



Europäisches Patentamt  
European Patent Office  
Office européen des brevets



(11) **EP 0 789 863 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention  
of the grant of the patent:

**23.04.2003 Bulletin 2003/17**

(21) Application number: **95939738.1**

(22) Date of filing: **03.11.1995**

(51) Int Cl.7: **G05D 11/03, B01F 5/04**

(86) International application number:  
**PCT/US95/14292**

(87) International publication number:  
**WO 96/014611 (17.05.1996 Gazette 1996/22)**

(54) **IN-LINE VENTURI**

IN-LINE VENTURI

VENTURI EN LIGNE

(84) Designated Contracting States:  
**AT BE CH DE DK ES FR GB GR IE IT LI LU MC NL  
PT SE**

(30) Priority: **04.11.1994 US 336065**  
**31.05.1995 US 455287**

(43) Date of publication of application:  
**20.08.1997 Bulletin 1997/34**

(73) Proprietor: **T I Properties, Inc.**  
**Los Angeles, CA 90067 (US)**

(72) Inventors:  
• **CONRAD, Wayne, Ernest**  
**Hampton, Ontario L0B 1J0 (CA)**  
• **CONRAD, Helmut, Gerhard**  
**Oshawa, Ontario L1G 7T5 (CA)**

- **PHILLIPS, Richard, Stanley**  
**Courtice, Ontario L1E 1S1 (CA)**
- **PHILLIPS, Andrew, Richard, Henry**  
**Courtice, Ontario L1E 2B5 (CA)**
- **BOWMAN, Gerald, Earl**  
**Newcastle, Ontario L1B 1G4 (CA)**
- **PRESTON, Michael, John**  
**West Hill, Ontario M1C 3C1 (CA)**

(74) Representative:  
**Cornish, Kristina Victoria Joy et al**  
**Kilburn & Strode,**  
**20 Red Lion Street**  
**London WC1R 4PJ (GB)**

(56) References cited:  
**DE-A- 1 808 849**                      **US-A- 2 873 758**  
**US-A- 3 188 055**                      **US-A- 4 344 752**  
**US-A- 4 519 423**                      **US-E- R E25 037**

**EP 0 789 863 B1**

Note: Within nine months from the publication of the mention of the grant of the European patent, any person may give notice to the European Patent Office of opposition to the European patent granted. Notice of opposition shall be filed in a written reasoned statement. It shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European Patent Convention).

**Description****RELATED APPLICATION:**

**[0001]** This application is a continuation-in-part of U. S. application Serial No. 08/336,065, filed 4 November 1994.

**FIELD OF THE INVENTION:**

**[0002]** The invention relates to a venturi tube apparatus.

**BACKGROUND:**

**[0003]** Venturi tubes are well known in the art for introducing a second fluid into a first fluid. Typically, the inlet of the venturi tube is attached to a conduit for the first fluid, and the second fluid is introduced through a second inlet, hereafter called an aspirator inlet, so that the combined fluid exits through the venturi's outlet. In operation, the gas or liquid to be introduced is sucked into the venturi through the aspirator inlet, as the fluid flows through the venturi tube. For a given venturi tube, the aspiration rate depends on the flow rate of the fluid which passes through the venturi inlet and the viscosity of the fluids.

**[0004]** US-A-3 188 055 is directed to a fertiliser mixing device.

**[0005]** One of the major problems associated with conventional venturi tubes is that any single tube can only operate over a narrow range of fluid flow rates. This is in part because back pressure produced within the venturi increases greatly with increases in the fluid flow rate. It is known that this problem can be overcome by connecting an external bypass system to the fluid conduit, in parallel to a venturi tube, so that a portion of the fluid flow stream flowing through the conduit bypasses the venturi by flowing through the bypass system. Conventional bypass systems have several limitations including being costly, bulky and requiring complex plumbing which hinders easy installation in association with an existing fluid conduit.

**[0006]** There exists a need for a simple venturi tube apparatus which can be added easily to an existing fluid carrying conduit and which can operate over a wider range of fluid flow conditions.

**[0007]** The present invention is set out in the independent claim. Some optional features are set out in the claims dependent thereto.

**[0008]** According to one embodiment, an apparatus is provided for insertion of a venturi tube directly within a fluid flow stream. According to a further embodiment there is provided an apparatus for use within a conduit for a fluid flow stream comprising a venturi tube having an inlet, an aspirator inlet and an outlet; and supporting means for supporting said venturi tube within said conduit in such a manner that said venturi tube is

aligned axially in the direction of said flow stream with the aspirator inlet not in contact with the fluid flow stream.

**[0009]** According to a further embodiment there is provided a fluid flow control means which divides the fluid flow stream into a first stream which flows through the venturi tube and a second stream which flows around the venturi tube. The fluid flow control means is adapted to allow the back pressure within the venturi tube (which increases as the fluid flow rate increases) to force an increasing proportion of the flow stream to flow around the venturi tube in order to maintain a relatively constant aspiration rate within the venturi tube. this permits a relatively constant and consistent operation of the venturi tube over a wider range of fluid flow rates by increasing the flow rate of the second stream rather than increasing the flow rate of the first stream as the rate of the fluid flow stream increases.

**[0010]** According to another embodiment there is provided means for inducing a vortex in the second stream, preferably at or near the venturi tube outlet. This induced vortex produces a surprising increase in the venturi effect and reduces backpressure at any given fluid flow rate. In addition, the vortex increases the mixing action of the first and second streams. The induced vortex permits more constant flow rates in the first stream, yielding a satisfactory venturi effect over a wider range of fluid flow rates.

**[0011]** According to one embodiment there is provided an apparatus for reducing pressure at the venturi tube outlet by means of an increased pipe diameter at that point relative to the diameter of the fluid flow inlet pipe. Preferably, this increased pipe diameter persists over a distance of about 1 to about 4 pipe diameters extending from the venturi outlet; even more preferably, over a distance of about 2 to about 3 diameters from that point.

**[0012]** According to yet another embodiment there is provided an aspirator inlet having, at its point of intersection with the venturi tube, a diameter selected so as to achieve a desired flow velocity (or range of flow velocities) as the second fluid is introduced into the first fluid. Preferably, the inner diameter of the aspirator inlet will be selected so as to achieve, in conjunction with the other components of the invention as described herein, high flow velocities, which may be subsonic, sonic or hypersonic, over at least a portion of the operating range of fluid flow rates for a given system.

**[0013]** According to one embodiment there is provided an in-line venturi comprising vortex inducing means and increased fluid flow outlet diameter relative to the fluid flow inlet pipe diameter. In a particularly preferred embodiment, the aspect ratio is adjusted so as to provide for optimal vortex formation under the particular flow conditions of the system, and the aspirator inlet comprises an aspirator tube.

**[0014]** In a preferred embodiment the supporting means comprises a plate or disc inserted within the con-

duit (or integral therewith). The fluid flow control means comprises first passage means through said plate or disc for allowing said first stream to flow through said venturi tube and second passage means, preferably in the form of at least one aperture, through said plate or disc, for allowing said second stream to flow. The aspiration rate of the venturi tube, for a given fluid flow rate, is determined by the cross sectional area of the venturi tube relative to the cross sectional area of the second passage means. The cross section of the second passage means can therefore be preset for a given venturi tube to be used within a fluid flow stream having a given flow rate, in order to achieve a desired aspiration rate.

**[0015]** Preferably said fluid flow control means further comprises adjusting means for adjusting the flow rate of the second stream, typically by adjustably blocking (or unblocking) said second passage means, in order to maintain a relatively constant flow rate through the venturi tube. Thus the total cross sectional area of the at least one aperture of the second passage means, relative to the cross sectional area of the venturi tube, can be adjusted by varying the extent the apertures of the second passage means are blocked. This allows for a greater range of flow rates of the fluid flow stream to be used with a given venturi tube to produce a desired aspiration rate.

**[0016]** In one embodiment, the adjusting means allows for adjustment of the extent to which the second passage means is blocked.

**[0017]** In another embodiment, the adjusting means includes regulating means, responsive to changes in the fluid flow rate for regulating the flow rate of the second stream. In one such embodiment, the regulating means comprises a blocking means which is biased towards the plate (or disc) by some resilient means, so as to block the second passage means. The blocking means is moved away from the second passage means, against the bias of the said resilient means, by the fluid flow stream as the flow rate (and resulting pressure) increases. Furthermore, both such adjusting means can be utilized together, if desired.

**[0018]** In some applications (for example in cases of high back pressure downstream from the venturi tube), it is desirable to increase the pressure drop across the venturi tube. This acts to increase the aspiration rate of the venturi tube. Consequently, another aspect of the invention provides for an optional constriction means for reducing the pressure at the venturi tube outlet, by constricting the flow of the second stream, in the vicinity of the venturi tube outlet.

**[0019]** In another embodiment, there is provided a venturi support body having, at the fluid inflow end, a concave face which acts to direct the incoming fluid stream toward a central aperture and therethrough into a venturi tube which is partly integral to the venturi support body and partly a separate tube held in close apposition against a mating surface on the venturi support body, in which the separate venturi tube further compris-

es one or more flow directors which cause the formation of a vortex in a portion of the fluid stream which is diverted through a series of apertures surrounding the central aperture as a function of increasing back pressure within the venturi tube, and in which the diameter of the fluid flow outlet pipe is greater than the diameter of the fluid flow inlet pipe over a distance of not less than between about 2 and about 3 outlet pipe diameters beginning at the venturi tube outlet.

**[0020]** Preferred embodiments will now be described by way of example with reference to the accompanying drawings in which:

Figure 1 is an exploded, perspective view of a preferred embodiment of the present invention, with the conduit shown in partial cutaway.

Figure 2 is a cross sectional view of the assembled parts illustrated in Figure 1.

Figure 3 is a cross sectional view taken along line 3-3 of Figure 2.

Figure 4 is an exploded, perspective view of another embodiment of the present invention, with the conduit shown in partial cutaway.

Figure 5 is a cross sectional view of the assembled parts illustrated in Figure 4, but with the tube 17 omitted for clarity.

Figure 6 is an exploded, perspective view of a variation of the embodiment shown in Figures 4 and 5, showing an alternative regulating means.

Figure 7 is a cross sectional view of the assembled parts illustrated in Figure 6, but with the tube 17 omitted for clarity.

Figure 8 is a front plan view of the alternative regulating means of Figures 6 and 7.

Figure 9 is a cross sectional view along line 9-9 of Figure 8 with the spokes 215 shown in phantom.

Figure 10 is an exploded, cross sectional view of a preferred embodiment of the invention.

Figure 11 is a cross sectional view of the assembled parts shown in Figure 10.

Figure 12 is a perspective view of the embodiment shown in Figures 10 and 11, with flow directors 605 shown in partial cutaway, omitting adjusting means 650 and conduit 500 for clarity.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS:

**[0021]** Figures 1 and 2 show a preferred embodiment of the present invention installed within a conduit 20 through which a fluid can flow in a stream. In this embodiment a venturi support body, shown generally at 10, comprises a disc 24 which is sized to closely fit within cylindrical conduit 20. Any suitable means for securing disc 24 in a sealing relationship within the conduit 20 can be used (for example, a suitable adhesive, a shoulder, or disc 24 and conduit 20 can be molded as one integral unit). The securing means should be sufficiently strong to withstand the pressures of the fluid flow stream and to keep the support body in sealing relationship with the conduit. In the preferred embodiment shown in Figures 1 and 2, an inner seating ring 300, attached to the inside of conduit 20, prevents downstream movement of disc 24, while allowing withdrawal of the unit, in the upstream direction, for maintenance if necessary. A key 301, attached to the inside of conduit 20, fits through keyway 302 in disc 24 to prevent rotation of disc 24.

**[0022]** Face 23 of disc 24, which faces the fluid flow stream, is preferably concave. Preferably located centrally within face 23 is aperture 25 leading into pipe 26 which extends axially from disc 24 on the side remote from face 23. Pipe 26 can be integral with disc 24 or connected thereto. Disc 24 also has apertures 27 which allow the fluid flow stream to pass through disc 24. Disc 24 acts to obstruct the fluid flow stream so that all the flow must be through apertures 25 or 27. In the preferred embodiment shown, apertures 27 are circular holes through disc 24, arranged in a circular pattern around aperture 25. Apertures 27 can vary in size, shape, and orientation.

**[0023]** Preferably an adjusting means is included to adjust the flow rate of the second stream (i.e., the portion of the fluid flow stream which flows around the venturi tube), by adjustably blocking (or unblocking) apertures 27. This adjustment means can either be adjustable, automatic (i.e., responsive to changes in the fluid flow rate) or a combination thereof.

**[0024]** In the preferred embodiment shown in Figures 1 and 2, adjusting means, generally shown at 12, allows for the external adjustment of the extent to which the apertures 27 are blocked. In this embodiment, adjusting means 12 comprises a disc 30 which is able to rotate with respect to disc 24, such as by being journaled on pipe 26. Disc 30 includes central aperture 35 for receiving pipe 26. Disc 30 also has apertures 31 which preferably are similar in size and spacing to apertures 27 of disc 24. Disc 30 obstructs the flow of the fluid stream through apertures 27, except for flow through apertures 31, which depends on the extent to which apertures 31 are in axial alignment with apertures 27. By rotating disc 30 with respect to disc 24, the degree of axial alignment of apertures 31 with respect to apertures 27, and thus the extent apertures 27 are blocked, is adjusted. Figures

1, 2, and 3 show one form of rotation means for rotating disc 30. In this embodiment, disc 30 includes a threaded hole 40 adapted to receive actuator 14. As can be seen in Figure 3, actuator 14 extends outwardly through slot 45 of conduit 20, gasket 16b, gasket 16a and washer 16c. Actuator 14 comprises a threaded bolt for engaging threaded hole 40, a handle which acts as a lever, and a shoulder 14b for engaging gasket 16b. Keyway 303 ensures that disc 30 is not obstructed by key 301 as the disc is rotated or during withdrawal of the assembly.

**[0025]** During normal operation, actuator 14 is screwed down in its tightened position. Shoulder 14b presses against gaskets 16b and 16a which serve to seal against leaks through washer 16c and slot 45 respectively, and also frictionally maintains disc 30 in a fixed position. In order to rotate disc 30, actuator 14 is externally loosened sufficiently so that it is free to move with respect to conduit 20, but so that a portion of it remains within threaded hole 40. Actuator 14 is then moved, as shown by arrows 47 in Figure 3, in order to rotate disc 30. Actuator 14 is then retightened in order to prevent further rotation of disc 30 with respect to disc 24. Alternative rotation means can be implemented. For example disc 30 can be provided with a one part of a worm gear or bevel gear arrangement (not shown), with the mating gear arrangement on a member (not shown) which extends through the conduit 20. Thus, by rotating the member from outside the conduit, the gear arrangement will rotate the disc 30.

**[0026]** A locking nut 13, screwed onto pipe 26 against a shoulder, maintains disc 30 in close proximity to disc 24, but with a sufficient gap so as to allow disc 30 to rotate. Pipe 26 is connected, for example by means of a threaded connection and optional locking nut 304, to the inlet of the venturi tube 11. In this embodiment, the venturi tube is supported within the conduit by pipe 26, which is in turn supported by disc 24, and aperture 25 acts as an inlet passage through disc 24 leading to pipe 26, and hence to the venturi tube inlet. Locking nut 304 prevents rotation of the venturi tube with respect to the pipe 26. Alternative supporting means can be provided while remaining within the scope of the invention. For example, the venturi tube 11 can be directly received and seated in aperture 25 of disc 24, with disc 30 journaled on venturi tube 11. Alternatively, pipe 26 can be flexible, and the venturi tube can be supported by spacer arms or struts which extend from it to the conduit wall.

**[0027]** Tube 17 leading to aspirator inlet 18 of venturi tube 11, is used for introducing a gas or liquid into the venturi tube. Tube 17 leads to an external source (not shown) of the gas or liquid to be introduced or can additionally include a pressure gauge (not shown), if desired. Depending on the application, tube 17 can either extend directly through a bore hole in the conduit 20 (not shown), or penetrate through the wall of the conduit 20 through a conventional compression fitting (not shown) at a convenient point along the conduit 20.

**[0028]** In operation the fluid flow stream within conduit

20 is diverted into inlet passage 25 and apertures 27 of disc 24 by face 23. Preferably face 23 is concave in order to help funnel a portion of the fluid flow stream (i.e., the first stream) through inlet passage 25 and consequently into venturi tube 11, by means of pipe 26. For any given flow rate of the fluid flow stream, the flow rate of the first stream, and the flow rate of the second stream (i.e., the portion which flows through apertures 27) depends on the relative cross sectional area of the apertures 27 compared with the cross sectional area of the venturi tube 11, and the back pressure produced within venturi tube 11. As the fluid flow rate increases, the resulting back pressure within venturi tube 11 increases, thereby forcing a larger proportion of the flow stream to flow through apertures 27 (i.e., increases the flow rate of the second stream), rather than increasing the flow rate through venturi tube 11. Thus, although any given venturi tube can only operate effectively for a narrow range of flow rates, the invention allows for operation of the venturi tube over a greater range of fluid flow stream flow rates than would be possible with the venturi tube alone, by keeping the flow rate of the first stream relatively constant over the greater range.

