

Dec. 4, 1962

P. MERCIER

3,066,893

STREAMLINED BODY PROPULSION SYSTEM

Filed July 31, 1958

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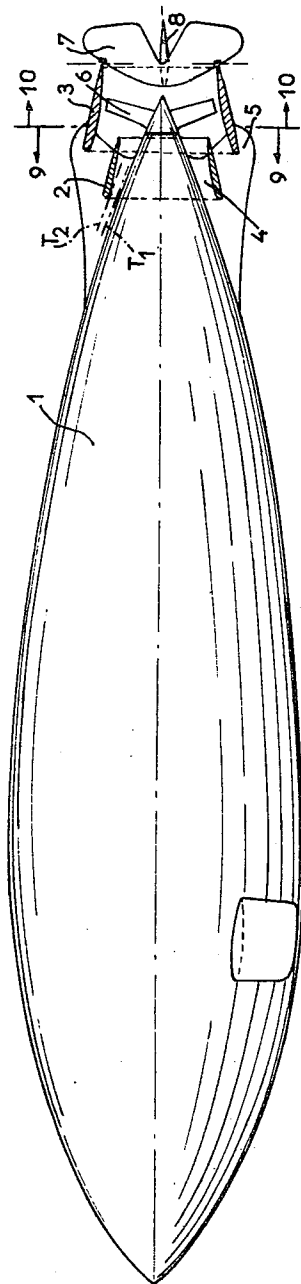


