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(54) Self-priming jet pump with built-in ejector.

(57) According to the invention a centrifugal self-priming jet pump (1) is obtained, comprising a pump casing (2, 30, 40, 50, 60, 70) which presents a shape lacking any surfaces with undercuts and in which the nozzle-ejector unit (19) is mounted on seats (15, 20, 31, 36, 49, 46, 59, 56, 69, 66, 79, 76) which are coaxial with the axis (21) of rotation of the impeller (22). Said nozzle-ejector unit (19) presents a diaphragm (7, 32, 42, 52, 62, 72), arranged transversally, which divides the inner volume of the pump casing (2, 30, 40, 50, 60, 70) so as to create a suction chamber (3) and a pressure chamber (5) and a frontal collar (10, 37, 47, 57, 67, 77), which is suited to divide the suction chamber (3), so as to create a channel (24) and a high-pressure chest (11, 35, 45, 55, 65, 75) for supplying the driving medium into the nozzle (12), arranged eccentrically in the collar (10, 37, 47, 57, 67, 77) with an anti-vortex arrangement in the high-pressure chest (11, 35, 45, 55, 65, 75).

Said pump (2, 30, 40, 50, 60, 70) casing presents its suction connection (4, 34, 44, 54, 64, 74) positioned at the front end of the pump (1) above the collar (10, 37, 47, 47, 67, 77) and is partially or completely circumscribed by the diaphragm (7, 32, 42, 52, 62, 72).

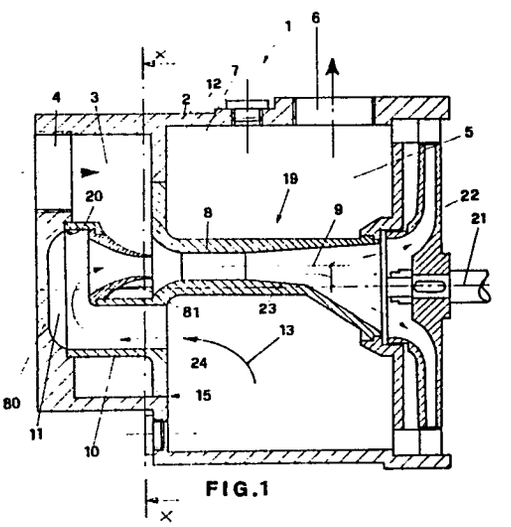

FIG.1

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SELF-PRIMING JET PUMP WITH BUILT-IN EJECTOR

The invention concerns a self-priming jet pump with a pump casing without any undercut, the seats of the ejector for its connection with the pump casing being coaxial with the rotation axis of the impeller and the suction connection being positioned at the front end of the pump above the rotation axis.

Centrifugal, self-priming jet pumps, usually known as "Jet" pumps are special types of centrifugal pumps combined with a venturi ejector, which are used in several domains and for a plurality of applications, such as drawing water out of a well or, more in general, drawing liquids from tanks placed at a certain depth. They may also be used as pressure boosting pumps for central low pressure water systems.

In some of the known forms of execution the self-priming jet pumps are built with a pump casing containing the suction chamber and the pressure chamber, which are obtained by dividing the inner volume of the pump casing by means of partitions. Said forms of execution entail some difficulty in the manufacture of the pump casing, because of the presence of the undercuts, which require, when the pump casing is a single piece obtained through casting, the use of complicated dies and the necessity of inserting cores. Even when the pump casing is obtained through die drawing, it requires some complex carpentry operations for the welding of the added diaphragms.

In some types of self-priming jet pumps the pump casing is built without undercuts, since it contains the suction chamber in the ejector unit, which is directly connected with the suction connection positioned above the rotation axis.

This type of execution entails the inconvenience that the ejector presents closed chambers, obtained through casting with a core, as disclosed in the US patent 2 700 338, or through die-drawing and then joining together several parts by welding or by means of screws or of snap hooks or by other means and by interposing sealing or gluing materials, which make the disassembly and the ensuing re-assembly difficult and sometimes impossible.

Said types of execution also entail the inconvenience that the presence of the closed chambers make it difficult to check whether within the pump casing or the ejector there are foreign bodies which may have entered accidentally while the pump was operating or whether there are settling solids.

In other types of self-priming jet pumps the pump casing is made without any undercut and the seats for the connection of the ejector are coaxial with the axis of rotation while the suction connection is positioned on the plane passing through the axis of rotation, as disclosed for instance in the US patent 2 934 021. Such an execution presents the inconvenience of preventing the pump casing from filling up with a sufficient amount of water at the initial priming, unless there is a check valve in the suction pipe.

The purpose of the present invention is that of overcoming the mentioned inconveniences.