**[0029]** If the flow rate of the fluid flow stream is approximately constant, the size of apertures 27 can be predetermined to produce a desired flow rate through the venturi tube 11.

**[0030]** However if the flow rate of the fluid flow stream is variable, then optional adjusting means 12 is preferably added for adjusting the effective cross sectional area of the apertures 27 (in relation to the cross sectional area of the venturi tube 11). In the preferred embodiment shown in Figures 1 and 2, this adjustment is made by rotating disc 30, changing the axial alignment of apertures 31 and 27, thereby adjusting the degree to which apertures 27 are blocked by disc 30, as hereinbefore discussed. These adjustments change the relative cross sectional area of the apertures 27 in relation to the cross sectional area of the venturi tube. This accordingly will change the relative proportions of the first and second streams for any constant flow rate of the fluid flow stream. Thus for any constant flow rate, for a given set of fluids, the flow rate of the first stream, and hence the aspiration rate, can be set by appropriately rotating disc 30. Furthermore, this aspiration rate can be monitored by means of a gauge (not shown) located on tube 17, without visual access to the interior of the conduit and without opening the venturi tube assembly within the conduit.

**[0031]** In some applications (for example in cases of high back pressure downstream from the venturi tube), it is desirable to increase the rate of flow through the venturi tube. Consequently, another aspect of the invention provides for an optional means for reducing the pressure at the venturi tube outlet, by constricting the flow of the second stream, in the vicinity of the venturi tube outlet. This operates to increase the drop in pressure across the venturi tube, thus increasing its aspira-

tion rate. A preferred means for reducing the pressure at the venturi tube outlet is shown in Figures 1 and 2 as the optional flow diverter 15 affixed to the outlet of the venturi tube. Flow diverter 15 narrows the effective size of the conduit 20 in the vicinity of the venturi tube outlet. The second stream is therefore forced through the gap between the diverter 15 and the conduit 20. This increases the flow rate of the second stream as the second stream flows through the gap between diverter 15 and conduit 20, thus increasing the suction at the outlet end of the venturi tube. Flow diverter 15 is preferably conically shaped, in order to reduce resistance to the fluid flow. Other means for reducing the effective size of the conduit in the vicinity of the venturi tube outlet can be employed. For example, a ring extending radially inward from the inside perimeter of the conduit (not shown) can be utilized.

**[0032]** An alternative adjusting mechanism, not shown, for the rotating disc 30 is a blocking mechanism, for blocking apertures 27, which moves axially towards or away from the disc 24. In this embodiment, rather than rotating the adjusting mechanism, the effective size of the apertures 27 (in relation to the diameter of the venturi tube 11) is adjusted by axially moving a series of blockers (one for each aperture 27) away from, or closer to, the apertures 27. Each blocker can, for example be conically shaped and sized to totally occlude each aperture 27 if fully inserted within aperture 27, and partially occlude aperture 27 if partially withdrawn. Each blocker can conveniently be attached to a central hub by a spoke, for example, as illustrated in Figures 8 and 9. The hub can then be axially moved in order to vary the gap between the blockers and the apertures and thus the effective size of the second passage means through which the second stream can flow.

**[0033]** Figures 4 and 5 illustrate another embodiment of the invention, wherein an automatic adjustment means for regulating the flow rate of the second stream, responsive to changes in the fluid flow rate, has been added to the embodiment shown in Figures 1 and 2. In the embodiment shown in Figures 4 and 5, this regulating means, generally shown at 100, is illustrated for use in conjunction with the manually rotatable disk 30 of Figures 1 and 2. It should be noted that the regulating means 100 can also be used without disk 30. Figures 4 and 5 show essentially the same apparatus as shown in Figures 1 and 2, with the corresponding parts labelled with the same numbers as that of Figures 1 and 2, except for a change to the thread and shoulder arrangement on pipe 26; the addition of automatic adjustment means 100; and the removal of locking nut 13.

**[0034]** Blocking ring 60 is mounted on pipe 26 for axial movement towards and away from disc 30. A helical spring 70 and a locking nut 80 are mounted on pipe 26, with locking nut 80 adjacent pipe shoulder 50. A second locking nut 304, adjacent locking nut 80, prevents the venturi 11 from rotating. Spring 70, which is held in place by locking nut 80, biases blocking ring 60 against disc

30 such that ring 60 blocks apertures 31. The pressure of the fluid flow stream within the conduit 20 exerts a force on blocking ring 60 against the bias of spring 70. As the pressure increases, so does the force. Thus, under low flow stream rates, spring 70 biases blocking ring 60 against disc 30, blocking apertures 31, thus forcing the majority of the flow stream (or all the flow stream if blocking ring 60 totally occludes apertures 31) into the venturi tube. As the flow rate of the flow stream increases the resulting pressure increase acting on blocking ring 60 moves blocking ring 60 away from apertures 31, against the bias of spring 70, allowing fluid to flow through apertures 31. Thus, as the pressure increases, the proportion of the fluid flow stream flowing through the apertures 31 increases until blocking ring 60 has moved sufficiently away from ring 30 so as to offer no significant resistance to the flow.

**[0035]** In this embodiment, the disc 30 is rotated in order to adjust the initial effective sizes of the apertures through which the second stream can flow. The blocking ring 60 will then regulate the actual flow through the apertures, allowing increased flow through the apertures as the flow rate (and resulting fluid pressure) increases, and allowing decreased flow through the apertures as the flow rate of the fluid flow stream decreases. Thus as the flow rate increases, the portion of the fluid flow stream flowing through the venturi tube will remain constant, but the second stream will increase. If disc 30 is not utilized, the blocking ring 60 is biased towards disc 24, in order to regulate the flow through apertures 27. Furthermore, alternative resilient means can be substituted for spring 70.

**[0036]** An alternative regulating means is shown generally at 200 in Figures 6, 7, 8 and 9, replacing the blocking ring 60 of Figures 4 and 5. This alternative regulating means 200 comprises a series of blockers 220 sized and shaped to block apertures 31, or alternatively apertures 27, if disc 30 is not utilized. These blockers are supported by spokes 215 which extend radially outward from a hub 210. Blockers 220 are resiliently biased against apertures 31 by a resilient means, such as helical spring 70, as shown in Figures 6 and 7.

**[0037]** In this embodiment, a means is necessary to maintain alignment of blockers 220 with apertures 31 if disc 30 is rotated. As seen in Figures 6 and 7, disc 30 is provided with an axially extending sleeve 330 which surrounds pipe 26. As shown in Figure 8, key 205 extends radially inward from hub 210 for sliding axial movement within keyway 206 (as shown in Figure 7) of sleeve 330. Thus, hub 210 can move axially along sleeve 330, but key 205 within keyway 206 prevents rotation of hub 210 with respect to disc 30. In operation, regulating means 200 works in the same manner as blocking ring 60 in Figures 4 and 5, but provides easier flow for the second stream once the pressure of the fluid flow stream has moved the regulating means 200 away from the disc 30. Alternatively, hub 210 can be fixed in place, with spokes 215 longer than shown and con-

structed from a sufficiently resilient material so as to act as a living hinge, with the resiliency of spokes 215 biasing the blockers 220 to block apertures 31.

**[0038]** Figures 10, 11 and 12 show another preferred embodiment of the present invention. In this embodiment a venturi support body, shown generally at 400, comprises a fluid flow inlet 405 having a diameter approximately equal to the diameter of the fluid supply inflow pipe (not shown), venturi support body 400 being removably sealably connected to the fluid supply inflow pipe by means of a standard compression fitting using threads 410. Any suitable means for securing venturi support body 400 in a sealing relationship with the fluid supply inflow pipe can be used. For example, the base 415 of venturi support body 400 may have a concentric groove sized so as to receive an O-ring which seals against a suitable face of the fluid supply inflow pipe (not shown).

**[0039]** In the preferred embodiment shown in Figures 10 and 11, venturi support body 400 comprises a face 420 which faces the fluid flow stream and is preferably concave. Preferably located centrally within face 420 is aperture 425, having a diameter approximately 0.100" less than the inlet diameter of integral venturi 430 to which it leads, resulting in shoulder 433. As shown in Figures 10 and 11, beginning at shoulder 433, integral venturi 430 is cylindrical at the point of entry of aspirator inlet 440 and for a short distance beyond aspirator inlet 440, after which it is frustoconical. Face 420 also has apertures 435 which allow the fluid flow stream to pass through venturi support body 400. Face 420 acts to obstruct the fluid flow stream so that all the flow must be through apertures 425 or 435. In the preferred embodiment shown, apertures 435 are circular holes through venturi support body 400, arranged in a circular pattern around aperture 425. Apertures 435 can vary in size, shape and orientation. In the preferred embodiment shown, aspirator inlet 440 is sized to receive aspirator tube 445 by means of a threaded connection.

**[0040]** Venturi support body 400 is sealably removably connected to conduit 500. In the preferred embodiment shown, the sealable, reversible connection means comprise matching left-hand thread 450 on venturi support body 400 and conduit 500, and shoulder 455 in venturi support body 400 which can support an O-ring (not shown) against which the end of conduit 500 sealably bears as it is drawn toward shoulder 455. Any suitable sealing means may be employed; for example, shoulder 455 itself can act as the sealing surface against which the inlet end 505 of conduit 500 may bear when conduit 500 is threaded onto venturi support body 400. Threads 530 allow conduit 500 to be sealably, removably connected to the fluid supply outflow pipe (not shown) by means of a standard compression fitting. Any suitable means for securing conduit 500 in a sealing relationship with the fluid supply outflow pipe can be used. For this purpose, for example, outlet end 540 of conduit 500 is preferably sized to match the diameter of the fluid supply

outflow pipe and includes a concentric groove sized to receive an O-ring (not shown) which seals against a suitable surface of the fluid supply outflow pipe (not shown). Fluid flow outlet 520 of conduit 500 has a diameter which, in the preferred embodiment shown, is greater than the diameter of fluid flow inlet 405 of venturi support body 400.

**[0041]** Shoulder 510 of conduit 500 bears against venturi tube 600, which, in turn, fits in closely mating surfaces of venturi support body 400. In the preferred embodiment shown, venturi tube 600 comprises flow directors 605 which are angled with respect to the direction of the second stream (i.e., the portion of the fluid flow stream which flows through apertures 435). Adjusting means 650 comprises disk 655 and helical spring 660.

**[0042]** The preferred embodiment of Figure 10 is shown assembled in Figure 11. Venturi support body 400 and conduit 500 are shown sealably drawn together by means of left-hand threads 450. Shoulder 510 forces venturi tube 600 into venturi support body 400 such that venturi tube 600 forms an extension of integral venturi 430. It is not necessary that venturi tube 600 mate precisely with venturi support body 400 as shown in Figure 11; for example, where an O-ring is interposed between shoulder 455 of venturi support body 400 and inlet end 505 of conduit 500 to effect a seal (not shown), a gap between the mating surfaces of venturi support body 400 and venturi tube 600 will exist which is equal in size to the compressed O-ring diameter, and such a gap will not impede the desired venturi effect. Helical spring 660 biases disk 655 against apertures 435 of venturi support body 400, and simultaneously biases venturi tube 600 against shoulder 510 of conduit 500.

**[0043]** In operation, the fluid flow stream from the fluid supply inflow pipe enters fluid flow inlet 405 and is diverted into apertures 425 and 435 by face 420. The preferred concavity of face 420 assists in funneling a portion of the fluid flow stream (i.e., the first stream) through aperture 425 and into the venturi formed by integral venturi 430 and venturi tube 600. At a given fluid flow stream flow rate, the first stream flow rate and the second stream flow rate (i.e., the rate of the flow of that portion of the fluid flow stream which flows through apertures 435) is a function of the ratio between the cumulative cross-sectional area of apertures 435 and the cross-sectional area of aperture 425, and of back pressure produced within the venturi tube. These values typically will be selected in order to achieve a desired (preferably, a relatively constant) amount of venturi draw or suction over the anticipated operational range of fluid flow stream flow rates for the system.

**[0044]** In practice, the cross sectional area of aperture 425 typically will be selected in order to achieve the desired venturi draw at the low end of the operational range. At low fluid flow stream flow rates, disk 655 is biased against apertures 435 by helical spring 660, with the result that apertures 435 are occluded and substan-

tially all of the fluid flow passes through aperture 425. As the fluid flow rate increases, the increase in back pressure within the venturi tube forces an increasing proportion of the fluid flow stream through apertures 435, which are progressively opened as the force of the second stream flow overcomes the bias of disk 655 against apertures 435 from helical spring 660. Adjusting means 650, then, acts to maintain a relatively constant fluid flow rate of the first stream over a range of second stream flow rates. Thus, where the range of the fluid flow rates is known for a given system, the characteristics of helical spring 660 may be selected such that adjusting means 650 produces an acceptable flow rate of the first stream through the venturi tube over that range.

**[0045]** In the embodiment shown, the ratio of the cross sectional area of aperture 425 to the cumulative cross sectional area of apertures 435 is approximately 1:2, and typically will be selected such that the first stream flow rate and the second stream flow rate are approximately equal over the operational range.

**[0046]** As described above, it is frequently desirable to increase the rate of flow through the venturi tube. In the preferred embodiment shown in Figures 10-12, the pressure at the venturi tube outlet is decreased due to the fact that the diameter of the fluid flow outlet 520 is greater than the diameter of the fluid flow inlet 405. While any increase in fluid flow outlet 520 diameter over fluid flow inlet 405 diameter will produce increased flow rate through the venturi tube, it is preferred that the increase in pipe diameter be between about 25% and about 75%; more preferably, between about 35% and about 65%; and even more preferably, about 50%. The length of the increased pipe diameter, measured from the outlet of venturi tube 600 (which, in the embodiment shown, corresponds to the location of shoulder 510), should be a minimum of between about 1 and about 4 pipe diameters; preferably between about 2 and about 3 pipe diameters. Longer lengths will, of course, also work.

**[0047]** As shown in Figure 12, venturi tube 600 comprises flow directors 605 which are oriented at an angle to the direction of the second stream as it emerges from apertures 435 and passes disk 655. As the second stream passes through flow directors 605, a vortex is created in the fluid flow outlet 520 portion of conduit 500. The angle at which flow directors 605 intersect the direction of the second stream may be varied over a wide range, for example, between about 5° and about 95°; preferably between about 10° and about 90°; more preferably between about 15° and 85°; even more preferably between about 20° and about 80°; more preferably still, between about 25° and about 75°; yet more preferably, between about 30° and about 70°, or between about 35° and about 65°, or between about 40° and about 60°; most preferably between about 45° and about 55°, in order to achieve a satisfactory vortex. In the embodiment shown, the angle of flow directors 605 is about 45°. In practice, the vortex formed in the second

stream by flow directors 605 can extend for a considerable distance into the fluid supply outflow pipe (not shown) beyond outlet end 540.

**[0048]** This induced vortex produces a surprising increase in the venturi effect and reduces backpressure at any given fluid flow rate, and contributes to the unexpected and surprisingly wide operational range of the embodiment shown. The vortex also contributes to improved mixing of the first stream with the second stream as the first stream emerges from the outlet of venturi tube 600. Formation of an optimal vortex is dependent upon a number of factors, including the angle and cross sectional area of the flow directors and the increase in diameter of fluid flow outlet 520 over the diameter of fluid flow inlet 405.

**[0049]** In the embodiment shown in Figure 12, flow directors 605 are a series of radial fins formed at an angle of about 45% to the direction of the second fluid stream as it emerges from apertures 435, and arranged in a circular pattern around the outlet of venturi tube 600. The size and shape of flow directors 605 may be varied. The cumulative cross sectional area of flow directors 605 may be smaller than, larger than, or equal to that of apertures 435. The choice of flow director size and shape, but particularly size, will affect the characteristics of the vortex induced in the second fluid stream as it emerges from apertures 435. Preferably, the cumulative cross sectional area of flow directors 605 will be no larger than that of apertures 435; even more preferably, the cumulative cross sectional area of flow directors 605 will be equal to or, most preferably, slightly less than that of apertures 435. Flow directors 605 may comprise circular angled holes. Alternatively, flow directors 605 may take the form of the radial fin shown in cutaway in Figure 12 which extend all the way to the inner wall of conduit 500 and rest directly on shoulder 510, such that the outer wall of flow directors 605 is effectively formed by the inner wall of conduit 500 as opposed to being an integral part of venturi tube 600 as shown in Figure 12.

