July 2, 1957 H. L. P. MEULIEN ET AL. 2,797,547

JET DEFLECTING DEVICE, ESPECIALLY INTENDED FOR DISCHARGE NOZZLES OR PROPULSION UNITS

Filed Nov. 28, 1955 6 Sheets-Sheet 1

Fig. 1

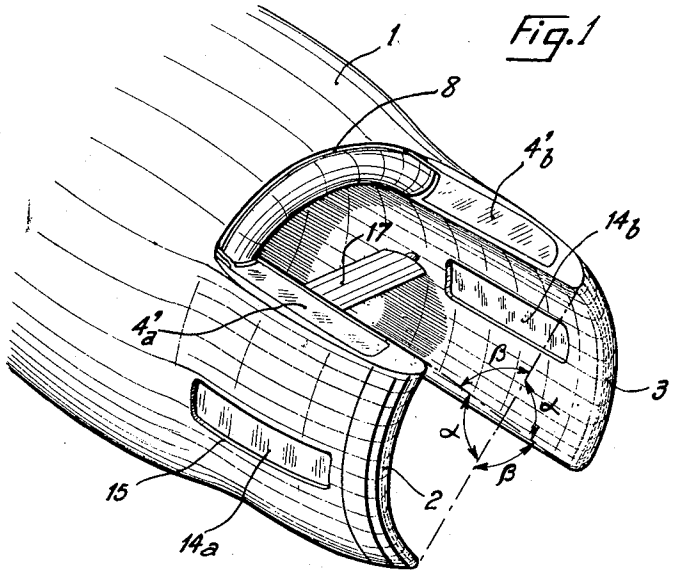
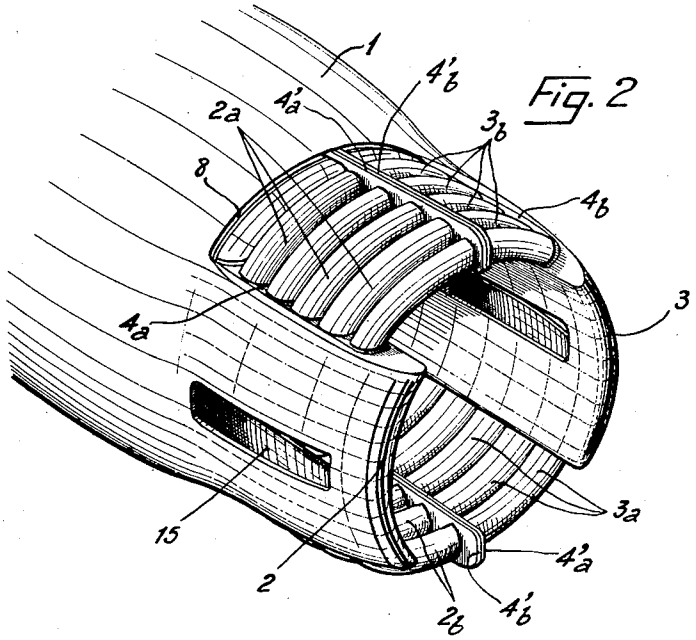


Fig. 2



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Filed Nov. 28, 1955 6 Sheets-Sheet 2

