

June 17, 1958

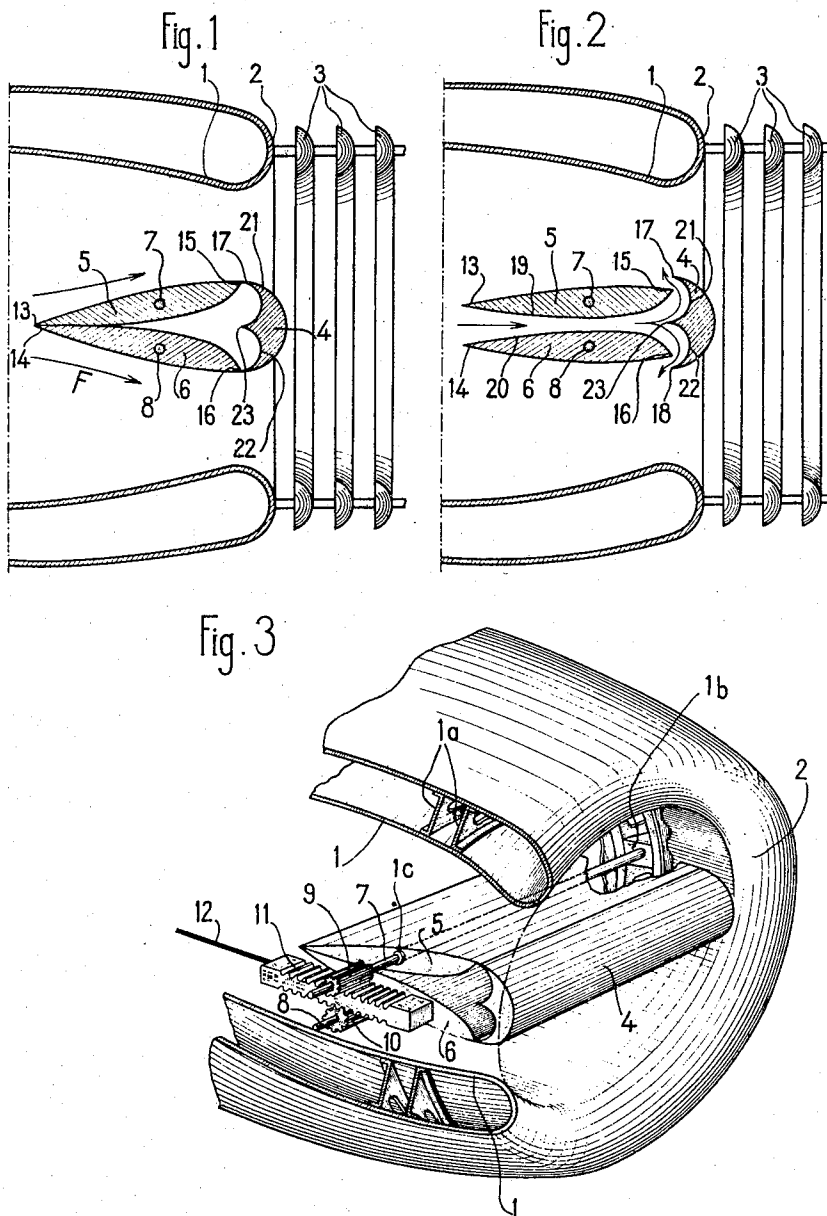
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2,838,909