**[0050]** In another aspect the invention is directed to an aspirator inlet having, at its point of intersection with the venturi tube, a diameter selected so as to achieve high flow velocities as the second fluid is introduced into the first fluid. Preferably, the inner diameter of the aspirator inlet will be selected so as to achieve subsonic, sonic or hypersonic flow velocities over at least a portion of the operating range of fluid flow rates for a given system.

**[0051]** Selection of the inner diameter of the aspirator inlet is varied depending upon the fluid flow rates for which a given system is designed, so as to achieve a desired second fluid introduction flow velocity over the operating range. The flow velocity at which the second fluid is introduced into the first fluid will affect the degree to which the second fluid (either the first or the second liquid may comprise a gas or a liquid) is incorporated into the first fluid, and can be varied, then, to achieve a desired degree of incorporation.

**[0052]** For example, where the first fluid is a liquid such as water and the second fluid is a gas such as ozone, selection of the aspirator inlet inner diameter, as well as other variables of the design of the apparatus as described herein, may be determined in order to maximize the incorporation of ozone into the water, thereby minimizing unincorporated ozone offgas. Similarly, where it is desired to introduce a solute into the first fluid, the choice of flow velocity, and thus of the inner diameter of the aspirator inlet, will vary depending upon the nature and properties of the solute. Thus, less soluble solutes may require higher flow velocities to be incorporated into a first fluid at a desired concentration.

**[0053]** In the preferred embodiment shown in Figures 10-12, venturi support body 400 comprises integral aspirator inlet 440. Because aspirator inlet 440 is an integral part of venturi support body 400, it does not come into contact with the second fluid stream. In the embodiment shown, aspirator inlet 440 is formed such that shoulder 433 is uninterrupted; it is also preferred to form aspirator inlet 440 completely through venturi support body 400, such that shoulder 433 is interrupted (not shown). Aspirator inlet 440 is sized to receive aspirator tube 445 by means of a threaded connection. Aspirator tube 445, which is replaceable, is fabricated from a material having sufficient tensile strength to withstand the forces exerted in operation upon aspirator tip 448 where it enters integral venturi 430; a preferred material having suitable characteristics for this purpose is stainless steel. It is preferred that aspirator tip 448 have a slight conical depression formed therein as shown, and that it be slightly below the surface of integral venturi 430 in operation. Where the second fluid is ozone gas, aspirator tube 445 is preferably constructed of 316 stainless steel. It will be appreciated that aspirator tube 445 of the embodiment shown may easily and economically be replaced if it should become worn, or in order to optimize the apparatus for a particular first fluid, second fluid or both.

**[0054]** The inner diameter of aspirator tube 445 may be varied as described herein. In the embodiment shown, the inner diameter of aspirator tube 445 is about 0.25" at the inlet end, and is reduced to about 0.046" at aspirator tip 448. The embodiment shown was designed to consistently draw between about 15 ft<sup>3</sup>/hr and about 17 ft<sup>3</sup>/hr at first fluid flow rates of 40 gal/min or greater. It has been shown to draw within these specifications at first fluid flow rates as great as 120 gal/min, giving it a surprisingly wide operational range of at least 80 gal/min. Based upon the results of testing performed so far, it is expected that this embodiment will continue to draw within specifications at first fluid flow rates in excess of 120 gal/min. Moreover, the embodiment shown has been demonstrated to draw near specifications at first fluid flow rates as low as 35 gal/min, and to continue to draw at first fluid flow rates as low as 18-20 gal/min. The embodiment shown has a fluid flow inlet 405 diameter of about 2.0", a fluid flow outlet 510 diameter of about



2.5", and an aperture 425 diameter of about 0.625".

**[0055]** The preferred embodiment shown in Figures 10 - 12 is particularly well suited for introducing a second fluid comprising ozone gas into a first fluid comprising water. Unexpected and surprisingly high incorporation of ozone into water has been observed in the operation of this embodiment. Further, while not wishing to be bound to a particular theory, it is believed that the flow velocities achieved at aspirator tip 448 in the operation of this embodiment effect a chemical change in the ozone as it is incorporated into the water, which may include the conversion of ozone to hydroxyl radicals. This embodiment is particularly useful for the purification of water by ozone.

**[0056]** The above embodiments can be used for fluids that can be used with a conventional venturi. As is known in the art, the fluids must be sufficiently viscous so as to be aspirated. For example, the invention can be used as an ozonator for introducing ozone into water. Preferably, the various parts of the above mentioned embodiments are formed by injection molding of a suitable thermoplastic which is chemically inert with respect to the fluids used. The above described embodiments are designed for installation within existing conduits. For facilitating such installation, the apparatus can be pre-

installed in a section of conduit, with the said section of conduit subsequently inserted within an existing conduit.

**[0057]** It will be apparent that many other changes may be made to the illustrative embodiments, while falling within the scope of the invention and it is intended that all such changes be covered by the claims appended hereto.

## Claims

1. Apparatus for use within a conduit (20) for a fluid flow stream comprising:

a venturi tube (11) having an inlet (25), an aspirator inlet (18) and an outlet;  
 supporting means (10) for supporting said venturi tube within said conduit in such a manner that said venturi tube is aligned axially in the direction of said fluid flow stream; and  
 fluid flow control means (24), comprising first passage means (25) for allowing a first stream to flow, and a second passage means (27) for allowing a second stream to flow; **characterised in that** the fluid flow control means is for dividing said fluid flow stream into a first stream which flows through said venturi tube and a second stream which flows axially around said venturi tube; the apparatus further including:

vortex inducing means (605) in said second passage means to induce net axially

symmetric vorticity in said fluid flow stream.

2. Apparatus as claimed in claim 1, wherein said vortex is induced at or near said outlet.
3. Apparatus as claimed in claim 1 or claim 2, wherein said vortex inducing means comprises one or more flow directors (605).
4. Apparatus as claimed in claim 3, wherein said one or more flow directors (605) is oriented at an angle to the direction of said fluid flow stream.
5. Apparatus as claimed in claim 4, wherein said angle of said one or more flow directors (605) is between about 5° and about 95°; and preferably wherein said angle of said one or more flow directors (605) is between about 10° and about 90°; and preferably wherein said angle of said one or more flow directors (605) is between about 15° and about 85°; and preferably wherein said angle of said one or more flow directors (605) is between about 20° and about 80°; and preferably wherein said angle of said one or more flow directors (605) is between about 25° and about 75°; and preferably wherein said angle of said one or more flow directors (605) is between about 30° and about 70°; and preferably wherein said angle of said one or more flow directors (605) is between about 35° and about 65°; and preferably wherein said angle of said one or more flow directors (605) is between about 40° and about 60°; and preferably wherein said angle of said one or more flow directors (605) is between about 45° and about 55°; and preferably wherein said angle of said one or more flow directors (605) is about 45°.
6. Apparatus as claimed in claim 3, wherein said one or more flow directors (605) comprises a one or more radial fins as shown in Figure 12.
7. Apparatus as claimed in claim 3, further comprising fluid flow control means for dividing the fluid flow stream into a first stream which flows through said venturi tube and a second stream which flows around said venturi tube.
8. Apparatus as claimed in claim 7, wherein said fluid flow control means comprises:

first passage means through said venturi support means for allowing said first stream to flow;

and  
second passage means through said venturi  
support means for allowing said second stream  
to flow.

9. Apparatus as claimed in claim 8, wherein said first passage means comprises at least one first aperture (25) through said supporting means, and wherein said second passage means comprises at least one second aperture (27) through said supporting means. 5
10. Apparatus as claimed in claim 9, wherein the cross sectional area of said one or more flow directors (605) is equal to or less than the cross sectional area of said at least one second aperture (27). 10
11. Apparatus as claimed in claim 10, wherein the ratio of the cross sectional area of said at least one first aperture to the cross sectional area of said at least one second aperture is 1:2. 20
12. Apparatus as claimed in claim 1, wherein the diameter of said conduit at said venturi tube outlet is greater than the diameter of said conduit at said venturi tube inlet. 25
13. Apparatus as claimed in claim 1, wherein the diameter of said conduit at said venturi tube outlet is between about 25% and about 75% greater than the diameter of said conduit at said venturi tube inlet. 30
14. Apparatus as claimed in claim 1, wherein the diameter of said conduit at said venturi tube outlet is between about 35% and about 65% greater than the diameter of said conduit at said venturi tube inlet. 35
15. Apparatus as claimed in claim 1, wherein the diameter of said conduit at said venturi tube outlet is about 50% greater than the diameter of said conduit at said venturi tube inlet. 40
16. Apparatus as claimed in any one of claims 12, 13, 14 or 15, wherein the diameter of said conduit at said venturi tube outlet is greater than the diameter of said conduit at said venturi tube inlet for a distance no less than between about 1 and about 4 pipe diameters beyond said venturi tube outlet. 45
17. Apparatus as claimed in claim 16, wherein the diameter of said conduit at said venturi tube outlet is greater than the diameter of said conduit at said venturi tube inlet for a distance of no less than between about 2 and about 3 pipe diameters beyond said venturi tube outlet. 50
18. Apparatus as claimed in claim 1, wherein a disc (24) is positioned within said conduit in a sealable rela-

tionship therewith, said disc having a first aperture (25) in communication with said venturi inlet and a plurality of second apertures (27) which are not in communication with said venturi inlet, said second apertures arranged in a circular configuration around said first aperture, said disc has a concave face (23) which divides the fluid flow stream into a first stream flowing through said first aperture and a second stream flowing through said second apertures.

19. Apparatus as claimed in claim 18, further comprising constriction means for reducing the pressure at the venturi tube outlet by constricting the flow of the fluid flow stream which flowed around said venturi tube through said second apertures in the vicinity of said venturi tube outlet.
20. Apparatus as claimed in claim 18, further comprising adjusting means (12) for adjusting the flow rate of the second stream.
21. Apparatus as claimed in claim 20, further comprising first locking means (301) for preventing rotation of the disc within the conduit and second locking means (300) for preventing downstream movement of said disc within said conduit.
22. Apparatus as claimed in claim 1, wherein said supporting means further comprises, at the fluid inflow end, a concave face (23) which acts to direct an incoming fluid stream toward a central aperture (25) and therethrough into a venturi tube (11) which is partly integral to said venturi support body and partly a separate tube held in close apposition against a mating surface on said venturi support body, wherein said separate venturi tube further comprises one or more flow directors which cause the formation of a vortex-in a portion of said fluid stream which is diverted through a series of apertures (27) surrounding said central aperture (25) as a function of increasing back pressure within said venturi tube, and wherein the diameter of the fluid flow outlet pipe is greater than the diameter of the fluid flow inlet pipe over a distance of not less than between about 2 and about 3 outlet pipe diameters beginning at the venturi tube outlet.
23. Apparatus as claimed in claim 1, wherein said supporting means comprises:
- a fluid flow inlet having a diameter approximately equal to the diameter of the fluid supply inflow pipe, said venturi support body being removably sealably connected to said fluid supply inflow pipe;
- a concave face (23) which faces the fluid flow stream, having therein a central aperture (25),

said central aperture having a diameter approximately 0.100" less than the inlet diameter of an integral venturi (11) to which said central aperture leads; and having radial apertures (27) which allow said fluid flow stream to pass through said venturi support body;

wherein said venturi support body is sealably removably connected to a conduit, said conduit having a diameter which is greater than the diameter of said fluid flow inlet;

wherein said venturi support body removably supports a venturi tube, said venturi tube comprising flow directors (605) angled with respect to the direction of the portion of the fluid flow stream which flows through said radial apertures; and

wherein said venturi support body further comprises adjusting means (12) comprising a disk (30) biased against said radial apertures by a helical spring (70), said helical spring also biasing said venturi tube against a shoulder on said conduit.

- 24.** Apparatus as claimed in claim 1, wherein said supporting means (10) comprises a plate positioned within said conduit in a sealable relationship therewith, said fluid flow control means including:

first passage means through said plate for allowing said first stream to flow; and  
 second passage means through said plate for allowing said second stream to flow;  
 adjusting means (12) for adjusting the flow rate of the second stream;  
 constriction means for reducing the pressure at the venturi tube outlet by constricting the flow of the second stream in the vicinity of said venturi tube outlet;

wherein said constriction means comprises a conically shaped flow diverter (15) connected to said venturi tube outlet.

- 25.** Apparatus as claimed in claim 1, wherein said supporting means (10) comprises a plate positioned within said conduit in a sealable relationship therewith, said fluid flow control means including:

first passage means through said plate for allowing said first stream to flow; and  
 second passage means through said plate for allowing said second stream to flow; adjusting means for adjusting the flow rate of the second stream;

wherein said second passage means comprises at least one aperture through said plate and

said adjusting means comprises:

a second plate, rotatable with respect to said first plate, said second plate having at least one aperture axially alignable with the at least one aperture of said first plate; and  
 means for rotating said second plate in order to vary the extent to which the at least one aperture of said second plate is axially aligned with the at least one aperture of the first plate.

- 26.** Apparatus as claimed in claim 25, wherein said adjusting means further comprises regulating means (100), responsive to changes in the fluid flow rate, for regulating the flow through the at least one aperture of said second plate, allowing the flow through said at least one aperture to increase as the flow rate of the fluid flow stream increases and decrease as the flow rate of the fluid flow stream decreases.

- 27.** Apparatus as claimed in claim 26, wherein said regulating means comprises: blocking means for blocking the at least one aperture of said second plate; resilient means (70) for biasing said blocking means towards the at least one aperture of said second plate.

- 28.** Apparatus as claimed in claim 27, wherein said supporting means further comprises a pipe (26) extending axially downstream from said first plate, said venturi tube supported axially by said pipe, said pipe forming a channel from said first passage means to said venturi inlet; said second plate (20) is journaled on said pipe; and wherein said blocking means comprises a blocking ring (60) mounted on said pipe between said second plate and said venturi tube for axial sliding movement on said pipe towards and away from said second plate.

- 29.** Apparatus as claimed in claim 27, wherein said supporting means further comprises a pipe (26) extending axially downstream from said first plate, said venturi tube supported axially by said pipe, said pipe forming a channel from said first passage means to said venturi inlet; said second plate is journaled on said pipe; and wherein said blocking means comprises a number of blockers (220) equal to the number of apertures of said second plate, each blocker sized and shaped to block one aperture, each said blocker supported by a spoke (215) extending radially from a hub (210), and means (70) for mounting said hub on said pipe in order to allow for axial movement of said hub but prevent rotation of said hub with respect to said second plate.

- 30.** Apparatus as claimed in claim 1, wherein said supporting means (10) compris-

es a plate positioned within said conduit in a sealable relationship therewith, said fluid flow control means including:

first passage means through said plate for allowing said first stream to flow; and  
 second passage means through said plate for allowing said second stream to flow;  
 adjusting means (12) for adjusting the flow rate of the second stream; said adjusting means comprises regulating means (100), responsive to changes in the fluid flow rate, for regulating the flow through said second passage means, allowing the flow through said second passage means to increase as the flow rate of the fluid flow stream increases and decrease as the flow rate of the fluid flow stream decreases;

wherein said regulating means (200) comprises: blocking means for blocking said second passage means;

resilient means (70) for biasing said blocking means towards said second passage means;

wherein said supporting means further comprises a pipe extending axially downstream from said first plate, said venturi tube supported axially by said pipe, said pipe forming a channel from said first passage means to said venturi inlet; and wherein said blocking means comprises a blocking ring (60) mounted on said pipe between said plate and said venturi tube for axial sliding movement on said pipe towards and away from said plate.

**31.** Apparatus as claimed in claim 1,

wherein said supporting means (10) comprises a plate positioned within said conduit in a sealable relationship therewith, said fluid flow control means including:

first passage means through said plate for allowing said first stream to flow; and  
 second passage means through said plate for allowing said second stream to flow;  
 adjusting means (12) for adjusting the flow rate of the second stream; said adjusting means comprises regulating means (100), responsive to changes in the fluid flow rate, for regulating the flow through said second passage means, allowing the flow through said second passage means to increase as the flow rate of the fluid flow stream increases and decrease as the flow rate of the fluid flow stream decreases;

wherein said regulating means (200) comprises: blocking means for blocking said second passage means;

resilient means (70) for biasing said blocking means towards said second passage means;

wherein said second passage means comprises at least one aperture through said plate; said supporting means further comprises a pipe extending axially downstream from said first plate, said venturi tube supported axially by said pipe, said pipe forming a channel from said first passage means to said venturi inlet; and wherein said blocking means comprises a number of blockers (220) equal to the number of apertures of said second passage means, each blocker sized and shaped to block one aperture, each said blocker supported by a spoke (215) extending radially from a hub (210), said hub mounted on said pipe between said plate and said venturi tube for axial sliding movement on said pipe towards and away from said plate.

