

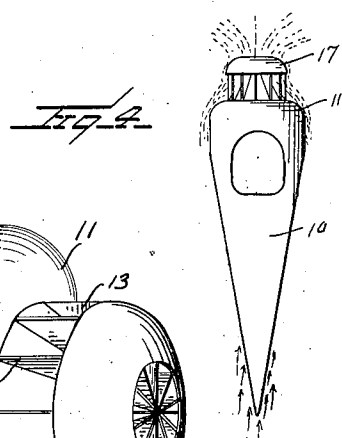
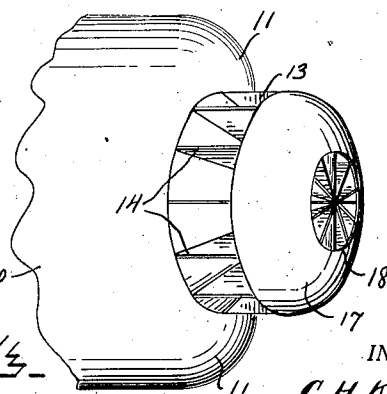
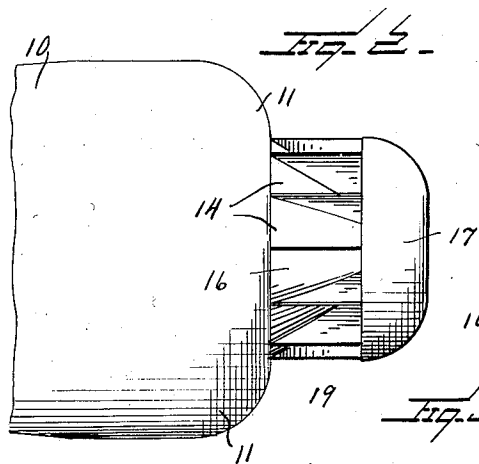
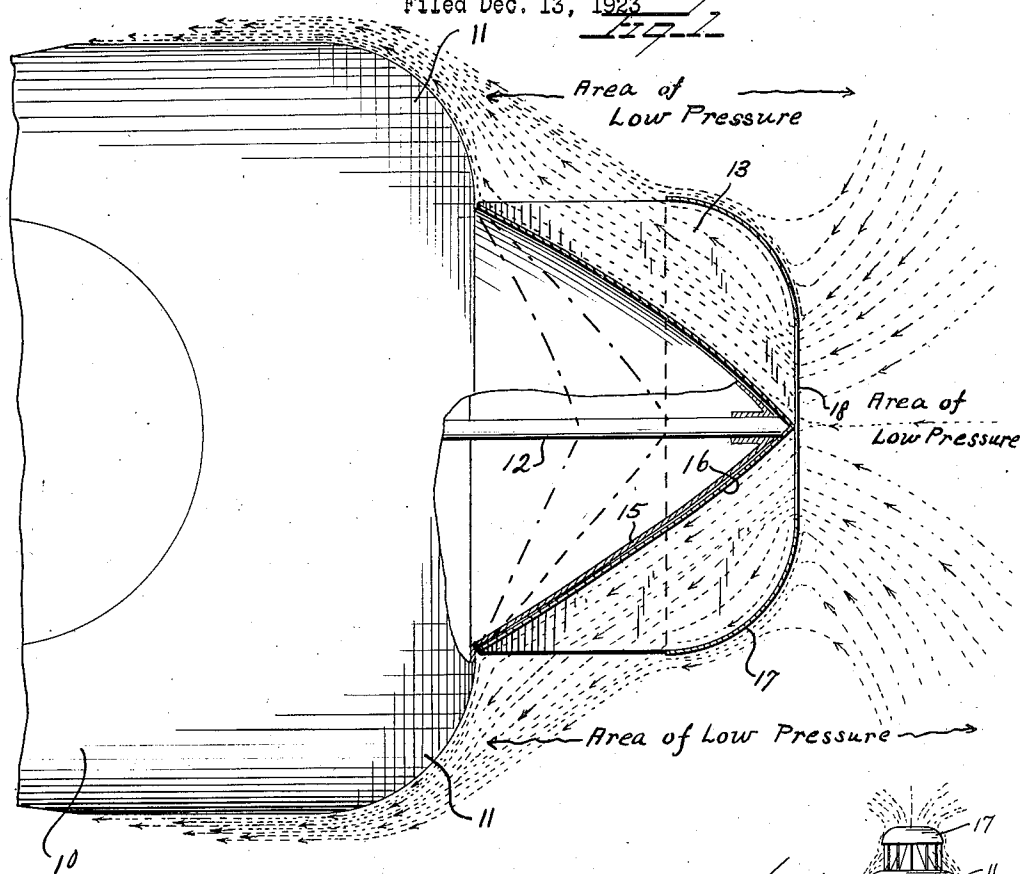
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C. H. KEEFER

LIFTING AND PROPELLING DEVICE FOR AIRCRAFT

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UNITED STATES PATENT OFFICE.

