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J. H. BERTIN ET AL
ARRANGEMENTS FOR DEFLECTING THE JET EXPELLED
FROM A DISCHARGE NOZZLE OR FROM
A REACTION-PROPULSION UNIT

3,024,602

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3 Sheets-Sheet 1

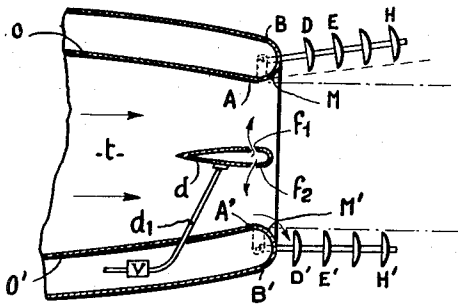


Fig. 1

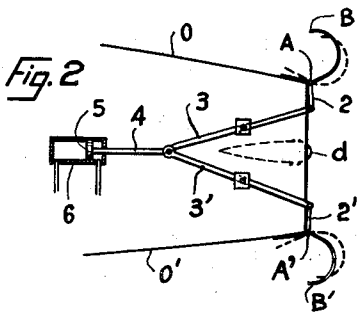


Fig. 2

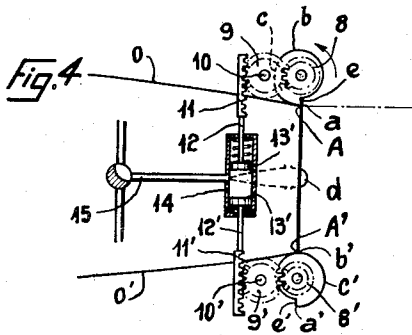


Fig. 4

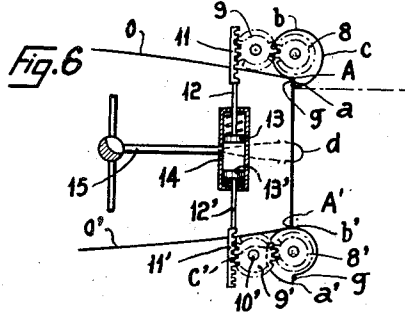


Fig. 6

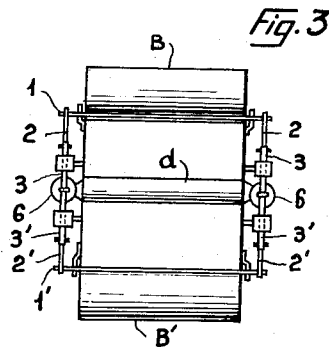


Fig. 3

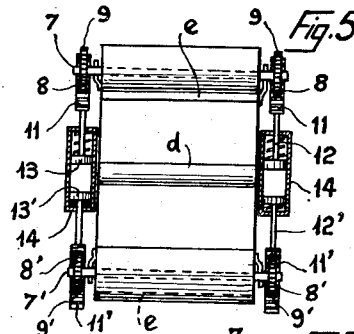


Fig. 5

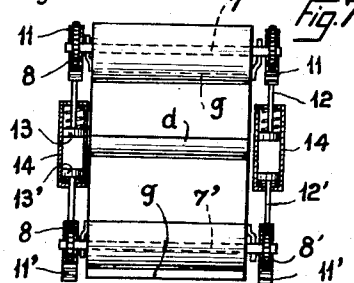


Fig. 7

INVENTORS

Jean H. Bertin
Marcel Xadosch
Francis M. L. Mounoury
Louis M. B. de La Salle
Henri Turinetti

