00: Wings – Subgroup 3/14: Aerofoil Profile.
Since the said type of wing can be applied to wings with adjustable parts to increase camber, wings made of fabric and wind-generator rotor blades, the invention can also be classified as 3/50: Varying camber by leading or trailing edge flaps, or 31/00: Aircraft intended to be sustained without power plant; powered hang-glider-type aircraft; Microlight-type aircraft, as well as F 03 D: Wind motors.

2. TECHNICAL PROBLEM

Wing is the most important element of an aircraft or wind-generator structure, which determines its flying or lifting properties. Wing is to produce lift power sufficient to lift and carry an aircraft, with as least as possible aerodynamic resistance in all flight or wind-generator working conditions, at a given wind speed and generator load.
A wing's aerodynamic lift force results from positive difference of air pressures at the wing's under and upper surfaces, which again results from air asymmetrical flow and circulation around the wing profile in flight. The lift force depends on aerodynamic parameters: lift coefficient of the selected wing aerodynamic profile, air density, wing speed through air and size of the wing carrying surface.
Selection of type of aerodynamic profile is aimed to achieving the optimum relation of lift and resistance forces, that is, the lift and resistance coefficients, in all flight conditions and stages. Normally, the attempt is to obtain the most favourable relation of lift and resistance forces in the flight conditions and stages that the aircraft is primarily intended for. Every deviation from such conditions, such as speed decrease at take-off and landing, changes of load, etc., require adjustment of the lift force, which results in aircraft propulsion increased power consumption.

The technical problem that is solved by this invention is related to structure of the wing that will, with the same aerodynamic parameters, obtain larger and adjustable lift force, with the least possible increase of aerodynamic resistance and the least possible loading of the aircraft with mass and complexity of the technical solution.

3. STATE OF THE ART

Most solutions of the above described technical problem, that are tested and practised, may be classified in a few technically close groups:

1. Solutions based upon changing of geometry and camber of the wing aerodynamic profile by means of moving and swinging of mobile front and back parts of wings such as ailerons, single- and multi-part flaps, slats, swinging of the wing front edge, etc.
2. Solutions based upon changing of geometry and camber of the wing aerodynamic profile by means of continuous changing of camber such as swinging of elastic front and back pats of the wing by in the wing built moving mechanisms, or swinging of parts of wing that are made of fabrics or similar materials, as it is with kites, gliders and paragliders.
3. Solutions based upon changing of wing geometry and size by adding elements for changing the aerodynamic profile geometry, such as changing of camber of the mobile part of the wing, connected to the aircraft body by joints.
4. Solutions influencing the air boundary layer or speed along the wing profile, such as acceleration of the air boundary layer by injecting of compressed air, suction of slowed down and disturbed boundary layer by additional air from the aircraft turbopropulsor, most often along the wing upper surface or beneath the back part of the wing – creation of air ailerons.

4. DISCLOSURE OF THE INVENTION

The essence of the invention is a wing whose aerodynamic profile does not have a closed outer contour, but along the wing profile there is a specially designed tunnel to cause air flow through the wing. The tunnel shape and position in the wing is such that its vertical cross-section in the flight direction is positioned along the wing aerodynamic profile causing the tunnel front – intake opening to be by the entire or most part of its cross-section below the profile axis of symmetry, whereas the tunnel entire outlet opening is below the profile axis of symmetry at the back – outlet wing edge. Thus, by the flight dynamics, the tunnel takes a part of the air stream that would, with wings of conventional – closed profile, flow by the wing underside, and directs it through the tunnel inner camber and lets it out below the wing back edge. The shape of the wing intake part, and the built-in flaps, direct the intaken part of air stream upwards, whereas the tunnel outlet opening, and the built-in directing flaps, direct the same air stream downward. Moving of the wing through air creates aerodynamic pressure at the tunnel intake and much lower aerostatic pressure at the tunnel outlet, which assures the pressure gradient for the inner air flow.

Further invention aims, in its particular variants are:

- further enhancing of the lift force by injecting into the tunnel of air brought from the propulsion turbopulsor;
- enhancing of characteristics of existing solutions of increasing the lift force, such as with wings with flaps;
- application to wings with carrying surface made of fabrics or similar materials, such as wings of gliders and kites;
- application to wind-generator blades.

5. ILLUSTRATION DESCRIPTIONS

Figure 1. shows the basic structure of a wing with internal air-flow – view of the lower surface and partial cross-section.

Figure 2. shows aerodynamic air flow of the wing in Fig. 1

Figure 3. shows wing with built-in devices for closing the internal-air-flow tunnel intake opening and the additional, forced, flow.

Figure 4. shows wing shown in Fig. 3 with partly closed tunnel intake opening.

Figure 5. shows wing shown in Fig. 3 and 4 with completely closed tunnel intake opening.

Figure 6. shows wing with built-in one-piece flap in pulled in position.

Figure 7. shows wing shown in Fig. 6 with one-piece flap in pulled out position.

Figure 8. shows invention application to a glider-paraglider wing, outlook and a partial cross-section.

Figure 9. shows wing shown in Fig. 8 with aerodynamic flows of a glider profile.

Figure 10. shows invention application to a kite – view from below.

Figure 11. shows aerodynamic flows of kite wing shown in Fig. 10.