Fig. 4

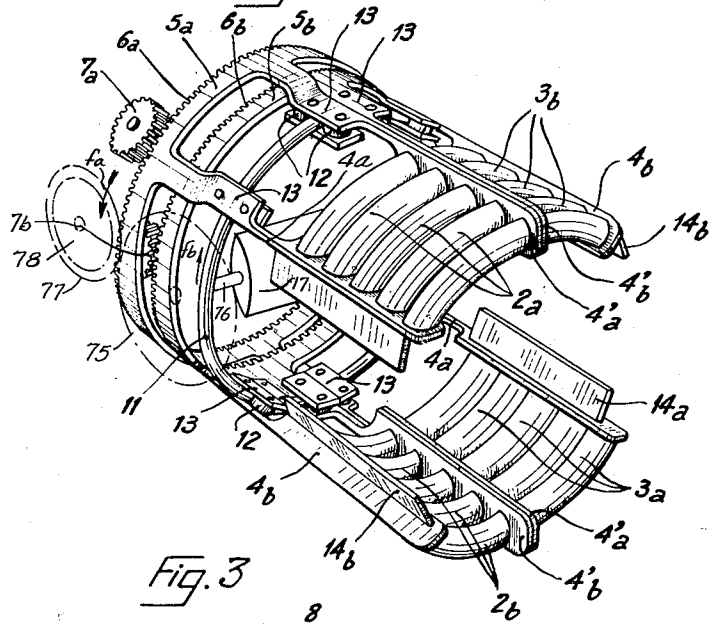
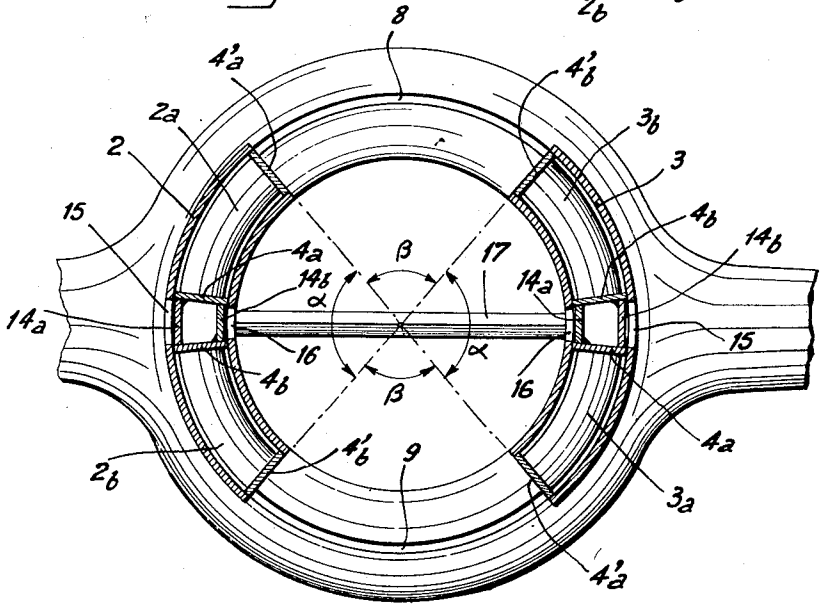


Fig. 3



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Filed Nov. 28, 1955 6 Sheets-Sheet 3

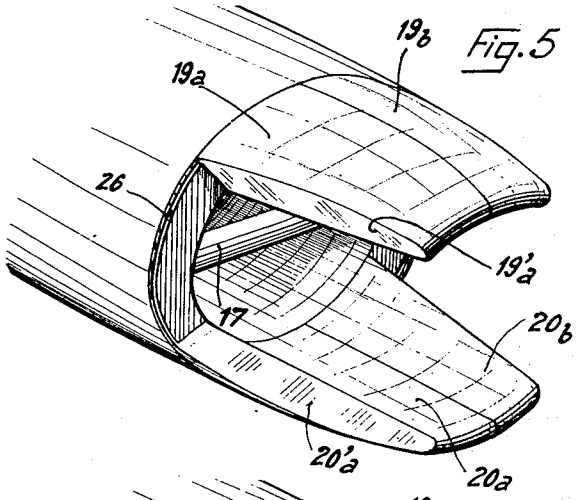


Fig. 5

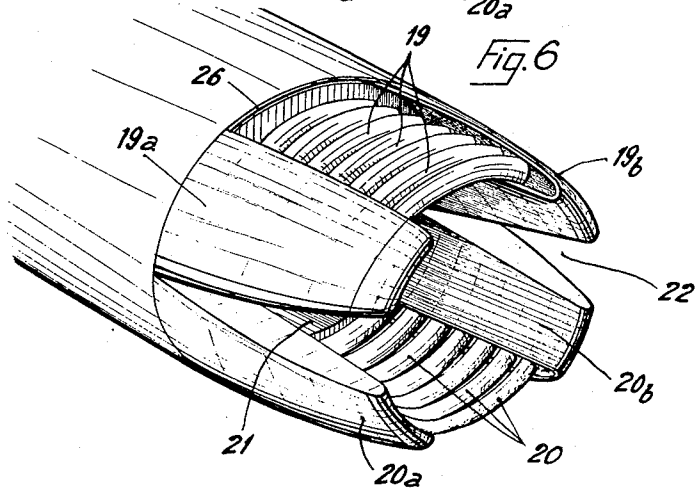


Fig. 6

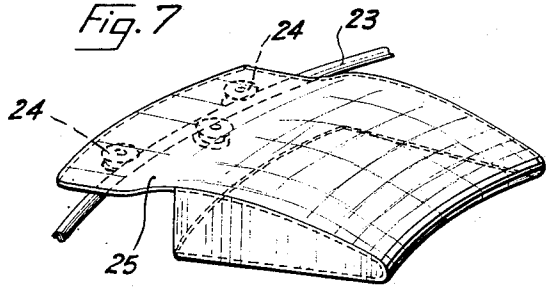


Fig. 7

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Filed Nov. 28, 1955 6 Sheets-Sheet 4