By Watson, Cole, Brindley & Watson
ATTORNEYS

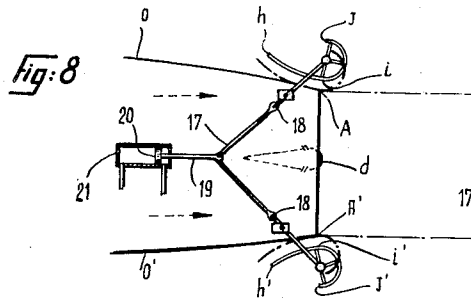
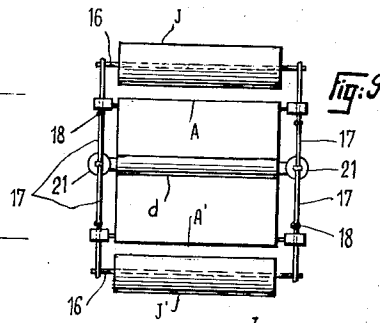
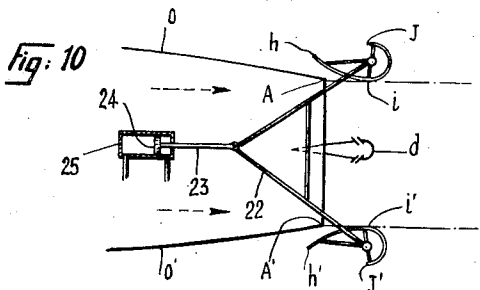
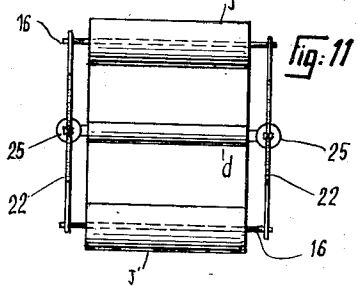
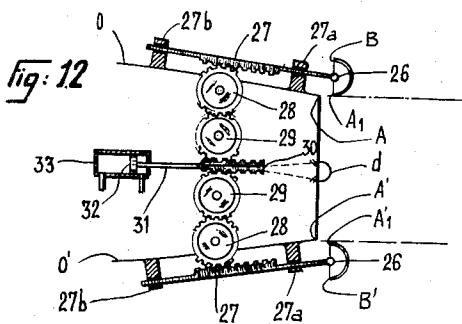
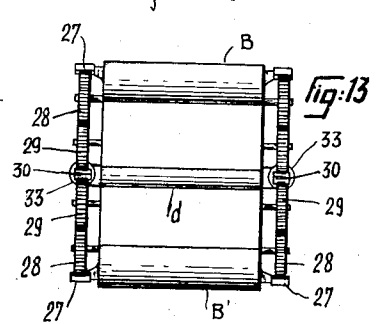
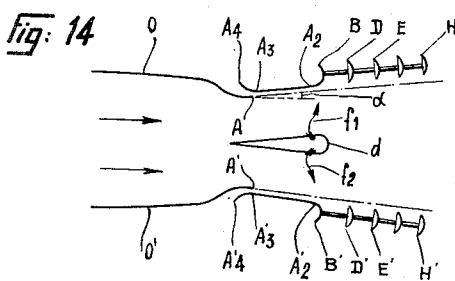
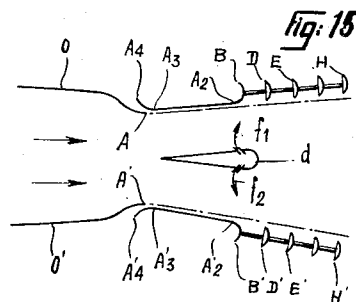
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Louis M. H. de La Salle
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ATTORNEYS

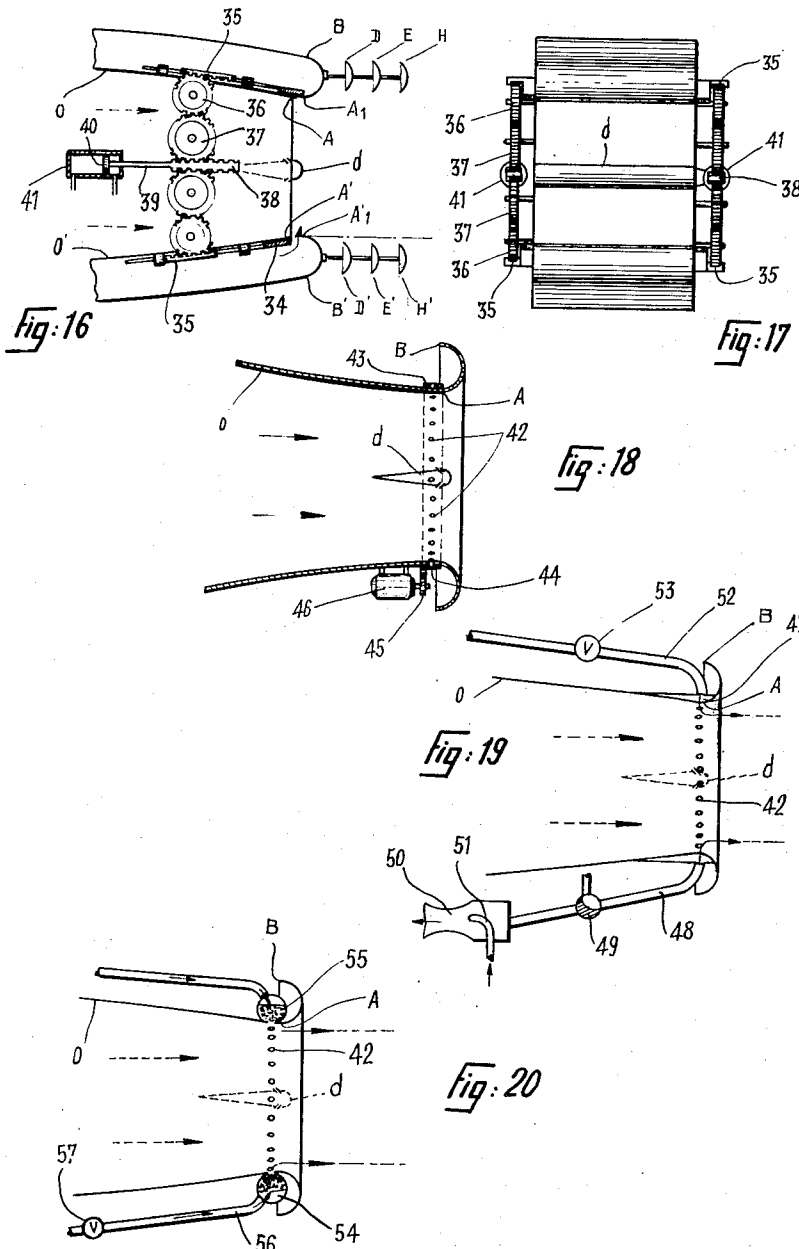
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Jean H. Bertin
Marcel Kadosch
Francis M. L. Maunoury
Louis M. B. de La Salle
Henri Turinetti
By Watson, Cole, Brindley & Watson
ATTORNEYS