**32.** Apparatus as claimed in claim 2, said supporting means comprises a plate positioned within said conduit in a sealable relationship therewith, said fluid control means including:

first passage means through said plate for allowing said first stream to flow; and  
 second passage means through said plate for allowing said second stream to flow.

**33.** Apparatus as claimed in claim 32, further comprising adjusting means for adjusting the flow rate of the second stream.

**34.** Apparatus as claimed in claim 33, further comprising constriction means for reducing the pressure at the venturi tube outlet by constricting the flow of the second stream in the vicinity of said venturi tube outlet.

**35.** Apparatus as claimed in claim 33 or claim 34, wherein said second passage means comprises at least one aperture through said plate and said adjusting means comprises means for varying the cross sectional area of said at least one aperture by adjustably blocking said at least one aperture.

**36.** Apparatus as claimed in claim 33, wherein said adjusting means comprises regulating means, responsive to changes in the fluid flow rate, for regulating the flow through said second passage means, allowing the flow through said second passage means to increase as the flow rate of the fluid flow stream increases and decrease as the flow rate of the fluid flow stream decreases.

**37.** Apparatus as claimed in claim 36, wherein said regulating means comprises:

blocking means for blocking said second passage means; and  
 resilient means (70) for biasing said blocking

means towards said second passage means.

### Patentansprüche

1. Vorrichtung zur Anwendung innerhalb einer Leitung (20) für einen Fluidstrom, welche aufweist:

ein Venturi-Rohr (11) mit einer Einlassöffnung (25), einer Ansaugelinlassöffnung (18) und einer Auslassöffnung;  
 ein Stützmittel (10) zum Stützen des Venturi-Rohrs innerhalb der Leitung auf eine Weise, dass das Venturi-Rohr axial in der Richtung des Fluidstroms ausgerichtet ist; und  
 ein Fluidstromsteuerorgan (24), das ein erstes Durchgangsorgan (25), damit ein erster Strom fließen kann, und ein zweites Durchgangsorgan (27), damit ein zweiter Strom fließen kann, aufweist; **dadurch gekennzeichnet, dass** das Fluidstromsteuerorgan dazu dient, den Fluidstrom in einen ersten Strom zu unterteilen, der durch das Venturi-Rohr fließt, und in einen zweiten Strom, der axial rund um das Venturi-Rohr fließt; wobei die Vorrichtung weiters aufweist:

ein Wirbelinduktionsorgan (605) im zweiten Durchgangsorgan, um eine axial symmetrische Wirbelbewegung im Fluidstrom zu induzieren.

2. Vorrichtung nach Anspruch 1, wobei der Wirbel an oder in der Nähe der Auslassöffnung induziert wird.  
 3. Vorrichtung nach Anspruch 1 oder 2, wobei das Wirbelinduktionsorgan ein oder mehrere Strömungsrichtungsgeber (605) umfasst.  
 4. Vorrichtung nach Anspruch 3, wobei der eine oder die mehreren Strömungsrichtungsgeber (605) in einem Winkel zur Richtung des Fluidstroms ausgerichtet ist bzw. sind.  
 5. Vorrichtung nach Anspruch 4, wobei der Winkel des einen oder der mehreren Strömungsrichtungsgeber (605) zwischen etwa 5° und etwa 95° liegt; und wobei vorzugsweise  
 der Winkel des einen oder der mehreren Strömungsrichtungsgeber (605) zwischen etwa 10° und etwa 90° liegt; und wobei vorzugsweise  
 der Winkel des einen oder der mehreren Strömungsrichtungsgeber (605) zwischen etwa 15° und etwa 85° liegt; und wobei vorzugsweise  
 der Winkel des einen oder der mehreren Strömungsrichtungsgeber (605) zwischen etwa 20° und etwa 80° liegt; und wobei vorzugsweise  
 der Winkel des einen oder der mehreren Ström-

ungssichtungsgeber (605) zwischen etwa 25° und etwa 75° liegt; und wobei vorzugsweise  
 der Winkel des einen oder der mehreren Strömungsrichtungsgeber (605) zwischen etwa 30° und etwa 70° liegt; und wobei vorzugsweise  
 der Winkel des einen oder der mehreren Strömungsrichtungsgeber (605) zwischen etwa 35° und etwa 65° liegt; und wobei vorzugsweise  
 der Winkel des einen oder der mehreren Strömungsrichtungsgeber (605) zwischen etwa 40° und etwa 60° liegt; und wobei vorzugsweise  
 der Winkel des einen oder der mehreren Strömungsrichtungsgeber (605) zwischen etwa 45° und etwa 55° liegt; und wobei vorzugsweise  
 der Winkel des einen oder der mehreren Strömungsrichtungsgeber (605) etwa 45° beträgt.

6. Vorrichtung nach Anspruch 3, wobei der eine oder die mehreren Strömungsrichtungsgeber (605) eine oder mehrere radiale Rippen aufweisen, wie dies in Figur 12 dargestellt ist.  
 7. Vorrichtung nach Anspruch 3, weicht weiters ein Fluidstromsteuerorgan zur Unterteilung des Fluidstroms in einen ersten Strom, der durch das Venturi-Rohr fließt, und einen zweiten Strom, der rund um das Venturi-Rohr fließt, aufweist.  
 8. Vorrichtung nach Anspruch 7, wobei das Fluidstromsteuerorgan  
 ein erstes Durchgangsorgan durch das Venturi-Stützmittel, damit der erste Strom fließen kann; und  
 ein zweites Durchgangsorgan durch das Venturi-Stützmittel, damit der zweite Strom fließen kann, aufweist.  
 9. Vorrichtung nach Anspruch 8, wobei das erste Durchgangsorgan mindestens eine erste Öffnung (25) durch das Stützmittel hindurch aufweist, und wobei das zweite Durchgangsorgan mindestens eine zweite Öffnung (27) durch das Stützmittel hindurch aufweist.  
 10. Vorrichtung nach Anspruch 9, wobei die Querschnittsfläche des einen oder der mehreren Strömungsrichtungsgeber (605) gleich wie oder kleiner als die Querschnittsfläche der mindestens einen zweiten Öffnung (27) ist.  
 11. Vorrichtung nach Anspruch 10, wobei das Verhältnis zwischen der Querschnittsfläche der mindestens einen ersten Öffnung und der Querschnittsfläche der mindestens zweiten Öffnung 1:2 ist.  
 12. Vorrichtung nach Anspruch 1, wobei der Durchmesser der Leitung an der Auslassöffnung des Venturi-Rohrs größer ist als der Durchmesser der Röhre an

der Einlassöffnung des Venturi-Rohrs.

13. Vorrichtung nach Anspruch 1, wobei der Durchmesser der Leitung an der Auslassöffnung des Venturi-Rohrs um zwischen etwa 25% und etwa 75% größer ist als der Durchmesser der Röhre an der Einlassöffnung des Venturi-Rohrs.

14. Vorrichtung nach Anspruch 1, wobei der Durchmesser der Leitung an der Auslassöffnung des Venturi-Rohrs um zwischen etwa 35% und etwa 65% größer ist als der Durchmesser der Röhre an der Einlassöffnung des Venturi-Rohrs.

15. Vorrichtung nach Anspruch 1, wobei der Durchmesser der Leitung an der Auslassöffnung des Venturi-Rohrs um etwa 50% größer ist als der Durchmesser der Leitung an der Einlassöffnung des Venturi-Rohrs.

16. Vorrichtung nach einem der Ansprüche 12, 13, 14, oder 15, wobei der Durchmesser der Leitung an der Auslassöffnung des Venturi-Rohrs größer ist als der Durchmesser der Leitung an der Einlassöffnung des Venturi-Rohrs über einen Abstand, der nicht geringer ist als zwischen etwa 1 und etwa 4 Rohrdurchmessern über die Auslassöffnung des Venturi-Rohrs hinaus.

17. Vorrichtung nach Anspruch 16, wobei der Durchmesser der Leitung an der Auslassöffnung des Venturi-Rohrs größer ist als der Durchmesser der Leitung an der Einlassöffnung des Venturi-Rohrs über einen Abstand, der nicht kleiner ist als zwischen etwa 2 und etwa 3 Rohrdurchmessern über die Auslassöffnung des Venturi-Rohrs hinaus.

18. Vorrichtung nach Anspruch 1, wobei eine Scheibe (24) innerhalb der Leitung gegeneinander abdichtend angeordnet ist, wobei die Scheibe eine erste Öffnung (25) besitzt, welche in Kommunikation mit der Venturi-Einlassöffnung steht, und eine Vielzahl an zweiten Öffnungen (27) besitzt, welche nicht in Kommunikation mit der Venturi-Einlassöffnung stehen, wobei die zweiten Öffnungen kreisförmig rund um die erste Öffnung angeordnet sind, wobei die Scheibe eine konkave Fläche (23) besitzt, welche den Fluidstrom in einen ersten Strom unterteilt, der durch die erste Öffnung fließt, und in einen zweiten Strom, der durch die zweiten Öffnungen fließt.

19. Vorrichtung nach Anspruch 18, welche weiters ein Einengungsorgan zur Verringerung des Drucks an der Auslassöffnung des Venturi-Rohrs durch Beschränkung des Durchflusses des Fluidstroms aufweist, der rund um das Venturi-Rohr durch die zweiten Öffnungen in der Nahe der Auslassöffnung des Venturi-Rohrs geflossen ist.

20. Vorrichtung nach Anspruch 18, welche weiters ein Einstellmittel (12) zum Einstellen der Durchflussschwindigkeit des zweiten Stroms aufweist.

21. Vorrichtung nach Anspruch 20, welche weiters ein erstes Verriegelungsmittel (301), um eine Drehung der Scheibe innerhalb der Röhre zu verhindern, und ein zweites Verriegelungsmittel (300), um eine stromabwärts gerichtete Bewegung der Scheibe innerhalb der Röhre zu verhindern, aufweist.

22. Vorrichtung nach Anspruch 1, wobei das Stützmittel weiters am Fluidemtrittseude eine konkave Stimfläche (23) aufweist, die dazu dient, einen eintretenden Fluidstrom zu einer zentralen Öffnung (25) und durch diese hindurch in ein Venturi-Rohr (11) zu leiten, welches teilweise einstückig mit dem Venturi-Stützkörper ausgebildet und teilweise ein separates Rohr ist, das in enger Anlage an eine Passfläche am Venturi-Stützkörper gehalten wird, wobei das separate Venturi-Rohr weiters ein oder mehrere Strömungsrichtungsgeber aufweist, die eine Ausbildung eines Wirbels in einem Abschnitt des Fluidstroms bewirken, der durch eine Reihe von Öffnungen (27) geteilt wird, welche die zentrale Öffnung (25) umgeben, und zwar als Funktion des zunehmenden Gegendrucks innerhalb des Venturi-Rohrs, und wobei der Durchmesser des Fluidstromauslassrohrs größer ist als der Durchmesser des Fluidstromeinlassrohrs über eine Distanz, die nicht kleiner ist als zwischen etwa 2 und etwa 3 Auslassrohrdurchmesser, beginnend an der Auslassöffnung des Venturi-Rohrs.

23. Vorrichtung nach Anspruch 1, wobei das Stützmittel aufweist:

eine Fluidstromeinlassöffnung mit einem Durchmesser, der ungefähr gleich groß ist wie der Durchmesser des Fluidstromeintrittsrohrs, wobei der Venturi-Stützkörper abnehmbar und abdichtend mit dem Fluidstromeintrittsrohr verbunden ist;

eine konkave Stirnfläche (23), die zum Fluidstrom gerichtet ist und eine zentrale Öffnung (25) aufweist, wobei die zentrale Öffnung einen Durchmesser besitzt, der ungefähr 0,100" kleiner ist als der Einlassdurchmesser eines einstückigen Venturi-Rohrs (11), zu welchem die zentrale Öffnung führt; und radiale Öffnungen (27) aufweist, durch welche der Fluidstrom durch den Venturi-Stützkörper hindurch treten kann;

wobei der Venturi-Stützkörper abdichtend und abnehmbar mit einer Leitung verbunden ist, wobei die Leitung einen Durchmesser besitzt, der größer ist als der Durchmesser der Fluideinlassöff-

nung;

wobei der Venturi-Stützkörper das Venturi-Rohr abnehmbar stützt, wobei die Störungsrichtungsgeber (605) am Venturi-Rohr im Hinblick auf die Richtung des Abschnitts des Fluidstroms abgewinkelt sind, der durch die radialen Öffnungen fließt; und

wobei der Venturi-Stützkörper weiters ein Einstellmittel (12) aufweist, das eine Scheibe (30) enthält, die gegen die radialen Öffnungen durch eine Schraubenfeder (70) vorgespannt ist, wobei die Schraubenfeder auch das Venturi-Rohr gegen eine Schulter an der Leitung vorspannt.

**24.** Vorrichtung nach Anspruch 1,

wobei das Stützmittel (10) eine Platte aufweist, welche innerhalb der Leitung abdichtend angeordnet ist, wobei das Fluidstromsteuermitel aufweist:

ein erstes Durchgangsorgan durch die Platte, damit der erste Strom fließen kann; und  
ein zweites Durchgangsorgan durch die Platte, damit der zweite Strom fließen kann;  
ein Einstellmittel (12) zum Einstellen der Fließgeschwindigkeit des zweiten Stroms;  
ein Einengungsorgan zum Verringern des Drucks an der Auslassöffnung des Venturi-Rohrs durch Beschränkung des Durchflusses des zweiten Stroms in der Nähe der Auslassöffnung des Venturi-Rohrs;

wobei das Einengungsorgan einen konisch geformten Durchflussteiler (15) aufweist, der an der Auslassöffnung des Venturi-Rohrs befestigt ist.

**25.** Vorrichtung nach Anspruch 1,

wobei das Stützmittel (10) eine Platte aufweist, die innerhalb der Leitung abdichtend angeordnet ist, wobei das Fluidstromsteuermitel aufweist:

ein erstes Durchgangsorgan durch die Platte, damit der erste Strom fließen kann; und  
ein zweites Durchgangsorgan durch die Platte, damit der zweite Strom fließen kann; ein Einstellmittel zum Einstellen der Fließgeschwindigkeit des zweiten Stroms;

wobei das zweite Durchgangsorgan mindestens eine Öffnung durch die Platte aufweist und das Einstellmittel aufweist:

eine zweite Platte, die relativ zur ersten Platte drehbar ist, wobei die zweite Platte mindestens eine Öffnung besitzt, die axial zu der mindestens einen Öffnung der ersten Platte ausgerichtet ist; und

ein Mittel zum Drehen der zweiten Platte, um das Ausmaß zu verändern, in dem die mindestens eine Öffnung der zweiten Platte axial zu der mindestens einen Öffnung der ersten Platte ausgerichtet ist.

**26.** Vorrichtung nach Anspruch 25, wobei das Einstellmittel weiters ein Regulierungsmittel (100) aufweist, welches auf Änderungen der Fließgeschwindigkeit reagiert, um den Durchfluss durch die mindestens eine Öffnung der zweiten Platte zu regeln, damit der Strom durch die mindestens eine Öffnung zunehmen kann, wenn die Fließgeschwindigkeit des Fluidstroms ansteigt, und abnehmen kann, wenn die Fließgeschwindigkeit des Fluidstroms abnimmt.

**27.** Vorrichtung nach Anspruch 26, wobei das Regulierungsmittel aufweist:

ein Blockierungsmittel zum Blockieren der mindestens einen Öffnung der zweiten Platte; ein elastisches Organ (70) zum Vorsparmen des Blockierungsmittels gegen die mindestens eine Öffnung der zweiten Platte.

**28.** Vorrichtung nach Anspruch 27, wobei das Stützmittel weiters ein Rohr (26) aufweist, das sich axial stromabwärts von der ersten Platte erstreckt, wobei das Venturi-Rohr axial vom Rohr gehalten wird, wobei das Rohr einen Kanal vom ersten Durchgangsorgan zur Venturi-Einlassöffnung bildet; wobei die zweite Platte (20) am Rohr gelagert ist; und wobei das Blockierungsmittel einen Blockiererring (60) aufweist, der am Rohr zwischen der zweiten Platte und dem Venturi-Rohr befestigt ist, um eine axiale Gleitbewegung am Rohr zur zweiten Platte hin und von dieser weg durchführen zu können.

**29.** Vorrichtung nach Anspruch 27, wobei das Stützmittel weiters ein Rohr (26) aufweist, das sich axial stromabwärts von der ersten Platte erstreckt, wobei das Venturi-Rohr axial vom Rohr gestützt wird, wobei das Rohr einen Kanal vom ersten Durchgangsorgan zur Venturi-Einlassöffnung bildet; wobei die zweite Platte am Rohr gelagert ist; und wobei das Blockierungsmittel eine Anzahl von Blockiereinrichtungen (220) umfasst, welche der Anzahl an Öffnungen in der zweiten Platte entspricht, wobei Größe und Form jeder Blockiereinrichtung so ausgelegt sind, dass jeweils eine Öffnung blockiert wird, wobei jede Blockiereinrichtung von einer Speiche (215) gehalten wird, die sich radial von einer Nabe (210) weg erstreckt, und ein Mittel (70) zur Befestigung der Nabe am Rohr vorgesehen ist, damit eine axiale Bewegung der Nabe ermöglicht wird, aber eine Drehung der Nabe relativ zur zweiten Platte verhindert wird.

