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(54) **Self-priming jet pump with an axial diffuser.**

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DE-A- 3 718 273
DE-C- 906 894
US-A- 2 941 474
US-A- 3 730 641

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Description

The invention concerns a centrifugal self-priming jet pump according to the pre-characterizing portion of Claim 1.

Self-priming jet pumps, generally known as "jet" pumps of the known type have a radial diffuser around the periphery of their impeller, i.e. a channel with a sectional area increasing in the stream direction for the purpose of converting as far as possible the kinetic energy of the medium flowing out of the impeller into pressure energy.

Said radial diffuser around the periphery of the impeller presents some inconveniences, when it is inserted within the circular shaped casing of a pump:

– an inconvenience arises from the fact that the induced medium flows out of the diffuser with a rotational component which, in the priming phase, drags along the air contained in the pump casing.

The centrifugal effect separates the air from the induced medium. The air has a tendency to collect around the axis of rotation and it arrives with difficulty at the delivery connection.

For this reason, the pumps of the known type almost always require complicated adjustment devices with a throttle valve, in order to obtain the priming with the maximum suction heights.

– Another inconvenience arises from the fact that the presence of the radial diffuser causes an increase in the radial overall dimensions of the pump, since its outer diameter equals the diameter of the impeller plus the height of the diffuser increased by the thickness of the pump casing.

Some constructions are known, some of them being disclosed in some patents, for instance in patent DE 3718273, in patent US 2941474 and in patent US 2934021, wherein, in order to intercept the rotation and the high rotational speed of the induced medium and of the air at the exit from the radial diffuser along the periphery of the impeller, a separation wall or a separating device or a perforated screen is arranged behind the diffuser, with the task of dividing the pressure chamber within the pump casing into a chamber with a high whirling speed and a fast rotational movement and a chamber with a slower whirling motion and a slower rotational movement.

In other known embodiments the rotation of the medium and of the air within the pump casing is slowed down by means of extensive longitudinal blades. Said known devices present, however, the inconvenience that they do not prevent and do not eliminate the origin of the whirling and of the rotation of the medium/air mixture, but they only intercept them, in order to reduce their intensity, which negatively influences the performance and the noise level. Moreover, said devices require in their construction a special component inserted between the pump casing and the diffuser or the addition to the pump casing or to the diffuser of said separating devices, or the addition of blades within the pump casing, or on the diffuser or on the ejector, which complicates the manufacturing process for the casting or the die-drawing process or for the machining and the assembly, which entails increases in weight and in manufacturing costs.

Some types of multistage pumps are also known, with axial-type diffusers, some being also disclosed in patents, such as patent DE 906 894, without a radial diffuser around the impellers.

In the multistage pumps the diffuser has the purpose of conveying the outflowing medium from an impeller to the suction connection of the subsequent impeller and it is arranged on the backside of each impeller.

The axial diffuser having radial return channels with a central exit, such as disclosed in patent US 3 730 641, has found up to now a special application in submerged multistage pumps for wells, since it permits the decrease in the number of the pump stages by increasing the diameter of the impellers in a pump casing wherein the maximum diameter is dictated by the diameter of the well. In the multistage pumps, in order to maintain the length of the stages and, therefore the total axial length of the pump as short as possible and in order to maintain a positive pre-rotation which will improve the suction capacity of the subsequent stage, the blades of the return channels end radially and/or axially before the exit opening.

However, no embodiment of single-impeller, centrifugal jet pumps with an axial-type diffuser without a radial diffuser around the impeller is known.

The purpose of the present invention is to eliminate said inconveniences and to overcome the limitations presented by the known embodiments.

A purpose of the present invention is a self-priming jet pump with an axial diffuser, wherein the medium flowing into the pressure chamber may flow axially without any rotational component, so as to make it easier for the air to exit from the delivery connection and to allow the priming regularity even when the delivery connection is completely open and even with the maximum suction heights, this being obtained without adding may device for this purpose besides the diffuser.

Another purpose of the invention is to obtain a self-priming jet pump running more silently by eliminating the rotation of the induced medium and of the air within the pump casing.

Another purpose of the present invention is a self-priming jet pump, wherein the replacement of the radial diffuser with an axial diffuser yields a pump casing with an external diameter which is smaller than the outer diameter of a pump offering the same performance and having an impeller with the same diameter.