6. DETAILED DESCRIPTION OF THE INVENTION EMBODIMENT

The invention will be described and shown as a wing able to enhance the lift by air flowing through a tunnel, in the basic and some other embodiments that enable change of the lift force:

- wing able to increase the lift by air flowing through the tunnel, in its basic embodiment;
- wing variants that enable changing the lift force by building of movable or immovable back blades in the tunnel, to direct the exiting air streams, by building in gate for partial or complete closing of the tunnel intake opening and synchronous turning of exit directing blades, and increasing the lift force by building in air supply into the tunnel from the aircraft turbopropulsor;
- wing variant that enables increase of the lift force by improving the conventional wing design – tunnel through wings and flaps;
- invention application with tunnel placed through wing, the carrying surface of which is made of fabrics or similar materials, such as glider-paraglider wings;
- invention application with tunnel placed through wing, the carrying surface of which is made of fabrics fixed between hard-structure elements, such as kites;
- invention application to wing used as a wind-generator rotor blade.

Description of the above mentioned embodiments and variants

The basic structure of the wing with tunnel for increasing the lift force by interior air flow is shown in Figs. 1 and 2.

The wing consists of aerodynamically shaped carrying surfaces, the top surface 1 and the bottom surface 2, mutually connected by connecting ribs 3 throughout the length of the profile, at certain distances. Planes 1 and 2, with connecting ribs 3, make a unique wing structure, whose vertical, cross, section in the flight direction, produces the selected wing aerodynamic profile. Inner surfaces of shaped planes 1 and 2, with their mutual distance and the connecting ribs 3 mutual distance, make aerodynamically shaped tunnel 4 for interior air flow. The tunnel 4 runs from the front wing edge 5, with opening 7, to the back wing edge 6, with opening 8. Opening 7, of the incoming air flow 12, is placed mostly or completely below the axis of symmetry of the aerodynamic profile 9. Opening 8, of the exiting air flow 13, is placed completely below the axis of symmetry of the aerodynamic profile 9, by the wing back edge 6 (Fig. 2). Tunnel 4 is placed within the wing profile so that from the air flow in front of the wing, at the wing front edge 5, there is separated an upgoing air flow 12 that is directed upwards into the tunnel 4. In the exit part of the tunnel 4, the air flow is directed downwards in order to obtain a downgoing exiting air flow 13. In the invention basic embodiment, in the tunnel 4 there are placed adequate front directing blades 10, to direct the incoming air flow 12, and back directing blades 11, to direct the exiting air flow 13.

Invention embodiment with tunnel provided with immovable or movable directing back blades, gate for partial or complete closing of the tunnel intake opening and synchronous turning of exit directing blades, and bringing air into the tunnel from the aircraft turbopropulsor, as shown in Figs. 3, 4 and 5.

a) Blades 11 have aerodynamic profile and are built in the exit opening 8 of the tunnel 4, running between two adjacent connecting ribs 3, that limit the tunnel 4 width laterally. Blades 11, in their immovable variant, are fitted at the angle that, with selected aerodynamic parameters, produce the selected aberration of the exit air flow 13 and its impact to the lift force.
b) In their movable variant, blades 11 may turn in the vertical plane around their longitudinal axis 14 which runs between the connecting ribs 3, and is achieved by adequate mechanism placed within the structure of the connecting ribs 3. This variant of blades 11 enables fine tuning of the lift force from the blade angle, which by turning the exit air flow 13 down, provides the best increase of the lift force, to complete closing of the exit opening 8 and adjustment of blade surface 11 with the outer surface line of the wing bottom plane 2.
c) The same invention embodiment also enables simultaneous turning of exit directing blades 11, by moving of the gate 15, for partial or complete closing of the intake opening 7. The mechanism for closing the intake opening 7, of the tunnel 4, consists of: gate 15, shaped according to the wing front-part profile, gate guides and moving mechanism 16, located within the wing and the connecting ribs 3 structure, and of the mobile aberration plate 18, which at partial closing of the intake opening 7, leans against the directing blades 10, this aimed to adjusting of the intake shape of the tunnel 4 to the reduced air-flow requirements.

d) The invention embodiment that enables additional increase of the lift force is made, as shown in Fig. 3, by fitting of tubes 19 with nozzle 20 into the wing bottom plane 2. Compressed air is brought from the aircraft turbopropulsor and taken into the tunnel 4 by nozzles 20, in the free-flow direction, increasing its volume and flow speed and effect to the wing lift. In the same way, in this invention embodiment, the tunnel may be injected water aerosol, the effect of which is inertia and turning the exit air flow 13 down.

Invention embodiment that enables lift force increase by improving the conventional wing solutions, such as solutions with changing of the wing profile camber by turning flaps, tunnel running through wings and flaps, as shown in Figs. 6 and 7.

The mobile flap 21 is continuation of the wing exit part, made in accordance with the basic solution of the invention, including the end part of the air-flow tunnel 4 with directing blades 11 for directing the exit air force 13, built in the exit opening 8. Flap 21 is fitted to the movable part of the gondola 23, and the gondola is fitted through the joint 26 and the moving mechanism 25 to the immovable part of the gondola 24, which is fitted to the aircraft wing structure about the connecting ribs 3, that connect wing both carrying planes 1 and 2.

In the basic, pulled-in, position of the flaps 21, as shown in Fig. 6, the flap 21 is in the air flow coming from the tunnel 4, the same air flowing on to blades 11 for directing exit air flow, to the exit opening 8, forming thereby less or more down turned air flow 13 below wings. The effect of the air flow passing through the wing and its direction to the lift force can, as required, be diminished by lifting the spoiler 27 which is connected to the wing top carrying surface 1 and covers the gap between the wing and the flap. By rising the spoiler, which is an already known technical solution, a part of the air coming from the tunnel 4 is let above the flap, also lifting and pushing the air flow which passes above the wing carrying plane 1, acting thereby as a lift damper).