Fig. 8

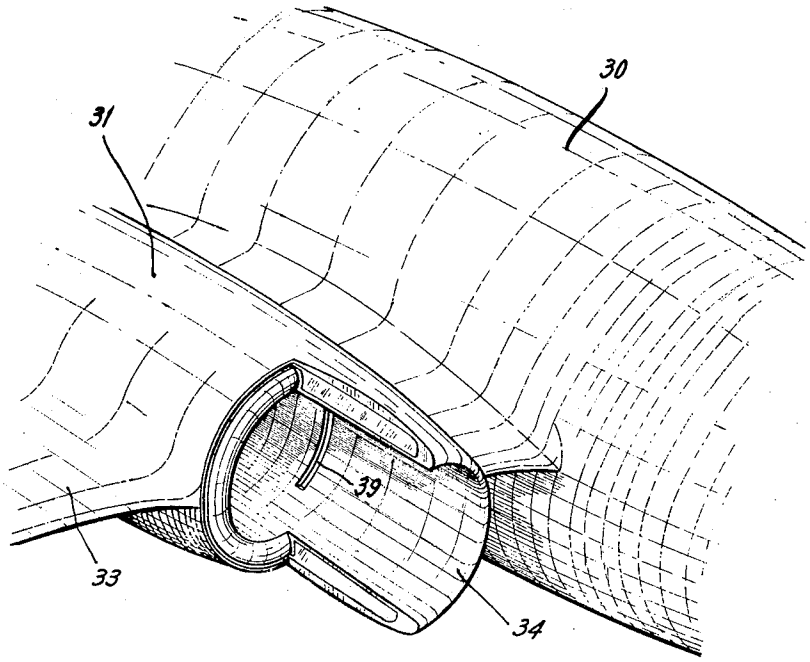
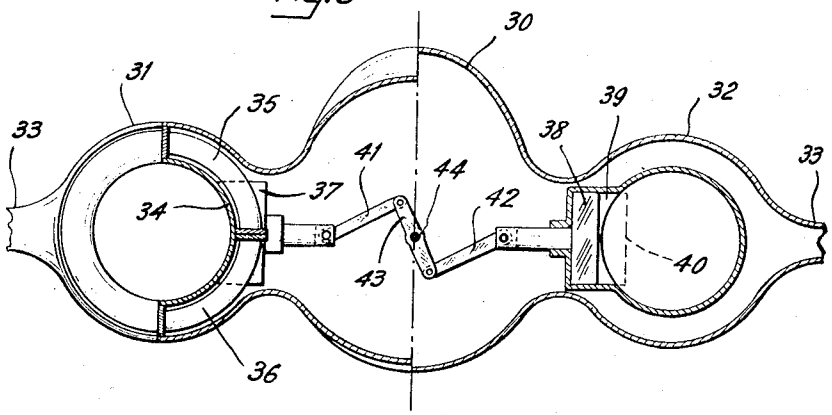


Fig. 9



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Filed Nov. 28, 1955 6 Sheets-Sheet 5