The main purpose of the invention is to obtain a centrifugal self-priming jet pump, whose pump casing does not present any undercuts and can be obtained by die-casting without core or by shell moulding or die-drawing and whose ejector consists of a single body made without closed chambers which is, therefore, easy to make by die-drawing and to check.

Another purpose of the invention is that of obtaining a centrifugal self-priming pump, whose pump casing presents the seats for the connection of the ejector being coaxial with the rotation axis of the impeller, so as to make it easily machinable, if necessary, by using a lathe.

Another purpose of the invention is that of obtaining a self-priming jet pump, wherein the nozzle is positioned eccentrically in the ejector collar, in order to obtain an anti-vortex arrangement in the supplying high-pressure chest.

The last but not the least purpose is that of obtaining a centrifugal self-priming jet pump which is easy to assemble and to disassemble.

The above-mentioned purposes and others, which will be better explained hereafter, are reached by a self-priming jet pump, comprising a pump casing complete with a suction connection and a delivery connection, within which a unit consisting of an ejector and a nozzle is arranged, said jet pump being characterized in that the pump casing presents a shape lacking undercut surfaces, since it is obtained by a moulding process using two axially counterposed plungers, one of which shapes the inner volume of the pump, while the other shapes the suction connection, said pump casing being provided with seats for the connection of the ejector which are coaxial with the rotation axis of the impeller. Moreover, said ejector presents a transversally arranged diaphragm, which is suited to divide the inner volume of the pump casing, so as to realize a suction chamber and a pressure chamber, and a frontal collar which is suited to divide the suction chamber, so as to realize a duct and a high-pressure chest for supplying the nozzle.

Said nozzle is connected in the ejector collar in an eccentric position. Moreover, the suction con-

nection is positioned frontally above the collar and it is partially or completely circumscribed by the diaphragm.

Advantageously, according to the invention, a more economical centrifugal self-priming pump is obtained, since the pump casing is easier to manufacture because of the absence of the undercuts and easier to machine in case it is obtained through casting because of the co-axiality of the seats for the connection of the ejector with the rotation axis of the impeller. Moreover, the absence of the undercuts in the pump casing permits to check completely and immediately whether any foreign bodies or settling solids are present in its interior, while the ejector drawn in a single body without any closed chambers also presents the advantage that it can be totally and immediately checked.

Moreover, the eccentric arrangement of the nozzle in the ejector collar yields the advantage, in comparison with a coaxial arrangement, of a larger cross-section of the driving medium channel through the collar, of a larger cross-section for the passage of the suction around the nozzle and of a minimum volume of the air pocket in the high-pressure chest at the first filling.

The above-mentioned purposes and others, which will be better explained hereafter, are to be better understood in the description of an embodiment of the invention, which is given by way of explanation only, 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 in a lengthwise cross-section the centrifugal self-priming jet pump of the invention;
- Fig. 2 shows a radial cross-section along the line x-x of the pump of Fig. 1;
- Fig. 3 shows a lengthwise cross-section of the pump casing of the invention with the junction of the impressions for the die-casting or the die-drawing;
- Fig. 4 shows a lengthwise cross-section of the nozzle-ejector unit of the pump according to the invention;
- Fig. 5 shows a cross-section of a different embodiment of the pump according to the invention;
- Fig. 6 shows a cross-section of yet another embodiment of the pump according to the invention;
- Fig. 7 shows a cross-section of another embodiment of the pump according to the invention;
- Fig. 8 shows a cross-section of yet another embodiment of the pump according to the invention.
- Fig. 9 represents a cross-section of yet another embodiment of the pump according to the invention.

The pump according to the invention, which is indicated as a whole with 1 in Fig. 1, consists of a pump casing 2 presenting in its interior the suction chamber 3, which is connected with the suction connection 4, and the pressure-chamber 5, which is connected with the delivery connection 6. The suction chamber 3 and the pressure chamber 5 are obtained through the separation of the inner volume of the pump casing 2 by means of a diaphragm 7, constituting a single body with ejector 8 and being arranged radially with an external diameter which is coaxial with axis 21 of impeller 22.

Moreover, suction chamber 3 presents in its interior a collar 10 arranged on the front part of ejector 8 and also constituting a single body with the ejector, said collar having also an external diameter which is coaxial with axis 21 and defining a high-pressure chest 11 for supplying nozzle 12 with the driving medium, which enters the supplying high-pressure chest 11 through channel 24 in the direction indicated by arrow 13. First of all, it can be observed that the pump casing 2 is made so as not to present any undercut in the front in the moulding directions indicated by the arrows 14 in Fig. 3, which makes it possible to obtain the pump casing 2 through casting by using a die with two plungers and without a core. The pump casing 2 can also be obtained through die-drawing of a metal sheet or by plastic moulding, since, as can be observed in Fig. 3, opening 15 for the lodging of diaphragm 7, can be obtained by means of a plunger 16, while the opening of the suction connection 4 can be obtained by means of a plunger 17 counterposed to the preceeding one.