1

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ARRANGEMENTS FOR DEFLECTING THE JET EXPULSED FROM A DISCHARGE NOZZLE OR FROM A REACTION-PROPULSION UNIT

Jean H. Bertin, Neuilly-sur-Seine, and Marcel Kadosch,
François M. L. Maunoury, Louis M. G. de la Salle, and
Henri Turinetti, Paris, France, assignors to Societe
Nationale d'Etude et de Construction de Moteurs
d'Aviation, Paris, France, a French company

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7 Claims. (Cl. 60—35.54)

In the U.S. patent application Serial No. 229,772, filed June 4, 1951, are described arrangements for deflecting the jet expelled from an exhaust discharge nozzle or from a reaction-propulsion unit in which the exhaust nozzle, combined with a tangential extension, curved back towards the exterior in the direction towards which the deflection is to be effected, comprises, close to the transverse plane which contains the tangential junction or coupling section of this extension, means intended to intercept a small part of the jet flowing out at a short distance from this junction and comprises, in addition, deflecting blades placed in the path of the deflected jet and the curvature of which is chosen so as to give the desired final value to the deflection.

In the U.S. patent application, Serial No. 335,442, filed February 6, 1953, is described an improvement made in this arrangement which consists in combining the grid or the grids of blades with means adapted to put the said blades out of action in order to eliminate the impedence to the flow of the jet which these blades would cause during the periods at which no deflection of the jet was taking place.

The object of the present invention is to provide an improvement which consists in combining, with the tangential coupling section, means which are designed during the normal operation of the exhaust nozzle, to ensure that the marginal layer of the jet in front of the extension is removed or dissipated.

In FIG. 1 is shown in diagrammatic form an axial cross-section of a reaction-exhaust nozzle t , for example of rectangular cross-section, the sides O and O' of which are integral with an extension $A-B$ and $A'-B'$ respectively, curved back towards the exterior. Grids of deflecting blades $DE \dots H$ and $D'E' \dots H'$ can be placed in the path of the deflected jet and an arrangement, such, for example, as one of those which have been described in the above-mentioned patent application Serial No. 335,442 may be provided to remove these blades from the jet. In addition, on the inside of the exhaust nozzle and close to the transverse plane containing the junction of the convex surfaces forming an extension to the walls of the exhaust nozzle, is placed an element d which, when it is in service, is intended to intercept a part of the fluid in motion and thus to ensure the deflection of the jet leaving the exhaust nozzle, as indicated in the patent application Serial No. 229,772 referred to above.

In the example shown, this element or member is constituted by a tube of aerofoil section which extends parallel to the sides O and O' in the central plane of the exhaust nozzle and parallel to its sides. This tube, which can be supplied from a pipe d_1 with air under pressure (derived for example from the air compressor of the turbo jet unit) when it is desired to begin to deflect the jet, is provided along its length with two symmetrical slots f_1 and f_2 which thus extend parallel to the sides O and O' and which are, preferably, obliquely disposed, the obliquity being directed towards the intake side of the exhaust nozzle. When the tube d is supplied with compressed air, the jets of air which escape through the slots

2

f_1 and f_2 come into contact with those portions of the jet flow which are close to the central plane, in such a way that the jet issuing from the exhaust nozzle tends to stick against the extended portions AB and $A'B'$ and is thus deflected from the two sides of the central plane of the exhaust nozzle which contains the axis of the tube d . The grids of blades $D \dots H$ and $D' \dots H'$ extend this deflection beyond the point at which it would cease if the blades did not exist.