Fig. 10

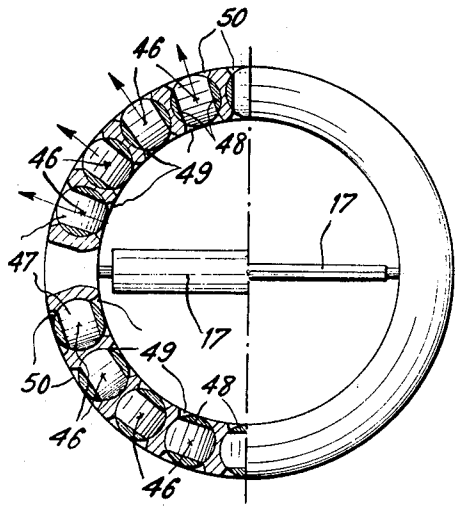


Fig. 11

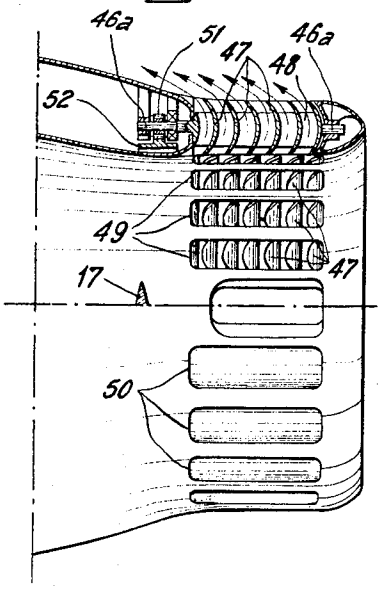
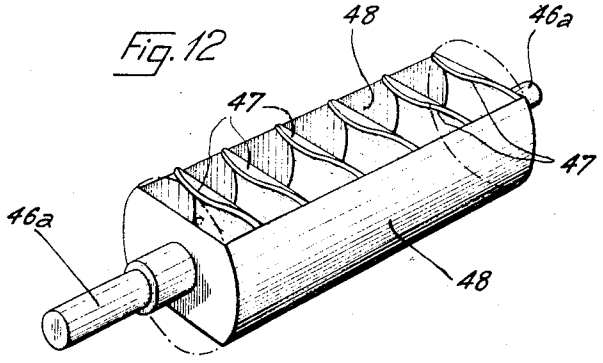


Fig. 12



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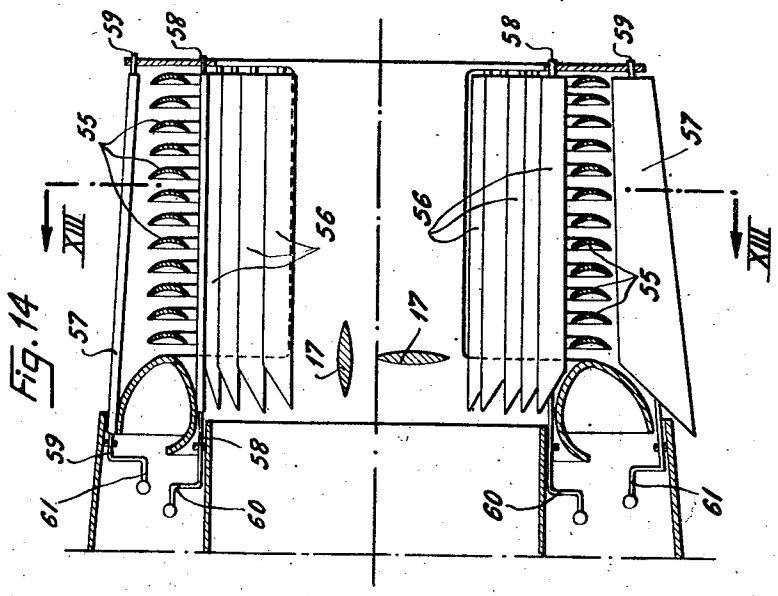


Fig. 14

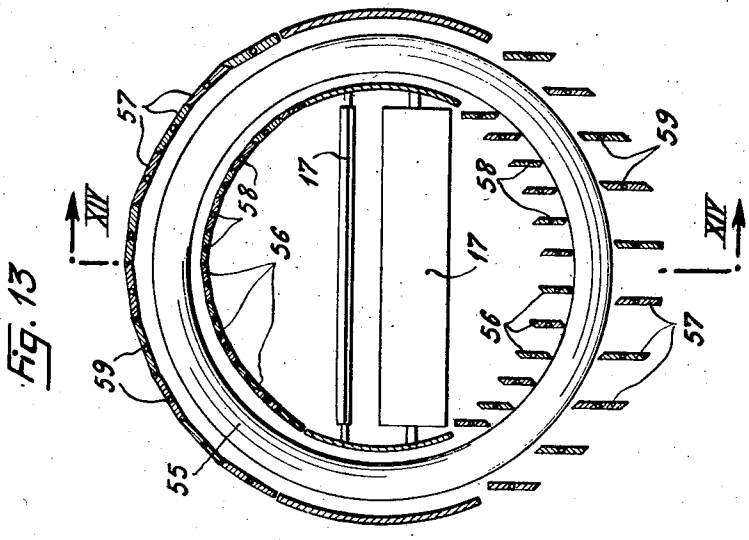


Fig. 13

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JET DEFLECTING DEVICE, ESPECIALLY INTENDED FOR DISCHARGE NOZZLES OR PROPULSION UNITS

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Application November 28, 1955, Serial No. 549,442

Claims priority, application France November 29, 1954

13 Claims. (Cl. 60—35.54)

In order momentarily to deflect the jet discharged from a reaction propulsion unit from its normal direction of flow, with a view to braking the movement of the moving body propelled or to modify the direction of the thrust, it has already been proposed to use grids of blades or deflecting fins which are placed around the normal trajectory of the jet, generally on the downstream side of the discharge nozzle, and which come into action when the jet is subjected to a system of forces which tend to cause it to deviate from its normal direction.