**30.** Vorrichtung nach Anspruch 1,

wobei das Stützmittel (10) eine Platte aufweist, die innerhalb der Leitung abdichtend dazu angeordnet ist, wobei das Fluidstromsteuerorgan aufweist:

ein erstes Durchgangsorgan durch die Platte, damit der erste Strom fließen kann; und  
 ein zweites Durchgangsorgan durch die Platte, damit der zweite Strom fließen kann;  
 ein Einstellmittel (12) zum Einstellen der Fließgeschwindigkeit des zweiten Stroms; wobei das Einstellmittel ein Regulierungsmittel (100) umfasst, welches auf Änderungen der Fließgeschwindigkeit reagiert, um den Durchfluss durch das zweite Durchgangsorgan zu regeln, damit der Strom durch das zweite Durchgangsorgan zunehmen kann, wenn sich die Fließgeschwindigkeit des Fluidstroms erhöht, und abnehmen kann, wenn sich die Fließgeschwindigkeit des Fluidstroms verringert;

wobei das Regulierungsmittel (200) aufweist: ein Blockierungsmittel zum Blockieren des zweiten Durchgangsorgans;

ein elastisches Organ (70) zum Vorspannen des Blockierungsmittels gegen die zweite Durchtrittsöffnung;

wobei das Stützmittel weiters ein Rohr aufweist, das sich axial stromabwärts von der ersten Platte erstreckt, wobei das Venturi-Rohr axial durch das Rohr gehalten ist, wobei das Rohr einen Kanal vom ersten Durchgangskanal zur Venturi-Einlassöffnung bildet; und wobei das Blockierungsmittel einen Blockiererring (60) aufweist, der am Rohr zwischen der Platte und dem Venturi-Rohr befestigt ist, um eine axiale Gleitbewegung am Rohr zur Platte hin und von der Platte weg durchführen zu können.

**31.** Vorrichtung nach Anspruch 1,

wobei das Stützmittel (10) eine Platte aufweist, die innerhalb der Leitung abdichtend dazu angeordnet ist, wobei das Fluidstromsteuerorgan umfasst:

ein erstes Durchgangsorgan durch die Platte, damit der erste Strom fließen kann; und  
 ein zweites Durchgangsorgan durch die Platte, damit der zweite Strom fließen kann;  
 ein Einstellmittel (12) zum Einstellen der Fließgeschwindigkeit des zweiten Stroms; wobei das Einstellmittel ein Regulierungsmittel (100) umfasst, welches auf Änderungen der Fließgeschwindigkeit reagiert, um den Durchfluss durch das zweite Durchgangsorgan zu regeln, damit der Strom durch das zweite Durchgangsorgan zunehmen kann, wenn sich die

Fließgeschwindigkeit des Fluidstroms erhöht, und abnehmen kann, wenn sich die Fließgeschwindigkeit des Fluidstroms verringert;

wobei das Regulierungsmittel (200) aufweist: ein Blockierungsmittel zum Blockieren des zweiten Durchgangsorgans;

ein elastisches Organ (70) zum Vorspannen des Blockierungsmittels gegen die zweite Durchtrittsöffnung;

wobei das zweite Durchgangsorgan mindestens eine Öffnung durch die Platte aufweist; wobei das Stützmittel weiters ein Rohr aufweist, das sich axial stromabwärts von der ersten Platte erstreckt, wobei das Venturi-Rohr axial vom Rohr gehalten wird, wobei das Rohr einen Kanal vom ersten Durchgangsorgan zur Venturi-Einlassöffnung bildet; und wobei das Blockierungsmittel eine Anzahl von Blockiervorrichtungen (220) umfasst, welche der Anzahl an Öffnungen im zweiten Durchgangsorgan entspricht, wobei Größe und Form jeder Blockiervorrichtung so ausgelegt sind, dass jeweils eine Öffnung blockiert wird, wobei jede Blockiervorrichtung von einer Speiche (215) gehalten wird, die sich radial von einer Nabe (210) weg erstreckt, wobei die Nabe am Rohr zwischen der Platte und dem Venturi-Rohr befestigt ist, damit eine axiale Gleitbewegung am Rohr zur Platte hin und von der Platte weg ermöglicht wird.

**32.** Vorrichtung nach Anspruch 2, wobei das Stützmittel eine Platte aufweist, die innerhalb der Röhre abdichtend angeordnet ist, wobei das Fluidstromsteuerorgan aufweist:

ein erstes Durchgangsorgan durch die Platte, damit der erste Strom fließen kann; und  
 ein zweites Durchgangsorgan durch die Platte, damit der zweite Strom fließen kann.

**33.** Vorrichtung nach Anspruch 32, welche weiters ein Einstellmittel zum Einstellen der Fließgeschwindigkeit des zweiten Stroms aufweist.**34.** Vorrichtung nach Anspruch 33, welche weiters ein Einengungsorgan zum Verringern des Drucks an der Auslassöffnung des Venturi-Rohrs durch Beschränkung des Durchflusses des zweiten Stroms in der Nähe der Auslassöffnung des Venturi-Rohrs aufweist.**35.** Vorrichtung nach Anspruch 33 oder Anspruch 34, wobei das zweite Durchgangsorgan mindestens eine Öffnung durch die Platte aufweist und das Einstellmittel ein Mittel zum Verändern der Querschnittsfläche der mindestens einen Öffnung durch verstellbare Blockierung der mindestens einen Öffnung aufweist.



36. Vorrichtung nach Anspruch 33, wobei das Einstellmittel ein Regulierungsmittel aufweist, welches auf Änderungen der Fließgeschwindigkeit anspricht, um den Durchfluss durch das zweite Durchgangsorgan zu regeln, damit der Strom durch das zweite Durchgangsorgan zunehmen kann, wenn die Fließgeschwindigkeit des Fluidstroms ansteigt, und abnehmen kann, wenn die Fließgeschwindigkeit des Fluidstroms abnimmt

37. Vorrichtung nach Anspruch 36, wobei das Regulierungsmittel aufweist:

ein Blockierungsmittel zum Blockieren des zweiten Durchgangsorgans; und  
ein elastisches Organ (70) zum Vorspannen des Blockierungsmittels gegen das zweite Durchgangsorgan.

### Revendications

1. Appareil destiné à être utilisé dans une conduite (20) pour un courant de fluide comprenant :

un tube venturi (11) ayant une entrée (25), une entrée d'aspiration (18) et une sortie;  
un moyen de support (10) pour supporter ledit tube venturi à l'intérieur de ladite conduite de manière que ledit tube venturi soit aligné axialement dans direction dudit courant de fluide; et un moyen de régulation de débit de fluide (24), comprenant un premier moyen de passage (25) pour permettre à un premier courant de s'écouler et un second moyen de passage (27) pour permettre à un second courant de s'écouler; **caractérisé en ce que** le moyen de régulation de débit de fluide est destiné à diviser ledit courant de fluide en un premier courant qui s'écoule à travers ledit tube venturi et en un second courant qui s'écoule axialement autour dudit tube venturi; l'appareil comprenant en outre :

un moyen inducteur de tourbillon (605) dans ledit second moyen de passage pour induire une vorticit  axialement sym trique nette dans ledit courant de fluide.

2. Appareil selon la revendication 1, dans lequel ledit tourbillon est induit   ladite sortie ou   proximit  de celle-ci.

3. Appareil selon la revendication 1 ou 2, dans lequel ledit moyen inducteur de tourbillon comprend un ou plusieurs directeurs d' coulement (605).

4. Appareil selon la revendication 3, dans lequel les-

directeurs d' coulement (605) sont orient s en faisant un angle avec la direction dudit courant de fluide.

5. Appareil selon la revendication 4, dans lequel ledit angle desdits un ou plusieurs directeurs d' coulement (605) se situe entre environ 5  et environ 95 ; et de pr f rence dans lequel :

ledit angle desdits un ou plusieurs directeurs d' coulement (605) se situe entre environ 10  et environ 90 ; et de pr f rence dans lequel :

ledit angle desdits un ou plusieurs directeurs d' coulement (605) se situe entre environ 15  et environ 85 ; et de pr f rence dans lequel :

ledit angle desdits un ou plusieurs directeurs d' coulement (605) se situe entre environ 20  et environ 80 ; et de pr f rence dans lequel :

ledit angle desdits un ou plusieurs directeurs d' coulement (605) se situe entre environ 25  et environ 75 ; et de pr f rence dans lequel :

ledit angle desdits un ou plusieurs directeurs d' coulement (605) se situe entre environ 30  et environ 70 ; et de pr f rence dans lequel :

ledit angle desdits un ou plusieurs directeurs d' coulement (605) se situe entre environ 35  et environ 65 ; et de pr f rence dans lequel :

ledit angle desdits un ou plusieurs directeurs d' coulement (605) se situe entre environ 40  et environ 60 ; et de pr f rence dans lequel :

ledit angle desdits un ou plusieurs directeurs d' coulement (605) se situe entre environ 45  et environ 55 ; et de pr f rence dans lequel :

ledit angle desdits un ou plusieurs directeurs d' coulement (605) est d'environ 45 .

6. Appareil selon la revendication 3, dans lequel lesdits un ou plusieurs directeurs d' coulement (605) comprennent une ou plusieurs ailettes radiales comme montr  dans la Fig. 12.

7. Appareil selon la revendication 3, comprenant en outre un moyen de r gulation de d bit de fluide pour diviser le courant de fluide en un premier courant qui s' coule   travers ledit tube venturi et en un second courant qui s' coule autour dudit tube venturi.

8. Appareil selon la revendication 7, dans lequel ledit moyen de r gulation de d bit de fluide comprend :

un premier moyen de passage   travers ledit moyen de support de venturi pour permettre audit premier courant de s' couler; et  
un second moyen de passage   travers ledit moyen de support de venturi pour permettre audit second courant de s' couler.

9. Appareil selon la revendication 8, dans lequel ledit

- premier moyen de passage comprend au moins une première ouverture (25) à travers ledit moyen de support et dans lequel ledit second moyen de passage comprend au moins une seconde ouverture (27) à travers ledit moyen de support. 5
10. Appareil selon la revendication 9, dans lequel la surface en coupe transversale desdits un ou plusieurs directeurs d'écoulement (75) est égale ou inférieure à la surface en coupe transversale de ladite au moins une seconde ouverture (27). 10
11. Appareil selon la revendication 10, dans lequel le rapport de la surface en coupe transversale de ladite au moins une première ouverture à la surface en coupe transversale de ladite au moins une seconde ouverture est de 1:2. 15
12. Appareil selon la revendication 1, dans lequel le diamètre de ladite conduite à ladite sortie du tube venturi est supérieur au diamètre de ladite conduite à ladite entrée du tube venturi. 20
13. Appareil selon la revendication 1, dans lequel le diamètre de ladite conduite à ladite sortie du tube venturi est entre environ 25% et environ 75% plus grand que le diamètre de ladite conduite à ladite entrée du tube venturi. 25
14. Appareil selon la revendication 1, dans lequel le diamètre de ladite conduite à ladite sortie du tube venturi est entre environ 35% et environ 65% plus grand que le diamètre de ladite conduite à ladite entrée du tube venturi. 30
15. Appareil selon la revendication 1, dans lequel le diamètre de ladite conduite à ladite sortie du tube venturi est environ 50% plus grand que le diamètre de ladite conduite à ladite entrée du tube venturi. 35
16. Appareil selon l'une quelconque des revendications 12, 13, 14 ou 15, dans lequel le diamètre de ladite conduite à ladite sortie du tube venturi est plus grand que le diamètre de ladite conduite à ladite entrée du tube venturi sur une distance qui n'est pas inférieure à environ 1 à environ 4 diamètres de tube au-delà de ladite sortie du tube venturi. 40
17. Appareil selon la revendication 16, dans lequel le diamètre de ladite conduite à ladite sortie du tube venturi est plus grand que le diamètre de ladite conduite à ladite entrée du tube venturi sur une distance qui n'est pas inférieure à environ 2 à environ 3 diamètres de tube au-delà de ladite sortie du tube venturi. 45
18. Appareil selon la revendication 1, dans lequel un disque (24) est positionné dans ladite conduite en relation étanche avec celle-ci, ledit disque ayant une première ouverture (25) en communication avec ladite entrée du venturi et une pluralité de secondes ouvertures (27) qui ne sont pas en communication avec ladite entrée du venturi, lesdites secondes ouvertures étant aménagées en configuration circulaire autour de ladite première ouverture, ledit disque ayant une face concave (23) qui divise le courant de fluide en un premier courant s'écoulant à travers ladite première ouverture et en un second courant s'écoulant à travers lesdites secondes ouvertures. 50
19. Appareil selon la revendication 18, comprenant en outre un moyen d'étranglement pour réduire la pression à la sortie du tube venturi en étranglant l'écoulement du courant de fluide qui s'est écoulé autour dudit tube venturi à travers lesdites secondes ouvertures au voisinage de ladite sortie du tube venturi. 55
20. Appareil selon la revendication 18, comprenant en outre un moyen d'ajustement (12) pour ajuster le débit du second courant.
21. Appareil selon la revendication 20, comprenant en outre un premier moyen de serrage (301) pour empêcher la rotation du disque dans la conduite et un second moyen de serrage (300) pour empêcher le mouvement en aval dudit disque à l'intérieur de ladite conduite.
22. Appareil selon la revendication 1, dans lequel ledit moyen de support comprend en outre, à l'extrémité d'entrée du fluide, une face concave (23) qui agit pour diriger un courant de fluide entrant vers une ouverture centrale (25) et, à travers celle-ci, dans un tube venturi (11), qui est en partie solidaire dudit corps de support de venturi et constitue en partie un tube séparé maintenu en application étroite contre une surface d'ajustement sur ledit corps de support de venturi, dans lequel ledit tube venturi séparé comprend en outre un ou plusieurs directeurs d'écoulement qui provoquent la formation d'un tourbillon dans une partie dudit courant de fluide qui est dévié à travers une série d'ouvertures (27) entourant ladite ouverture centrale (25) en fonction de l'augmentation de la contrepression à l'intérieur dudit tube venturi, et dans lequel le diamètre du tube de sortie de courant de fluide est supérieur au diamètre du tube d'entrée de courant de fluide sur une distance qui n'est pas inférieure à environ 2 à environ 3 diamètres du tube de sortie en partant de la sortie du tube venturi.
23. Appareil selon la revendication 1, dans lequel ledit moyen de support comprend :

une entrée de courant de fluide ayant un diamètre approximativement égal au diamètre du tube d'entrée d'amenée de fluide, ledit corps de support du venturi étant raccordé de manière amovible et étanche audit tube d'entrée d'amenée de fluide;

une face concave (23) qui fait face au courant de fluide, contenant une ouverture centrale (25), ladite ouverture centrale ayant un diamètre d'environ 2,54 mm (0,100 pouce) inférieur au diamètre d'entrée d'un venturi solidaire (11) auquel mène ladite ouverture centrale; et ayant des ouvertures radiales (27) qui permettent audit courant de fluide de passer à travers ledit corps de support de venturi;

dans lequel ledit corps de support de venturi est raccordé de manière amovible et étanche à une conduite, ladite conduite ayant un diamètre qui est supérieur au diamètre de ladite entrée de courant de fluide;

dans lequel ledit corps de support de venturi supporte de manière amovible un tube venturi, ledit tube venturi comprenant des directeurs d'écoulement (605) faisant un angle avec la direction de la partie du courant de fluide qui s'écoule à travers lesdites ouvertures radiales; et

dans lequel ledit corps de support de venturi comprend en outre un moyen d'ajustement (12) comprenant un disque (30) pressé contre lesdites ouvertures radiales par un ressort hélicoïdal (70), ledit ressort hélicoïdal pressant également ledit tube venturi contre un épaulement sur ladite conduite.

**24.** Appareil selon la revendication 1,

dans lequel ledit moyen de support (10) comprend une plaque positionnée dans ladite conduite en relation d'étanchéité avec elle, ledit moyen de régulation de débit de fluide comprenant :

un premier moyen de passage à travers ladite plaque pour permettre audit premier courant de s'écouler; et

un second moyen de passage à travers ladite plaque pour permettre audit second courant de s'écouler;

un moyen d'ajustement (12) pour ajuster le débit du second courant;

un moyen d'étranglement pour réduire la pression à la sortie du tube venturi en étranglant l'écoulement du second courant au voisinage de ladite sortie du tube venturi;

dans lequel ledit moyen d'étranglement comprend un déflecteur d'écoulement (15) de forme conique raccordé à ladite sortie du tube venturi.