On the other hand, when the tube d is not supplied with air, there is nothing to oppose the flow of the jet along the axis of the exhaust nozzle, the marginal layer of the jet being, in principle, obliged to follow the path shown in chain-dotted lines in FIG. 1. However, the exhaust nozzle and its convex extensions form a convergent-divergent conduit, the neck of which is located in the transverse plane $A-A'$, in such a manner that at a normal sub-sonic speed, the marginal layers of the jet passing through the exhaust nozzle tend to stick against these extensions, due to the effect of the force of their viscosity and do not come away from the wall until they have passed beyond the orifice AA' of the exhaust nozzle, for example at M , in order then to follow the path shown in dotted lines on the upper half of FIG. 1. The result of this is that the reaction-jet becomes re-compressed in the divergent portion $AM-A'M$ and slows down, thus reducing the thrust of the exhaust nozzle. Furthermore, the divergence which has for its result a progressive increase in the cross-section of the jet on the output side of the exhaust nozzle makes it necessary to place the grid of deflecting blades further back in relation to the ideal theoretical path of the marginal layer, as has been shown in the upper half of FIG. 1, in order to avoid, at normal speed, the friction of the jet as well as the losses in kinetic energy and in thrust which would result.

In accordance with the invention, the exhaust nozzle is provided, close to the section which couples its walls to its extended portion, with means which are intended under conditions of normal speed to ensure the disengagement of the reaction-jet close to the transverse plane of the orifice AA' of the exhaust nozzle and which can, when required, be placed wholly or partly out of action in order to allow the jet to stick against the tangential extensions AB and $A'B'$ when it is desired to effect a deflection of the jet. A simple and economic means suitable for ensuring the disengagement of the jet, consists in roughening, over a certain distance, the surface of that part of the convex extension which is adjacent to the wall of the exhaust nozzle.

In other forms of embodiment of the invention, the convex extension of the wall of the exhaust nozzle is formed by a member which is distinct from the latter and is arranged in such a way as to be movable with respect to the exhaust nozzle in order that it may be brought either to be tangential to the wall of the discharge nozzle in the transverse plane of its orifice, or to form on this wall a discontinuous portion which can ensure the disengagement of the marginal layer of the reaction-jet near to the transverse plane of the orifice of the exhaust nozzle.

In accordance with other forms of embodiment, there are provided near to the tangential coupling section of the wall of the exhaust nozzle and its convex extension, which, in this case, is fixed, one or more openings through which a lateral pressure may be applied to the jet flowing through the exhaust nozzle in order to disengage the marginal layer from the wall.

The description which follows below with reference to the attached drawings (which are given by way of example only and not in any sense of limitation) will make it quite clear how the invention may be carried into effect, the special features which are referred to, either

3

in the drawings or in the text, forming of course, a part of the said invention.

FIG. 1 is a view in axial cross-section of a reaction-discharge nozzle provided with a deflection arrangement which has already been partly described in the preamble in order to illustrate the effect of the sticking of the extreme outer layer of the reaction-jet against the deflecting wall.

FIGS. 2, 4, 6, 8, 10 and 12 are side elevations of exhaust nozzles of rectangular cross-section in accordance with the invention in which the convex extension of the wall of the exhaust nozzle is mobile and is formed by a piece which is separate from this latter, FIGS. 3, 5, 7, 9, 11 and 13 being end views of the exhaust nozzles shown in FIGS. 2, 4, 6, 8, 10 and 12 respectively.

FIGS. 14 to 16 are side elevations and FIG. 17 is an end view of FIG. 16, these figures showing exhaust nozzles of rectangular cross-section, the convex extension of which forms a member which is separate from the wall of the exhaust nozzle and is fixed with respect to this latter.

FIGS. 18 to 20 are axial cross-section views of three forms of embodiment of exhaust nozzles of circular cross-section provided with a number of openings through which a lateral pressure can be applied to the jet as it passes through the exhaust nozzle.

In the method of embodiment already partly described in FIG. 1, a simple means of ensuring the disengagement of the marginal layer in the transverse plane A—A' of the orifice of the exhaust nozzle, consists in roughening, over a certain distance, the surface of that part of the convex extension which is adjacent to the wall of the exhaust nozzle, for example, over the distance A—M and A'—M', the remainder of the surface of the deflecting wall MB and M'B' being normally smooth. The roughness of the surface AM and A'M' can be obtained by any particular means, for example with the aid of a coarse-grain metallic spray or by filing.

During the normal operation of the exhaust nozzle, the marginal layer of the reaction-jet is broken-up by the roughness of the surface AM or A'M' and is disengaged from the wall at A and A' in order to follow the path parallel to the axis of the exhaust nozzle as shown in chain-dotted lines on the figure. When the deflection of the jet is initiated, the broken marginal layer is "scraped" by the grid of blades D', E' . . . H' which, as shown in the lower portion of FIG. 1, can be placed very close to the limiting surface of the non-deflected jet, the disengagement of which is ensured. By reason of the simplicity of this means, which avoids any re-compression of the jet at normal speeds, the slight losses in thrust caused by the breaking-up of the marginal layers can quite easily be tolerated.