It can also be observed, in the Figs 1, 2 and 3, that the frontal superimposition of plunger 16, which has the task of creating opening 15 for the lodging of diaphragm 7 and seat 20 for the lodging of collar 10, and of punch 17, which has the task of opening the suction connection 4, creates the moulding of the suction opening 18 which is inserted within the difference between the two diameters of the seats 15 and 20.

Based on what has been said, the first purpose of the invention has been fulfilled. It concerned the realization of a centrifugal self-priming jet pump whose pump casing can be obtained through die-casting or die-drawing by using simple dies, thanks to the lack of undercuts.

By observing the Figs. 4 and 3 it can be noticed that the ejector-nozzle unit 19 is assembled within the pump casing by connecting diaphragm 7 of ejector 8 with seat 15 and collar 10 of the ejector 8 itself on seat 20 obtained on the vertical wall 80 of the pump casing 2 arranged facing impeller 22.The high-pressure chest presents an axial sym-

metry within the round-shaped seat 20 for the connection of collar 10 of ejector 8.Even though the drawings show a preferred assembly position of the nozzle-ejector unit 19 with nozzle 12 at the top and channel 24 at the bottom, the nozzle-ejector unit 19 can also be assembled within the seats 15 and 20 at different angular positions, without thereby compromising the operation of the pump. It is this form of execution which permits an easy assembly and disassembly of the nozzle-ejector unit 19 on and from the pump casing 2, which makes it easier to perform maintenance and check-up operations on the pump.

Moreover, it can be observed that the seats 15 and 20 present a transversal round-shaped cross-section and that they are coaxial with each other and with the axis 21 of rotation of impeller 22 and that they are, therefore, easily machinable, for instance, with a lathe, after the casting or die-drawing of the pump casing 2, in the case that the latter requires a finishing working process.

It is, therefore, easily understood how the other proposed goal of obtaining a pump casing, which is also easy to manufacture and, as a consequence, requires the lowest possible manufacturing costs, is also fulfilled.

By further observing Fig. 1, collar 10 connected with ejector 8 which creates the high-pressure chest 11, contains channel 24 supplying the driving medium flowing from impeller 22 and entering channel 24 in the direction 13. Nozzle 12 is coaxial with axis 9 of the venturi tube of ejector 8 and it is eccentrically arranged with eccentricity 23 in relation to the axis 21 of rotation of impellar 22 and of the seats 15 and 20 in the pump casing 2.

Such eccentric arrangement has been studied with the purpose of avoiding in the high-pressure chest 11, which is symmetrical in relation to axis 21, the formation of vortexes in the driving medium.

Moreover, such off-center arrangement of nozzle 12, as can be seen in Fig. 2, not only eliminates the vorticity of the driving medium, but it also allows the largest cross-section for the passage of the driving medium through collar 10, since the area of the radial section of channel 24 is increased to the maximum. Moreover, the area of section 81 for the passage of the induced medium around nozzle 12 is also made as large as possible, since as can observed in Fig. 2, the passage area 81 also includes area 25 arranged below axis 9 of nozzle 12 in ejector 8, area 25 representing the area increase ensuing from the off-center arrangement 23 between the axes 9 and 21 of the nozzle-ejector unit 19.

Different embodiments are provided which, based on the same inventive idea, create constructive forms of the pump of the invention differing from each other.

Fig. 5 shows a first embodiment, wherein the entire inner part of the pump casing 30 can be moulded with a single plunger, while diaphragm 32 belonging to ejector 33 circumscribes completely the suction connection 34, comprised between the seats 31 and 36 for the connection of ejector 33 within the pump casing 30. Fig. 6 represents another embodiment, wherein the pump casing 40 presents the same characteristics of the previously described pump casing 30, while diaphragm 42, which in this case, too, circumscribes and contains completely the suction connection 44, is separated from the ejector 43 and consists of a round-shaped crown inserted within seat 41 of the pump casing 40, while ejector 43 is inserted within seat 46 in the pump casing 40 and within seat 49 in diaphragm 42.

Fig. 7 shows another embodiment, wherein the inner part of the pump casing 50 presents the same moulding characteristics of its inner part with a single plunger, as in the already described examples of the pump casings 30 and 40. In this embodiment diaphragm 52 is separated from ejector 53 and, since it is shaped as a dome inserted within seat 51 of the pump casing 50, it includes also the high-pressure chest 55 and the seats 56 and 59 for the connection of ejector 53. One or more openings 58 obtained on dome 52 between the seats 56 and 59 constitute the suction passages.