Another purpose of the invention is to decrease the inner diameter of the casing containing an impel-

ler, whose diameter must be chosen according to the required performance.

Yet another purpose of the invention is to obtain a construction, which must be more compact and lighter in weight than a traditional jet pump with a radial diffuser and with an impeller of equal diameter and a pump casing made of the same material.

The minimum weight is important in order to obtain this type of pump in the portable version as well.

The above-mentioned purposes and others which will be better explained hereafter, are fulfilled by a centrifugal self-priming jet pump which, in accordance with the patent claims, comprises a pump casing, wherein an impeller, a diffuser and an ejector unit are arranged, and which is characterized in that the diffuser is of the axial type, that it is attached between the pump casing and the ejector, that it is arranged facing the impeller, on its suction side and that its interior presents some return channels with a tendencially radial arrangement, which are suited to convey axially and without rotation, through a central opening, the medium flowing out of the impeller into the pressure chamber of the pump casing.

A characteristic of the invention is the application of a diffuser having return channels with a central exit in a single-impeller pump, in general, and in a single-impeller jet pump, in particular.

Another characteristic of the invention is the arrangement of the axial diffuser having radial return channels with a central opening, facing the impeller on the suction side.

Yet another characteristic of the invention is the lengthening in the axial direction of the blades at the exit of the return channels, in order to eliminate even the residual rotation component.

Another characteristic of the invention is the replacement of the radial diffuser around the periphery of the impeller with a diffuser facing the impeller on its suction side, in order to decrease the outer diameter of a centrifugal, single-impeller jet pump, wherein the diameter of the impeller is dictated by the required performance of the pump itself.

Yet another characteristic of the invention is the presence of deflecting means having an axial inclination and a radial curvature, at the entrances of the axial diffuser in the round-shaped chamber around the impeller, which allows a speedier exit of the air during the priming phase.

Advantageously, according to the invention, a single-impeller, self-priming jet pump is obtained which, thanks to the presence of the axial diffuser arranged facing the impeller, presents decreased radial dimensions in relation to pumps with the same characteristics but with a radial diffuser arranged around the periphery of the impeller.

Moreove, the presence of the axial diffuser eliminates the rotational component of the medium flowing into the pressure chamber, so as to make the priming of the pump easier and its running less noisy.

Advantageously, the pump according to the invention also insures the priming regularity even with the delivery connection completely open and with the maximum values of suction heights. The above mentioned purposes and others which will be better understood hereafter are explained in the description of a preferred embodiment of the invention, which is given by way of example, but is not meant to limit the scope of the invention and which is represented in the enclosed tables of drawing, wherein:

- Fig. 1 represents a lengthwise cross-section of the pump according to the invention;
- Fig. 2 represents a cross-section along the x-x axis of the pump according to the invention.
- Fig. 3 shows a front view of the axial diffuser of the pump, as seen from the impeller side;
- Fig. 4 shows a lengthwise cross-section of the external side of the impeller and of the axial diffuser;
- Fig. 5 shows the development of the circumference above the diameter of the impeller.

In Fig. 1, wherein the pump of the invention is indicated as a whole with 1, it can be observed that it consists of a pump casing 2, within which there is an ejector 3 with its corresponding supplying nozzle 4 (not represented in the drawing), arranged co-axially to each other on axis 5, and the centrifugal impeller 6, which is attached to the motor shaft 7, connected with a driving motor (not represented in the drawing). It can be observed that axis 5 of the ejector is co-axial with axis 9 of rotation of impeller 6; the representation of the axes 5 and 9 which are co-axial to each other is purely indicative, since the idea of the present invention maintains its validity even if the axes of rotation of the centrifugal impeller and of the nozzle-ejector unit were not coinciding with each other.

Facing impeller 6 on its suction side there is the axial diffuser 10 which, as can be observed, consists of an inner disc 11 attached to ejector 3 and of an outer disc 12 facing each other. The inner disc 11 can also be made in a single unit together with ejector 3.

The axial diffusor arranged facing the impeller has the task of deflecting, with as little loss as possible, the vortex-free stream flowing out of the impeller and of converting it into an axial stream as free of whirling as possible, by decreasing its speed and increasing its static pressure.