When the flap 21 is pulled out and turned down, as shown in the Fig. 7, the air coming from tunnel 4 flows also through the flap tunnel and above the flap top plane. This enables elimination of turbulences that would occur behind flaps, by air flow 28 directed by the movable spoiler 27. In order to better distribute and direct air streams through the flap in its pulled out and turned down position, in the front part of the flap 21 there is build a slat

22, whereas covering of the gap between the flap 21 and the wing bottom carrying plane 2 is enabled by elastic spoilers 29 and 30.

Invention application to wing whose carrying surface is made of fabrics or similar materials, such as glider-paraglider wings that are connected with the flier's main harness by numerous front and back lines, as shown in Figs. 8 and 9.

In this invention application, the wing aerodynamic profile consists of: wing top 1 and bottom 2 carrying planes, made of fabrics, mutually connected, by a number of ribs 33 positioned in the flight direction, with the rib front parts 17. Ribs 17 are also made of fabrics, at mutual distances dictated by structure requirements. Shape of the carrying planes 1 and 2 produces wing of selected aerodynamic profile, with a number of parallel tunnels 4 for interior air flow. The selected profile and decrease of the tunnel cross-section along the profile assure fine filling with air and maintaining the wing shape and profile strained. The planes 1 and 2 front edges are strengthened with fabrics hem, as well as the front edges 17 of the ribs 33. The top carrying plane 1 is at the wing exit edge 6 longer than the wing bottom carrying plane.
The wing is connected to the flier's harness with a number of front lines 35, fixed to the lower carrying plane 2 near the front part 17 of the ribs 33, and a number of back lines 34 fixed to the bottom 2 and the top 1 carrying planes, also near the connection with ribs 33. This way, by pulling proper lines, the pilot can change the wing profile camber and the angle of turning the air flow 13 coming from the tunnel 4 down, increasing thereby lift of one of the wing sides and thereby operating the glider wing.
A special solution in this invention embodiment is the solution of profiling of the front edge 31 of the top carrying plane 1 and of front edge 32 of the carrying plane 2, as well as the front part 17 of the ribs 33, as shown in the wing cross-section in Fig 9. The above mentioned edges 31, 32 and 17 are made as aerodynamically shaped tubes, made of fabrics that is in that part made airtight, so that the aerodynamic form of the front edges 31, 32 and 17 is achieved by inflating through the common inflating valve 38. This produces stretched form of the wing front part and safe openness of the inner air-flow tunnel, this significantly increasing start and flight safety.

Invention application to wing whose carrying surface is made of fabrics stretched over elements of hard carrying structure, such as kites, as shown in Figs. 10 and 11.

In this invention application, the wing aerodynamic profile consists of: two aerodynamically shaped carrying bars of the wing front edge – the top aerodynamic bar 36 and the bottom aerodynamic bar 37, mutually connected with hard connecting ribs 39 into a unique structure. The said bars and connecting ribs may be made of, e.g., aluminium alloys, glass-reinforced plastic or combinations of materials. To the entire length of the bars 31 and 32, there are connected the wing top carrying plane 1 and bottom carrying plane 2, made of fabrics, mutually connected by the entire profile length by a number of ribs 40, positioned in the flight direction and also made of fabrics. The wing top plane 1 and bottom plane 2, together with the connecting ribs 40 make a number of parallel tunnels 4 for inner air flow. The exit edge 6 of the wing top carrying plane 1 is longer than the exit part of the wing bottom carrying plane 2.
In a variant of this invention application, the exit edge 6 of the top carrying plane 1 is at several places bound with lines 41 and can be puled down by a simple mechanism, in order to increase camber of the wing exit part, as well as the angle of the exit air stream 13 from the tunnel 4.

Invention application to wind-generator rotor blades.

Invention application of building of air tunnels into a wing used as wind-generator rotor blade does not differ from the invention basic application in aircraft wings shown in Figs. 2 and 3, save that the wing is, through its console, positioned along the wing, about the profile's centre of gravity, linked to the wind-generator wheel head and axis. Through the same wing console pass connections of the mechanism for changing the wing front angle and possible control of air flow through the air flowing tunnels.

7. INVENTION APPLICATION
The invention and its embodiments descriptions contain also the invention application framework, such as:

- construction of aircraft wings, especially for transportation aircraft, special-purpose aircraft, aircraft with enhanced take-off and landing characteristics and enhanced abilities to control the carrying capacity in flight;
- construction of flying models with air flowing wings;
- construction of gliders-paragliders and kites of larger carrying capacity and enhanced characteristics and start and flight safety;
- construction of wind-generator rotor blades of enhanced ability to use light winds, etc.

Experts will find it obvious possibilities of making modifications to the wing able to enhance the lift power by inner air flow in accordance with the invention, still maintaining the spirit of the invention.