MEANS FOR THE DEFLECTION OF FLUID JETS

Filed July 6, 1953

4 Sheets-Sheet 1



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Fig. 4

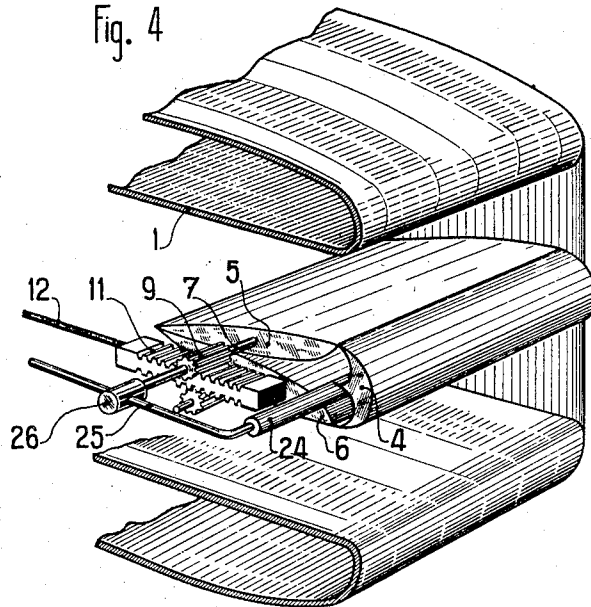
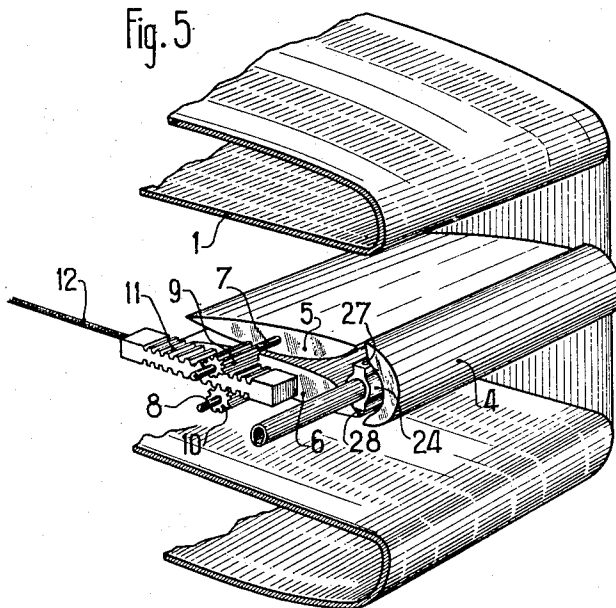


Fig. 5



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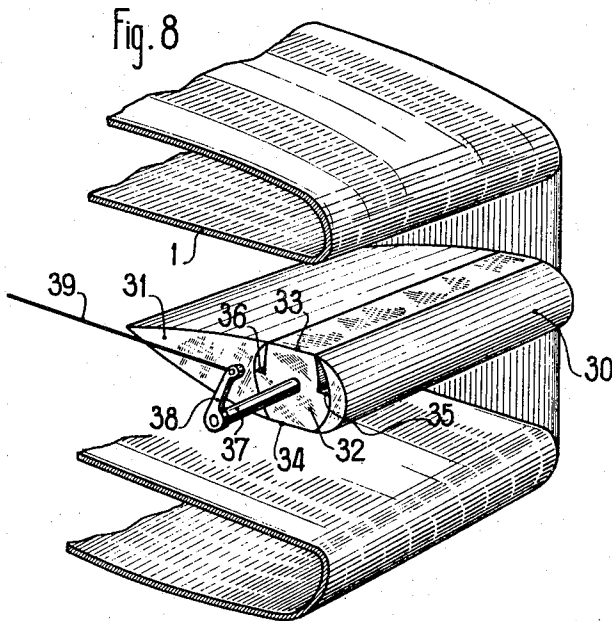
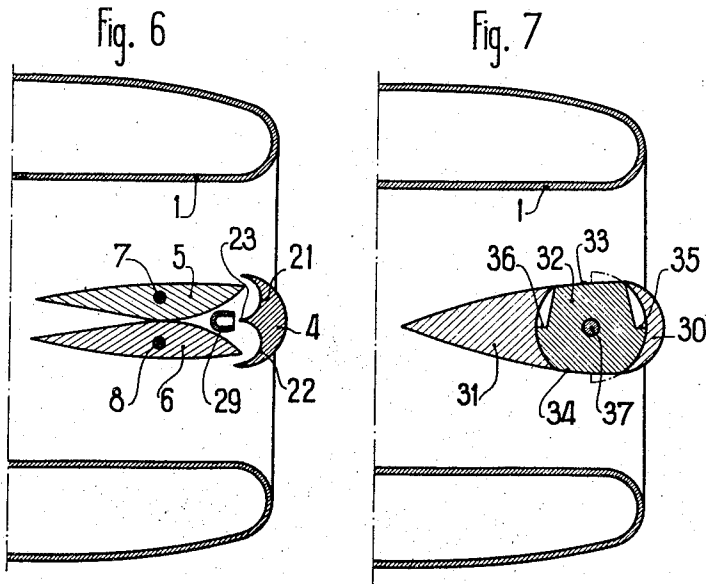
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Fig. 9