Yet another embodiment is represented in Fig. 8, wherein it can be observed that the pump casing 60 is preferably made of a die-drawn metal sheet with a suction connection 64 welded on its exterior, where the suction passage 68 is to be found, which is obtained between the seats 66 and 69.

In this case diaphragm 62, as the previously described diaphragm 52 of Fig. 7, besides incorporating the high-pressure chest 65 and the seats 66 and 69 for the connection of collar 67 of ejector 63, also constitutes a single body together with the pump casing 60.

Fig. 9 shows yet another embodiment, wherein the pump casing 70 is preferably made of a die-drawn metal sheet and it presents the same moulding characteristics of its inner part with a single plunger, as has been described for the previously described pump casings 30, 40 and 50 and it also includes the suction connection 74 and the high-pressure chest 75, while diaphragm 72, which in this case, too, circumscribes and contains completely the suction connection 74, is separated from ejector 73 and is inserted within seat 71 of the pump casing 70.

Ejector 73 is inserted within seat 76 in the pump casing 70 and within seat 79 of diaphragm 72.

The outer diameter of diaphragm 72 and its seat 71 within the pump casing 70 can be made concentrical with the inner diameter and coaxial with seat 76, as the previously described diaphragm 42.

In Fig. 9, the outer diameter of diaphragm 72 and its seat 71 are excentrical, since this is possible thanks to the die-drawn manufacture, in order to circumscribe the suction connection 74 with the least amount of material and in order to leave at the bottom enough space for the discharge opening 81.

The described embodiments also fulfil all the purposes proposed by the invention and make it possible to achieve all the corresponding advantages.

It has, therefore, been seen, how the pump according to the invention and its various embodiments fulfil all the purposes proposed by the invention.

In fact, it has been seen, first of all, that the main purpose of obtaining a self-priming jet pump presenting a pump casing without any undercuts, which can easily be obtained by casting or die drawing has been fulfilled.

It has also been seen that the special creation of the ejector without any closed chambers, since it consists of a single piece, rather than of several pieces connected with each other, permits an easy inspection, when it becomes necessary to check whether there may be some foreign bodies or settling solids in the induced medium.

It has also been seen that the pump casing can be made with the seats for the connection of the diaphragm and of the ejector collar, which are coaxial with the axis of rotation of the impeller, in order to be machined more easily.

Moreover, it has been seen that the special off-center arrangement of the axis of the nozzle in relation to the axis of rotation of the impeller permits to eliminate vortexes in the high-pressure chest for supplying the nozzle with the driving medium and it also makes it possible to enlarge as much as possible the section area for the passage of the driving medium through the collar and through the suction opening around the nozzle.

Finally it has been seen that the assembly of the ejector within the pump casing with the diaphragm and the collar flush against seats obtained within the pump casing itself, allows an easy removal of the ejector-nozzle unit and an easy access both to the suction chamber and to the pressure chamber for maintenance, cleaning and checking operations.

During the manufacturing phase modifications of a constructive nature suited to improve its performance or to make its manufacture easier may be performed on the pump according to the invention. It is, however, understood that said modifications will not exceed the scope of the present invention.

Claims

1) A centrifugal self-priming jet pump comprising a pump casing (2, 30, 40, 50, 60, 70) complete with a suction connection (4, 34, 44, 54, 64, 74) and with a delivery connection (6), a unit (19) consisting of an ejector (8, 33, 43, 53, 63, 73) with a nozzle (12), a centrifugal impeller (22) connected with a driving motor, characterized in that the pump casing (2, 30, 40, 50, 60, 70) presents a shape lacking surfaces with undercuts; the pump casing being obtained by moulding through the axial counterposition of two plungers (16, 17), one of them shaping the inner volume of the pump casing and the other shaping the suction connection, said nozzle-ejector unit (19) being assembled within seats (15, 20; 31, 36; 49, 46; 59,56; 69, 66; 79, 76) co-axial with the axis (21) of rotation of the impeller (22); further characterized in that the diaphragm (7, 32, 42, 52, 62, 72) divides the inner volume of the pump casing, thereby creating a suction chamber (3) and a pressure chamber (5), and that the frontal collar (10,37, 47, 57, 67, 77) divides the suction chamber (3), thereby creating a channel (24) and a high-pressure chest (11, 35, 45, 55, 65, 75) for supplying the nozzle (12), and in that the suction connection (4, 34, 44, 54, 64, 74) is arranged frontally above the collar (10, 37, 47, 57, 67, 77) and is partially or completely circumscribed by the diaphragm (7, 32, 42, 52, 62, 72).