FIG. 1

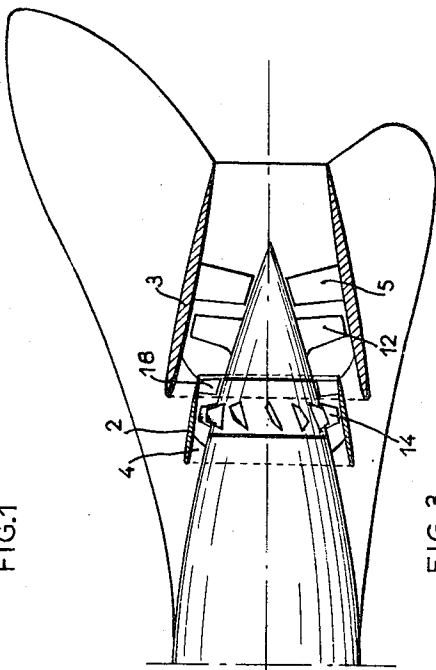


FIG. 3

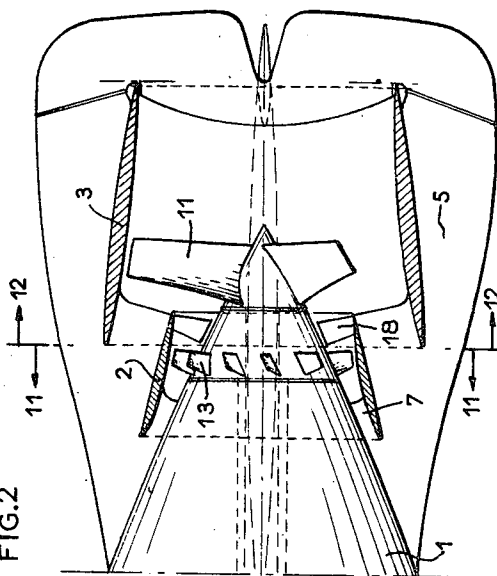


FIG. 2

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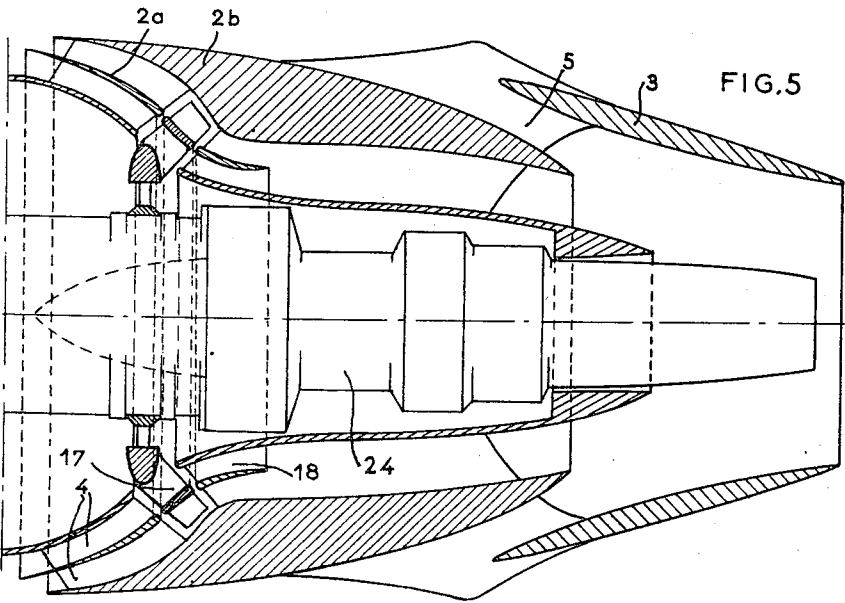