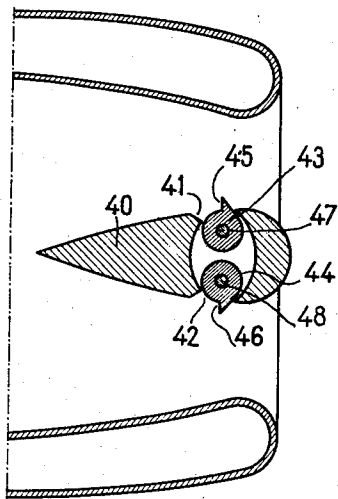


Fig. 11

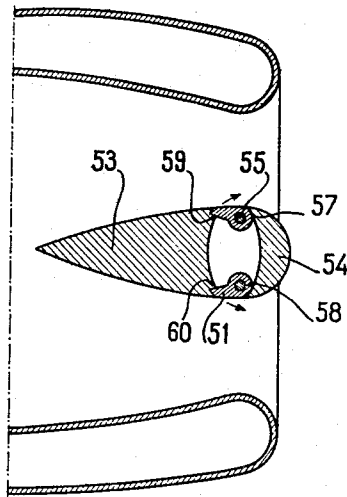
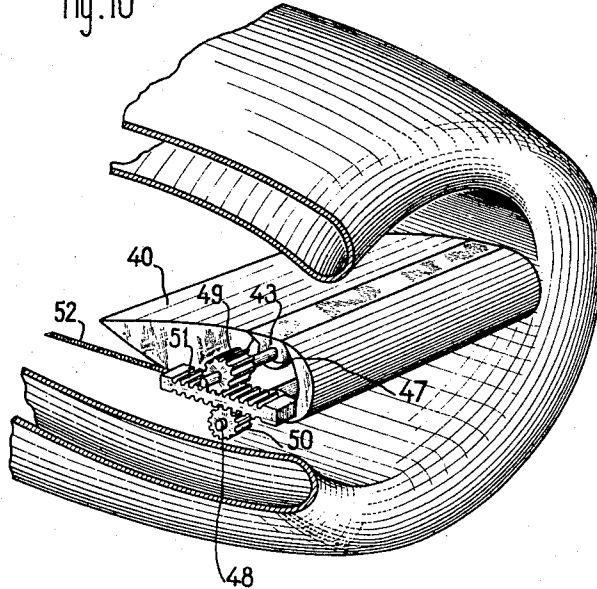


Fig. 10



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MEANS FOR THE DEFLECTION OF FLUID JETS

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Claims priority, application France July 17, 1952

6 Claims. (Cl. 60—35.54)

The object of the present invention is to present improvements in the means for deflection of fluid jets which have been described in U. S. patent applications Ser. No. 108,758, filed August 5, 1949, Ser. No. 268,016, filed January 24, 1952, and Ser. No. 221,551, filed April 18, 1951.

The method described in U. S. patent applications Ser. No. 108,758 and Ser. No. 268,016 consists in modifying the balance of the tangential forces produced between the jet, and the walls in contact with which it flows, by the use of an obstacle which creates a discontinuity in the flow and tends to deflect the jet from its normal direction of flow.

A particular method of carrying this into effect described in this patent, consists of a deflector arranged in the centre of the jet and which can be moved in such a way as to vary the magnitude or the direction of the deflected jet or both these at the same time.

In U. S. patent application Ser. No. 221,551 there has been described an embodiment of the method of deflection which consists in diverting a portion of the flow and in re-introducing the diverted flow into the main flow through a narrow slot, in such a way that the diverted flow has a transverse speed with respect to the main flow. According to another embodiment, the deflection of the jet is obtained by means of a slot through which is expelled a transverse jet of fluid derived from an auxiliary source. Finally, there has been described in this patent application a means for re-inforcing or for stabilizing the deflection, which comprises a convex extension of the wall of the discharge nozzle, combined, according to circumstances, with a grid of incurved blades which may be reduced to a single blade.