Therefore, with the axial outlet of the diffusor without rotary movement of the induced medium and of the air in the pump casing, the air can stream more easily out of the delivery connection and, at the same time, the driving medium is conveyed to the nozzle without any whirling and without any recycling of air, so that the suction flow through the ejector will be prevented from being set into pre-rotation toward the impeller.

From a functional point of view, with the medium flowing out of the diffuser without rotation, it is possible to obtain the most favourable conditions of inflow to the delivery connection, to the nozzle and to the impeller, with a positive effect both on the priming proficiency and on the characteristic curve of capacity and head performance, thereby compensating for the better hydraulic performance of a properly designed radial diffuser around the periphery of the impeller in comparison with an axial diffuser facing the impeller in a centrifugal self-priming, single-impeller jet pump.

Between the inner disc 11 and the outer disc 12 are arranged the blades 13 which, therefore, constitute a unit forming the axial diffuser 10 attached within the pump casing 2.

The blades 13 connect the openings 14 obtained in the outer band of the inner disc 11 with the opening 15 obtained in the inner band of the outer disc 12. Each opening 14 is connected through the blades 13 with opening 15 by a return channel 16 having a tendencially radial arrangement.

The blades 13 continue axially for a stretch 19 over collar 21, beyond opening 15, so as to eliminate even the residual rotation. This axial lengthening of the blades 13 occurs within the pressure chamber 17, without influencing the length of the pump. The axial lengthening of the blades 13 can also be made within opening 15, whenever said opening 15 on disc 12 has a tube-shaped extension 23 (in the shape of a cylinder, or a cone or another shape) in the axial direction.

The medium flowing out of impeller 6 enters through the openings 14, along the channel 16 having a radial direction and flows into the pressure chamber 17 with an axial direction, as represented by arrow 18.

In order to let the air exit faster from the round chamber 22 surrounding the impeller during the priming phase, as can be observed in the Figs. 3, 4 and 5, diffuser 10 presents some deflecting means 24 projecting from wall 11, which are connected with the openings 14 at an axial inclination and are connected at a radial curvature with the cilyndrical wall of the round chamber 22.

On the basis of what has been described, it can be understood that the first purpose proposed by the invention has been reached, i.e. a self-priming jet pump with radial overall dimensions which are smaller than those of equivalent pumps. In fact, by observing Fig. 1 and from the description, it has been seen that the radial difference between the centrifugal impeller 6 and the interior of the pump casing 2 is reduced to the minimum necessary because of the absence of the radial diffuser, which is replaced by the axial diffuser 10.

It has also been seen that, because of the presence of the blades 13, which connect the openings 14 with the opening 15, a plurality of return channels 16, having a tendencially radial arrangement, is obtained, which by continuing in the axial direction beyond opening 15 for stretch 19 eliminates the rotational component of the induced medium in the pressure chamber 17.

Moreover, by preventing the induced medium and the air in the pressure chamber 17 of the pump casing 2 from rotating, the air can more easily stream out of the delivery connection 20.

Such construction concept also insures the priming regularity of the pump even when the delivery connection 20 is completely open and even under the conditions of maximum suction height, so that the throttle valve adjustment devices which are necessary in the self-priming jet pumps of the known types, are no longer needed. In the manufacturing phase of the diffusor according to the invention it will be possible to apply some modifications of a constructive or a functional nature with the purpose of improving its performance or of making the manufacture easier. Thus it will be possible to vary the dimensions and the shape of the openings 14 and 15, so as it will be possible to vary the number and the shape of the blades 13. It will also be possible to vary the radial and axial dimensions or the inclination and the shape of the deflecting means 24, but said variations or modifications will not exceed the scope of the patent rights of the present invention.

Claims

1. A centrifugal self-priming jet pump with a single impeller comprising a pump casing (2), within which an impeller (6), a diffuser (10) and an ejector unit (3) are arranged, characterized in that the diffuser (10) is of the axial type and is arranged facing the impeller (6) on its suction side and is attached between the interior of the pump casing (2) and the exterior of the ejector (3), said diffuser presenting in its interior some return channels (16) with a tendencially radial arrangement, suited to axially convey through a central opening (15) into the pressure chamber (17) of the pump casing (2) the flow streaming out of the impeller (6).