2) A centrifugal self-priming jet pump according to claim 1, characterized in that the nozzle (12) is arranged eccentrically in the collar (10,37, 47, 57, 67, 77) of the ejector (8, 33, 43, 53, 63, 73), so that its lengthwise axis (9) does not coincide with the lengthwise axis (21) of rotation of the impellar (22), while the collar (10, 37, 47, 57, 67, 77) is coaxial with the high-pressure chest (11, 35, 45, 55, 65, 75), which is symmetrical in relation to the axis (21) of rotation of the impeller (22).

3) A centrifugal self-priming jet pump according to claim 1, characterized in that the collar (10, 37, 47, 57, 67, 77) with the channel (24) constitutes a single body with the ejector (8, 33, 43, 53, 63, 73).

4) A centrifugal self-priming jet pump according to claim 1, characterized in that the diaphragm (7) constitutes a single unit together with the ejector (8) and partially circumscribes the suction connection (4) of the pump, said suction connection (4) being obtained through a plunger (17), which is counterposed to another plunger (16), shaping the inner volume of the pump casing (2), wherein the

junction between said plungers (16, 17) realizes the suction passage (18).

5) A centrifugal self-priming jet pump according to claim 1, characterized in that the diaphragm (32) constitutes a single unit together with the ejector (33) and circumscribes completely the suction connection (34) of the pump, wherein said suction connection (34) is obtained through the same plunger (16) shaping the inner volume of the pump casing (30).

6) A centrifugal self-priming jet pump according to claim 1, characterized in that the diaphragm (42) is a round crown co-axial with the axis (21) of rotation and connected between the ejector (43) and the interior of the pump casing (40) and it circumscribes completely the suction connection (44).

7) A centrifugal self-priming jet pump according to claim 1, characterized in that the diaphragm (52) is a dome connected within the pump casing (50), said dome (52) also incorporating the high-pressure chest (55) and the seats (56, 59) for the connection of the ejector (53).

8) A centrifugal self-priming jet pump according to claim 1, characterized in that the diaphragm (62) constitutes a single unit together with the pump casing (60) also incorporating the high-pressure chest (65) and the seats (66, 69) for the connection of the ejector (63).

9) A centrifugal self-priming jet pump according to claim 8, characterized in that the suction connection (64) is welded to the pump casing (60).

10) A centrifugal self-priming jet pump according to claim 1, characterized in that the diaphragm (72) is a disc connected between the ejector (73) and the inner part of the pump casing (70) and it circumscribes completely the suction connection (74), said diaphragm (72) having its outer diameter (71) not coinciding with the inner diameter (79).