On the other hand, in the U. S. patent application Ser. No. 229,772, filed June 4, 1951, for "Improvements Relating to Discharge Nozzles and Reaction Propulsion Units," is described a deflection arrangement comprising a streamlined body provided with one or a number of slots close to the transverse plane in which the deflection should be effected, through which slots there may be injected into the discharge nozzle, in a suitable direction, a compressed fluid which causes the deflection of the jet.

The object of the present invention is to provide an arrangement for deflection of the fluid jet discharged from a nozzle or from a channel by applying the method described in U. S. patent applications Ser. No. 108,758, filed August 5, 1949, Ser. No. 268,016, filed January 24, 1952, and Ser. No. 221,551, filed April 18, 1951, an arrangement in which the displacements of a mobile member arranged in the centre of the fluid jet and serving to create in the flow a material obstacle intended to intercept some portions of the fluid jet, are produced by the elastic deformation of a control device.

In accordance with one preferred form of embodiment of the invention, the control device forms the support of the said mobile member and is constituted preferably by a torsion bar which is anchored, at one of its extremities, to the external portion of the discharge nozzle and which is also operated externally to the discharge nozzle

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by its other extremity near to which the said mobile member is keyed on to it.

In the case in which the wall of the discharge nozzle is provided with a tangential extension curved back towards the exterior and against which the jet of deflected gas comes to adhere, the mobile member is arranged near to the transverse plane which contains the junction of the wall of the discharge nozzle and its extension. This mobile member is preferably combined with a streamlined body arranged in the centre of the fluid jet in such a way that, by a movement of rotation caused by the said torsion bar, this member causes an obstacle to the flow to appear on the surface of the said body.

The description which follows below with respect 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 referred to, either in the drawings or in the text, forming, of course, a part of the said invention.

Fig. 1 is an axial cross-section of a discharge nozzle of circular cross-section, which is provided with a streamlined body shown in the position of normal flow of the jet from the discharge nozzle.

Fig. 2 is a section similar to that of Fig. 1, showing the streamlined body in its active position for deflection of the jet.

Fig. 3 is a perspective view with partly broken away portions, of a discharge nozzle similar to that of Figs. 1 and 2 but which is not provided with a grid of deflecting blades.

Fig. 4 is a perspective view with partial broken away portions, of a discharge nozzle of rectangular cross-section comprising an alternative embodiment of the arrangement in accordance with the invention.

Fig. 5 is a view in perspective of another modification of the invention.

Fig. 6 is a transverse cross-section of a further form of embodiment of the invention.

Fig. 7 is a vertical cross-section and Fig. 8 is a view in perspective of another form of embodiment.

Fig. 9 is a vertical cross-section and Fig. 10 is a view in perspective of another modification of embodiment of the invention.

Fig. 11 is an axial vertical cross-section of a further form of embodiment.

In Figs. 1 and 2 there is shown a reaction discharge nozzle 1, of circular cross-section, which is provided at its orifice with a convex extension 2 curved back towards the exterior and having also a grid of deflecting blades 3. There has been shown in Fig. 3 a similar discharge nozzle having a double wall, the separation of which is maintained by means of profiled members 1a, but on which the grid of blades is not shown. The discharge nozzle includes in a diametrical plane, a streamlined body extended in the shape of a wing and comprising a rear portion 4, the exterior surface of which forms the trailing edge and two symmetrical profiled shutters 5 and 6 forming the extrados and the intrados of this body. The shutters 5 and 6 are each carried on a torsion bar 7, 8, and each of these bars is anchored at one extremity (at the right hand end in Fig. 3) to the exterior of the wall of the discharge nozzle, for example by means of a block 1b fixed between two profiled members 1a. Each of these bars is, in addition, keyed to the corresponding shutter 5, 6, at the point 1c, near to that extremity of the latter which is opposite to the anchorage of the bar 7, 8 (left-hand end in Fig. 3). On the side at which it is keyed to the corresponding shutter, each torsion bar carries a pinion 9, 10, keyed on to it on the outside of the discharge nozzle. These pinions, which are of the same initial diameter and of the same tooth

size, engage with a common rack 11 attached to a traction cable 12 which may be pulled towards the front end of the discharge nozzle by any suitable control arrangement, the rack and the cable 12 as well as the pinions 9 and 10 being located externally to the discharge nozzle as shown in the partially cut away portion of Fig. 3.