2. A centrifugal self-priming jet pump according to claim 1, characterized in that the diffuser (10) consists of one inner disc (11) attached between the interior of the pump casing (2) and the exterior of the ejector (3), said inner disc (11) presenting a plurality of openings (14) arranged along its outer circumferential periphery, and of an outer disc (12) being attached to the previous one and facing it, said outer disc (12) presenting a central opening (15) having the shape of a round-shaped crown arranged around the collar (21) of the inner disc (11), some blades (13) being positioned between said discs, forming a plurality of return channels (16), obtained by connecting each opening (14), positioned along the outer circumferential periphery of the inner disc (11), with the central opening (15) on the outer disc (12), said blades (13) con-

tinuing in the axial direction on the collar (21) for a stretch (19).

3. A centrifugal pump according to claim 1, characterized in that the diffuser (10) is keyed between the interior of the pump casing (2) and the exterior of the ejector (3) when said ejector (3) is inside the pump casing (2).

4. A centrifugal pump according to claim 1, characterized in that the round chamber (22) around the impeller (6) presents some deflecting means (24) having an axial inclination and a radial curvature.

5. A centrifugal self-priming jet pump according to claim 2, characterized in that the inner disc (11) of the diffuser (10) constitutes a single unit together with ejector (3).

Patentansprüche

1. Einstufige Kreiselpumpe, selbstansaugend durch eingebauten Ejektor, die folgendes einschliesst: ein Pumpengehäuse (2), worin ein Laufrad (6), ein Diffusor-Leitrad (10) und eine Ejektor-Einheit (3) eingebaut sind, dadurch gekennzeichnet, daß das Diffusor-Leitrad (10) der axialen Art ist und gegenüber dem Laufrad (6) an seiner Saugseite zwischen dem Inneren des Pumpengehäuses (2) und dem Äusseren des Ejektors (3) angeordnet ist, wobei das genannte Diffusor-Leitrad in seinem Inneren einige Rückführkanäle (16) mit einer Neigung nach radialen Anordnung aufweist, die dazu geeignet sind, die aus dem Laufrad (6) austretenden Strömung durch eine zentrale Öffnung (15) in den Druckraum (17) des Pumpengehäuses (2) axial zu fördern.

2. Selbstansaugende Kreiselumpe nach Anspruch 1, dadurch gekennzeichnet, daß das Diffusor-Leitrad (10) aus einer inneren Scheibe (11), die zwischen dem Inneren des Pumpengehäuses (2) und dem Äusseren des Ejektors (3) angeordnet ist, wobei die genannte innere Scheibe (11) entlang ihrem äusseren Kreisumfang eine Mehrzahl von Öffnungen (14) aufweist, und aus einer äusseren der ersten gegenüberliegenden und ihr angeschlossenen Scheibe (12) besteht, wobei die genannte äussere Scheibe (12) eine zentrale Öffnung (15) mit der Form einer Krone um den Hals (21) der inneren Scheibe (11) aufweist, wobei einige zwischen den genannten Scheiben angeordneten Leitschaufeln (13) Rückführkanäle (16) bilden, die jeder Öffnung (14) entlang dem äusseren Kreisumfang der inneren Scheibe (11) mit der zentralen Öffnung (15) der äusseren Scheibe (12) verbinden, wobei die genannten Leitschaufeln (13) in die axiale Richtung über den Hals (21) um eine bestimmte Strecke (19) weitergehen.

3. Kreiselpumpe nach Anspruch 1, dadurch gekennzeichnet, daß das Diffusor-Leitrad (10) zwischen dem Inneren des Pumpengehäuses (2) und dem Äusseren des Ejektor (3) angeschlossen ist, wenn der genannte Ejektor (3) sich innerhalb des Pumpengehäuses (2) befindet.

4. Kreiselpumpe nach Anspruch 1, dadurch gekennzeichnet, daß der Ringraum (22) um das Laufrad (6) einige Ablenkungsschaufeln (24) mit einer axialen Neigung und einer radialen Krümmung aufweist.

5. Selbstansaugende Kreiselpumpe nach Anspruch 2, dadurch gekennzeichnet, daß die innere Scheibe (11) des Diffusor-Leitrads (10) eine einzelne Einheit mit dem Ejektor (3) bildet.

