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(54) Benævnelse: **Ultralydsmåler**

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Description

The present invention relates to an ultrasonic meter for detecting the through flow rate of a fluid, for example, water, in particular a so-called ultrasonic bulk water meter. Ultrasonic bulk water meters are water meters having nominal widths from 50 mm.

An ultrasonic flow sensor having a waveguide in the flow pipe is described in DE 10 2009 045 620 A1, wherein the waveguide is designed so that ultrasonic waves are conducted from a first ultrasonic transducer by way of single or multiple reflection on the walls of the waveguide to a second ultrasonic transducer. In this case, the waveguide is designed to have the fluid medium flow through it.

An ultrasonic measuring device insertable into a flow pipe having ultrasonic transducers arranged inclined in relation to one another and a reflection surface arranged on the opposing wall is described in DE 10 2004 060 063 A1 und DE 10 2004 060 065 A10, which comprises a V-shaped ultrasound measurement path.

EP 1 693 652 A2 discloses an ultrasonic through flow meter, which comprises a measurement channel insert arranged in the through-flow measurement channel and a holding plate, on which the reflectors are arranged.

An ultrasonic through flow meter is known from JP 3 557735 B2, which comprises a flow channel and a bypass channel arranged thereon, in which an ultrasonic measurement path is provided. The bypass channel receives a flow fraction of the total flow of the flow channel. A flow resistance element is provided in the flow channel, which generates a pressure drop in the flow channel to introduce a fraction of the total flow into the bypass channel.

Object of the Present Invention

The object of the present invention is to provide a novel ultrasonic meter, which in particular ensures improved metrological properties even as an ultrasonic bulk water meter by means of a cost-effective design.

Achievement of the Object

The present object is achieved by a through flow meter according to Claim 1, which comprises a preferably tubular housing, which has a flow channel, and an ultrasound measurement path, arranged within the flow channel, with a measurement channel for detecting the through flow rate of the fluid,

wherein the ultrasound measurement path is provided in a bypass channel which is arranged within the flow channel and which receives a flow fraction of the total flow of the flow channel, and

wherein the flow fraction serves as a representative fraction for the detection of the through flow rate, wherein

means for generating a pressure drop in the form of a nozzle arranged in the flow channel or of a screen arranged in the flow channel are provided in the region of the bypass channel, albeit outside the latter, such that an introduction of the flow fraction of the total flow into the bypass channel is realized due to a pressure drop,

a measurement insert is provided as a subassembly which comprises the measurement channel, a measurement channel holder, and the deflecting mirrors,

the measurement insert is situated in a bypass holder, and the bypass holder is able to be introduced together with the measurement insert and with the means for generating a pressure drop into the flow channel in the longitudinal

direction with respect to the housing.

Because of the integration of the bypass channel with its ultrasound measurement path into the flow channel of the housing, the design of the ultrasonic meter becomes simpler, more cost-effective, and more easily scalable. In particular, a measurement insert constructed from measurement tube, measurement tube holder, and reflectors as a subassembly of ultrasonic meters having nominal width less than 50 mm can thus also be used for ultrasonic meters having a nominal width of greater than 50 mm (and of course for ultrasonic meters having different nominal widths), whereby the total costs can be significantly reduced.

Because according to the invention means for generating a pressure drop are provided in the region of the bypass channel, a part of the total flow is branched into the bypass channel in a simple manner, i.e., guided thereto. In this way, irregularities and/or disturbed flows of the total flow are not also taken into the bypass channel, with the result that significantly better metrological properties with respect to the overload stability and the insensitivity can be achieved than is the case with disturbed flows.

The ultrasound measurement path is formed U-shaped. The ultrasonic signal then assumes a U-shaped profile between the two ultrasonic transducers.

The measurement insert is advantageously conceived as a subassembly which comprises the measurement channel, a measurement channel holder, and the deflecting mirrors. The measurement channel holder can be provided for this purpose simultaneously as a holder for the deflection mirrors. The subassembly can expediently be used as a standardized subassembly for ultrasonic meters of different nominal widths. Only the relevant means for generating a pressure drop have to be kept in stock matching with the nominal width. The measurement insert itself, in contrast, can be used in

standardized form.

A preferably ring-shaped nozzle, preferably a so-called Venturi nozzle, is provided as the means for generating the pressure drop. In the ideal case, it generates a pressure drop proportional to the square of the through flow by constricting the flow.