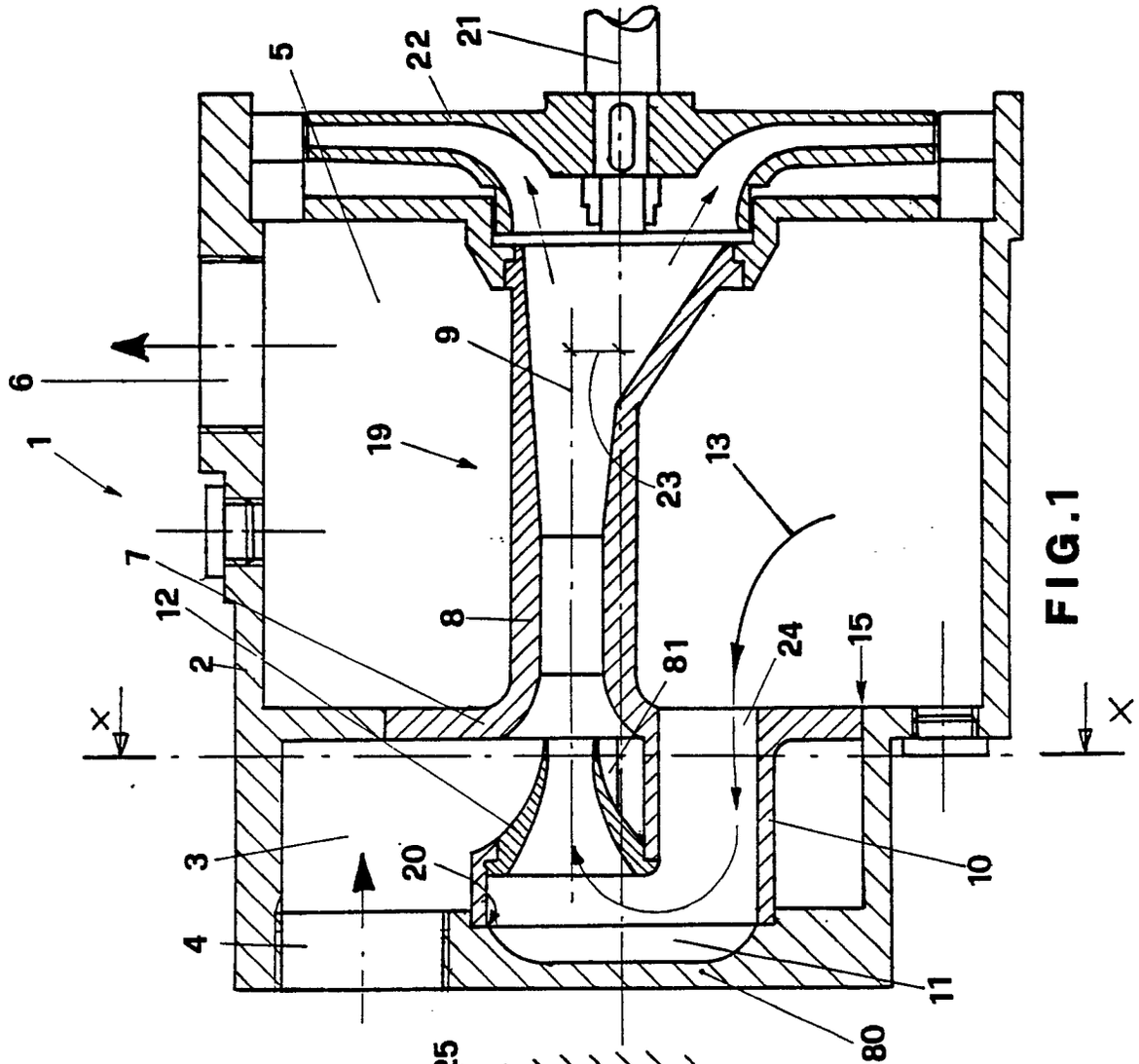

FIG.1

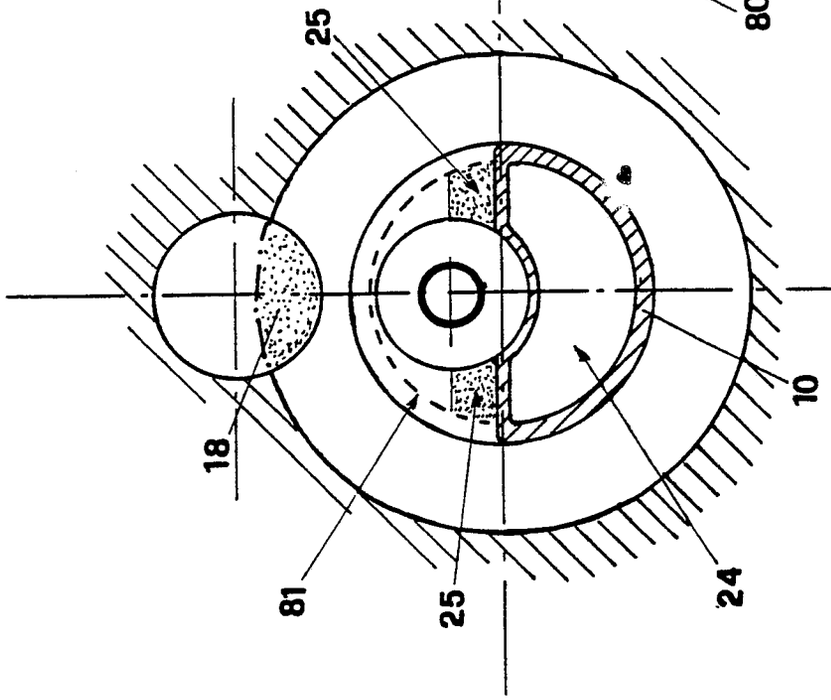

FIG.2

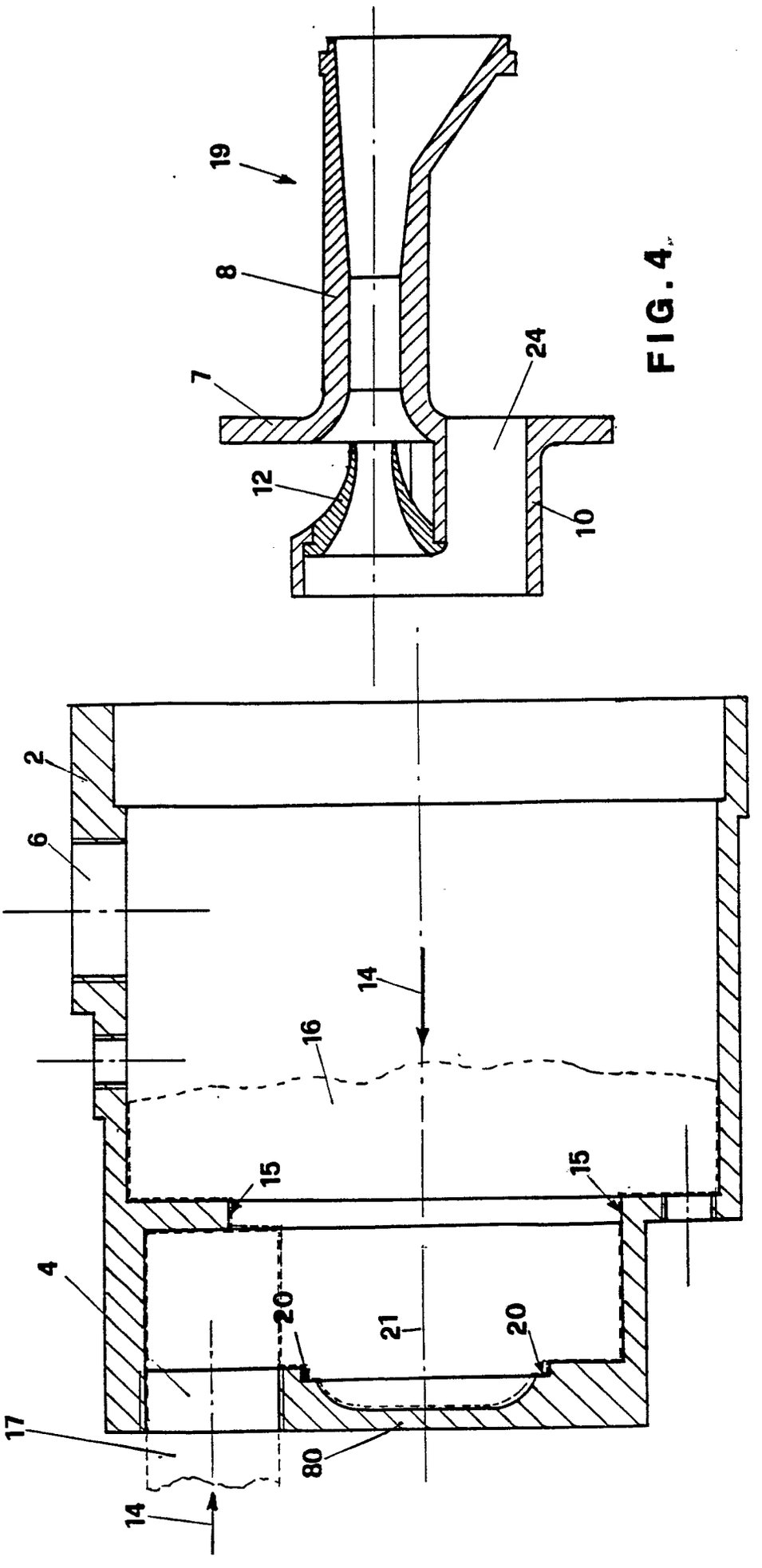

FIG. 4

FIG. 3

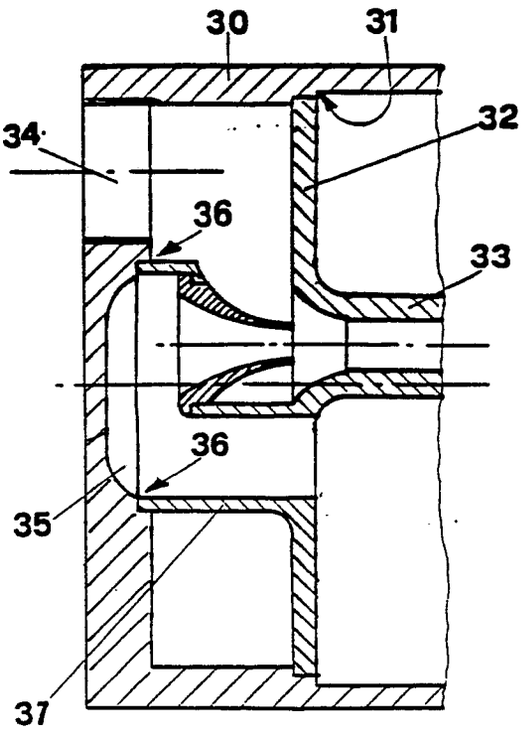

FIG.5

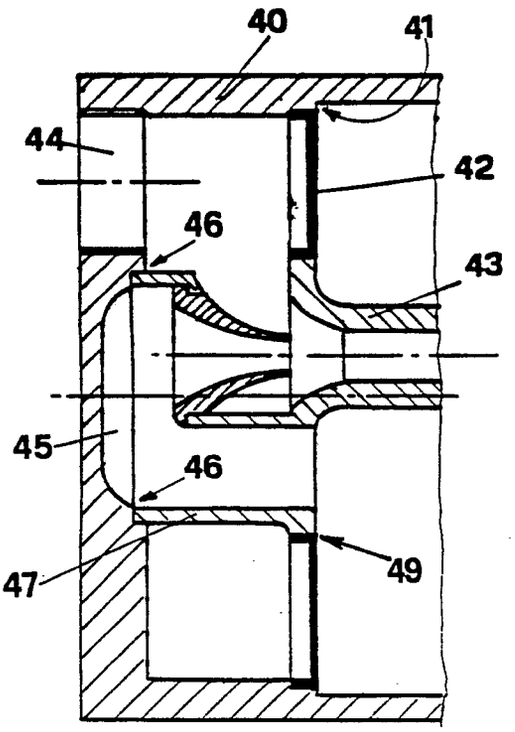

FIG.6

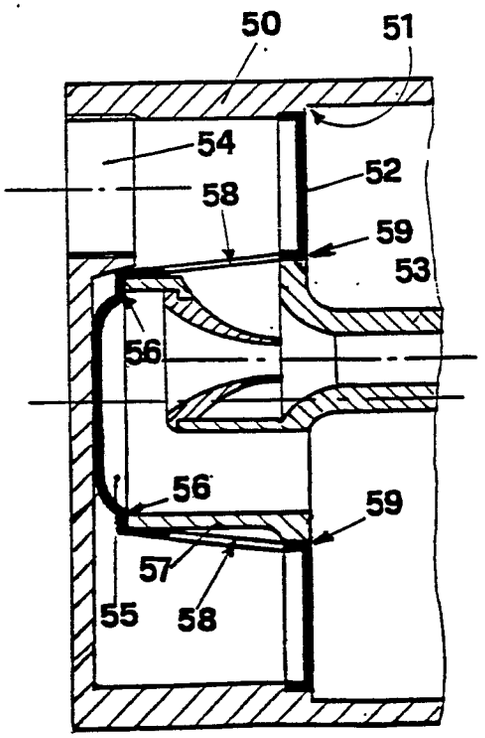

FIG.7

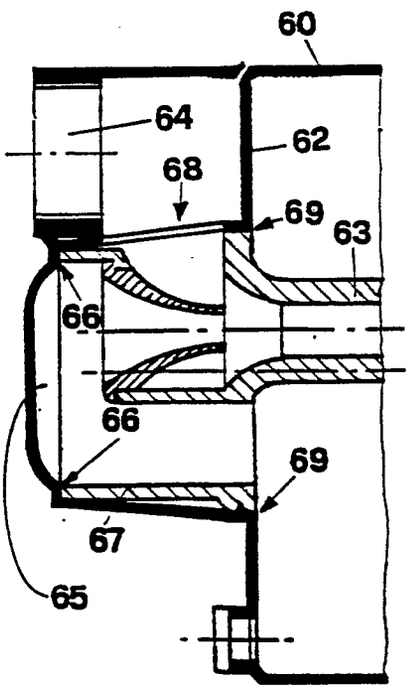