Revendications

1. Pompe centrifuge à un étage autoamorçante à jet comprenante un corps de pompe (2), dans lequel sont positionnés une roue (6), un diffuseur (10) et une unité ejecteur (3), caractérisée en ce que le diffuseur (10) est de type axial et il est positionné en face de la roue (6) de son côté aspirant et qu'il est attaché entre l'intérieur du corps de pompe (2) et l'extérieur de l'éjecteur (3), ledit diffuseur présentant à l'intérieur des canaux de retour (16) avec un arrangement fondamentalement radial, aptes à convoyer axiallement à travers une ouverture centrale (15) dans la chambre de refoulement (17) du corps de pompe (2) le flux sortant de la roue (6).

2. Pompe centrifuge autoamorçante à jet selon la revendication 1, caractérisée en ce que le diffuseur (10) consiste en un disque intérieur (11) fixé entre l'intérieur du corps de pompe (2) et l'extérieur de l'éjecteur (3), ledit disque intérieur (11) présentant une pluralité d'ouvertures (14) arrangées le long de sa périphérie circumférentielle extérieure, et en un disque extérieur (12) qui est attaché au précédent et en face du même, ledit disque extérieur (12) présentant une ouverture centrale (15) ayante la forme d'une couronne ronde positionnée autour du collier (21) du disque intérieur (11), des aubes (13) étant positionnées entre lesdits disques, formant une pluralité de canaux de retour (16), obtenus en raccordant chaque ouverture (14), positionnée le long de la périphérie circumférentielle extérieure du disque intérieur (11) avec l'ouverture centrale (15) du disque extérieur (12), lesdites aubes (13) continuant pour un certain trait axial (19) en direction axiale sur le collier (21).

3. Pompe centrifuge selon la revendication 1, caractérisée en ce que le diffuseur (10) est claveté entre l'intérieur du corps de pompe (2) et l'extérieur de l'éjecteur (3) lorsque l'éjecteur (3) est dans le corps de pompe (2).

4. Pompe centrifuge selon la revendication 1, caractérisée en ce que la chambre ronde (22) autour de la roue (6) présente des déflecteurs (24) ayants une inclinaison axiale et un cintrage radial.

5. Pompe centrifuge autoamorçante à jet selon la revendication 2, caractérisée en ce que le disque intérieur (11) du diffuseur (10) constitue une seule unité avec l'éjecteur (3).