Alternatively, a screen, for example, a central screen, for generating a ring-shaped or ring-segment-shaped through flow can be provided as the means for generating a pressure drop. An introduction of a part of the total flow into the bypass channel also thus takes place because of the pressure drop. The central screen has the advantage of an enhanced measurement effect above all in the laminar flow region, since a greater fraction is conducted into the bypass channel because of the significantly greater dynamic pressure in the center of the flow.

The surface structuring of the means for generating a pressure drop, in particular in the form of recesses, ensure, above all in the case of small through flows and thus with actually laminar flow conditions, an eddy-induced stabilization of the Reynolds number and, accompanying this, a stabilization and/or linearization of the pressure drop. A more favorable meter characteristic curve having less necessity for correction results therefrom.

Channels and/or notches can advantageously be provided for this purpose. This surface structuring which induces flow turbulence is expediently provided on the incident-flow surface and/or on the incident-flow edge and/or also along the passage channel of the means for generating a pressure drop. Because the bypass channel, as viewed in the cross section of the flow channel, is arranged off center, i.e., eccentrically with respect to the midline of the flow channel, preferably in the immediate vicinity of the wall of the housing, a particularly short distance can be maintained between the

ultrasonic transducers and the deflection mirrors. A good signal quality and thus a good measurement accuracy result therefrom.

At least the end side of the bypass channel, i.e., its front end, is expediently closed on the inflow side, so that the fluid cannot flow into the bypass channel in the longitudinal direction thereof. A cap or the like can expediently be provided for this purpose. In this way, "disturbed flows" derived from the main flow are prevented from reaching the bypass channel directly, i.e., unchanged, but rather have to pass through a path provided for the entry by the design, in which the flow to be branched off is stabilized and/or mixed.

The branched-off flow fraction expediently flows into the bypass channel at an angle to the longitudinal direction of the management channel, for example, at a right angle or an oblique angle or even an angle of greater than 90° (viewed from the outflow direction of the bypass channel).

Flow-conducting means provided at the inflow or in the region of the inflow of the bypass channel also serve to stabilize and/or mix the branched-off flow fraction and thus supply it in a stabilized and/or well-mixed manner to the measurement channel or the measurement path.

Description of the Invention on the Basis of Exemplary Embodiments

Different embodiments of the present inventions are explained in greater detail hereafter on the basis of exemplary embodiments. Repeating features are only provided with a reference sign once for the sake of comprehensibility. In the figures:

Figure 1 shows a longitudinal sectional illustration in a perspective view through a possible embodiment of the ultrasonic meter according to the invention;

Figure 2 shows a longitudinal sectional illustration in perspective view through a bypass channel and through the means for generating a pressure drop according to a further embodiment;

Figure 3 shows a longitudinal sectional illustration in perspective view through a bypass channel and through the means for generating a pressure drop according to a further embodiment;

Figure 4 shows a perspective view of a further embodiment of the means for generating a pressure drop in conjunction with a bypass channel according to the present invention;

Figure 5 shows a perspective view of a further embodiment of means for generating a pressure drop in conjunction with a bypass channel according to the present invention;

Figure 6 shows a perspective view of a further embodiment of means for generating a pressure drop in conjunction with a bypass channel according to the present invention;

Figure 7 shows different, greatly simplified illustrations of flow conditions in comparison, and

Figure 8 shows a graphic comparison of the profile of the Reynolds number over the through flow, specifically in non-linearized form (curve A) on the one hand and in linearized form (curve B), on the other hand.

Reference sign 1 in Figure 1 shows an expedient embodiment of an ultrasonic meter according to the invention in its entirety. It comprises a preferably tubular housing 2, which has a linear flow channel 23 and can be connected via flanges 3a, 3b to a fluid line (not shown). The housing 2 represents a so-called single-pipe connection housing in this case.

Two ultrasonic transducers 8a and 8b, which are positioned in associated boreholes in the wall of the housing 2, are located on the upper side of the housing 2. The two ultrasonic transducers 8a and 8b are connected to an analysis unit (not shown in Figure 1).

The ultrasonic meter illustrated in Figure 1 is expediently a so-called ultrasonic bulk water meter having a flow channel nominal width of at least 50 mm. Such ultrasonic bulk water meters can have nominal widths of the flow channel 23 of up to 250 mm or more.