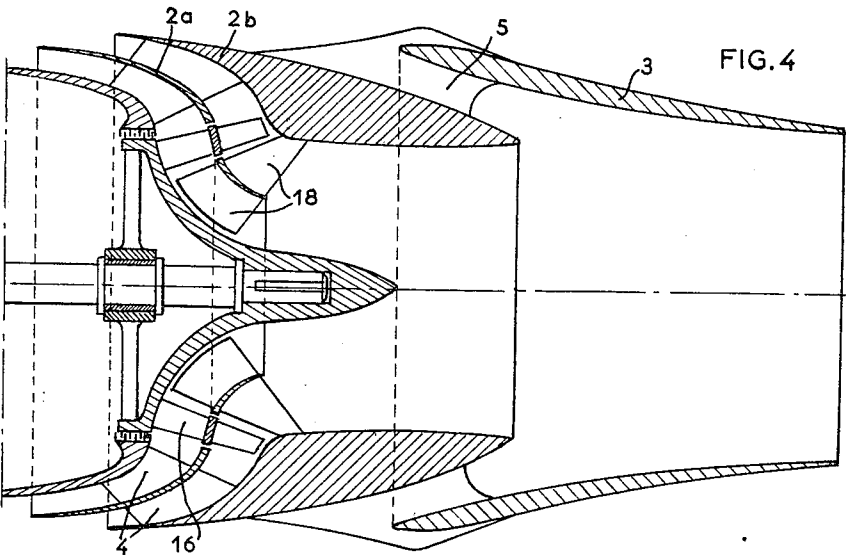
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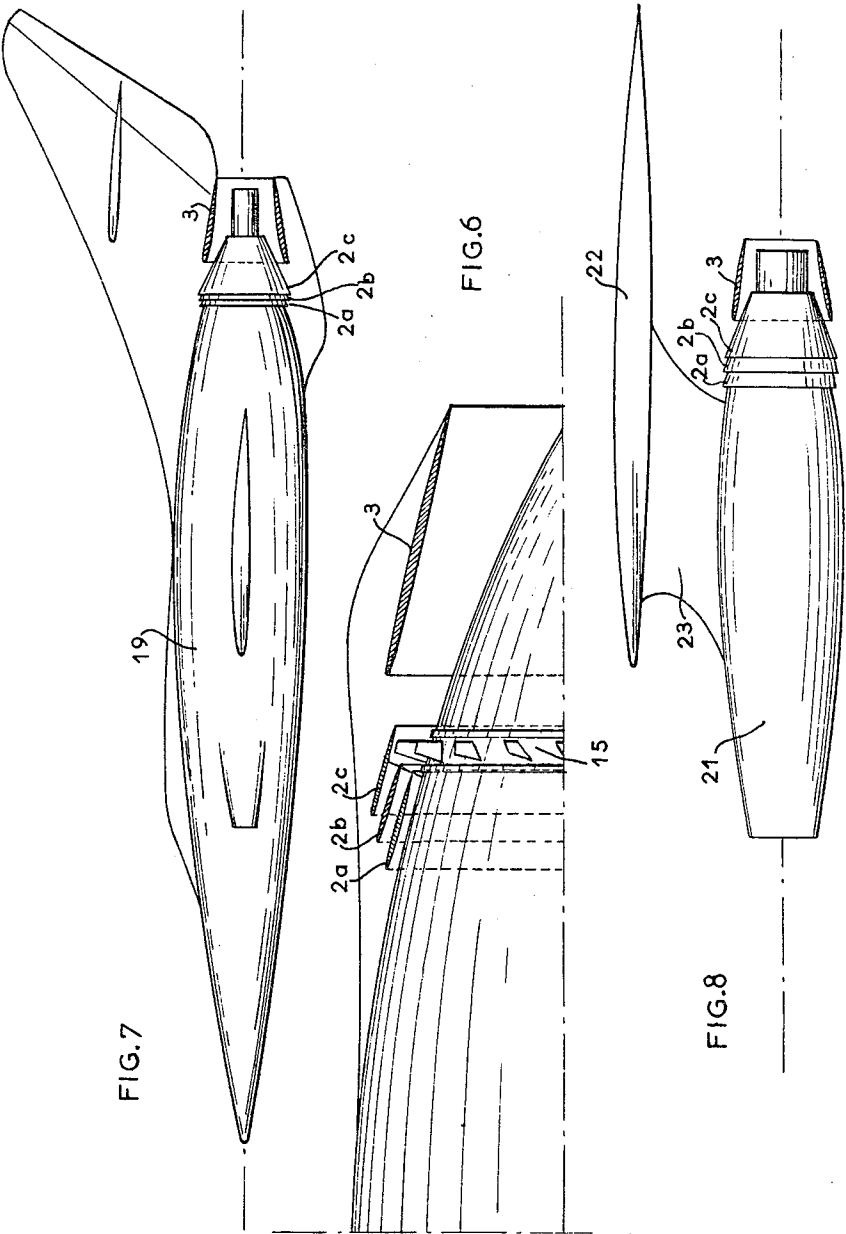
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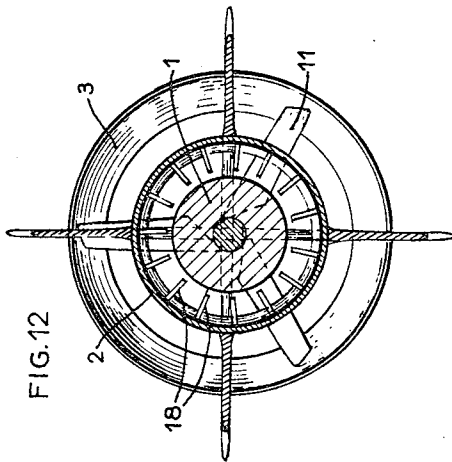