FIGS. 2 and 3 show an embodiment in which the connection of the convex extension A—B and of the wall O of the exhaust nozzle forms an angle open towards the exterior of the exhaust nozzle. The point of inflection thus formed in the wall, in the transverse plane of the orifice AA', causes the disengagement of the marginal layer of the jet at normal speeds. In a discharge nozzle of circular cross-section, in which, for example, the wall O and its extension AB are integral the one with the other, a grid of deflecting blades similar to that which is shown in FIG. 1 and suitably arranged close to the marginal layer of the non-deflected jet, facilitates the re-attachment of the marginal layer against the extension, when the jet interception arrangement *d* is put into operation.

In the case of the exhaust nozzle of rectangular section shown in FIGS. 2 and 3, the convex extensions AB and A'B' form members separate from the adjacent walls O and O' of the exhaust nozzle and are carried by axes 1 and 1' arranged in the plane of the walls O and O' and in the transverse plane AA' of the coupling section of these walls and the members AB and A'B'. These

4

members are free to pivot about these axes and can be arranged either to extend the walls of the exhaust nozzle tangentially in the position shown in dotted lines in FIG. 2 so as to facilitate the deflection of the jet when the member *d* is put into operation, or to form an angle with the walls O and O' at their edges adjacent to these walls so as to facilitate the disengagement of the jet at normal speed, for example in the position shown in full lines in FIG. 2.

The angle formed by the tangents to the surfaces O and A—B, O' and A'B' respectively, can be modified at will by any suitable system of control, which offers the advantage that the location of the point of disengagement of the marginal layer on the convex extension can be varied, and thus the value of the deflection of the reaction-jet may therefore be controlled and this also varies the value of the thrust. In this way, the speed of the expelled jet can be varied, within certain narrow limits, and the lack of flexibility of turbo-jet units which is due to the great inertia of the rotors of the compressor and of the turbine when rotating at high speeds, can be completely overcome.

The pivoting action of the deflecting walls AB and A'B' can be controlled in any suitable manner. By way of example, there have been shown in the drawing, levers 2 and 2' keyed on to one end of each of the axes 1 and 1' and having their other ends connected to cranked arms 3 and 3' operated by the shaft 4 of a piston 5 which moves in a cylinder 6 the latter being supplied by fluid under pressure at either of its two extremities.

In the alternative mode of embodiment shown in FIGS. 4 and 5, the deflecting walls of the exhaust nozzle, which is of rectangular cross-section, are formed by curved surfaces, preferably closed, and comprising at least one semi-cylindrical portion *a*, *c*, *b*, of which one extremity *a* is connected to a small lateral projection *e*, forming an angle, for example of 90°, with the tangent to this surface at the point of junction. These deflecting walls are carried by axes 7 and 7' parallel to the plane of the walls O and O' and to the plane of the orifice AA' of the exhaust nozzle and are arranged in such a way that the semi-cylindrical portion *a*—*c*—*b* and *a'*—*c'*—*b'* respectively is tangential to the walls O and O' respectively of the exhaust nozzle.

At the normal operating speed, the semi-cylindrical portion of the deflecting wall is turned towards the intake side of the exhaust nozzle (see the upper half of FIG. 4) and the extension *e* is located in the plane of the orifice of the exhaust nozzle, thus forming, at the extremity of the wall O, a free edge which facilitates the disengagement of the reaction-jet. By suitably rotating the deflecting wall about its axis, the semi-cylindrical surface can be brought to form a tangential extension of the wall of the exhaust nozzle (see the lower half of FIG. 4), so as to facilitate the deflection of the jet, the marginal or limiting layer of which tends to adhere to the surface *a'*—*c'*—*b'*, when the intercepting arrangement *d* is put into operation.

The rotation of the deflecting walls can be obtained by any suitable control arrangement. In the drawings there have been shown pinions 8 and 8' keyed to the ends of the shafts 7 and 7' and engaging with toothed wheels 9 and 9' pivoting about the axes 10 and 10' parallel to the shafts 7 and 7'. Toothed racks 11 and 11', engaging with the wheels 9 and 9' are operated by rods 12 and 12'; the pistons 13 and 13' which move in a common double-acting cylinder 14 are supplied with fluid under pressure or may be exhausted by the pipe 15.

The alternative method shown in FIGS. 6 and 7 differs from that of FIGS. 4 and 5 in that the extension of the semi-cylindrical part *abc* of the deflecting wall, instead of being set back from the extremity of the surface of this wall forms a projection *g*, therefrom. At the normal speed of ejection of gas from the exhaust nozzle, the projecting *g* forms an obstacle to the movement of the

5

marginal layer of the jet in the transverse plane of the orifice AA', and causes the disengagement of this layer (see the upper half of FIG. 6). By suitably rotating the deflecting wall, this projection can be removed from the path of the reacting-jet thereby causing the semi-cylindrical portion *a, b, c*, to form a tangential extension of the wall O of the exhaust nozzle when the jet is deflected (see the lower half of FIG. 6). The rotation of the deflecting walls can be obtained by a control arrangement similar to that shown in FIGS. 4 and 5.