These deflecting blades may however have the drawback of increasing the drag outside the periods of deflection, by their action on the air which flows round the propulsion unit, and also of reducing the thrust produced by the said unit by "scraping" the peripheral streams of the jet.

The device which forms the object of the present invention enables this drawback to be overcome and also enables a smooth surface to be presented both to the jet and to the external air flow during the non-deflecting periods.

In accordance with the invention, the blades are combined with one or a number of cowlings adapted to mask the blades during non-deflection periods and, on the other hand, to uncover them when it is desired to deflect the jet, by a relative movement of the blades with respect to the cowling, or of the blades and of the cowling with respect to the fixed parts of the exhaust nozzle, this rotational movement being carried out about one or a plurality of axes substantially parallel to that of the discharge nozzle.

The description which follows below with reference to the attached drawings (which are given by way of example only and not in any sense by way of limitation), will make it quite clear how the invention may be carried into effect, the special features which are brought out, either in the text or in the drawings, being understood to form a part of the said invention.

Figs. 1 to 4 relate to a first form of embodiment of the invention and represent:

In Fig. 1, a perspective view of the rear portion of the discharge nozzle with the blades withdrawn to the non-operative position.

In Fig. 2, a similar view with the blades in the deflecting position.

In Fig. 3, a rear view of the discharge nozzle with the blades withdrawn, the cowlings being cut through a plane at right angles to the axis of the discharge nozzle.

In Fig. 4, a view in perspective of the mechanism by which the displacement of the blades is effected.

Figs. 5 to 7 relate to a second form of embodiment of the invention, Fig. 5 showing in perspective the rear portion of the discharge nozzle with the blades retracted, Fig. 6 being a similar view with the blades in the operative position, and Fig. 7 being a view to a larger scale of a movable cowling.

Figs. 8 and 9 relate to a third form of embodiment which is applicable to the case of two reaction units symmetrically mounted on each side of the fuselage of an aircraft, Fig. 8 showing a perspective view of the discharge-nozzle of one of these reactors with the blades withdrawn, Fig. 9 being a transverse cross-section through two laterally-displaced planes of the reactors and of the fuselage.

Figs. 10 to 12 illustrate a fourth form of embodiment in which the blades are in a number of parts which are individually retractable; one-half of Fig. 10 is an end view of the discharge nozzle, and the other half is a view in cross-section through a plane located on the upstream side; one-half of Fig. 11 is a view in axial cross-section of the discharge-nozzle, while the other half is a view in lateral projection; Fig. 12 shows a detail of a rotating element to a larger scale.

Figs. 13 and 14 illustrate a fifth form of embodiment of the invention; Fig. 13 is a cross-section through a transverse plane and showing in its lower half the members placed in the deflecting position, whilst in its upper half, the said members are in the position which corresponds to the normal flow of the jet; Fig. 14 is a cross-section through an axial plane.

In the form of embodiment shown in Figs. 1 to 4, the discharge nozzle is extended, both internally and externally by two cowling members **2—3** which include in cross-section (see Fig. 3) two opposite angles α at the centre, so that the solid formed by the discharge-nozzle and by the cowling members comprises two lateral slots which extend over the opposite angles β, subtended at the centre. In the example shown in the drawing, the angles α are a little greater than 90° and the angles β are slightly smaller. In addition, the cowlings have sections in the form of circular arcs centered on the axis of the discharge-nozzle. With these cowlings are adapted to co-operate four segments of a grid of blades *2a*, *2b*, *3a*, *3b*, which each extend over an angle at the centre equal to one-half of β. The grids *2a* and *3a* are fixed by means of arms *4a*, *4'a*, parallel to the axis of the discharge-nozzle to a ring *5a* which is concentric to the discharge-nozzle. In the same way, the grids *2b—3b* are fixed by means of arms *4b*, *4'b* to a ring *5b* concentric with the discharge-nozzle. The two rings are arranged in the interior of the cowling **1** of the discharge-nozzle so as to be able to rotate in opposite directions. The drawing shows these rings provided with rack teeth *6a—6b* with which engage pinions *7a—7b*, the spindles of which rotate in fixed bearings and are coupled to an operating device (not shown).