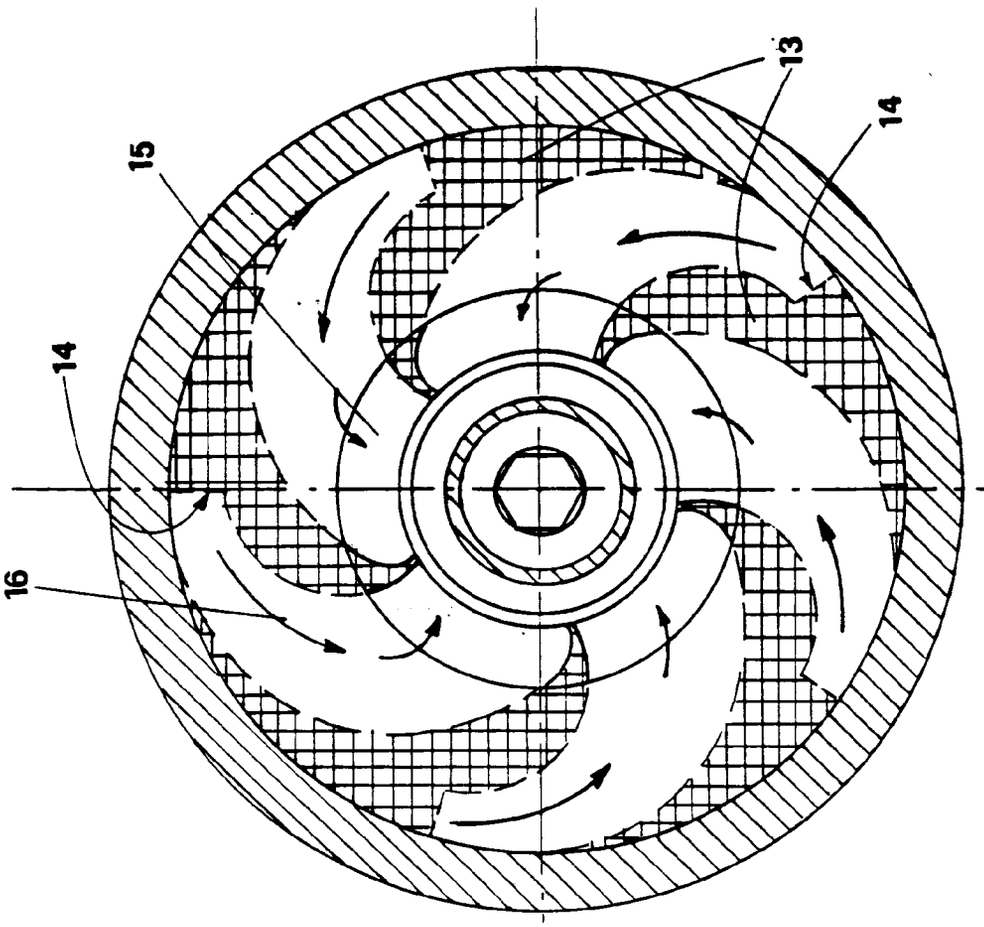

FIG.2

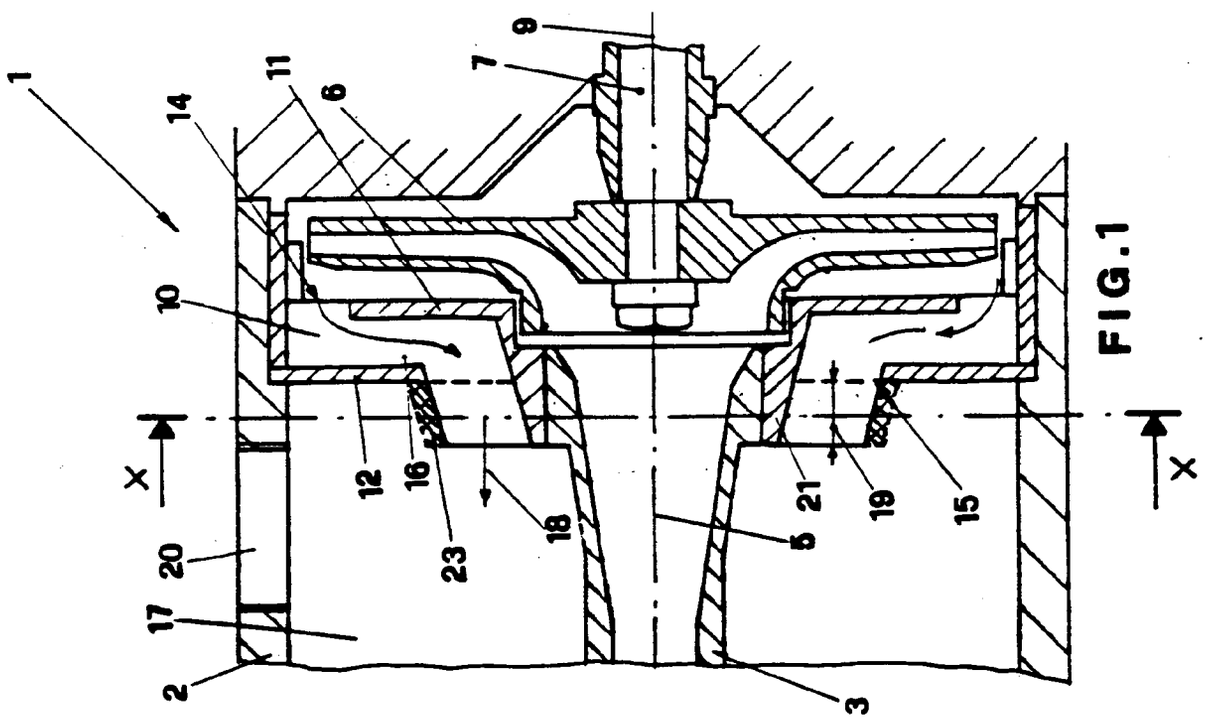

FIG.1

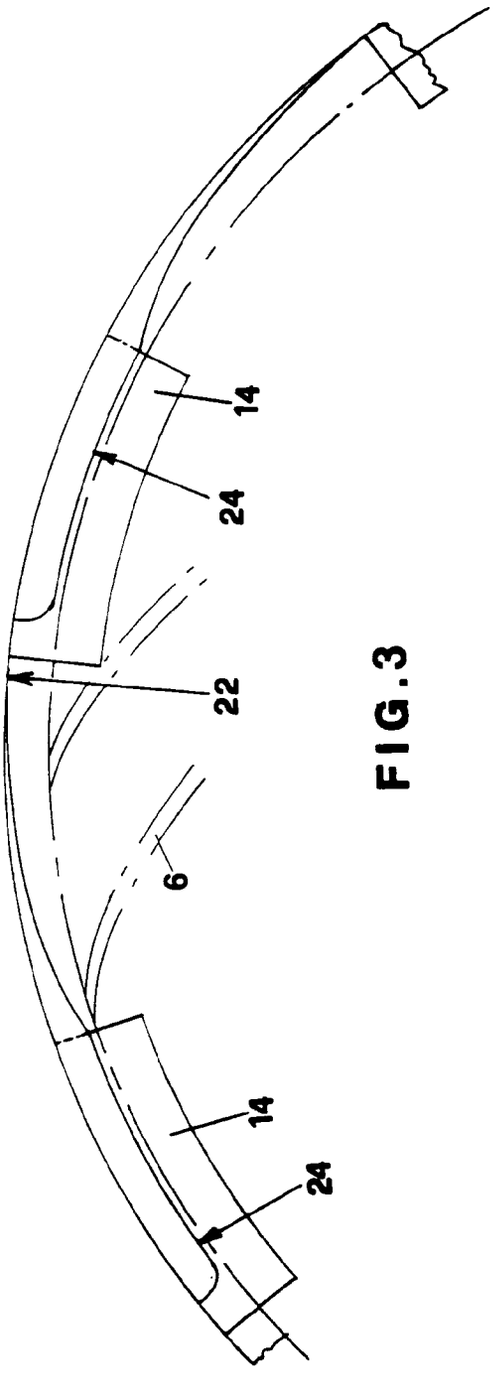