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LIFTING AND PROPELLING DEVICE FOR AIRCRAFT.

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To all whom it may concern:

Be it known that I, CHARLES H. KEEFER, a citizen of the United States, residing at Washington, in the District of Columbia, have invented certain new and useful Improvements in Lifting and Propelling Devices for Aircraft, of which the following is a specification.

This invention relates to aeronautics, and particularly to propelling and lifting means for heavier-than-air machines of that character wherein the pressure of air in front of or above a body is reduced to thereby permit the static atmospheric pressure to act on the body to propel it or lift it.

This invention is based on the fact that motion is the result of unbalanced forces and that, therefore, if atmospheric pressure can be reduced on one side of a body, allowing the static pressure to act against the opposite face of the body, if the difference in pressure is great enough to overcome inertia, it will cause the body to move forward or in the direction of the reduced pressure.

It has heretofore been proposed to take advantage of this difference in pressure by forcing a stream of air to flow outward over and closely contiguous to and parallel with a more or less plane anterior surface. I have found by experiments, however, that this will not cause a sufficient reduction of pressure on the anterior face of the body or aerofoil as to cause the motion of the body under the action of the static pressure behind it, and my experiments have demonstrated, on the contrary, that in order to cause a positive reduction of pressure on the anterior face of the aerofoil or other body and a forward movement of the body through space that the stream of air must be caused to impinge the aerofoil at an angle to the face of what may be termed the entering or leading edge of the aerofoil to thereby cause the stream to be deflected in its direction of flow, and that unless this is done the stream of air will simply flow over the surface of the body without causing any reduction in pressure to amount to anything. This air stream may impinge against the aerofoil at its leading edge and be discharged in a stream or mass over the face of the aerofoil and this will cause a reduction in pressure in front of

the body or aerofoil sufficient to cause the static atmospheric pressure against the posterior face of the aerofoil to urge it forward or upward.

It might be supposed that a fluid stream having a direction angular to the surface it strikes would rebound or be reflected at an angle equal to the angle of incidence. This would be probably true, for instance, if the stream is directed through a fluid of unlike density, thus, for instance, if a jet of water is directed through air against a surface, but it is not the case where a fluid stream is set up in the midst of or discharged through a like fluid, as an air stream set up in a mass of air. Such a fluid stream impinging against a body at an angle thereto clings to the surface of the body against which it is impinged. This tendency to be reflected is resisted by the pressure of the air which, therefore, forces the stream against the surface of the body and holds it thereto. This stream will follow the surface until it comes to an angle too sharp for it to turn or until static resistance is equal to the force of the stream.

My invention is illustrated in the accompanying drawings, wherein:—

Figure 1 is a fragmentary section of the anterior end of an aircraft, the propelling means therefor being shown in section, the figure showing in dotted lines the manner in which an air stream will be projected against the annular aerofoil and showing the manner in which an area of low pressure will be formed in advance of the propelling means and of the aircraft;

Figure 2 is a fragmentary side elevation of the construction shown in Figure 1;

Figure 3 is a fragmentary perspective view of this construction;

Figure 4 is a top plan view showing the general shape of the machine and indicating the manner in which the static acts to carry the machine forward.

In these figures, 10 designates the body as, for instance, the body of an aircraft having a general streamline form and carrying a motor (not shown) and steering means (not shown). The forward end of the body is so shaped as to provide an annular aerofoil 11 preferably convex, the trailing edge of the aerofoil merging into the outer surface of the more or less cylindrical body 10.

Extending through the forward end of the body is a shaft 12, which is either the motor shaft itself or a shaft driven thereby. Carried on this shaft is a rotatable or centrifugal fan, designated generally 13. The blades 14 of the fan are preferably radial and the extreme diameter of the fan is equal to the internal diameter of the aerofoil. The central portion 15 of the forward end of the body 10 is preferably outwardly bulged or convex and the shaft passes through the apex or most protuberant portion of this convexly bulged end.