**25.** Appareil selon la revendication 1,

dans lequel ledit moyen de support (10) comprend une plaque positionnée à l'intérieur de ladite conduite en relation d'étanchéité avec elle, ledit moyen de régulation de débit de fluide comprenant :

un premier moyen de passage à travers ladite plaque pour permettre audit premier courant de s'écouler; et

un second moyen de passage à travers ladite plaque pour permettre audit second courant de s'écouler;

un moyen d'ajustement pour ajuster le débit du second courant;

dans lequel ledit second moyen de passage comprend au moins une ouverture à travers ladite plaque et ledit moyen d'ajustement comprend :

une seconde plaque, pouvant tourner par rapport à ladite première plaque, ladite seconde plaque ayant au moins une ouverture qui peut s'aligner axialement avec la au moins une ouverture de ladite première plaque; et

un moyen pour faire tourner ladite seconde plaque de manière à faire varier le degré d'alignement axial de la au moins une ouverture de ladite seconde plaque avec la au moins une ouverture de la première plaque.

**26.** Appareil selon la revendication 25, dans lequel ledit moyen d'ajustement comprend en outre un moyen de régulation (100), sensible aux fluctuations du débit de fluide, pour réguler l'écoulement à travers la au moins une ouverture de ladite seconde plaque, en permettant à l'écoulement à travers ladite au moins une ouverture d'augmenter lorsque le débit du courant de fluide augmente et de diminuer lorsque le débit du courant de fluide diminue.

**27.** Appareil selon la revendication 26, dans lequel ledit moyen de régulation comprend un moyen de blocage pour bloquer la au moins une ouverture de ladite seconde plaque; un moyen élastique (70) pour presser ledit moyen de blocage vers la au moins une ouverture de ladite seconde plaque.

**28.** Appareil selon la revendication 27, dans lequel ledit moyen de support comprend en outre un tube (26) s'étendant axialement en aval de ladite première plaque; ledit tube venturi étant supporté axialement par ledit tube, ledit tube formant un canal dudit premier moyen de passage à ladite entrée du venturi; dans lequel ladite seconde plaque (20) est tourillonnée sur ledit tube; et dans lequel ledit moyen de blocage comprend un anneau de blocage (20) monté sur ledit tube entre ladite seconde plaque et ledit tube venturi pour un déplacement coulissant axial sur ledit tube vers ladite seconde plaque et en sens

inverse.

**29.** Appareil selon la revendication 27, dans lequel ledit moyen de support comprend en outre un tube (26) s'étendant axialement en aval de ladite première plaque, ledit tube venturi étant supporté axialement par ledit tube, ledit tube formant un canal entre ledit premier moyen de passage et ladite entrée du venturi; dans lequel ladite seconde plaque est tourbillonnée sur ledit tube; et dans lequel ledit moyen de blocage comprend un certain nombre d'éléments de blocage (220) égal au nombre d'ouvertures de ladite seconde plaque, chaque élément de blocage étant calibré et conformé pour bloquer une ouverture, chaque dit élément de blocage étant supporté par un rayon (215) s'étendant radialement d'un moyeu (210), et un moyen (70) pour monter ledit moyeu dans ledit tube de manière à permettre un déplacement axial dudit moyeu, mais à empêcher la rotation dudit moyeu par rapport à ladite seconde plaque.

**30.** Appareil selon la revendication 1, dans lequel ledit moyen de support (10) comprend une plaque positionnée dans ladite conduite en relation d'étanchéité avec elle, ledit moyen de régulation de débit comprenant :

un premier moyen de passage à travers ladite plaque pour permettre audit premier courant de s'écouler; et

un second moyen de passage à travers ladite plaque pour permettre audit second courant de s'écouler;

un moyen d'ajustement (12) pour ajuster le débit du second courant; ledit moyen d'ajustement comprenant un moyen de régulation (100), sensible aux fluctuations du débit de fluide, pour réguler l'écoulement à travers ledit second moyen de passage, en permettant à l'écoulement à travers ledit second moyen de passage d'augmenter lorsque le débit du courant de fluide augmente et de diminuer lorsque le débit du courant de fluide diminue;

dans lequel ledit moyen de régulation (200) comprend un moyen de blocage pour bloquer ledit second moyen de passage;

un moyen élastique (70) pour presser ledit moyen de blocage vers ledit second moyen de passage;

dans lequel ledit moyen de support comprend en outre un tube s'étendant axialement en aval de ladite première plaque, ledit tube venturi étant supporté axialement par ledit tube, ledit tube formant un canal dudit premier moyen de passage à ladite entrée du venturi; et dans lequel ledit moyen de blocage comprend un anneau de blocage (60) monté

sur ledit tube entre ladite plaque et ledit tube venturi pour un déplacement coulissant axial sur ledit tube vers ladite plaque et en sens inverse.

**31.** Appareil selon la revendication 1, dans lequel ledit moyen de support (10) comprend une plaque disposée dans ladite conduite en relation d'étanchéité avec elle, ledit moyen de régulation de débit de fluide comprenant :

un premier moyen de passage à travers ladite plaque pour permettre audit premier courant de s'écouler; et

un second moyen de passage à travers ladite plaque pour permettre audit second courant de s'écouler;

un moyen d'ajustement (12) pour ajuster le débit du second courant; ledit moyen d'ajustement comprenant un moyen de régulation (100), sensible aux fluctuations du débit de fluide, pour réguler l'écoulement à travers ledit second moyen de passage, en permettant à l'écoulement à travers le second moyen de passage d'augmenter lorsque le débit du courant de fluide augmente et de diminuer lorsque le débit du courant de fluide diminue;

dans lequel ledit moyen de régulation (200) comprend un moyen de blocage pour bloquer ledit second moyen de passage;

un moyen élastique (70) pour presser ledit moyen de blocage vers ledit second moyen de passage;

dans lequel ledit second moyen de passage comprend au moins une ouverture à travers ladite plaque; ledit moyen de support comprenant en outre un tube s'étendant axialement en aval de ladite première plaque, ledit tube venturi étant supporté axialement par ledit tube, ledit tube formant un canal dudit premier moyen de passage à ladite entrée du venturi; et dans lequel ledit moyen de blocage comprend un certain nombre d'éléments de blocage (220) égal au nombre d'ouvertures dudit second moyen de passage, chaque élément de blocage étant calibré et conformé pour bloquer une ouverture, chaque dit élément de blocage étant supporté par un rayon (215) s'étendant radialement d'un moyeu (210), ledit moyeu étant monté sur ledit tube entre ladite plaque et ledit tube venturi pour un mouvement coulissant axial sur ledit tube vers ladite plaque et en sens inverse.

**32.** Appareil selon la revendication 2, dans lequel ledit moyen de support comprend une plaque disposée à l'intérieur de ladite conduite en relation d'étanchéité avec elle, ledit moyen de régulation de débit de fluide comprenant :

un premier moyen de passage à travers ladite plaque pour permettre audit premier courant de s'écouler; et  
 un second moyen de passage à travers ladite plaque pour permettre audit second courant de s'écouler. 5

**33.** Appareil selon la revendication 32, comprenant en outre un moyen d'ajustement pour ajuster le débit du second courant. 10

**34.** Appareil selon la revendication 33, comprenant en outre un moyen d'étranglement pour réduire la pression à la sortie du tube venturi en étranglant l'écoulement du second courant au voisinage de ladite sortie du tube venturi. 15

**35.** Appareil selon la revendication 33 ou 34, dans lequel ledit second moyen de passage comprend au moins une ouverture à travers ladite plaque et ledit moyen d'ajustement comprend un moyen pour faire varier la surface en coupe transversale de ladite au moins une ouverture en bloquant de manière réglable ladite au moins une ouverture. 20  
25

**36.** Appareil selon la revendication 33, dans lequel ledit moyen d'ajustement comprend un moyen de régulation, sensible aux fluctuations du débit de fluide, pour réguler l'écoulement à travers ledit second moyen de passage, en permettant à l'écoulement à travers ledit second moyen de passage d'augmenter lorsque le débit du courant de fluide augmente et de diminuer lorsque le débit du courant de fluide diminue. 30  
35

**37.** Appareil selon la revendication 36, dans lequel ledit moyen de régulation comprend :

un moyen de blocage pour bloquer ledit second moyen de passage; et 40  
 un moyen élastique (70) pour presser ledit moyen de blocage vers ledit second moyen de passage. 45

50

55

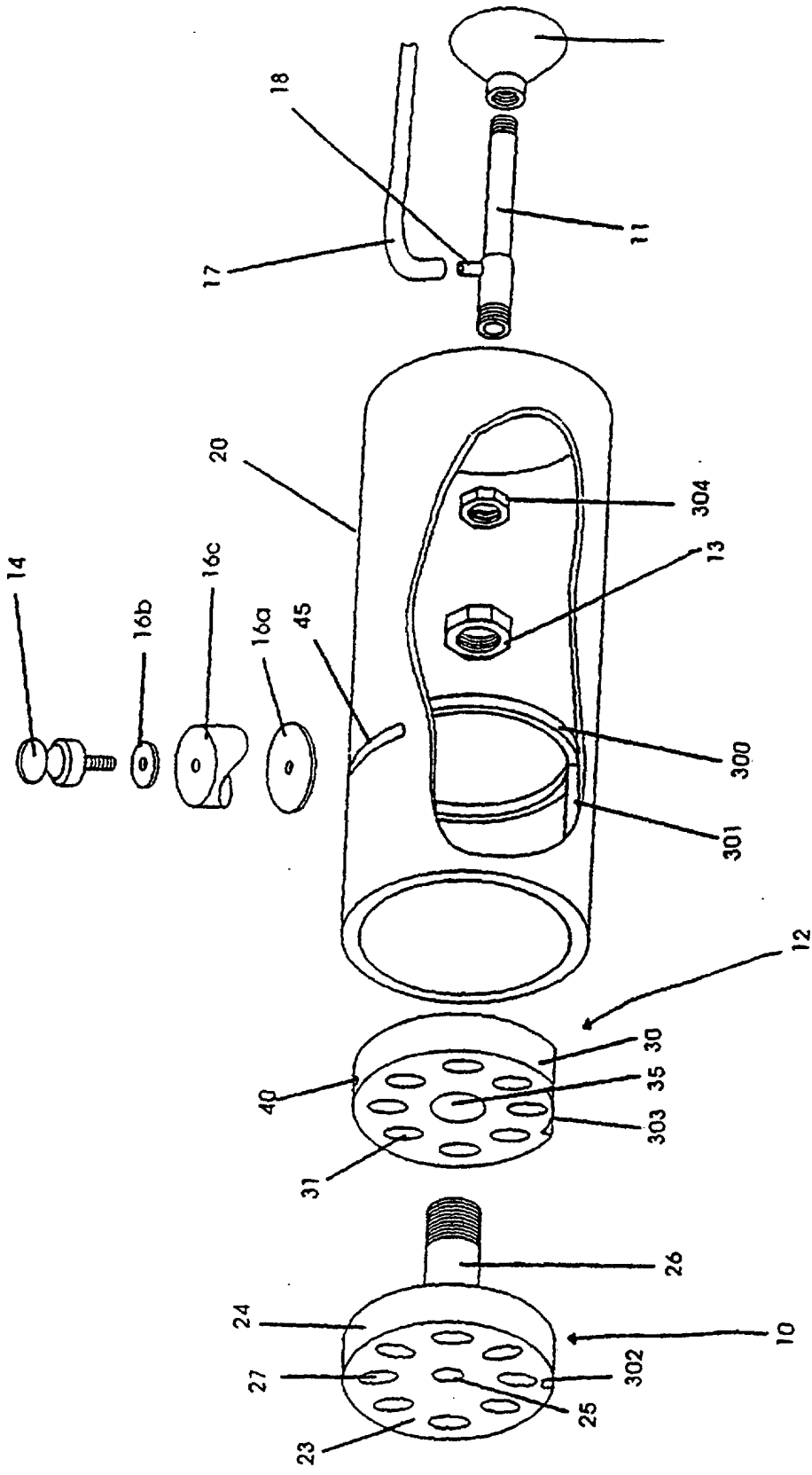
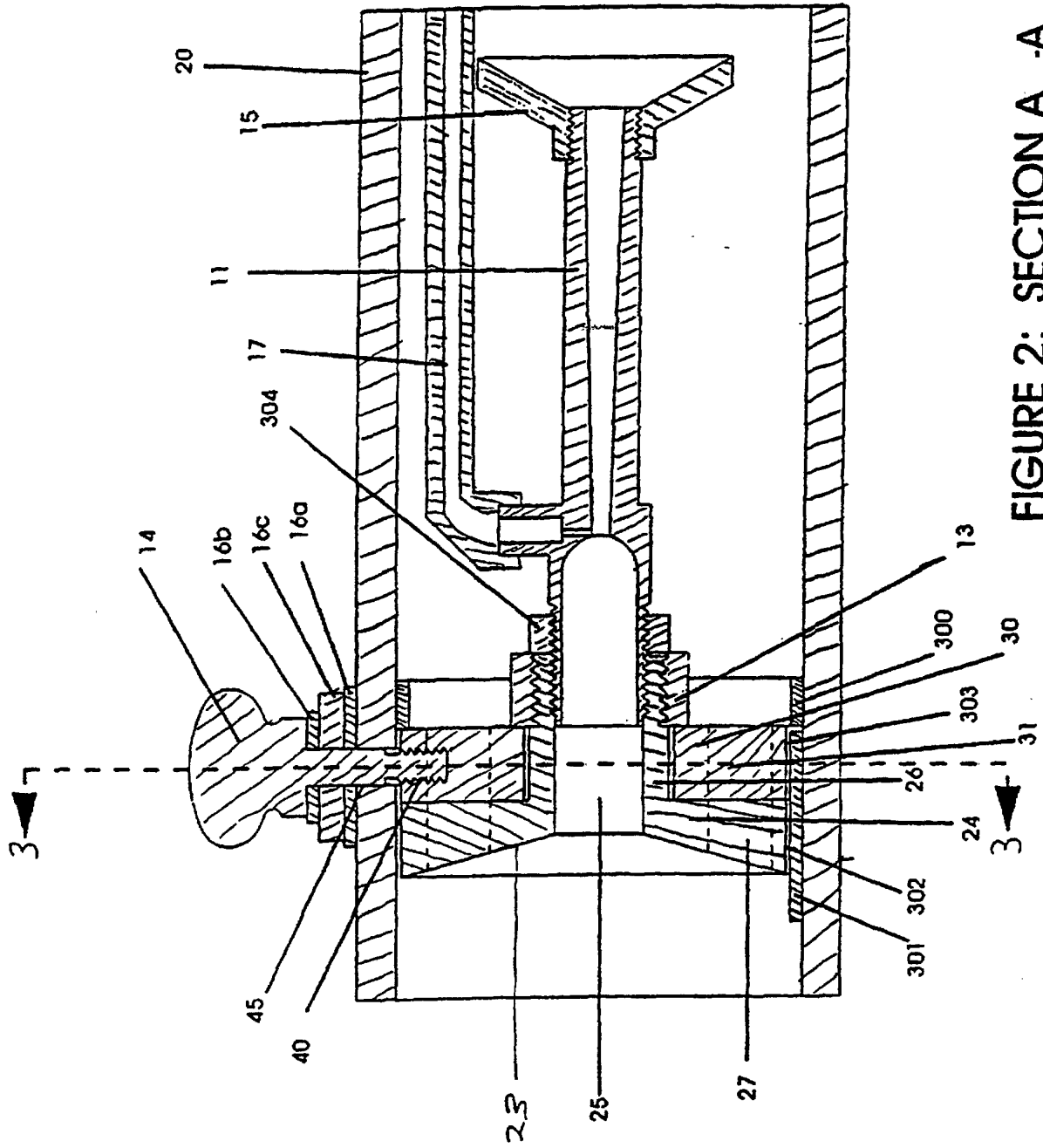
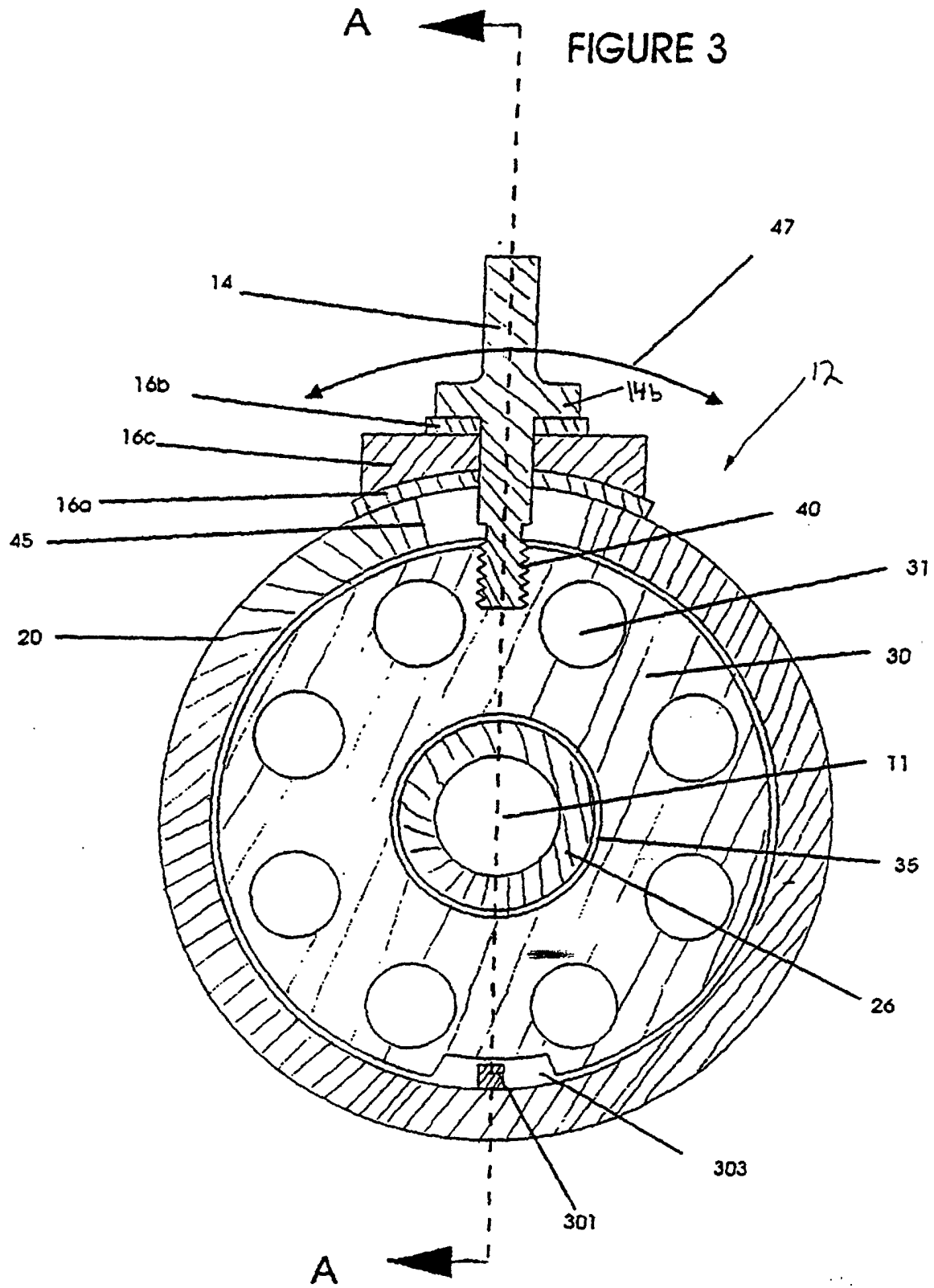