As the flow of the gaseous jet takes place in the direction of the arrow F, the axis of the torsion bars 7, 8 is arranged in the plane of the centre of thrust of the corresponding shutters or profiled members 5, 6. When the flow of the jet is taking place normally, the leading edges 13 and 14 of the shutters 5 and 6 are joined together, and the external surfaces of these profiled members and the rear portion of the streamlined body are joined together without any break in surface continuity, as is shown in Fig. 1.

When the cable 12 is tightened, the shutters 5 and 6 are caused to rotate in opposite directions with respect to each other and the edges 15 and 16 of the shutters 5 and 6 which are normally joined to form the rear portion 4, are turned back towards the central plane of symmetry of the streamlined body (the position shown in Fig. 2) in such a way that the extreme edges 17 and 18 of the rear portion 4 form projections from the sides of this body and constitute an obstacle to some portions of the flow of gas, thus deflecting the jet towards the convex extensions 2 of the wall of the discharge nozzle, where it is intercepted, as the case may be, by the grid of blades 3 as has been described in U. S. patent application Ser. No. 221,551.

The internal surfaces 19 and 20 of the profiled members 5 and 6 are arranged so as to form, in their turned-back position, a convergent-divergent channel in which some portions of the gaseous flow are intercepted. At the rear side, the internal surface of the rear portion 4 forms two deflecting walls 21 and 22 joined together by a ridge 23 which projects towards the front in the axial plane of the convergent-divergent channel.

In the turned-back position, the shutters 5 and 6 leave open a slot between their edges 15, 16 and the ridges 17 and 18 respectively. The jet derived from the main flow which passes into the convergent-divergent channel, is divided by the ridge 23 and is deflected by the walls 21 and 22 towards these slots through which it escapes to exert on the fluid jet flowing in the discharge nozzle, a lateral thrust which emphasizes the deflection effect caused by the projecting ridges 17 and 18.

The width of the slot which is produced between the edges 15 and 16 and the ridges 17 and 18 is variable in accordance with the amount of the rotation of the profiled members 5 and 6 about their axes, which enables the value of the lateral thrust of the jet diverted from the main jet to be varied. By giving the deflecting walls a suitable shape, any desired law of variation of the width of the slot as a function of the angle of rotation of the profiled members 5 and 6, may be obtained. In particular, a constant width of slot may be obtained by giving the deflecting wall a surface of cylindrical shape, the axis of which is that of rotation of the profiled members 5 and 6.

Being both simple and light, as there is neither an air collector nor a shutter, the arrangement of Figs. 1 to 3 may be used with advantage for the deflection of the jet delivered by the discharge nozzles of jet aircraft, with the object of obtaining a reduction or even an annulment of the thrust of the reactor, but it is to be understood that this arrangement, as well as all the modifications described in the present text, can be employed for all useful applications, and in particular those which have been mentioned in U. S. patent applications Ser. Nos. 108,758 and 268,016.

Fig. 4 is a perspective view of a discharge nozzle of rectangular cross-section, in the plane of longitudinal symmetry of which there is arranged a streamlined body

similar to that of Figs. 1 to 3, but to which is added a collector 24 having blowing orifices and mounted in the plane of symmetry of the body, close to the plane of junction of the profiled members 5, 6 and the rear portion 4. In a jet-propelled aircraft, the blowing may be obtained, for example, by using compressed air from the compressor of the turbo-jet unit. The pipe 25, which supplies air to the collector 24 may be provided with a valve 26 operated by the extremity of one of the torsion bars 7 or 8 (by the bar 7 in the example shown), carrying the profiled members 5 and 6, so that the control of the cock 26 for the supply of air to the collector 24 may be directly obtained from the operation of the toothed rack 11. Therefore, as the members 5 and 6 are moved to operating position (shown in Fig. 2), air under pressure is admitted through the cock 26 into the collector 24 and this air flows into the main exhaust stream through the slots just formed between the members 5 and 6 and the part 4.