The blades 14 of the fan are preferably approximately triangular in elevation, the base of the triangle approximating the face of the central portion 15. The outer corner or apex of each triangular blade is rounded off. Thus the forward edge of the blade extends radially outward at right angles to the axis of rotation, then curves outward and rearward, and then extends longitudinally parallel to the axis and at right angles to the leading edge of the aerofoil. A plate 16 may be attached to and from the bottom wall of the fan so as to cause the air to move inward as well as laterally.

Suitably supported on the body 10 in spaced relation to its forward end is an annular fan casing 17 having a curvature approximately the curvature given to the corners of the fan blades. The central opening 18 of this casing constitutes the fan intake opening and the peripheral opening 19 between the inner edge of the casing and the leading edge of the aerofoil constitutes the discharge opening. Of course, the face of the central portion 15 or the bottom wall of the fan constitutes in effect part of the fan casing.

The manner in which this mechanism operates to produce a reduction in pressure forward of the body 10 is shown clearly by the dotted lines in Figure 1, which illustrate approximately the air flow to a centrifugal fan. The fan draws the air from in front of it, both directly in front and laterally, and discharges this air rearward and outward in lines diagonal to the axis of the body and in an annular stream which impinges against and at an angle to the annular face of the leading edge of the aerofoil surface. The stream of air is deflected thereby and then follows the lines of the fuselage or body rearward, clinging to the surface of this body. The stream of air is relatively thick or deep due to the peculiar formation of the fan and the stream flows rearward over the surface of the rounded fuselage of the body 10 until it reaches the rear end thereof.

As before remarked, the air in front of the body and particularly in front of the fan is drawn centrally and toward the fan,

indicated by the dotted lines, and then is forced outward at a high speed against the aerofoil surface. As a consequence there is a reduction in pressure in front of the body and particularly a reduction in pressure immediately in front of the annular aerofoil so that the thrust on the body is approximately equal to the difference between the reduced pressure on the aerofoil surface and the pressure on the posterior surface of the body immediately behind the aerofoil surface. Preferably the body tapers toward its rear end in the manner indicated so as to eliminate turbulence as much as possible.

It will be seen that the highest velocity of the air stream is adjacent to the plate 16 and the lowest velocity of the air stream is adjacent to the inner face of the fan casing. This is for the reason that the air stream has to travel at the same radial speed along the base line of the triangular blades as it has to travel adjacent the outer corners of the blades. Therefore, the air which is caused to directly impinge against the leading edge of the aerofoil surface is traveling at a very high speed. The shape of the fan causes a relatively thick stream of air to be discharged from the discharge opening of the fan toward and over the aerofoil surface, and I have discovered in actual practice that it is particularly advisable to have this stream of air relatively deep or thick and that the deeper the stream of air within certain limits the greater the propulsive effect.

By using a centrifugal fan so designed as to draw a stream of air to its center at the front and discharge this stream radially over the surface of the aerofoil, I secure a reduction in pressure at the front of the fan as well as a reduction in pressure over the face of the aerofoil. Laboratory tests with an aerofoil and fan constructed as described have shown a reduction in pressure of 224.5 pounds per horsepower of energy expended. This is more than five times greater than the theoretical limit of 44 pounds per horsepower for standard type propeller aerofoils and is nearly 66 times as great as the 3.43 pounds per horsepower developed by the propeller used on the Martin bomber.

As before remarked, I have found by experiment that the thickness of the stratum or stream of air flowing over the aerofoil has an important effect on the lifting value of the aerofoil. For instance, on a six-inch annular aerofoil with an air stream of .12 of an inch in thickness, a certain lift value was obtained, but when the thickness of the stratum was increased to .24 of an inch the lift value was found to be 16 times as great. By deduction from the results obtained with a four-inch aerofoil, it is apparent that a stream .48 inch thick will give a lift some-

where between 64 and 96 times the lift obtained with the .12 inch stratum.

The rapid passage of the air downward over the bottom plate of the fan creates an area of low pressure adjacent the plate and this aids the movement of the air toward the aerofoil and causes all of the air in front of the fan to seek this low pressure area, or in other words to flow in a stream contiguous to the face of the aerofoil.