FIGURE 7







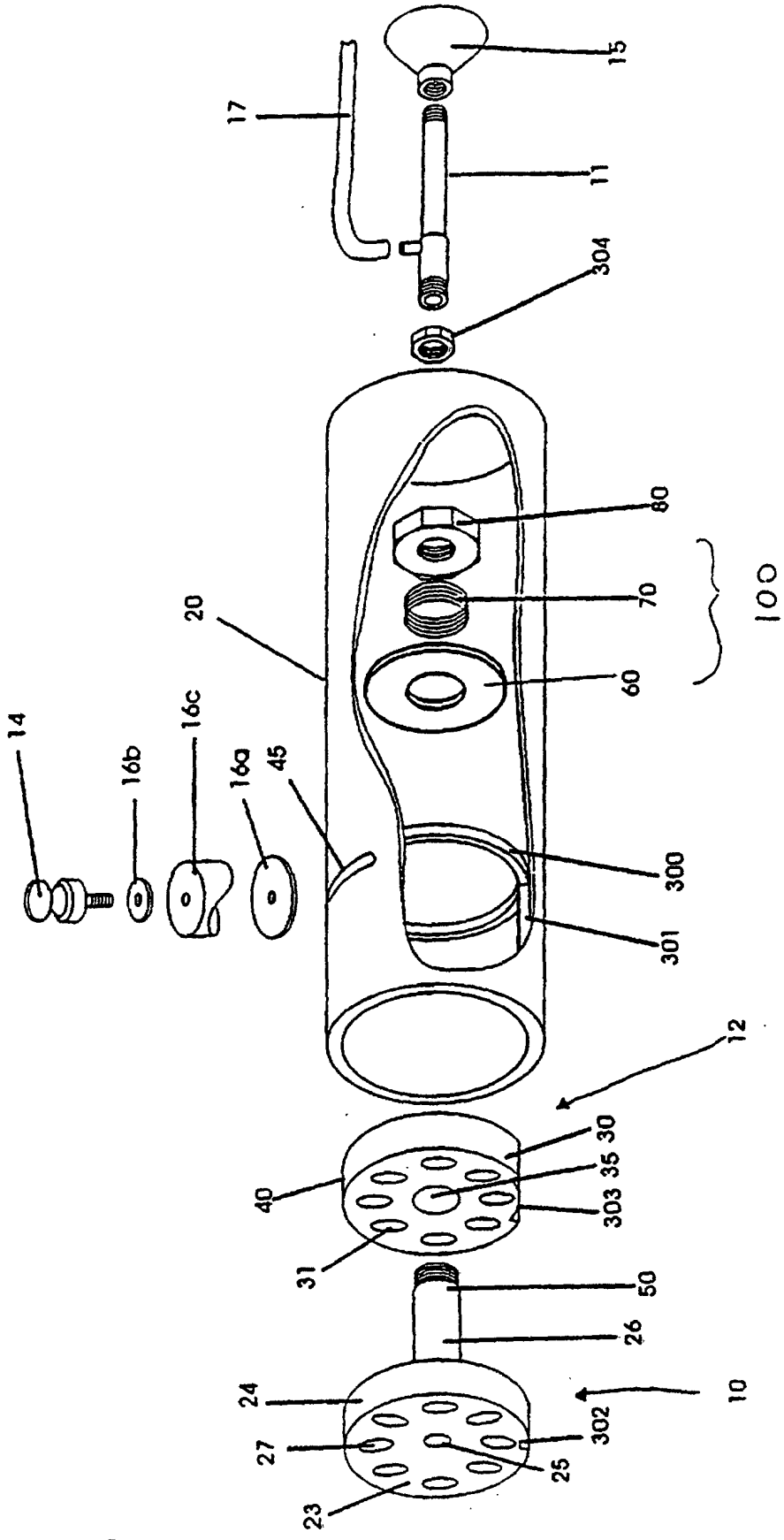
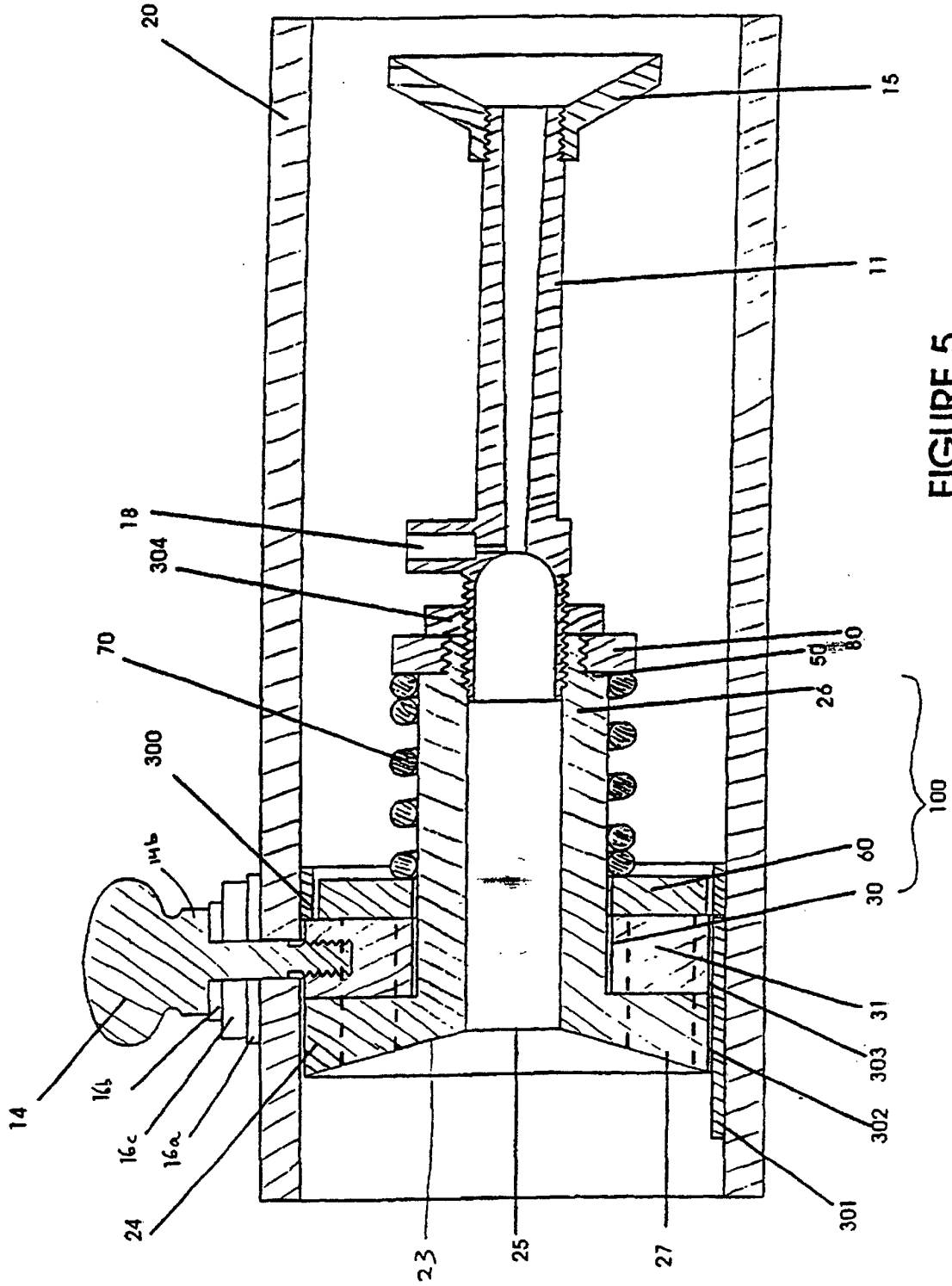