FIG.3

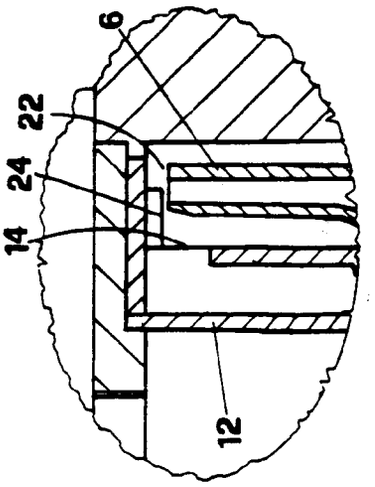

FIG.4

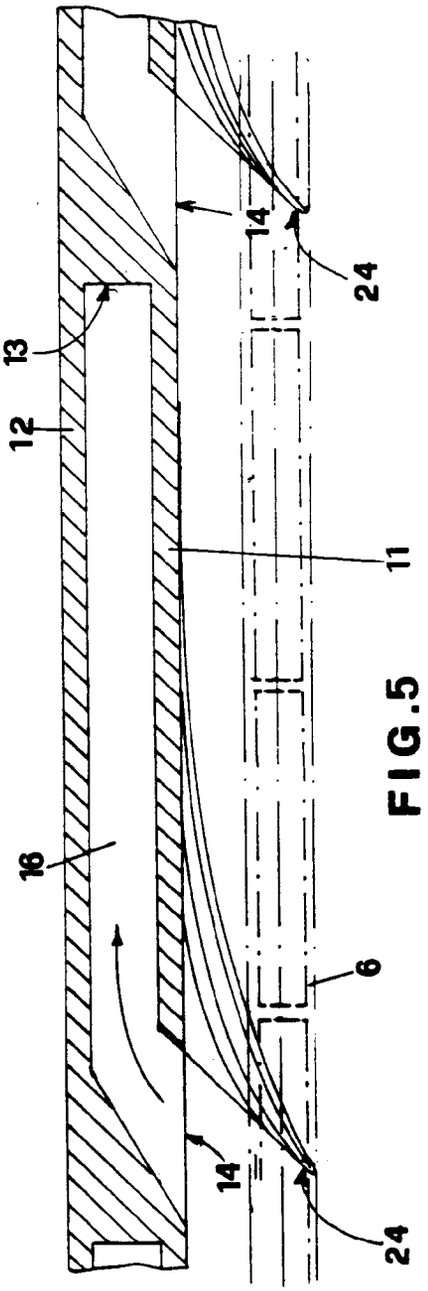

FIG.5