FIG. 12

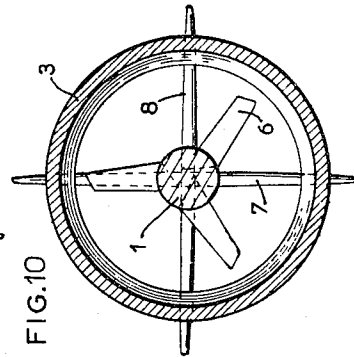


FIG. 10

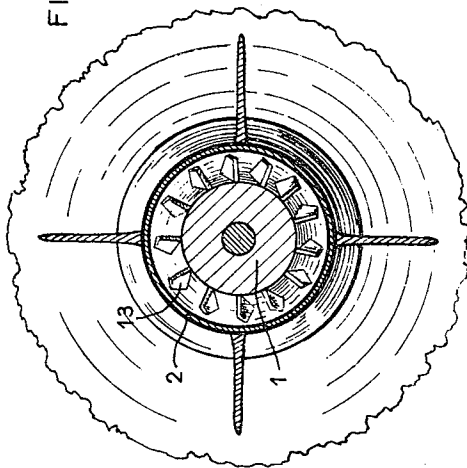


FIG. 11

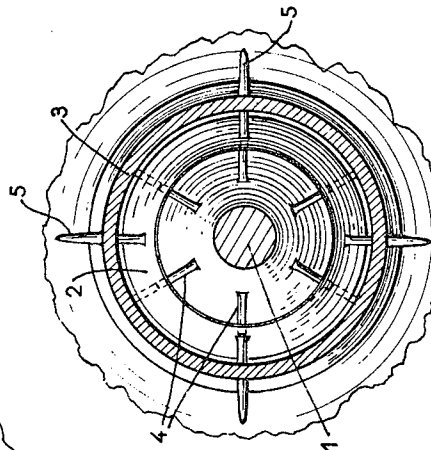


FIG. 9

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STREAMLINED BODY PROPULSION SYSTEM

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Filed July 31, 1958, Ser. No. 752,234

Claims priority, application France Aug. 7, 1957

4 Claims. (Cl. 244-73)

The present invention has for its purpose to improve the propulsion of streamlined bodies having a surface region where transition of the boundary layer fluid flow from laminar to turbulent condition initiates, the external parts of the propulsion means being disposed in co-axial relation with the axis of symmetry of the body.

It is known that the distribution of theoretical pressure exerted by a fluid on a stream-lined body having an axis aligned or slightly inclined with respect to the general direction of relative flow between the body and fluid, is characterised, beginning at the forward end of the body, by:

(a) A forward zone of dynamic pressure greater than the ambient static pressure of the fluid. The pressure is a maximum at the extreme forward point of the body and decreases rearwardly to a value equal to the ambient static pressure;

(b) A depression zone follows the aforementioned forward zone, wherein the static pressure becomes less than the ambient static pressure. The location of the minimum pressure in the depression zone depends upon the shape of the body. The said pressure increases rearwardly of the minimum pressure, until it reaches a value equal to the ambient static pressure of the surrounding fluid at a location far from the body;

(c) A rear super-pressure zone much less in intensity than the forward zone *a*.

This theoretical distribution of the pressures due to the flow of the fluid about the body, is modified by the frictional forces in contact with the body. These frictional forces give rise to a layer of fluid particles retarded by the presence of the body, and the structure of which is more turbulent towards the rear of the line of maximum depression surrounding the body in the zone (b). This turbulent layer has a thickness which increases towards the rear, and opposes the establishment and the transmission of the pressures in the rear super-pressure zone.

The result is an increase of drag, which it has been sought to reduce in various ways, without hitherto obtaining a perfectly satisfactory result.

An object of the invention is to improve the performance of streamlined bodies by increasing the speed thereof for the same energy consumption, or to reduce the amount of energy necessary to impart a predetermined speed to the body.

A further object of the invention is to provide a device mounted about the rear part of the stream-lined body, at least over the entire length of the zone wherein the fluid streams are in danger of breaking away, and which comprises one or more blade assemblies offering one or more closed, annular, supporting surfaces which, on the one hand, oppose the break-away of the fluid streams, and on the other hand the incidence of which is such that the super-pressure in the rear zone of the stream-lined body, are replaced by supporting forces distributed over the said surfaces and comprising a forwardly directed axial component.

Furthermore, since the said surfaces are closed upon themselves, the afore-mentioned supporting forces give rise to only little or no induced drag, and the said surfaces only cause losses due to friction, which is of slight importance, by reason of the thinness of the blade assemblies which constitute them. Finally they co-operate in

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the longitudinal and directional stabilities of the body as a whole.

Another object of the invention is to provide stream-lined, complex bodies comprising on the one hand a main stream-lined body, the forward part of which is treated for the purpose of bringing about a laminar flow over the maximum possible length and on the other hand a device with annular supporting surfaces, as defined above, disposed at the rear part of the main stream-lined body, which permits, apart from the advantages inherent in the said device, of imparting to the rear end of the main stream-lined body a much shorter shape than that of conventional stream-lined bodies, without however involving break-away of fluid streams.