PATENT CLAIMS

1. Wing able to enhance lift by inner air flow, consisting of the hard top, aerodynamically shaped, carrying plane (1) and the bottom, aerodynamically shaped plane (2), mutually distanced and firmly connected by connecting ribs (3) along the entire inner profile of the top and the bottom carrying planes, so that the top and the bottom carrying planes together with the connecting ribs make a unique wing structure whose vertical cross-section in the flight direction, by the line that encompasses the outer contour of both carrying planes, produces the wing optimum aerodynamic profile, ***wherein***, between the adjacent surfaces of the aerodynamically shaped top plane (1) and bottom plane (2), by their mutual distance and distance between connecting ribs (3), there are formed at least one aerodynamically shaped air flowing tunnel (4), whereby the tunnel (4) front intake opening (7), that lets the air flow (12) in, at the wing front edge (5), is positioned with most of or its entire vertical cross-section below the wing profile axis of symmetry (9), whereas the tunnel (4) back exit opening (8), that lets the air flow out, by the wing profile back edge (6), is fully positioned below the wing profile axis of symmetry (9), whereas the tunnel inner shape, in its vertical cross-section in the flight direction, is such that the intaken air flow (12), as related to the profile axis of symmetry, takes into the tunnel (4) up-going, and the tunnel (4) exit air flow (13) releases down-going streams; in the front (intaking) opening (7) of the tunnel (4), there are fitted in an immobile way at least one directing blade (10) whose vertical cross-section in the flight direction is aerodynamically shaped, whereas in the back (exit) opening (8) of the tunnel (4), there are in an immovable way fitted at least one directing blade (11) whose vertical cross-section in the flight direction is aerodynamically shaped.

2. The wing as claimed in Claim 1, ***wherein*** in the wing front part there is fitted a movable gate (15), shaped according to the profile and dimensions of the front, intake, opening (7) of the tunnel (4), which is, when the opening is fully open, fully pulled in structure of the front part of the wing bottom carrying plane (2), and which gate, if necessary, can be controlled by remote mechanism (16) and directed by guides built in the wing structure, and pulled out to partly or fully close the intake opening (7), whereas in the exit opening (8) there are fitted directing blades (11) that

can be turned around their longitudinal axes (14) to direct by their position the exiting air flow (13) in accordance with the control system requirements, and also can take a position in which they fully close the exit opening (8), aligning roughly thereby with the outer contour of the bottom carrying plane (2), if necessary, simultaneous with operating of the gate (15).

3. The wing as claimed in Claims 1 and 2, ***w h e r e i n*** inside the aerodynamically shaped wing structure, in the bottom plane (2), there is fitted device for producing additional air flow through the tunnel (4), consisting of pipes (19) that bring compressed air, with air nozzle (20) entering the tunnel (4), the so injected air being directed down the inner air flow, which pipe (19) and nozzle (20) may also be used for injecting of water spray into the tunnel (4) which spray with air in the tunnel produce aerosol.

4. The wing as claimed in Claim 1, ***w h e r e i n*** the back, exit, part of the wing, with the exit opening (8) of the tunnel (4) is made as a separate movable unit doing the role of a flap (21), limited by its width by mutual distances of connecting ribs (3), at its front end aerodynamically shaped and fitted into adequately shaped end part of the immovable wing part, whereas at the upper part of this connecting link there is left a gap covered with adequately shaped spoiler (27) which is connected to the immovable part of the top carrying plane (1) and can lift and open the said gap between the immovable and the movable parts of the wing (1) and the flap; the flap (21) is by its bottom side fixed to structure of the movable part of the gondola (23), the joint (26) and the turning mechanisms (25), which by their movements bring the flap (21) to pulled out and down turned position, which enables air from the tunnel (4) to pass freely, split around the fitted slat (22), by one part flow through the flap (21) and exits between the directing blades (11) and through the exit opening (8), and by other part of its flow passes below the turning spoiler (27) and flows above the outer top surface of the pulled-out flap (21); whereas at the connecting point of immovable parts of the wing and flap (21) bottom carrying plane (2), there are fitted two elastic spoilers (29 and 30) which, when the flap (21) is in the pulled-in position, are pulled into adequate gaps in wing and flap bodies, whereas in the pulled-out and down turned position of the flap (21), they band elastically and cover the gap between

carrying planes (2) of the immovable part of the wing and the bottom part of the flap (21).

5. The glider-paraglider wing, connected with a number of front and back lines with the flyer's harness, ***w h e r e i n*** in building the glider-paraglider wing there is applied the wing basic embodiment in line with the Claim 1, which wing consists of aerodynamically shaped carrying planes, tip (1) and bottom (2), connected by ribs (33) with front part of the connecting ribs (17), made of fabrics or some similar material, taking the shape of the connecting ribs (17) and (32), which assures the selected aerodynamical shape of the wing, where the front parts (31) and (32) of the carrying planes (1) and (2) and front parts (17) of the ribs (33) are made in the form of an aerodynaically profiled and airtight, pipe, mutually connected so that they can be inflated through at least one common valve (38), and decreasing the height of the connecting ribs (33) alongside the wing profile is made to assure fine filling of the tunnel (4) with air and to maintain the stretched form of the profile and the wing, and where the top plane (1) is at the wing exit edge (6) longer than the exit edge of the bottom carrying plane (2), whereas specially selected back lines (34) which connect the wing and the flyer, enable changing the profile camber at a selected part of the wing, changing the angle of the exit air flow (13) from the tunnel (4), this controlling changes of lift and operating the wing.