In Fig. 5, there is shown a perspective view of a streamlined body of the type shown in Fig. 4, the rear members of the profiles 5 and 6 being turned inwards and thus permitting the passage between them of some portions of gas flow derived from the main jet, and the collector 24 of which is provided with two oppositely arranged blowing slots 27 and 28 directed towards the slots formed by the rotation of the profiled members 5 and 6. When the deflecting arrangement is put in use, the blowing fluid, the supply of which can be controlled by a member similar to that which is shown in Fig. 4, is expelled through the slots 27 and 28, and draws with it the gases entering between the profiled members 5 and 6 which are discharged through the slots thus formed in the surface of the streamlined body. In this embodiment, the deflection of the fluid jet flowing in the discharge nozzle, is obtained at the same time by the physical obstacles formed by the ridges 17 and 18 of the rear portion of the streamlined body, and by a lateral pressure exerted by the deflection of the jet from the discharge nozzle and by the blowing effect of an auxiliary fluid.

In certain cases, it may be preferable to dispense with the diversion of gases from the jet flowing through the discharge nozzle but to retain the lateral blowing system to effect the deflection of the main jet.

Fig. 6 is a transverse cross-section of a streamlined body which fulfils these conditions. The profiled members 5 and 6 each include a portion having a cylindrical surface, the axis of which coincides with that of the rotation of the profiled members. These portions of surfaces remain in contact with each other along a generator line as they roll one on the other when the profiled members rotate, and thus they do not allow any gas to pass between them.

The blowing collector, instead of having two lateral slots in the case of Fig. 5, may have in the present case the shape of a gutter 29 open opposite the central ridge 23 of the rear portion 4. The blowing jet is divided by the ridge 23 into two deflected portions by the surfaces 21 and 22 and is discharged through the open slots on the sides of the streamlined body when the deflecting arrangement is set in operation.

Instead of being constituted by the exterior ridges caused to project from the rear portion by a lowering of the sides of the streamlined body, the deflecting obstacle may be formed by portions of the walls having sharp projections and which project through slots arranged in the surface of this body which, in such a case, does not have any moving parts.

Figs. 7 and 8 show in axial cross-section and in perspective a streamlined body in the form of a wing arranged within the interior of a discharge nozzle, for example in a plane of symmetry of a discharge nozzle 1 of rectangular cross-section. The trailing edge is constituted by the exterior surface of a member 30 added on to the walls of the discharge nozzle and distant from

the front portion 31 in such a way that the streamlined body is formed with two lateral slots. Between the two parts of the streamlined body, there is arranged a rotating core 32 consisting on the one hand of two portions of surfaces 33 and 34 which are diametrically opposite and which are adapted to join tangentially together the surfaces of the parts 30 and 31 of this body (the position shown in full lines in Fig. 7), and, on the other hand, two walls having diametrically opposite sharp angular projections 35 and 36, symmetrically arranged very nearly at right angles with respect to the surfaces 33 and 34, and which are adapted to project from the surface of the streamlined body through the slots comprised between the parts 30 and 31 of this body (the position shown in chain dotted lines in Fig. 7).

The core 32 is carried by a torsion bar 37 anchored at one of its ends to the end portion of the discharge nozzle (the right-end portion of Fig. 8) and provided at its other end with a crank arm 38 attached to a tension cable 39 which is connected to a control device of any kind. The core 32 is keyed to the bar 37 at the opposite end to that by which the bar is anchored.

In order to obtain a deflection of the jet flowing through the discharge nozzle, it is sufficient to exert a tractive effort on the cable 39 so as to cause the core 32 to turn about its axis and to cause the surfaces 35 and 36 to project into the jet and thereby to intercept some portions of the gas flow. The core is mounted on the torsion bar 37 in such a way that the position of rest of the latter corresponds to the closure of the slots in the streamlined body by the surfaces 33 and 34.