Starting from the position of Figs. 2 and 4, in which the grids fill the slots formed between the cowlings 2 and 3 in order to carry out the deflection of the jet, it will be understood that if the ring *5a* is rotated through an angle equal to one-half of β in the direction of the arrow f_a, and the ring *5b* through an equal angle in the direction of the arrow f_b, the segments of blades *2a—2b* will pass into the cowling **2** (Figs. 1 and 3), whilst the segments *3a—3b* will disappear into the cowling **3**. The casing of the discharge-nozzle is of course provided with two opposite slots **8—9** in the form of circular arcs, so as to permit the passage of the arms *4a*, *4'a*, *4b*, *4'b*, which are of flat shape at that point. The guiding of the rotation of the rings *5a—5b* may be effected in any suitable manner. The drawing shows a fixed circular rod **10** which can be mounted in the casing of the discharge-nozzle and may be attached to this casing in any appropriate manner, for example at two diametrically-opposite points such as **11**. This rod serves as a rolling rail for rollers **12** which are fitted with side-plates **13** provided on the arms *4a*, *4'a*, *4b*, *4'b*. The number of

guides of this kind may, furthermore, be increased as required.

At the points at which the blades are attached to them, the arms 4*a*, 4'*a*, 4*b*, 4'*b*, have a flat shape located in radial planes and having a surface which corresponds to the internal section of the cowlings **2** and **3**. In this way, the arms 4'*a*, 4'*b*, close the cowlings **2—3** when the blades are retracted, whilst they come together, one flat on the other, when the blades are in the deflecting position. In the same way, the arms 4*a*, 4*b*, which pass into the cowlings when the blades are retracted, close the said cowlings when the blades are in the deflection position. In the example shown in the drawing, it has been assumed that the commencement of the deflection is obtained by means of an eclipsable diametral obstacle **17** which acts in the bisecting plane of the angles α subtended by the cowlings. This obstacle may be formed, for example, by means of a blade of aerofoil section pivotally mounted at its extremities with respect to the discharge-nozzle. It may thus take up either the position shown in Figs. 1 and 3, in which the profile of the said blade is in the direction of flow of the jet and thus offers only a very small resistance to the passage of the jet, or the position at right angles to that referred to, in which this blade intercepts the streams of the jet and divides these into two parts which are respectively deflected towards the two slots β. In the latter case, the streams of the jet thus deflected come in contact with the grids of blades placed in these slots, and these blades give the final desired deflection to the two halves of the jet.

In a system of this kind, it is important to fill the wake-zone which forms on the downstream side of the obstacle, in order to avoid the tendency of the two halves of the jet to become re-attached to each other. For this purpose, the external and internal walls of the cowlings **2—3** are pierced with slots **15—16** in the plane of the obstacle **17**. When the blades are retracted into the cowlings, these slots are closed by means of plates **14***a*—**14***b* fixed respectively on the arms 4*a*—4*b*. On the other hand, these slots are open when the blades are in their operative position. The consequence of this in an embodiment of this kind is that the grids of blades each extend over an angle less than one-half of α, and that β, which is equal to the sum of the angles subtended by two adjacent grids of blades, is itself smaller than α.

It is however possible to envisage other arrangements which enable the useful angle β of the slots, through which the parts of the deflected jet are discharged, to be increased. For example, the blades of two grids such as **2***a*—**2***b* which are retracted into the same cowling, may be arranged so as to fit in between each other in the retracted position, which would enable α to be reduced and β to be increased. In this case, the slots **15—16** supplying the wake-zones may have smaller longitudinal dimensions so as only to be associated with the zone located immediately on the downstream side of the obstacle, before the beginning of the grids of blades.

The device is further applicable to deflecting arrangements having other methods of operation, for example to those in which the deflection of the jet is initiated by a centrifugal zone created in the jet inside the discharge-nozzle before the outlet of this nozzle, by means of inclinable blades or auxiliary jets forming fluid blades.