In the alternative embodiment of an exhaust nozzle of rectangular section shown in FIGS. 8 to 11, the guiding wall *i—j* of the marginal layer of the reaction-jet when the jet is being deflected comprises, at the side of the wall O, a convex extension *i—h* which extends towards the intake side of the exhaust nozzle. This guiding wall is movable and can be arranged to extend the wall of the exhaust nozzle tangentially in the transverse plane of the orifice AA' (a position shown in chain-dotted lines in FIGS. 8 to 10), or it may be placed at a distance from this wall, either set back a little distance from the nozzle (the position shown in full lines in FIG. 8), or on the delivery side of the nozzle (the position shown in full lines in FIG. 10).

When the guiding wall is tangential at *i* to the wall O, at the speed corresponding to deflection of the jet from its normal path, the marginal layer adheres to the guiding wall *i—j* curved back towards the exterior. On the other hand, at normal speed, the guiding wall is placed at a distance from the wall O and the latter forms, together with the extension *i—h*, a convergent passage through which is drawn air from the atmosphere which is directed, tangentially to the path of flow of the reaction-jet, on to the marginal layer which is thus detached from the orifice AA' of the exhaust nozzle.

By suitably shaping the ejector arrangement thus constituted by the wall of the exhaust nozzle and by the extension *i—h* of the guiding wall, it is possible to obtain an effective blowing action on the marginal layer of the reaction-jet flowing through the exhaust nozzle and to ensure a high thrust efficiency of this jet.

The displacement of the guiding wall can be effected in any particular manner. By way of example, there has been shown in FIGS. 8 and 9, a rod 16 parallel to the surface *h, i, j* and carrying the guiding wall. A lever 17, articulated at 18, is fixed to each of the extremities of the rod 16 and is jointed to the rod 19 of a piston 20 which moves in a cylinder 21 parallel to the axis of the exhaust nozzle and which can be supplied at each of its ends by a fluid under pressure. This control arrangement allows the guiding wall *h, i, j*, to be set back with reference to the wall of the exhaust nozzle, by rotating it about the joint 18.

The displacement of the guiding wall of the alternative embodiment shown in FIGS. 10 and 11 is obtained by a translation movement which permits this wall to be moved away towards the delivery side of the orifice AA' of the exhaust nozzle. A rigid support, formed by the rods 16, 22 and 23 is attached to the piston 24, which moves in the cylinder 25 parallel to the axis of the exhaust nozzle and supplied at the one or the other of its ends with fluid under pressure.

There have been shown in FIGS. 14 and 15 two alternative embodiments similar to those of FIGS. 8 to 11, but in which, however, the convex extension is fixed in relation to the wall of the exhaust nozzle. The walls O and O' of the exhaust nozzle, which has a rectangular cross-section, form, at their extremities, a slightly convergent-divergent passage which terminates in a free edge A, A' respectively, in such a way that the reaction-jet is expelled with a certain angle of divergence which is equal to α .

The guiding wall of the reaction-jet, which extends the wall of the exhaust nozzle, includes a plane surface A₃ and A₂ which extends towards the delivery side of the exhaust nozzle, parallel to the marginal layer of the un-

6

deflected jet. This plane surface is preferably arranged in such a way that the distance which separates it from the marginal layer at normal speed without any deflection, is roughly equal to the maximum space which is to be provided in order that the jet shall not readhere. Towards the delivery side of the plane surface A₃A₂, the guiding wall comprises the extension A₂B, which is curved back towards the exterior whilst, towards the intake side, it is extended by a member A₃A₄ having a convex surface and which forms, with the exterior surface of the extremity of the wall O of the exhaust nozzle, a convergent-divergent passage which constitutes an ejector arrangement for drawing-in atmospheric air.

The extension A₂B of the guiding wall is combined, in the examples shown in FIGS. 14 and 15, with a grid of blades for guiding the jet when the latter is deflected from its normal trajectory.

At normal speed, that is to say when the member *d* which intercepts a part of the jet, is not in use, the ejector formed by the extension A₃A₄ and the wall of the exhaust nozzle, directs on to the marginal layer, and parallel to this latter, a current of air which has a pressure greater than the static pressure of the jet and which applies a lateral thrust to the jet which prevents it from adhering to the wall A₃A₂B.

The surface A₃A₂ being situated very near to the marginal layer of the jet, a very slight deflection, caused by putting the member *d* into operation by passing compressed air through the slots *f*₁ and *f*₂ would be enough to cause the jet to come into adherence with the guiding walls. On the other hand, in order to avoid a wave of back-pressure from being transmitted back along the jet, it is necessary that the length of the plane surface A₃A₂ should be great enough for the effective cross-section of the jet, in the plane A₂A'₂, to be greater, taking the divergence into account, than the transverse cross-section of the orifice AA' of the discharge nozzle, in spite of the reduction in the cross-section of the passage of the flow, which is caused by the deflecting air-current in the plane A₂A'₂. If these indications are observed, the desired conditions for efficient deflection are fulfilled.