In the alternative embodiment of Figs. 9 and 10, the streamlined body 40 which is also shaped like a wing, comprises two slots 41 and 42, each of which may be closed by a rotating core 43, 44, provided with a surface 45, 46, forming an acute angle and which can be caused to project from the surface of the body 40 through the slots 41 and 42 by rotating the cores (the position shown in Fig. 9). The cores are arranged in such a way as to connect tangentially in the position of rest (the position shown in Fig. 10), the surfaces of the two parts of the streamlined body which are separated by the slots 41 and 42. Each core is carried by a torsion bar 47, 48, to which it is keyed at one of its ends whilst the torsion bar is anchored to the exterior of the discharge nozzle at the opposite end. On the side at which they are keyed to the cores, the torsion bars are each provided, externally to the discharge nozzle, with a pinion 49, 50 engaging with a common toothed rack 51 attached to a cable 52. The cores are mounted in such a way that in the position of rest of the torsion bars, they effect a tangential junction of the two portions of the surface of the streamlined body, whilst a tractive effort exerted on the cable causes them to turn, in the opposite direction to each other, so as to cause the acute angle surfaces 45, 46 to project through the slots 41 and 42.

Fig. 11 shows a transverse cross-section of an alternative form of streamlined body, the surface of the front portion 53 and the rear portion 54 of which is joined tangentially by flap-valves 55 and 56 mounted on torsion bars 57, 58 and being supported in the position of rest against the stop-members 59 and 60. The control of the flap-valves may be effected in a similar way to that used for the cores of Fig. 10, the torsion bars 57 and 58 returning the flap-valves against their stops in the position of rest.

In all the preceding examples, there have been shown extended streamlined bodies having the shape of a wing and which may be arranged, either in a diametrical plane of a discharge nozzle of circular cross-section, or in a plane parallel to one of the walls of a discharge nozzle of rectangular cross-section, but it is to be clearly understood that the invention may be applied to a streamlined body of any type, for example to a circular streamlined body mounted in the axis of a discharge nozzle having

also a circular cross-section and on the surface of which there can be caused to project a physical obstacle operated by a torsion bar mounted, for example on the axis of this body.

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

What I claim is:

1. A device for deflecting a jet formed by a nozzle comprising a body within the jet, having a stationary part and two movable members mounted for angular displacement relatively to each other and to said part and extending upstream of said part, the arrangement of said members and said part being symmetrical about the axis of said nozzle, said body being so designed that, in one relative position of said members and said part, the body has a streamlined shape allowing substantially undisturbed flow of the jet past said body whereas an angular displacement of said members from said relative position exposes to the jet two fluid intercepting surfaces adapted to deflect the jet and located on opposite sides of said axis, actuating means for displacing said members from said relative position, and resilient means for returning said members to said relative position upon release of said actuating means, said body containing an inner chamber bounded by said movable members and said stationary part, the arrangement being such that, when said members are displaced from said relative position, slot-like gaps are formed between said members and said part, said gaps connecting said chamber with the inside of the nozzle.

2. A device as claimed in claim 1, comprising means for supplying said chamber with pressure fluid, and valve means for controlling the flow of pressure fluid to said chamber.

3. A device as claimed in claim 2, wherein said valve means is controlled in synchronism with the members actuating means.

4. A device as claimed in claim 2, wherein the surfaces of the movable members bounding the chamber are so shaped that they are in contact with each other as the members move, thereby sealing the chamber.

5. A device as claimed in claim 1, wherein the surfaces of the movable members bounding the chamber are so shaped that they form a passage therebetween, said passage being opened at one end to collect a fraction of the jet and convey said fraction into the chamber.

6. A device for deflecting a jet formed by a nozzle comprising a body within the jet, having at least two members, one of which is stationary and secured to said nozzle, the other member being mounted for rotation about a transverse axis of said nozzle, said body being so designed that, in one position of said rotatable member, the body has a streamlined shape allowing substantially undisturbed flow of the jet past said body whereas a displacement of said rotatable member from said position exposes to the jet a fluid intercepting surface formed by a portion of said stationary member which projects into the jet, actuating means for displacing said rotatable member from said position, and resilient means for returning said rotatable member to said position upon release of said actuating means.

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