While I have heretofore referred to this propelling means as being particularly adapted to the propulsion of aircraft, I do not wish to be limited to this as it is obvious that the means which I have described might be used for the propulsion of submarines, or in other words that this propelling device is adapted to be used wherever a craft of any kind is entirely immersed in a fluid, whether this fluid be air, water or any other gas or liquid, and it is to be understood that under these circumstances the term "aerofoil" is considered throughout the specification as broad enough to cover any surface having the general form of an aerofoil and against which fluid reacts in the manner indicated for the reaction of air against an aerofoil on a lighter-than-air machine. It is also to be understood that the same principle might be used for the propulsion of water craft where a part of the hull is submerged or almost entirely submerged and, therefore, can have the streamline form having a foil or surface of like character at its forward end against which the fluid may be caused to impinge.

While it has heretofore been proposed, as before stated, to reduce the pressure of fluid in front of an aircraft by the provision of means driving an annular stream of air outward in all directions in close contiguity to the surface of the aerofoil, yet, as before stated, it is impossible for this to work properly unless the air is caused to impinge against a portion of said surface at an angle thereto so as to thereby deflect the air. Thus in a construction of this proposed character, it is impossible to secure any reduction in pressure in front of the aeroplane or other body which will be sufficient to cause the static pressure to drive the machine forward. The reason for this is that where the air stream is forced outward contiguous to a surface more or less at right angles to the axis of the machine and without the air stream impinging against the aerofoil and being deflected thereby, the air stream, while it causes a very slight low pressure area in front of the machine, also causes this air to be drawn from all directions and thus counteract the action of any low pressure area in front of the machine. In this present invention, because the air stream follows around the streamline form of the body being propelled, it is the body itself which is

fed into the low pressure area by the static pressure of air behind it instead of the air being fed into this low pressure area.

I claim:—

1. Means for moving a body through space including means for causing a stream of fluid at high velocity to move rearwardly and radially outward from a point in advance of the body and impinge against the forwardly exposed, anterior face of the body at an angle to the face and to the fore and aft axis of the body to thereby cause a reduction in the static air pressure in front of the body.

2. A body having an anterior, annular, cambered forwardly exposed surface, and means for discharging fluid under pressure rearwardly and radially outwardly in all directions from a point in advance of said surface at and against the leading edge of the cambered portion of said surface and at an angle thereto to cause the fluid to flow at a high speed over said surface to thereby reduce the static pressure in front of the body.

3. A flying machine having an annular, anterior, cambered, forwardly exposed surface, and means for causing air under pressure to be discharged rearwardly and radially outward in all directions from a point in advance of said surface at an angle to the fore and aft axis of the body and against the leading edge of the cambered surface and at an angle thereto to thus cause the air to flow at a high speed over said surface to thereby reduce the static atmospheric pressure in front thereof.

4. A body having a substantially annular, anterior, forwardly exposed, fluid-receiving surface defining a surface concentric to the line of flight and tapering toward the direction of flight, and means for projecting a stream of fluid at a high velocity rearwardly and radially to the longitudinal axis of the body from a point in advance of said surface at an angle to the fore and aft axis of the body against said surface and at an angle thereto.

5. A body having a substantially annular, anterior, forwardly exposed, fluid-receiving surface, said surface being concentric to the line of flight and tapering toward the direction of flight, and means for projecting a stream of air rearwardly from a point in advance of the surface and radially in all directions at a high velocity against said surface and at an obtuse angle thereto.

6. A body movable through space and including an annular anteriorly cambered, forwardly exposed surface, and a rotatable motor operated fan disposed at the center of the surface, such fan being formed to draw air from in front of the fan toward the fan and project said air at a high velocity outward and rearward at an angle

to the fore and aft axis of the body and against the surface and at an angle to the surface against which the projected air impinges to thereby cause the air to follow the surface of the body.

7. Means for causing differential air pressure on opposite faces of a body including an anterior, forwardly exposed, annular surface carried by the body, the anterior face of the surface being cambered, and means for delivering a stream of air at high velocity outward and rearward at an angle to the fore and aft axis of the body and against the entering edge of the cambered surface at an angle to the point on the surface against which the air is projected to thereby cause the said fluid stream to flow in all directions over and in close contiguity with said face of the body.

8. A body having an anterior, forwardly exposed surface and means for moving the body through space including motor operated means carried by the body for displacing the air in advance of the body and projecting the air so displaced rearward in a stream at an angle to the fore and aft axis of the body and against the anterior surface and at an angle to the same thereof less than a right angle rearwardly and radially in all directions to thereby cause the air to flow at a high velocity radially in all directions over and in close contiguity with the anterior face of the surface.