6. Kite wing made mostly of fabrics fixed over hard kite structure, ***w h e r e i n*** in building the kite wing there is applied the wing basic embodiment in line with the Claim 1, where the front edges of wing both carrying planes (1 and 2) are made as part of a hard kite structure consisting of two bars, aerodynamically shaped in their vertical cross-sections in the air-flow direction (36 and 37), made of a hard material and mutually connected by hard connecting ribs (39) positioned in the air-flow direction, of mutual rib distance dictated by the design requirements and of the top (36) and bottom (37) bars distance being dictated by the size of the tunnel (4) opening and the shape of the selected aerodynamic wing profile, to which bars and ribs, in special openings, there is inserted and fixed front edge of the wing top and bottom carrying planes (1 and 2) and of their connecting ribs (40), made of fabrics, so

that, together with the front bars, they make profile of the tunnel (4) for inner air flowing during the flight.

7. Wind-generator rotor blade, ***w h e r e i n*** in building the kite wing there is applied the wing basic embodiment in line with the Claim 1; the wing is, through the special constructive conection of its console, positioned along the wing, perpendicularly to the profile and about the profile's centre of gravity, linked to the wind-generator wheel head and axis, so that the said console structural connection enables change of the wing front angle relative to the wind direction and operating the mechanism stated in the Claim 2.