According to the invention, a bypass channel having a measurement insert 7 is located inside the flow channel 23 of the housing 2, preferably arranged eccentrically with respect to the midline of the flow channel 23, in the region of the two ultrasonic transducers 8a and 8b. The bypass channel is used to receive a flow fraction of the total flow flowing through the flow channel 23. This flow fraction is used as a representative fraction to be measured for detecting the total through flow quantity.

Means 4 for generating a pressure drop are expediently provided in the region of the bypass channel. They cause a dynamic pressure and ensure that a part of the total flow is conducted to the bypass channel and through it. The means for generating a pressure drop are, for example, a nozzle 4, in particular in the form of a so-called Venturi nozzle. The Venturi nozzle generates a pressure drop by constricting the flow in the flow channel 23, whereby a part of the total flow is conducted into the bypass channel and then reaches the outflow 19.

The measurement insert 7 shown in Figure 1 ensures a U-shaped measurement path and comprises a measurement tube 10, a measurement tube holder 6, and two deflection mirrors 9a and 9b, which are arranged inclined. The measurement insert 7 is conceived as a subassembly consisting of the above-mentioned

parts and can thus also be used for other nominal widths. The measurement insert 7 is enclosed by a tubular bypass holder 18, for example, in the form of a plastic tube. The arrangement consisting of the nozzle 4, the bypass holder 18, and the measurement insert 7 can be inserted in a simple manner via the frontal opening of the housing 2 and fixed in relation to the housing 2 by means of a pin 5 extending through a common passage opening 24.

Figure 2 shows a further possible embodiment of the bypass channel 7 and the means for generating a pressure drop for use in the ultrasonic meter according to the invention. The measurement insert 7 comprises the measurement channel 10 in the form of a measurement tube, which is enclosed by the measurement tube holder 6. The measurement tube holder 6 is preferably designed in the form of two longitudinally divided halves, which enclose not only the measurement tube 10 but rather also the two deflection mirrors 9a and 9b in the assembled state and thus fix them in the position thereof. The measurement insert 7 is located in the preferably tubular bypass holder 18, which has an externally flattened sound transmission region 14a and 14b having a reduced material thickness in the zones located respectively above the deflection mirrors 9a and 9b.

In the sound transmission regions 14a and 14b, the ultrasonic transducers 8a, 8b transmit sound through the bypass holder 18 in the direction of the deflection mirrors 9a and 9b located in the interior. The curved surface provided there on the inner side of the bypass holder 18 acts as a focusing lens and focuses the sound field reflected from the respective deflection mirror 9a and 9b effectively onto the respective receiving ultrasonic transducers 8a or 8b, respectively, whereby the resulting reception voltage is greater than in a tube of constant wall thickness (if the tube material has a greater acoustic impedance than the surrounding medium).

The bypass holder 18 consists of material through which sound

can be transmitted, preferably of plastic. An end piece 12 in the form of a cap is located in the region of the inflow of the bypass channel, which closes the end side of the bypass holder in its extension and which has an opening 28 in the side facing toward the center axis of the ultrasonic meter, in which a flow former 13 is located. The flow former 13 is also provided as a plastic insert part and comprises multiple flow channels 30 separate from one another.

The nozzle 4 comprises an incident-flow surface 26, an incident-flow edge 27, a passage region 29, and a section 17 tapering toward the outflow. Due to the pressure drop caused by the nozzle 4, a part of the total flow is introduced through the channels 30 of the flow former 13 at an angle of somewhat more than 90° to the longitudinal axis of the measurement channel 10. This partial flow can be precisely measured using a proven ultrasonic measurement method and standard components provided for this purpose. The design has the effect that independently of the flow profile (laminar or turbulent) of the total flow in the flow channel 23, a representative fraction of the total flow is always divided off and supplied to the bypass channel. The flow former 13 located in the opening 28 has the advantage, because of its geometry stabilizing the flow, that the flow flows into the end piece 12 in the most stabilized and oriented manner possible. Due to the orientation of the partial flow because of the flow former 13 at an angle of more than 90° to the center axis of the measurement channel 10, the fluid is strongly mixed and swirled in the end piece 12, thus in the inflow of the measurement channel 10, and then transported further in the direction of the measurement channel 10. In this manner, effects dependent on the flow of profile may be substantially avoided. Two grooves 16a, 16b, each for receiving one seal (not shown), are located on the outer side of the nozzle 4.