Other objects and advantages of the invention will be apparent from the following detailed description, together with the accompanying drawings submitted for purpose of illustration only and not intended to limit the scope of the invention, reference being had for that purpose to the sub-joined claims.

In the drawings:

FIGURE 1 is an elevational view of a stream-lined body upon which there is mounted and represented, in axial section, a device according to the invention, in an embodiment applicable equally well to aerodynes and to submarine craft.

FIGURE 2 shows, on a larger scale, a variant of the device according to FIGURE 1, applicable more especially to a submersible craft.

FIGURE 3 shows, also on a larger scale, another variant of the device according to FIGURE 1, applicable more especially to aircraft.

FIGURES 4 and 5 are two further variants for aircraft with utilisation of radial or semi-radial turbines.

FIGURE 6 is a variant of FIGURE 3, wherein the forward blading is sub-divided into a plurality of coaxial elements.

FIGURE 7 is an overall view of an airplane with a central power plant, equipped with a device of the type according to FIGURE 3.

FIGURE 8 is a variant of the form of embodiment according to FIGURE 7, wherein the device is applied to an engine nacelle suspended under the wing of an aircraft.

FIGURES 9 and 10 are cross-sections respectively along the lines 9-9 and 10-10 in FIGURE 1, and

FIGURES 11 and 12 are cross-sections along the lines 11-11 and 12-12 respectively in FIGURE 2.

If reference is made first to FIGURE 1, there is seen a stream-lined body 1, which may equally well be that of an airplane or that of a submarine. About the rear end of the stream-lined body 1 there are disposed a number (two in this example) of co-axial tubular elements 2, 3, which are partly superimposed from front to rear. Each of these tubular elements possesses a section in the form of a wing profile, as represented in section in FIGURE 1, the extrados of this wing being situated on the interior. Furthermore, if a transverse section is made through the body in the vicinity of the leading edge of each of the tubular elements, the tangent of the profile of the stream-lined body at such transverse sections is more inclined with respect to the axis of the said body than the chord line of the profile of the tubular element, or more precisely than its chord line of zero lift.

The tubular elements 2 and 3 are fixed in rigid fashion on the rear end of the stream-lined body, by means of profiled ribs 4, 5 respectively (see also FIGURE 9) disposed and arranged in such fashion as to penetrate as little as possible into the annular space included between the tubular elements and the stream-lined body.

The tubular element 2 has such a diameter at its lead-

ing edge that the radial distance between each point of the leading edge and the radially opposite point on the circumference of the body 1 is smaller than the radial distance between said point of body 1 and its longitudinal axis. The thus restricted radial width of the annular fluid passage at its forward end is necessary for the desired acceleration of boundary layer fluid flow to produce a forward thrust component.

In the form of embodiment as represented, the propulsion of the body is effected by an axial power unit as a propeller 6 disposed inside the tubular element 3 and working in the stream of fluid entering the interior of the tubular elements their leading edges, and issuing through the rear end of the tubular element 3. At 7 and 8 the direction and depth controls respectively have been indicated.

The tubular elements 2, 3 are thus situated in the zone where the fluid streams are in danger of breaking away; they oppose this break-away and reduce or even eliminate the fluid pressure in the rear super-pressure zone and modify the pressure into supporting forces distributed over the said elements and comprising an axial component directed forwardly.

The role of the smallest tubular body 2 consists above all in reaccelerating the layer of turbulent fluid included between the outer surface of the stream-lined body 1 and the said tubular element 2. This reacceleration is effected by the circulation established around the tubular element 2, which is accompanied by a retardation of the fluid particles passing round the external surface of the tubular element.

The propulsion means 6 add its action to that of the tubular elements. It is possible, under these conditions, not only to improve the flow about and in the vicinity of the stream-lined body, but also to reduce, in the wake thereof, the losses of energy resulting from the dragging of fluid particles behind the body. It must in fact be considered that the drag of the body results at the same time from the energy expended by friction in the layer of fluid circulating in the vicinity of its external surface, and from the flow of particles which escorts it immediately after its passage. On the contrary, a propulsion means gives rise to a propulsive force which depends upon the quantity of movement of the particles thrust back to the rear; but, whereas, when the particles in question are taken from the undisturbed ambient fluid, the propulsive yield is the greater, all other things being equal, as the speed of recoil of the particles displaced by the propulsion means is smaller, the neutralization, one by the other, of the masses of the particles entrained behind the body by friction and of those which the propulsion means sends to the rear would obviously correspond to an ideal arrangement from the point of view of the performance of the stream-lined body as regards movement in relation to the fluid. This is the goal at which the invention aims.