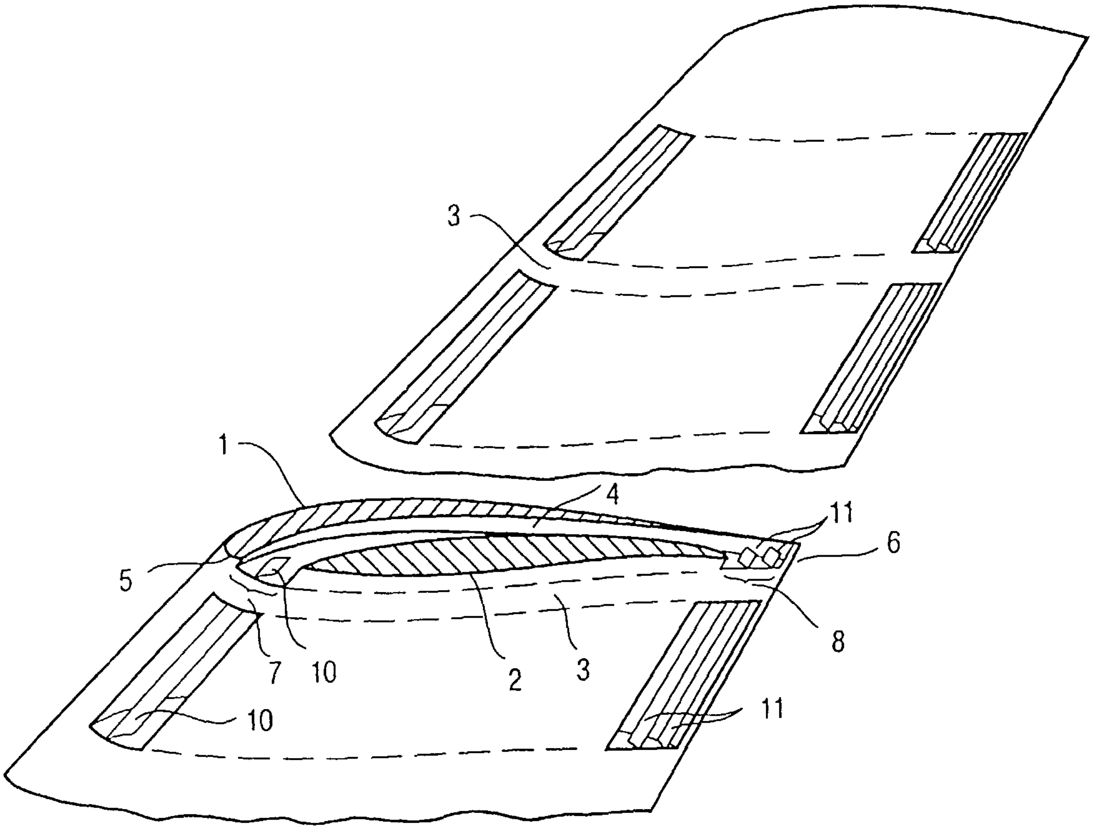


Fig. 1

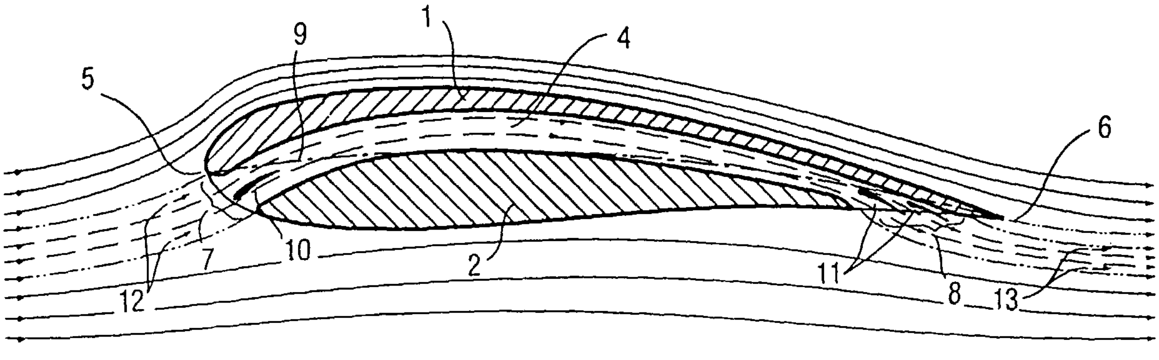


Fig. 2

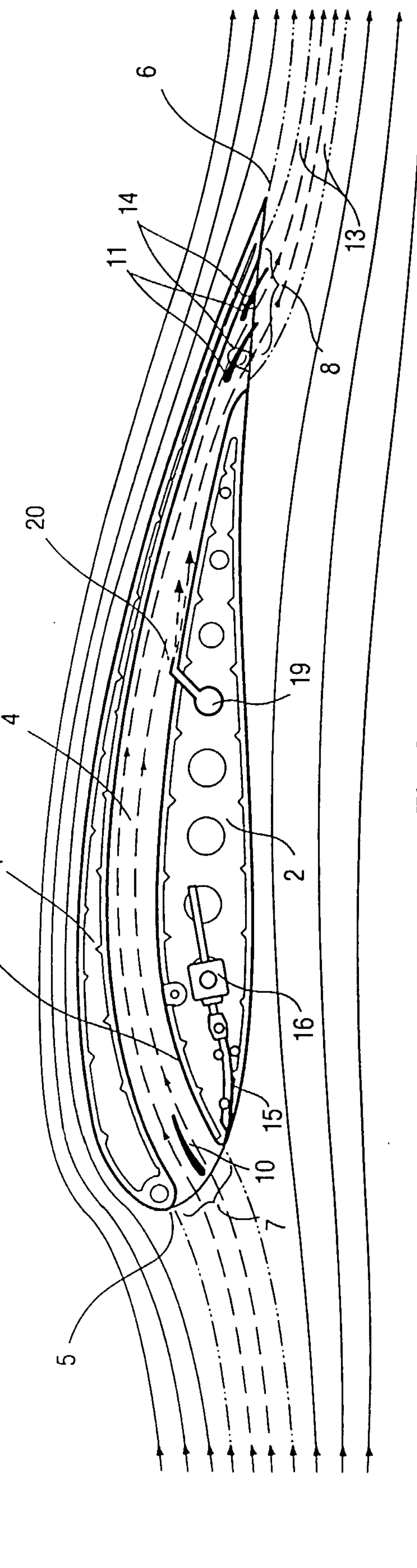


Fig. 3

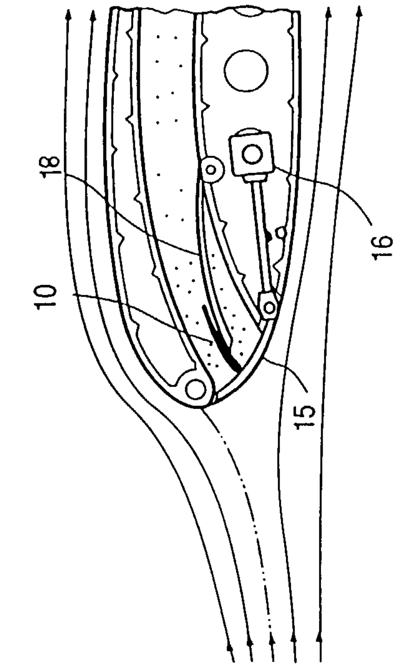


Fig. 5

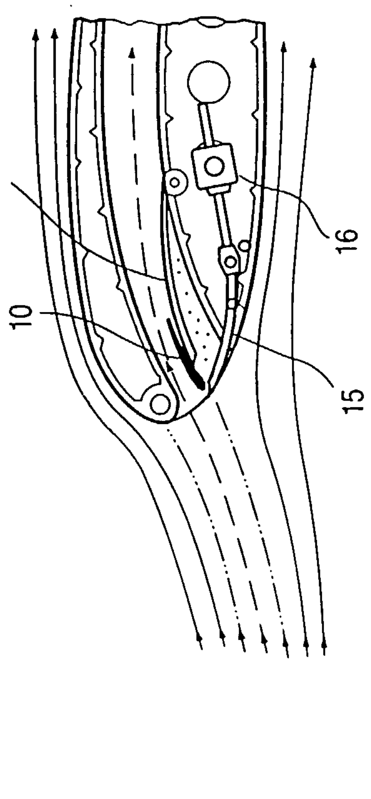