A different embodiment of the end piece 12 is provided in the embodiment according to Figure 3. Otherwise, the embodiment is

identical to the embodiment according to Figure 2. The end piece comprises multiple openings 28 which are arranged distributed, preferably in a circle, around the circumference of the cap or the end piece 12. The medium flows through the openings 28 into the end piece 12. More or less pronounced free jets form in this case depending on the diameter thereof, which meet one another in the center of the end piece 12. The fluid is transported further in a strongly mixed and swirled manner in the direction of the measurement insert 7 in this way. In this manner, effects dependent on the flow profile may be substantially avoided. Moreover, the characteristic curve can be linearized in a structurally simple manner and the overload range can be better defined via the variation of the total area of the openings and the pressure drop thus formed.

In the embodiment according to Figure 4, a central screen 25, which is connected via individual circumferentially distributed struts 20 to the housing 2 (not shown in Figure 4), is provided instead of a ring-shaped nozzle. This structural form has the advantage of an enhanced measurement effect above all in the laminar flow region, since because of the significantly greater dynamic pressure in the center of the flow, a larger fraction is conducted through the openings 28 into the bypass channel.

A further embodiment of the means for generating the pressure drop is illustrated in Figure 5. This is also a Venturi nozzle 4 in this case. Instead of a defined circular incident-flow edge 27 which is continuous over the diameter, in this embodiment the circumferential edge 27 has a course interrupted by small channels 21. This surface quality of the incident-flow surface 26 and/or the edge 27 and/or the passage region 29 ensures an eddy-induced stabilization of the Reynolds number and/or accompanying this a stabilization of the pressure drop in the case of small through flows and thus in the case of actually laminar flow conditions.

Furthermore, an end piece 12 having a plurality of small

circumferentially distributed openings 28 is illustrated solely by way of example in Figure 5. The plurality of the small openings 28 causes the formation of a plurality of free jets, which all meet one another in the center of the cap 12 and swirl. A particularly well-mixed stable flow which is thus advantageous to measure results in this way in the ultrasonic measurement zone of the measurement insert 7.

According to the embodiment in Figure 6, a plurality of notches 22 arranged distributed on the circumference are provided along the incident-flow edge 27. The plurality of the notches 22 along the circumference generate the desired disturbed flow in the interior of the means for generating the pressure drop in the form of the nozzle 4. The surface structure of the nozzle edge, for example, in the form of the notches 22, can expediently also be distributed unevenly and/or can be formed non-identically. They can also protrude into the passage region 29 of the nozzle 4.

The special effect of the above-mentioned surface structures in the form of, for example, channels 21 and/or notches 22 is explained in Figure 7. In the embodiment of Figure 7A, slowly flowing medium flows in a laminar manner through a nozzle 4 shown in simplified form. If one increases the through flow, at some time the turnover point of the flow is reached, wherein eddies begin to form suddenly in the nozzle interior and the flow tips into the turbulent flow state. Accompanying this, the Reynolds number suddenly decreases from a value of approximately 4000 to a smaller value at this through flow point and the pressure drop of the nozzle 4 also decreases, which simultaneously defines the bypass through flow, however. The characteristic curve of the ultrasonic meter will thus have an inflection point in this through flow value, which is difficult to correct mathematically and metrologically. This deflection of the Reynolds number is apparent from Figure 8 (cf. curve A therein).

The surface structures of the incident-flow edges 27 of the

nozzle 4 illustrated by way of example in the above-mentioned figures are schematically illustrated as small black triangles in Figure 7C. In the laminar flow conditions illustrated in Figure 7A, they generate small eddies in the region of the edge zone close to the wall, whereby the Reynolds number and the pressure drop become less but the meter characteristic curve becomes significantly more steady, in contrast. In this way, the expenditure for a linearization of the ultrasonic meter is reduced. A structurally corresponding linearized curve is schematically illustrated as curve B in Figure 8.

The present invention enables an accurate quantity measurement of fluid to be performed simply and cost-effectively, in particular for so-called ultrasonic bulk water meters. Subcombinations of the features shown are also expressly comprised by the content of the disclosure of the subject matter of the application.