FIG.8

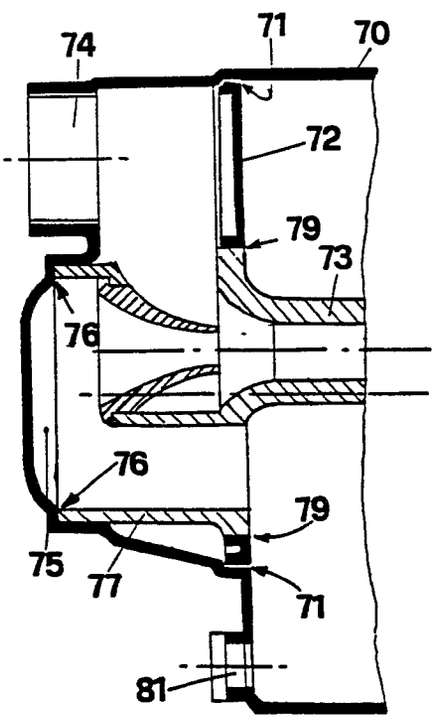

FIG.9

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 89 11 7554

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A,D	US-A-2700338 (SMITH) * column 1, lines 15 - 17 * * column 1, lines 50 - 52; figure 1 *	1	F04D9/06 F04D29/42
A,D	US-A-2934021 (CONERY) * figures 1, 2 *	1	
A	FR-A-1022632 (GUINARD) * abstract *	1	
A	US-A-3394655 (BROWN) * figure 1 *	1	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

F04D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	22 DECEMBER 1989	WALVOORT B.W.

CATEGORY OF CITED DOCUMENTS

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