In the alternative form shown in Figs. 5 to 7, the grids of blades **19—20**, which occupy two opposite segments on the downstream side of the outlet orifice of the discharge-nozzle are fixed, whilst the cowlings are rotatably movable about the axis of the discharge-nozzle. The cowling of each grid is formed of two halves **19***a*—**19***b*, **20***a*—**20***b*, which may either come one against the other (see Fig. 5) thus concealing the blades, or may be separated (see Fig. 6) to uncover the blades. These cowling halves may be terminated by oblique edges **19'***a*, **20'***a*, so as to form in the plane of the deflecting obstacle **17**, slots **21—22** which enable the wake-zone of the obstacle to be filled when the blades are exposed (see Fig. 6). Fig. 7 shows the method of guiding of each of the parts of the cowling, by means of a circular rail **23** against which are applied rollers **24** fixed on a flat extension **25** of the cowling which passes into the discharge-nozzle through a circular slot **26**. The movement of the cowling halves may be obtained by means of a mechanical arrangement similar to that described with reference to Fig. 4.

The cowlings may not be symmetrical, depending on the cases to which they are applied. A single cowling may also be provided which only extends over a portion of the periphery of the discharge-nozzle when the deflection of the jet is to be effected only to one side.

Figs. 8 and 9 illustrate an embodiment of this kind applied to an aircraft which is provided with two reactors symmetrically mounted with respect to the fuselage.

In these figures, there is seen at **30** the fuselage and at **31** and **32** the casings of the two reactors arranged at the roots of the wings **33**. The discharge-nozzle of each reactor is extended along side the fuselage by a cowling **34** having a semi-cylindrical cross-section. Each of these cowlings may receive two segments of grids of blades **35—36**, each of which extends over an arc of 90°. The left-hand side of Fig. 9 shows these grids retracted into the cowling. By means of a mechanism similar to that described with reference to Fig. 4, the grids may be withdrawn from the cowling so as to be placed in close contact opposite to the cowling and thus to ensure the deflection of the jet away from the fuselage. In a case of this kind, the deflecting obstacle **37—38** acts on the wall of the discharge-nozzle. In the example shown, it is constituted by a plate which is movable at right-angles to the axis of the corresponding discharge-nozzle, and may either be withdrawn into a slot **39** formed in the wall of this nozzle or be caused to project from this wall, as shown in dotted lines at **40** in the right-hand portion of Fig. 9. In the example considered, the movements of the obstacles **37—38** are effected conjointly by crank-arms **41—42** coupled to the extremities of a double arm **43** carried on a shaft **44** which can be rotated by the pilot.

The form of embodiment shown in Figs. 10 to 12 differs from the previous forms in that the grid of blades is sub-divided into a fairly large number of elements which can rotate individually, in the same way as the moving part of a tap, about axes **46** parallel to the axis of the discharge-nozzle and distributed around the discharge-nozzle. Fig. 12 shows one of these elements in perspective, comprising the portions of blades **47**, the lateral cylindrical cheeks **48**, between which the parts of blades are held, and the pivots **46***a* which constitute the axis of rotation of the element. Each element thus constituted is introduced into a cylindrical housing in the wall of the discharge-nozzle and communicate with the interior of the nozzle by means of ports **49**, and with the exterior by ports **50**. In the upper half of Fig. 10, the various elements occupy the angular position which corresponds to the deflection, for which position the fluid may pass out of the discharge-nozzle by passing through the ports **49**, the spaces between the deflecting blades **47** and the external ports **50**. The lower part of Fig. 10, on the other hand, shows the said elements rotated through 90° in order to close the wall of the discharge-nozzle. The position of the deflecting obstacle **17**, shown on the left-hand side of Fig. 10, corresponds to the position of the elements shown in the upper left-hand quarter of the said figure (deflection), whilst the position of the obstacle shown on the right-hand side of the figure corresponds to the position of the elements shown on the bottom left-hand side of this figure. The rotation of the

various elements may be synchronised by any appropriate means, for example by providing one of the pivots 46*a* of the elements with a pinion 51 and by causing all the pinions 51 to engage with a common toothed ring 52, the rotation of which about the axis of the discharge-nozzle is controlled by the pilot.

In the alternative form shown in Figs. 13 and 14, the grid of blades 55, which is extended around the whole periphery of the discharge-nozzle, is fixed. The grid is combined with an interior cowling and an exterior cowling, each constituted by a series of shutters 56—57 which are arranged to pivot about axes aparallel to that of the discharge-nozzle. To this end, the shutters are provided with pivots 58—59 and with crank-arms 60 and 61 which enable them to be actuated by a common control. The upper halves of Figs. 13 and 14 show the shutters closed to cover the grid of blades (the jet passing out without deflection), whilst the lower halves of the same figure show the shutters open so as to expose the grid of blades.