It can be advantageous that the means of propulsion are different according to whether they act upon the fluid particles flowing in the vicinity of the rear outer surface of the stream-lined body (rear turbulent layer) or upon the fluid particles flowing between the tubular elements.

In the form of embodiment according to FIGURE 1, there is one single means of propulsion acting upon the fluid particles flowing between the tubular elements, and it is constituted by a propeller 6 rotating inside the largest tubular element.

In the variants according to FIGURES 2 and 3, however the means of propulsion comprises not only a multiple screw 11, 12 respectively, as in the form of embodiment according to FIGURE 1, but additional suction means such as the blower rotor 13 or 14 is provided, acting upon the fluid particles flowing in the vicinity of the external surface of the streamlined body to increase the fluid flow. The form of embodiment according to FIGURE 2 is intended for submersible craft, and that according to FIGURE 3 is intended for aerodynes.

In the forms of embodiment according to FIGURES 4 and 5, there is no blower rotor, but the additional suction means comprises turbines 16, 17, acting upon the fluid particles flowing in the vicinity of the external surface of the stream-lined body.

Furthermore, since the mean speed in the rear turbulent layer increases from a zero value in the vicinity of the body, according to the shape of the body, and the speed and kinematic viscosity of the fluid, it is advantageous to proportion the action of the propulsion means acting in the turbulent layer to the energy which must be communicated to the particles of this layer in order to restore their kinetic energy to its theoretical value (in a perfect flow). For this purpose, in a more elaborate form of embodiment, the forward tubular element has been divided into a plurality of staggered coaxial bladings which guide the particles of the turbulent layer until they enter the turbine blading at a pre-determined level (see the bladings 2a, 2b in FIGURES 4 and 5, and the bladings 2a, 2b and 2c in FIGURES 6, 7 and 8). The blower blades of the additional suction means are arranged either as a single stage (blades 13, 14 and 15 in FIGURES 2, 3 and 6), or may be divided into successive stages (blades 16 and 17 in FIGURES 4 and 5).

Apart from improving the performance of the stream-lined body, the tubular elements according to the invention contribute to the stability, in direction and in depth, of the stream-lined body with which they are associated. This contribution, which is however insufficient in general, may be completed by the utilisation of radial surfaces which are at the same time advantageously used to support the aforementioned tubular elements.

Such radial surfaces can be seen at 4 and 5 in FIGURES 1, 2, 3, 4 and 5 for example.

The tubular elements preferably possess the shape of a body of rotation, if the stream-lined body, at least in the rear part thereof, is itself a body of rotation. In the converse case, the tubular elements may be of elliptical or ovoid forms respecting the relative positions of the tubular bodies and of the external surface of the stream-lined body in radial planes.

Finally, in the case when the propulsion means is associated with the tubular elements and is disposed between the same and the rear external surface of the stream-lined body, there are disposed fixed bladings arranged in such manner as to correct the distortion of the particles upon which the propulsion means have acted, before the ejection of the said particles at the rear part of the streamlining. Such fixed bladings are indicated at 18 in FIGURES 2 to 5.

Furthermore, when movable controls are provided inside the tubular elements, for the purpose of bringing about greater maneuverability of the stream-lined body, an asymmetrical shape with helicoidal twist is given to the leading edges of the said controls, which contributes to the correction of the fluid streams, before their emergence from the larger tubular element.

The propulsion means as represented in FIGURE 5 is a turbo-reactor 24 mounted inside the tubular bodies; FIGURE 7 shows an overall view of an airplane 19, provided with the device according to the invention; and FIGURE 8 shows the application of a device according to the invention to an engine nacelle 21 suspended from a wing 22 of an airplane by a profiled rib 23.