Fig. 4

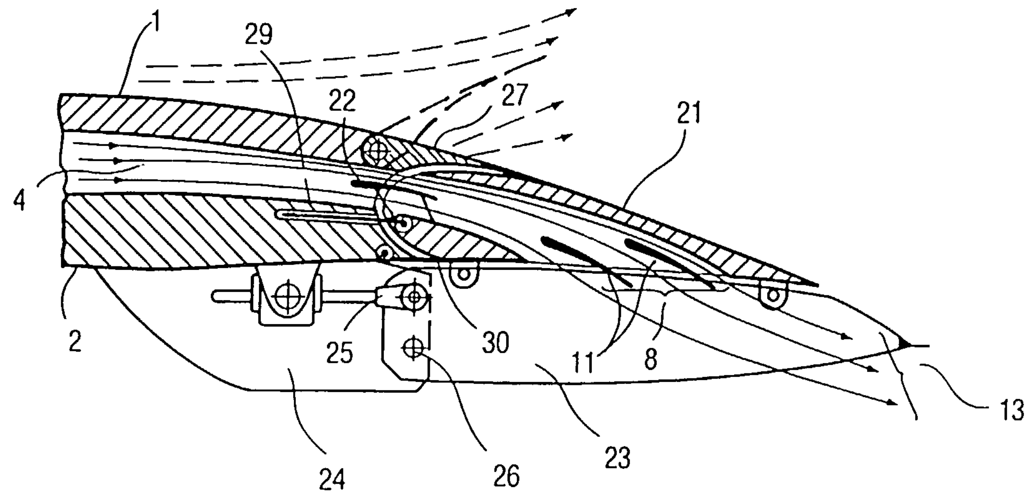

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Fig. 6

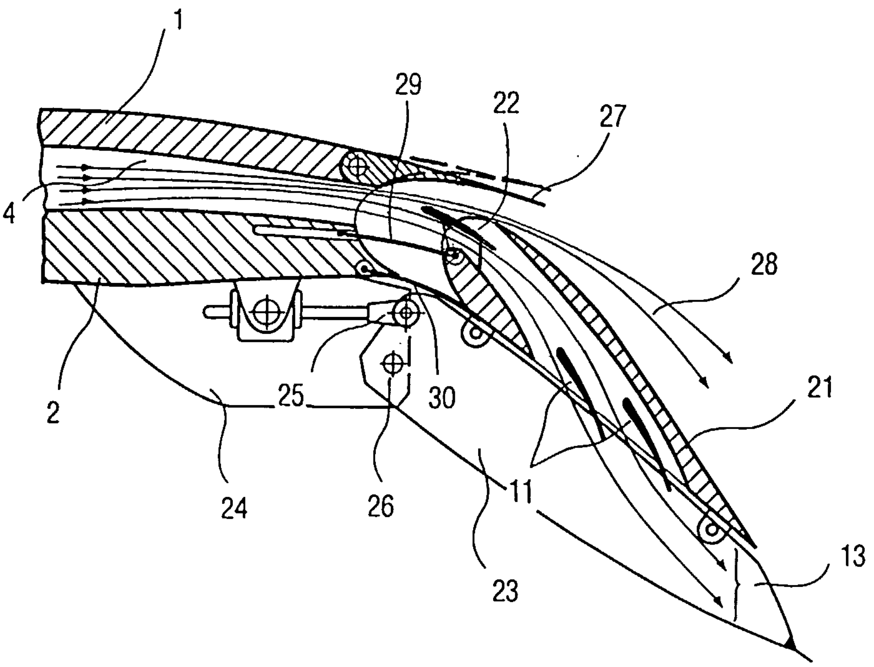
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Fig. 7