In order to obtain an adequate blowing effect, it is necessary that the slots *f*₁ and *f*₂ should be located close to the transverse plane A₂A'₂ in which is located the coupling section of the plane surface and the curved surface of the guiding wall. In the embodiment shown in FIG. 14, the leading edge of the aerofoil section body *d* is placed at the intake side of the plane of the orifice AA' of the discharge nozzle.

This particular method of embodiment of the invention also allows the member *d* to be placed completely outside the discharge nozzle, as has been shown in FIG. 15. In this way, the flow of the gases inside the discharge nozzle is identically the same as in the case of an ordinary reactor, and thus the invention may be carried into effect with the aid of a discharge nozzle of the normal type.

In the alternative embodiment of discharge nozzles of rectangular cross-section such as are shown in FIGS. 12, 13, 16 and 17, the disengagement of the jet at the orifice AA' is obtained by a break in continuity between the wall of the discharge nozzle and the extension A₁B, A'₁B' which is bent back towards the exterior, in such a way that the space thus formed between the orifice of the discharge nozzle and the origin of the extension is at atmospheric pressure, that is to say at a pressure in excess of the static pressure which obtains at that point in the discharge nozzle, whereby the marginal layer of the jet may be detached, while operating at normal speed, by a lateral pressure.

As has been shown in FIG. 16, the guiding wall A₁B can be combined with a grid of fixed or movable deflecting blades similar to those which have already been described in the patent applications referred to in the preamble. It will, of course, be clearly understood that such a grid of blades may be combined with each of the

method of embodiment of the invention described in the present specification.

When the interception member *d* is put into operation to deflect the jet, the break in continuity between the wall of the discharge nozzle and the guiding wall may be suppressed by any suitable arrangement, so as to allow the marginal layer to re-adhere to the convex extension A₁B. There may, for example, be provided a control arrangement which causes the displacement by rotation by sideways movement, or by pivotal movement of the guiding wall, such as one of those which have been shown in FIGS. 4 to 13.

There has been shown in diagrammatic form in FIG. 12 a control arrangement by means of which the guiding wall can be displaced by a lateral movement in the plane parallel to the wall O of the discharge nozzle. A toothed rack 27, which is fixed to each of the extremities of the axis 26 which carries the wall A₁B and which can slide in supporting members 27*a* and 27*b*, is controlled by toothed wheels 28 and 29 engaging with a rack 30 forming part of the extremity of the shaft 31 of the piston 32 which moves in the cylinder 33 parallel to the axis of the discharge nozzle and which is supplied at either one or the other of its ends with a fluid under pressure.

Instead of being movable, the guiding wall A₁B may be fixed and the space existing between the origin of this wall and the edge A of the wall to the discharge nozzle may be closed by any convenient means. There has been shown in FIGS. 16 and 17, a shutter device 34 which can move on the external surface of the wall O of the discharge nozzle so as either to close (see the upper half of FIG. 16), or to open the space referred to (see the lower half of FIG. 16). The shutter 34 is fixed, at each of its extremities, to a rack 35 which slides in a plane parallel to the plane of the wall O of the discharge nozzle. Toothed wheels 36 and 37, engage with the rack 35 and with a second rack 38 integral with a shaft 39 of a piston 40, moving in a cylinder 41, which is parallel to the axis of the discharge nozzle and which is supplied at either the one or the other of its extremities with fluid under pressure.

The continuous space thus arranged along the length of the coupling section of the wall of the discharge nozzle and of the convex extension may be replaced by a series of openings provided along the length of this coupling in the transverse plane of the orifice AA' of the exhaust nozzle, in such a way as to produce the same result as that which is obtained by the methods of embodiment of FIGS. 12, 13, 16 and 17.

By way of example, there has been shown in diagrammatical form in FIG. 18, a discharge nozzle of circular cross-section in which a series of small holes 42 are arranged close together along the length of the coupling portion of the wall O and its extension A—B which is curved back towards the exterior. Thus, at normal speed, the orifice of the discharge nozzle is at atmospheric pressure and the disengagement of the marginal layer of the reaction-jet is ensured by the lateral pressure applied to the said layer.

In order to overcome the difficulties caused during the deflection of the jet by this opening of the orifice of the discharge nozzle to atmospheric pressure, any suitable arrangement may be provided for closing these small holes. By way of example there has been indicated in FIG. 18 a ring 43 which surrounds the portion coupling the discharge nozzle with its extension and comprising also a series of small holes 44 which can be rotated so as to correspond to the holes 42 in the discharge nozzle. This ring can be given a rotation movement around the axis of the discharge nozzle, in order to close the openings 42 by its unperforated portions. In the example shown, a part of the ring carries on its exterior surface a toothed portion which engages with the pinion 45 keyed on the shaft of a small electric motor 46 which may rotate in either direction.