9. A body having an anterior, forwardly exposed, annular surface having an annular camber, the face of the body beyond said camber being convexly rounded, and means for moving the body through space including means carried by the body and disposed concentrically within the annular cambered portion for drawing the fluid in advance of the body toward the body and projecting the fluid rearwardly and radially rearward at an angle to the fore and aft axis of the body in all directions at a high velocity against said cambered face, the leading edge of said cambered face deflecting the fluid stream discharged thereagainst.

10. A body including an anterior annular surface having a cambered anterior forwardly exposed face, and means for moving the body through space including a motor operated centrifugal fan disposed at the center of and concentric to the annular surface, the fan discharging fluid continuously at its periphery rearward at an angle to the fore and aft axis of the body and against the cambered face, said cambered face being so placed that its leading edge deflects the fluid stream discharged by said fan.

11. A body having an anterior, annular, forwardly exposed surface having an annular camber, the surface beyond said camber being relatively flat, and means for moving the body through space including a

motor operated centrifugal fan carried by the body and disposed concentrically to the annular camber, said fan drawing the fluid in advance of the body toward the body and projecting said fluid at a high velocity in all directions rearward at an angle to the fore and aft axis of the body and against and at an angle to said cambered face, the leading edge of the cambered face deflecting the fluid stream discharged by said fan.

12. A flying machine having a cambered anterior forwardly exposed surface, and motor operated means for causing a stream of air to be discharged rearward at an angle to the fore and aft axis of the body, said means causing the air to be discharged only against the anterior face of the leading edge of said cambered surface at an angle thereto less than a right angle.

13. A flying machine including a forwardly exposed, anterior surface, the surface being cambered, and means carried by the machine for drawing a stream of fluid from a point in advance of the machine toward the anterior face of the surface and projecting the stream of fluid at a high velocity radially outward and rearward in all directions at an angle to the fore and aft axis of the body and at an angle to the face of the surface less than a right angle, the leading edge of the aerofoil deflecting the fluid stream.

14. A flying machine including a fuselage having a general streamline form, a motor operated shaft projecting through the forward end of the fuselage, a centrifugal fan mounted upon said shaft, an annular fan casing partially housing said shaft and having a centrally disposed intake opening, and a circumferentially disposed outlet opening, the fuselage having a diameter at its forward end greater than the diameter of the fan casing and that portion of the fuselage beyond the fan casing being curved to form an anterior, annular, forwardly exposed, fluid receiving surface against which the air from the fan is caused to impinge and by which said air is deflected.

15. A flying machine having a fuselage of general streamline form, a shaft extending through the fuselage and beyond its forward end, approximately triangular blades mounted upon the shaft and rotating therewith, the blades having their bases extending rearward and outward from the axial center of the fan to a point inward of the greatest diameter of the forward end of the fuselage, there being a floor extending along the bases of all of the blades, a fan casing extending over the blades and having a central intake opening and a peripheral discharge opening, that portion of the fuselage projecting beyond the fan casing being convexly rounded to form a cambered surface against which the air from the fan is discharged and by which the air is deflected.

16. In a flying machine, a fuselage, a shaft extending through the fuselage and beyond the same, a plurality of approximately triangular blades attached at their outer ends to said shaft and extending rearward and outward, the corners of the blades being rounded and there being a conical floor disposed contiguous to the bases of all of the blades, an annular casing transversely curved to fit the corners of the blades, said casing defining a central opening concentric to the shaft and a peripheral opening, the fuselage having a diameter greater than the diameter of the fan and being rounded to provide an annular cambered aerofoil surface merging at its rear end into the fuselage and against which the air projected by the fan blades is directed and by which said air is deflected.
17. A flying machine of the character described comprising a fuselage approximately circular in cross section and having a general streamline outer surface, the forward end of the fuselage having an approximately conical central portion, a motor operated shaft extending through the forward end of the fuselage through the conical portion, triangular blades mounted upon the shaft and rotating therewith, the blades having inner edges extending downward and rearward to the base of said conical portion, said conical portion conforming to the angle of the bases of said blades, the outer corners of the blades being truncated, an annular casing enclosing said truncated portions of the blades, the casing defining a central inlet opening concentric to the shaft and a peripheral discharge opening, the fuselage having a diameter adjacent the fan greater than the diameter of the fan and that portion of the fuselage projecting beyond the fan being formed to provide an annular surface, the air from said fan being driven outward and rearward in angular relation to the leading edge of the aerofoil, the surface extending rearward and merging into the surface contour of the fuselage.
- In testimony whereof I affix my signature.
- CHARLES H. KEEFER.