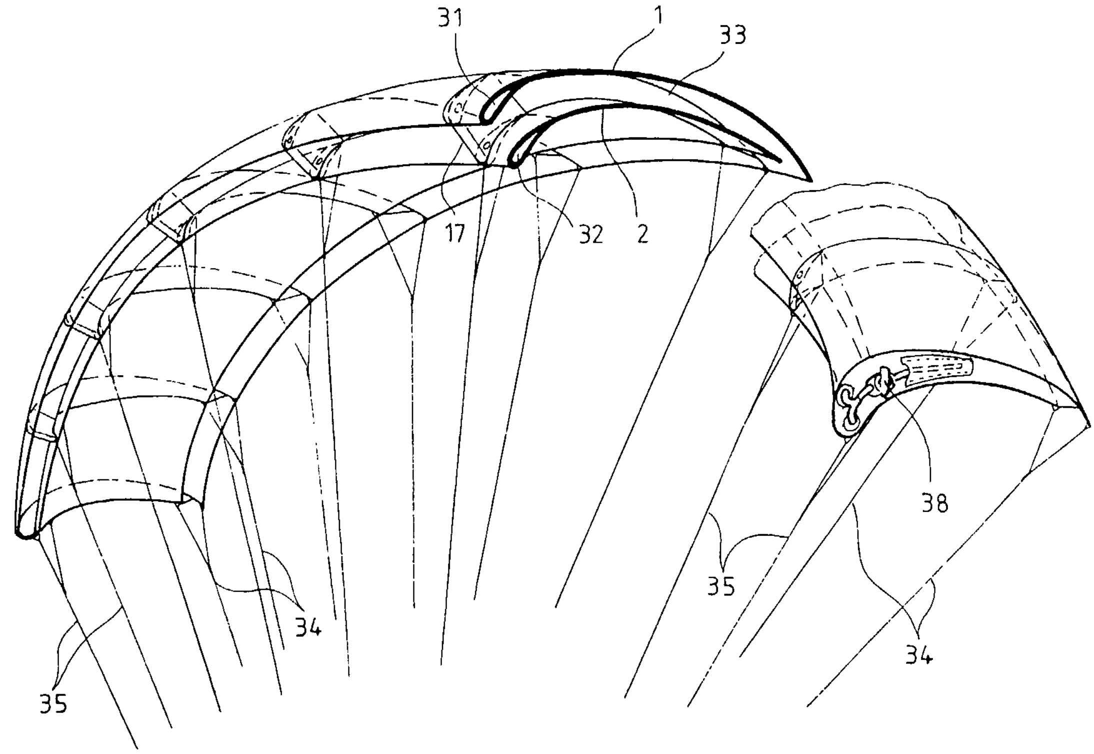

Fig. 8

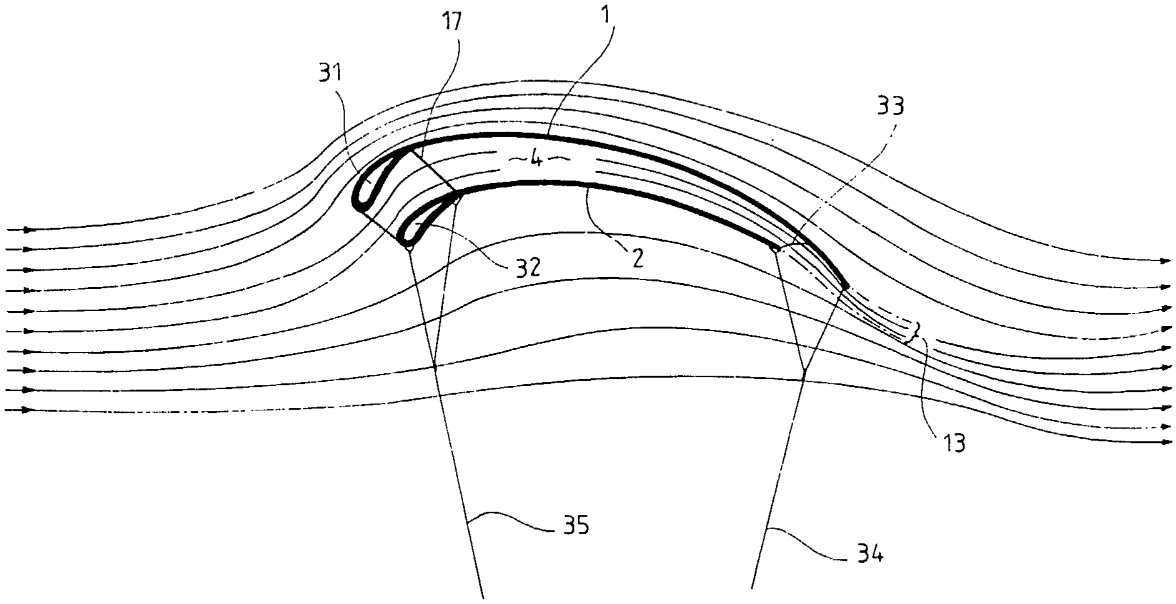

Fig. 9

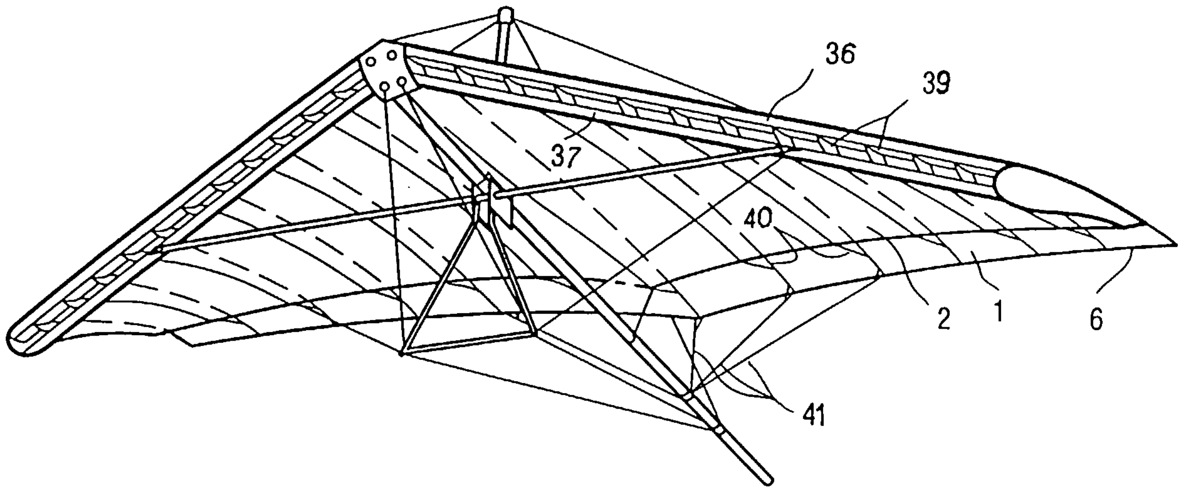

Fig. 10

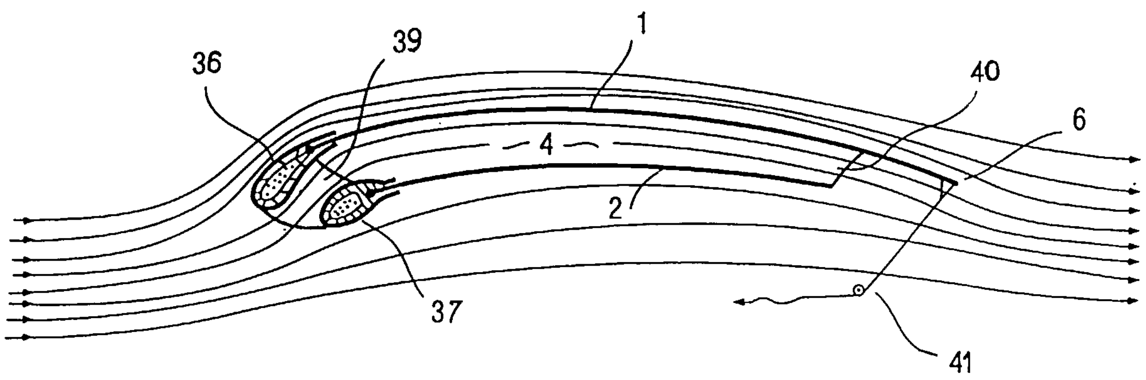

Fig. 11