FIGURE 4



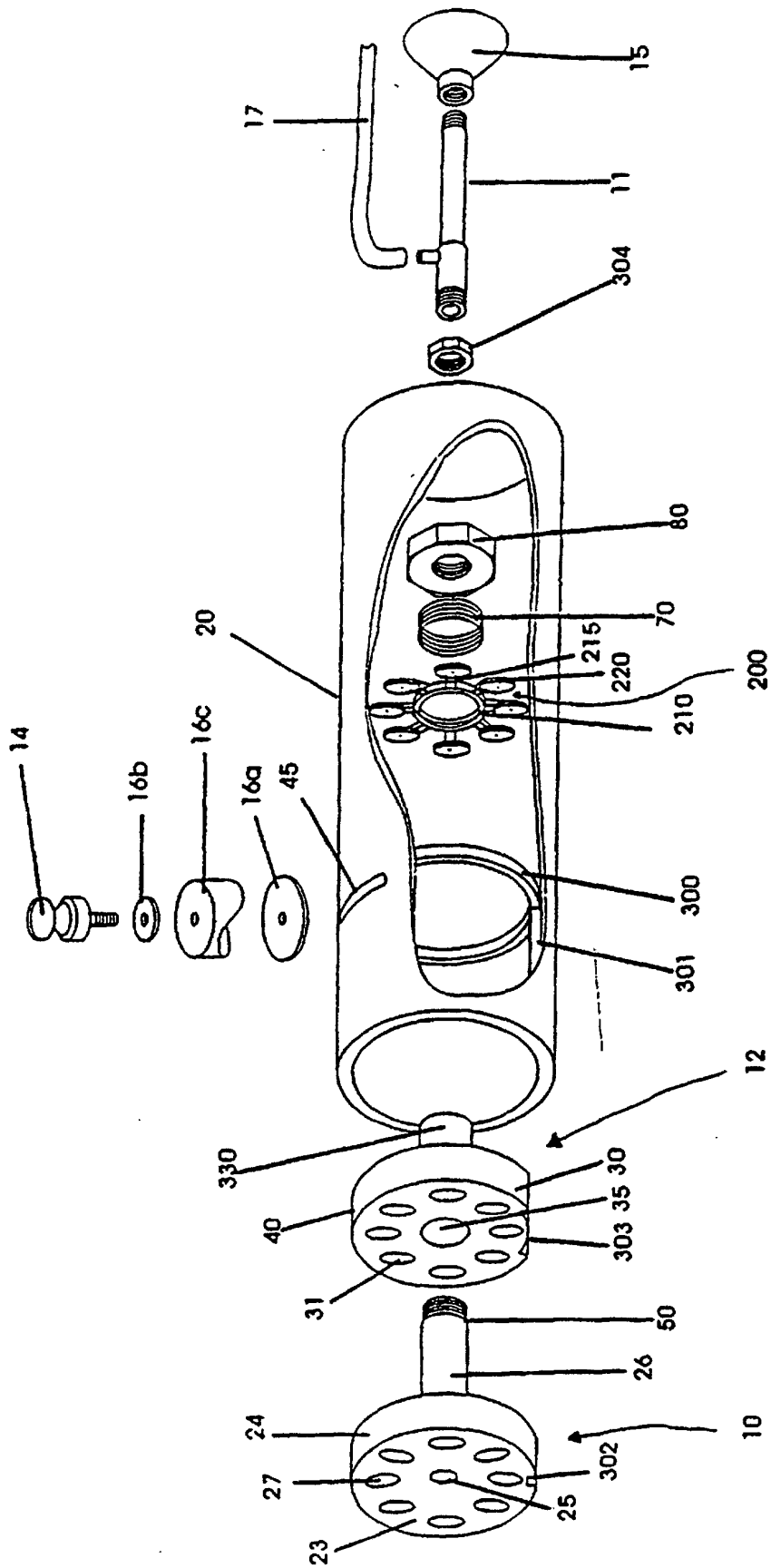


FIGURE 6

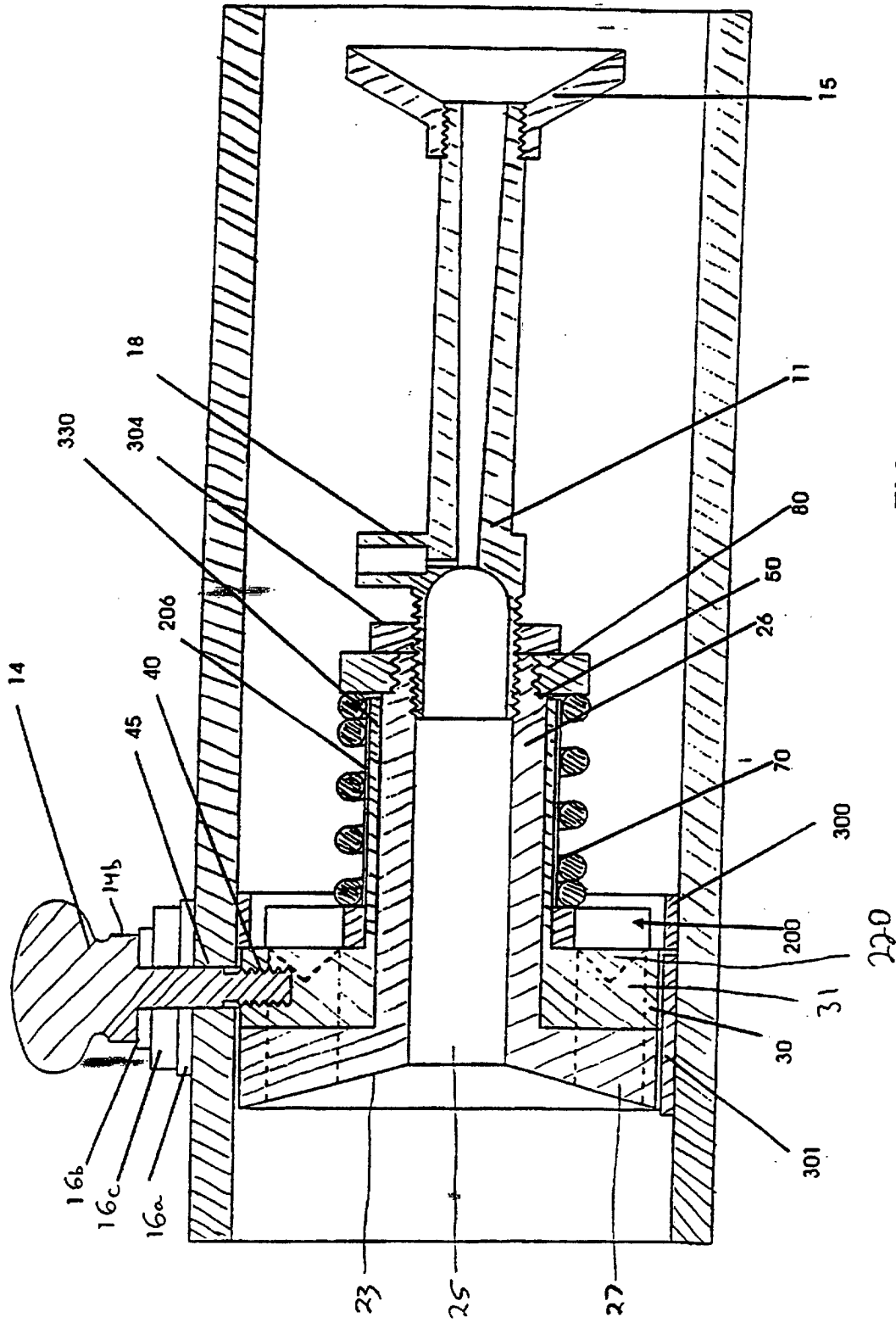
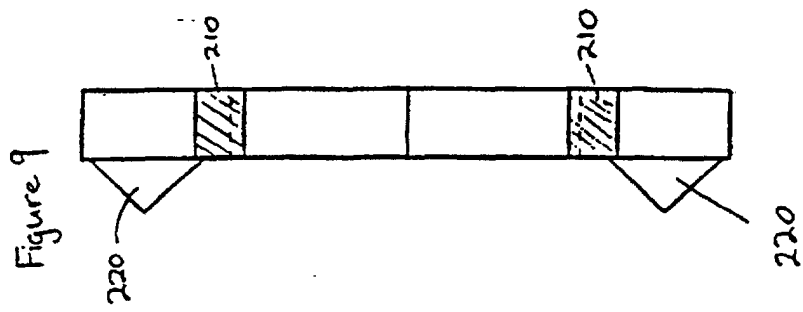
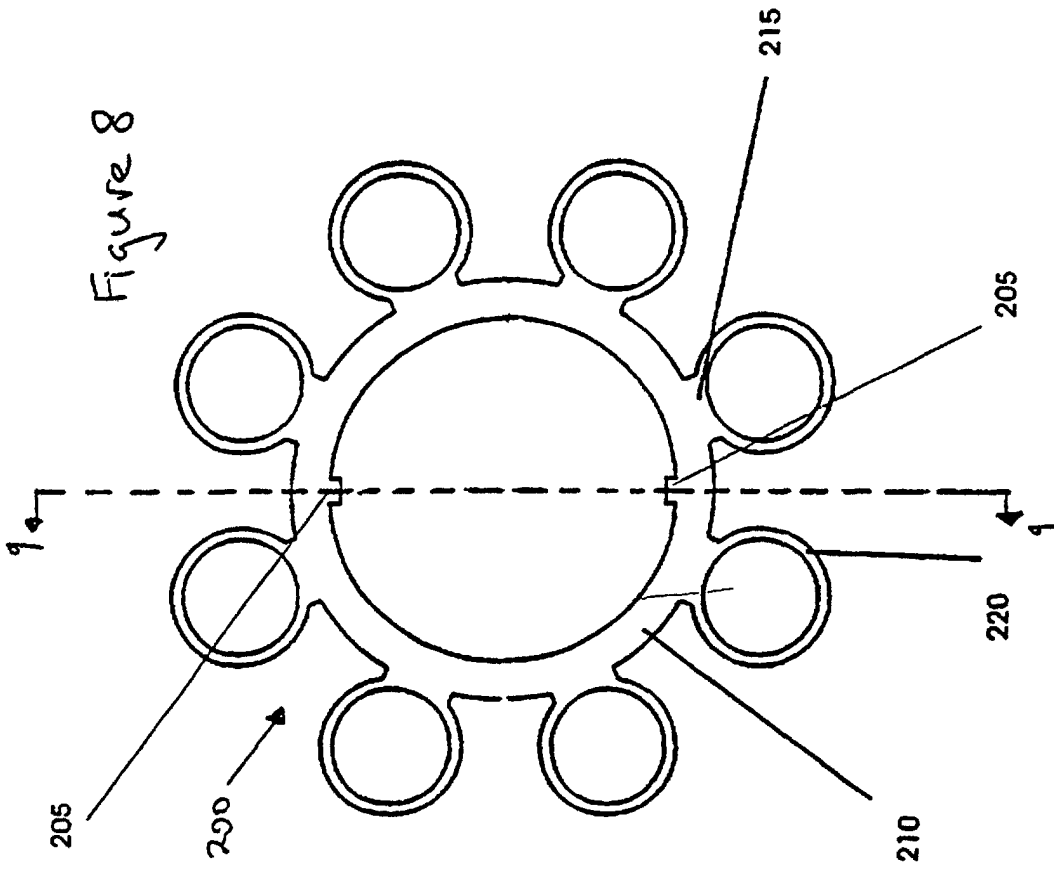


FIGURE 7



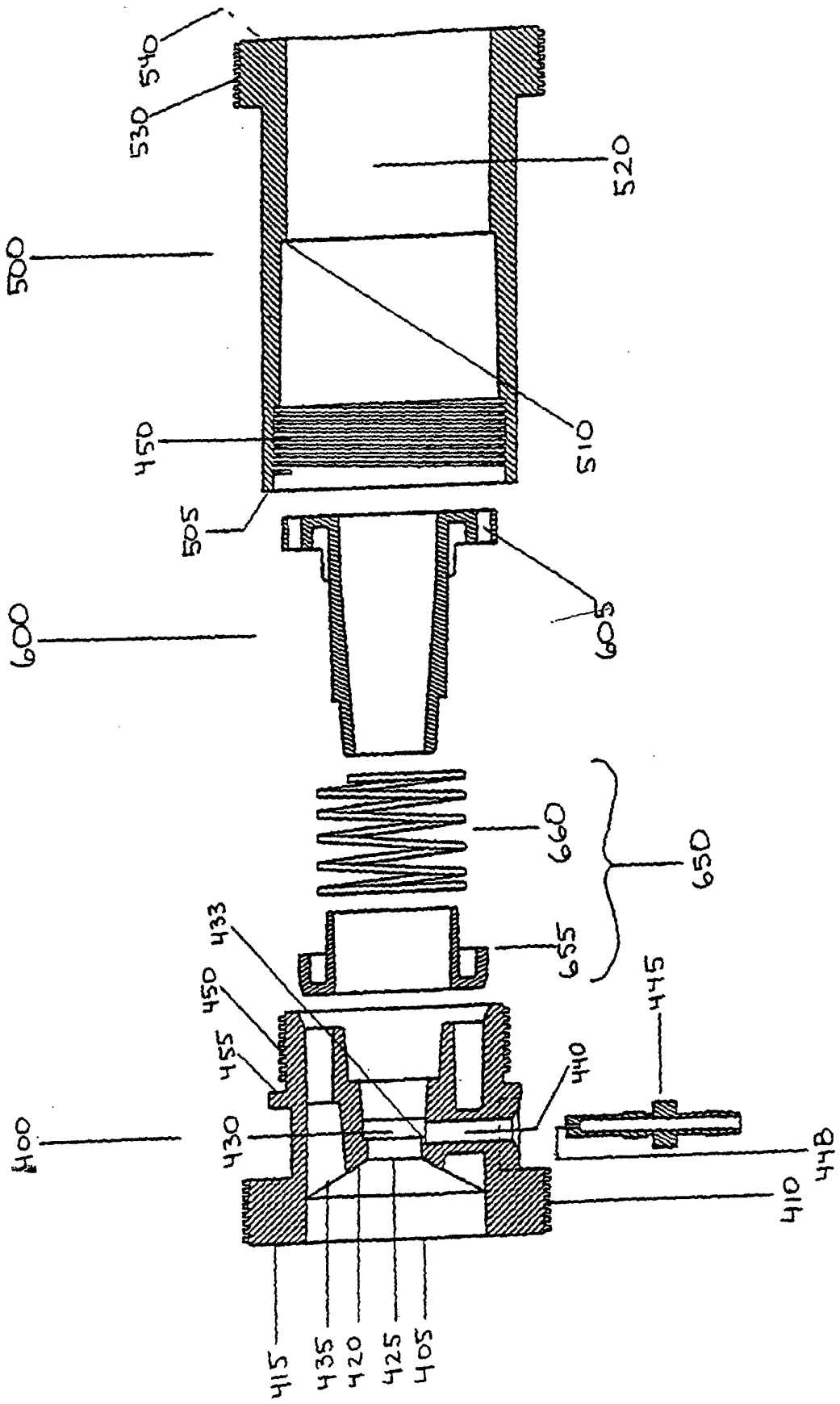


FIGURE 10

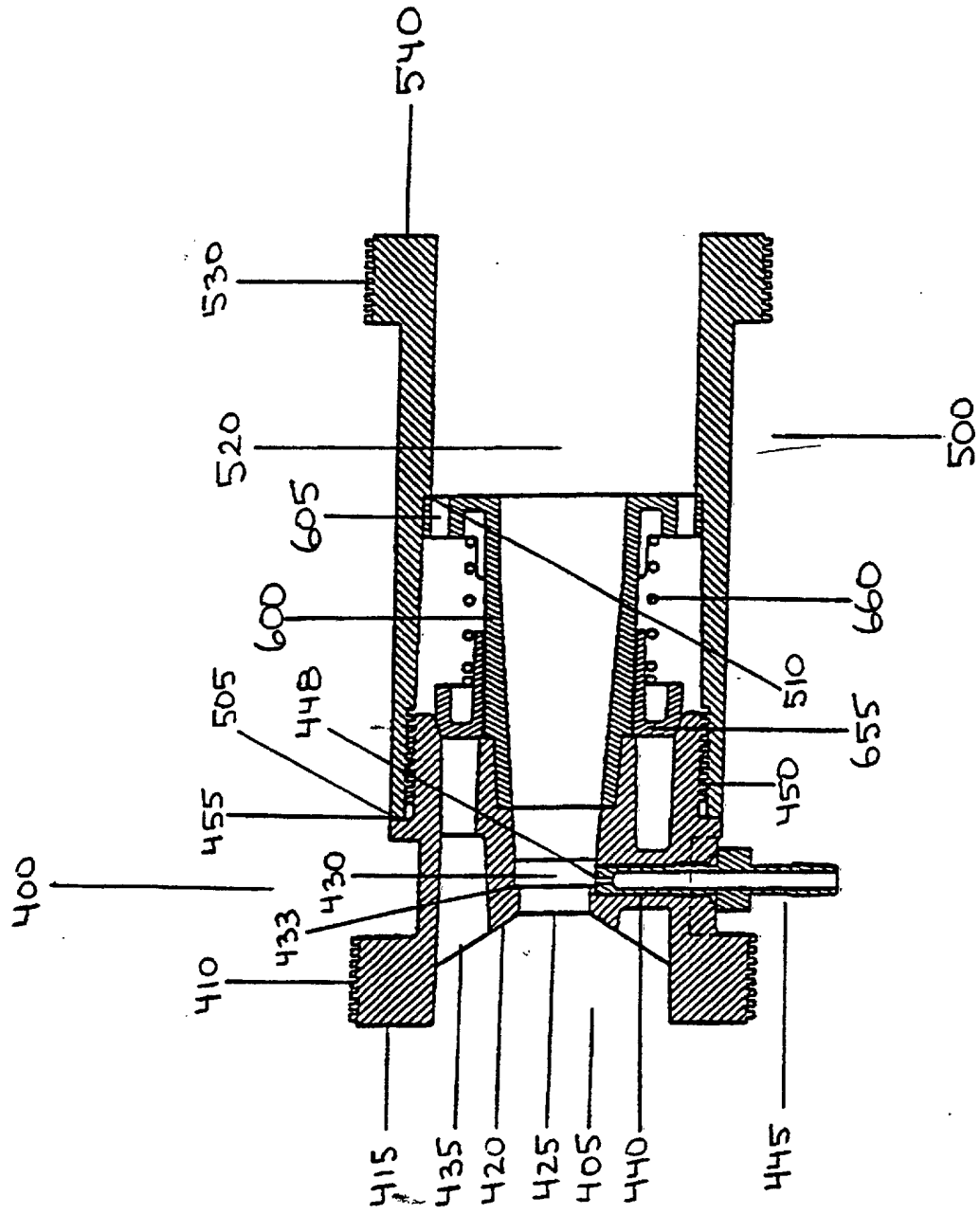


FIGURE 11

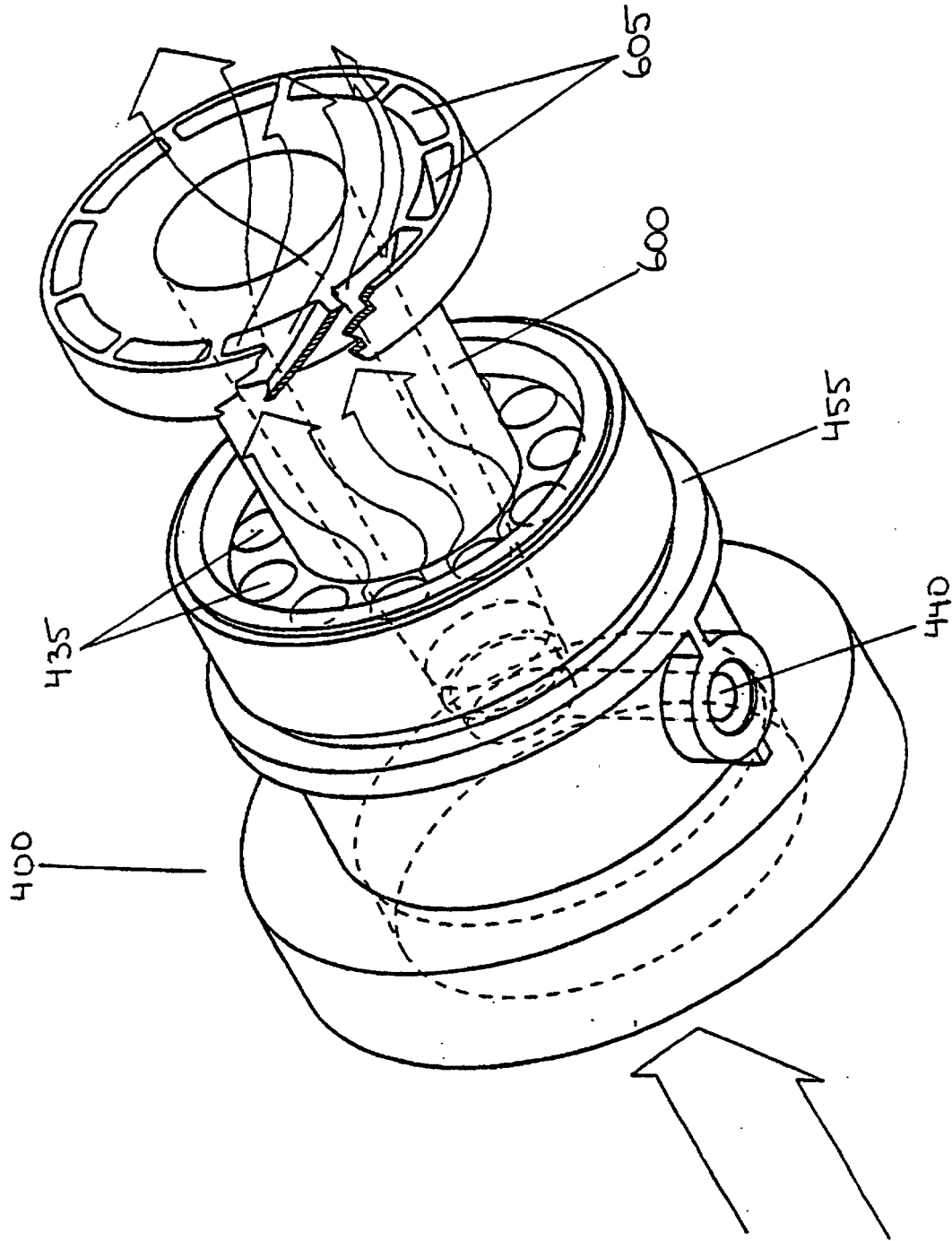


FIGURE 12