In the alternative embodiment of the arrangement for

controlling the opening of the small holes 42 shown in FIG. 19, the neck of the convergent-divergent passage formed by the discharge nozzle and its convex extension is surrounded by a collector 47. In the lower half of FIG. 19 there is shown a pipe 48 which may be connected through a valve 49 either to the surrounding air, or to an extractor 50, the nozzle 51 of which is supplied with compressed air which may, for example, be provided by the compressor of the turbo-jet unit.

At normal speed, the collector is placed at atmospheric pressure by means of the valve and the disengagement of the marginal layer of the reaction-jet is obtained as in the case of FIG. 18. When the jet-interception member is put into operation, the collector 47 may be connected to the extractor 50 by means of the valve 49 so as to put the collector at the static pressure which obtains at the orifice of the discharge nozzle.

When the jet disengages in the neighbourhood of the small holes, it sucks in the surrounding air through the holes which thus create a sub-pressure with respect to atmospheric pressure and the desired over-pressure on the ejection wall in the transverse plane of the orifice of the discharge nozzle is thereby somewhat reduced, as is also the disengaging effect on the marginal layer of the jet. The desired effect may, however, be increased by connecting the collector 47 to a pipe 42 (see the upper half of FIG. 19) which is supplied with air under pressure obtained for example from the compressor of the turbo-jet unit and including, in this pipe, a valve 53 by means of which the compressed air may be cut off when it is desired to proceed to the deflection of the jet against the convex extension AB.

The isobars of static pressure, not being very well known and being liable to be deformed in a discharge nozzle, according to the operating conditions of the reactor unit, there may result a circulation of the gases from the discharge nozzle or of the blowing air in the holes 42, which circulation results in a reduction of the speed of discharge of the reaction-jet. The alternative embodiment shown in FIG. 20 permits this drawback to be avoided.

A fluid-tight collector 54 is arranged around the coupling portion of the discharge nozzle and its convex extension, and the small holes 42 are closed by a suitable thickness of porous matter 55, similar to that which is used, for example, for closing the suction slots of the marginal layer, the disengagement of which from aerodynamic profiles is desired to be avoided. The collector 54 is connected by means of a pipe 56 to a source of compressed air such as the compressor of the turbo-jet unit, and the flow of air to the collector may be cut off by a valve 57.

At normal speed, the valve 57 is open and the air under pressure passes through the porous matter 55 and the small holes 42, in order to form jets which ensure the detachment of the marginal layer of the flow of gases in the transverse plane of the orifice A of the discharge nozzle.

In order to ensure the deflection of the jet by means of the interception member *d* and to allow the marginal layer to adhere against the extension AB which is curved back towards the exterior, the flow of compressed air is cut off by means of the valve 57 and the losses of pressure which are produced by the porous matter 55 on all flow of gas passing through the holes 42, are sufficient to prevent any circulation of gas between the collector 54 and the neck of the convergent-divergent passage formed by the discharge nozzle and its convex extension.

It will be well understood that modifications may be made to the improvements which have just been described, in particular by the substitution of equivalent technical means, without thereby departing from the scope or from the spirit of the present invention.

What we claim is:

1. In a jet propulsion unit having a propulsive nozzle facing towards the rear of said unit and jet deflector means positioned to the rear of said nozzle and of the type

9

comprising jet guiding surfaces extending laterally of the normal undeflected flow path of the jet and curved back towards the front of said unit, a device for rendering ineffective said jet guiding surfaces during normal operation of said jet, comprising means extending along the periphery of said flow path, upstream of said surfaces, for introducing a layer of air about said jet whereby the jet separates from said surfaces and flows clear of the same.

2. Device as claimed in claim 1 comprising a divergent wall extending between the air introducing means and the jet guiding surfaces, and wherein said air introducing means comprises an injector for sucking ambient air due to induction effect of the jet issuing from the nozzle and to discharge said air along said wall.

3. Device as claimed in claim 2 wherein the wall has a generally rectilinear longitudinal outline.

4. Device as claimed in claim 2 wherein the injector comprises an upstream extension of the wall close to the nozzle outlet and transversely spaced therefrom.

5. Device as claimed in claim 4 wherein the jet guiding surfaces, the wall and the upstream extension thereof

10

are fast with each other to form a rigid assembly, and said assembly is secured to the propulsive nozzle against displacement relatively thereto.

6. Device as claimed in claim 1 comprising means controlling the air introducing means for stopping air introduction whereby the jet adheres to said surfaces and is at least partially deflected thereby.

7. Device as claimed in claim 1 wherein the air introducing means comprises a source of compressed air.

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