The power necessary for the action of the propulsion means associated with the tubular elements can be taken from a motor situated further forward on the stream-lined body and remotely transmitted by mechanical, hydromechanical, pneumatic or electric means; or the power can be applied directly through a special piston-type thermal engine, or a gas-turbine engine.

While the invention has been described with particular reference to a preferred embodiment, it is not intended to limit the scope of the invention to the embodiment illus-

trated, nor otherwise than the terms of the subjoined claims.

What is claimed is:

1. In a streamlined body to be propelled in a fluid and having an outer surface region where transition of the boundary layer fluid flow from laminar to turbulent condition initiates, at least one tubular element the section of which, through a radial half-plane, has an airfoil contour with an inwardly facing extrados, and means for mounting the said tubular element on the stream-lined body coaxially therewith and rearwardly of said region, said tubular element circumferentially surrounding a rear part of the body and being radially spaced therefrom, the said means being arranged so as to penetrate as little as possible into an annular space included between the tubular element and the stream-lined body, the diameter of said tubular element at its leading edge being such that the distance between each point of the leading edge and a radially opposite point of the body is smaller than the radial distance between the last mentioned point and the longitudinal axis of the body, the tubular element having a chord line which is inclined with respect to the axis of the stream-lined body and which intersects said axis aft of the tubular element, the airfoil contour of the tubular element being such that, if a transverse section is made through said body adjacent the leading edge of the tubular element, the tangent of the profile of the stream-lined body at said transverse section is more inclined with respect to the axis of said body than the chord line of the airfoil contour of the tubular element, or than its direction of zero lift if the latter is appreciably inclined with respect to said chord line.

2. A device according to claim 1, wherein said mounting means are constituted by radial surfaces, disposed in such fashion as to serve at the same time for supporting the tubular elements and for contributing to the stability of the streamlined body in direction and depth.

3. In a streamlined body to be propelled in a fluid and having a surface region where transition of the boundary layer fluid flow from laminar to turbulent condition initiates, a first tubular element of airfoil shaped longitudinal section positioned aft said region and supported by said body in coaxial and radially spaced relation therewith to define with said body an annular fluid passage, the diameter of said tubular element at its leading edge being such that the radial distance between each point of said leading edge and a radially opposite point of the body is smaller than the radial distance between the last mentioned point and the longitudinal axis of the body, a second tubular element of airfoil shaped longitudinal section positioned aft said first tubular element and supported by said body in coaxial relation with said first tubular ele-

ment, the diameter of said second tubular element at its leading edge being greater than that of said first tubular element at said leading edge thereof but smaller than the largest diameter of said body, and power operated propulsion means disposed within said second tubular element in coaxial relation with said longitudinal axis of the body, said propulsion means sucking fluid from said region through said passage and into said second tubular element, and said airfoil section of the tubular elements being such as to cause acceleration of the fluid flow entering said elements and to provide a forwardly directed thrust component.

4. In a streamlined body to be propelled in a fluid and having a surface region where transition of the boundary layer fluid flow from laminar to turbulent condition initiates, a first tubular element of airfoil shaped longitudinal section positioned aft said region and supported by said body in coaxial and radially spaced relation therewith to define with said body an annular fluid passage, the diameter of said first tubular element at its leading edge being such that the distance between each point of said leading edge and a radially opposite point of the body is smaller than the radial distance between the last mentioned point and the longitudinal axis of the body, a second tubular element of airfoil shaped longitudinal section positioned aft said first tubular element and supported by said body in coaxial relation with said first tubular element, a leading edge portion of said second tubular element circumferentially surrounding and being radially spaced from a trailing edge portion of said first tubular element to define therewith a second fluid passage, power operated propulsion means in said second tubular element for sucking fluid from said region through said first passage and said second passage, and power operated blower means in said first tubular element for additionally sucking fluid from said region through said first passage, said airfoil section of the tubular elements being such as to cause acceleration of the fluid flow through said passages and to provide a forwardly directed thrust component.

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