It will be seen from the drawing that the moving shutters are all parallel to each other (and at right-angles to the axis of the obstacle) when they uncover the blades, during a deflection period. They thus effect a guiding action on the deflected jet which prevents the streams of this jet from diverging too rapidly, by virtue of which the deflected jet remains sufficiently compact and tight to develop a substantial thrust, which may be either negative (braking or counter-thrust), or applied in any particular direction with respect to the axis of the normal jet.

In all the foregoing forms of embodiment, there is an advantage in providing a coupling between the control of the device which initiates the deflection, for example a movable obstacle, and that of the moving blades or of the cowlings, so that the blades are placed in the active position (exposed by means of the cowling) at the same time as the deflection is commenced, or before. For example, there may be provided a single control lever which acts on the cowlings or on the moving blades in the first part of its travel, and on the device which initiates the deflection in the second part of its travel.

In the form of embodiment shown in Figs. 1 to 4, there may, for example, be provided a pinion 75 mounted on one of the pivots 76 of the pivoting obstacle 17 and engaging with one of the toothed racks 6*a*—6*b* through gears 77 and 78, the said pinion having a radius suitably chosen in order that the obstacle pivots through 90° in passing from its inactive to its active position or vice-versa, during the movement of the movable blades.

In the case of an obstacle formed by a fluid jet, the movement of the moving blades or moving cowlings may also be used to act on the supply valve of the fluid jet.

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

What we claim is:

1. A jet-deflection device for reaction discharge-nozzles, comprising at least one grid of deflecting blades which are placed outside the normal path of the jet, at least one cowling adapted to cover the said blades during non-deflection periods and to uncover the said blades during deflection periods by a relative movement of rotation of the blades with respect to the said cowling, the said movement of rotation being effected about an axis substantially parallel to the axis of the discharge-nozzle.

2. A device in accordance with claim 1, wherein the cowling is fixed and has the form of a part of a body of revolution about the axis of the discharge-nozzle, in extension to the said discharge-nozzle, said cowling being adapted to receive the grid of blades arranged in such manner as to rotate about the axis of revolution so as to pass into the said cowling or to project therefrom.

3. A device in accordance with claim 2, wherein the grid of blades is provided with a plate arranged in a radial plane to close the cowling when the said blades are retracted.

4. A device in accordance with claim 1, wherein the deflection is initiated by a movable obstacle and the cowling is provided, on the downstream side of the said obstacle, with ports intendeed to provide a passage for the exterior air to fill up the wake-zone on the downstream side of the said obstacle.

5. A device in accordance with claim 1, wherein two cowlings are provided in diametrically-opposite positions and co-operate with parts of grids of moving blades which are adapted, by movements of rotation in opposite directions, to come into the active position in the spaces between the said cowlings or to be retracted inside the said cowlings.

6. A device in accordance with claim 1, wherein the said grids of blades are fixed and arranged as parts of a body of revolution about the axis of the said discharge-nozzle, the said grids being combined with hollow cowlings arranged to rotate about the axis of the discharge-nozzle so as to cover or uncover the said grids.

7. A device in accordance with claim 1, wherein the edges of the said movable cowlings have a shape adapted to form between the cowlings when they uncover the said grids of blades, slots which permit of the passage of air.

8. A device in accordance with claim 1, characterised in that the said cowlings are located in such manner as to shield adjacent parts by only permitting deflection of the jet away from the said parts.

9. A device in accordance with claim 8, applicable to an aircraft provided with two propulsion units mounted on each side of the fuselage, wherein the said cowlings extend the discharge-nozzle along the side of the fuselage in such manner that the deflection is effected towards the opposite side.

10. A device in accordance with claim 1, wherein the said deflecting blades are divided into portions carried by separate elements which are adapted to rotate in cylindrical housings formed in the extremity of the discharge-nozzle and communicating by means of ports with the interior and the exterior of the said discharge-nozzle, the rotation of the said elements being conjugated with each other.

11. A device in accordance with claim 1, wherein the blades are fixed and are combined with shutters adapted to enclose them inside and outside the discharge-nozzle, the said shutters being pivotally mounted about axes parallel to the axis of the said discharge-nozzle.

12. A device in accordance with claim 11, wherein the said shutters are arranged so as to take up parallel positions directed in the sense of the deflection when they uncover the said blades, thereby reducing the divergence of the streams of the deflected jet.

13. A device in accordance with claim 1, comprising a coupling device between the control of the member which initiates the deflection and that of the moving blades or of the moving cowling, in such manner that the said blades are placed in the active position at least when the deflection is initiated.

No references cited.