LIST OF REFERENCE SIGNS

1	ultrasonic meter
2	housing
3	flange (3a, 3b)
4	means for generating a pressure drop
5	pin
6	measurement channel holder
7	measurement insert
8	ultrasonic transducer (8a, 8b)
9	deflection mirror (9a, 9b)
10	measurement channel
11	recess
12	end piece
13	flow former
14	sound transmission region (14a, 14b)
15	pin
16	groove (16a, 16b)
17	tapering section
18	bypass holder
19	outflow
20	strut
21	channel
22	notch
23	flow channel
24	passage opening
25	central screen
26	incident-flow surface
27	incident-flow edge
28	opening
29	passage region
30	flow channel

Patentkrav

1. Ultralydsmåler til forbindelse med et fluidnet til registrering af gennemstrømningsmængden af en fluid med et fortrinsvis rørformet hus (2), som har en strømningskanal (23), samt
en inde i strømningskanalen (23) anbragt ultralyds-målestrækning med målekanal (10) til registrering af fluidens gennemstrømningsmængde,
hvor ultralyds-målestrækningen er indrettet i en bypasskanal, der er anbragt inde i strømningskanalen (23), og som optager en strømningsandel af strømningskanalens (23) samlede strømning, og
hvor strømningsandelen som repræsentativ andel tjener til registreringen af gennemstrømningsmængden,
kendetegnet ved, at
der i bypasskanalens område, men dog uden for denne, er indrettet midler til generering af et trykfald i form af en i strømningskanalen (23) anbragt dyse (4) eller en i strømningskanalen (23) anbragt blænder, således at der betinget af trykfaldet sker en indledning af den samlede strømnings strømningsandel i bypasskanalen,
ultralyds-målestrækningen er U-formet,
der er indrettet en måleindsats (7) som et modul, der omfatter målekanalen (10), en målekanalholder (6) samt omstyringsspejle (9a, 9b),
måleindsatsen (7) befinder sig i en bypassholder (18), og bypassholderen (18) sammen med måleindsatsen (7) kan indføres i strømningskanalen (23) i længderetningen i forhold til huset (2).

2. Ultralydsmåler ifølge krav 1,
kendetegnet ved, at
der som dyse (4) er indrettet en venturidyse.

3. Ultralydsmåler ifølge krav 1,
kendetegnet ved, at
der som blænder er indrettet en centralblænder (25) til

generering af en ringformet eller ringafsnitsformet gennemstrømning.

4. Ultralydsmåler ifølge i det mindste et af de foregående krav,
kendetegnet ved, at
midlerne til generering af et trykfald har en overfladestrukturering.

5. Ultralydsmåler ifølge i det mindste et af de foregående krav,
kendetegnet ved, at
midlerne til generering af et trykfald er forsynet med udtagninger, især kanaler (21) og/eller kærve (22).

6. Ultralydsmåler ifølge krav 4 eller 5,
kendetegnet ved, at
overfladestruktureringen eller udtagningerne er indrettet på tilstrømningsfladen (26) og/eller tilstrømningskanten (27).

7. Ultralydsmåler ifølge i det mindste et af de foregående krav,
kendetegnet ved, at
bypasskanalen set i strømningskanalens (23) tværsnit er anbragt excentrisk i forhold til strømningskanalens (23) midterlinje.

8. Ultralydsmåler ifølge i det mindste et af de foregående krav,
kendetegnet ved, at
på indløbssiden er i det mindste bypasskanalens frontside lukket.

9. Ultralydsmåler ifølge i det mindste et af de foregående krav,
kendetegnet ved, at
den afgrenede strømningsandel strømmer ind i bypasskanalen i en vinkel i forhold til længderetningen af den lige

orienterede målekanal (10).

10. Ultralydsmåler ifølge i det mindste et af de foregående krav,
kendetegnet ved, at
der ved bypasskanalens indløb eller i indløbets område er indrettet strømningsledemidler, ved hjælp af hvilke den afgrenede strømningsandel stabiliseres og/eller blandes.

11. Ultralydsmåler ifølge i det mindste et af de foregående krav,
kendetegnet ved, at
måleindsatsen (7) befinder sig i en rørformet bypassholder (16).

12. Ultralydsmåler ifølge i det mindste et af de foregående krav,
kendetegnet ved, at
midlerne til generering af et trykfald (4) kan indføres i strømningskanalen (23) i længderetningen i forhold til huset (2).

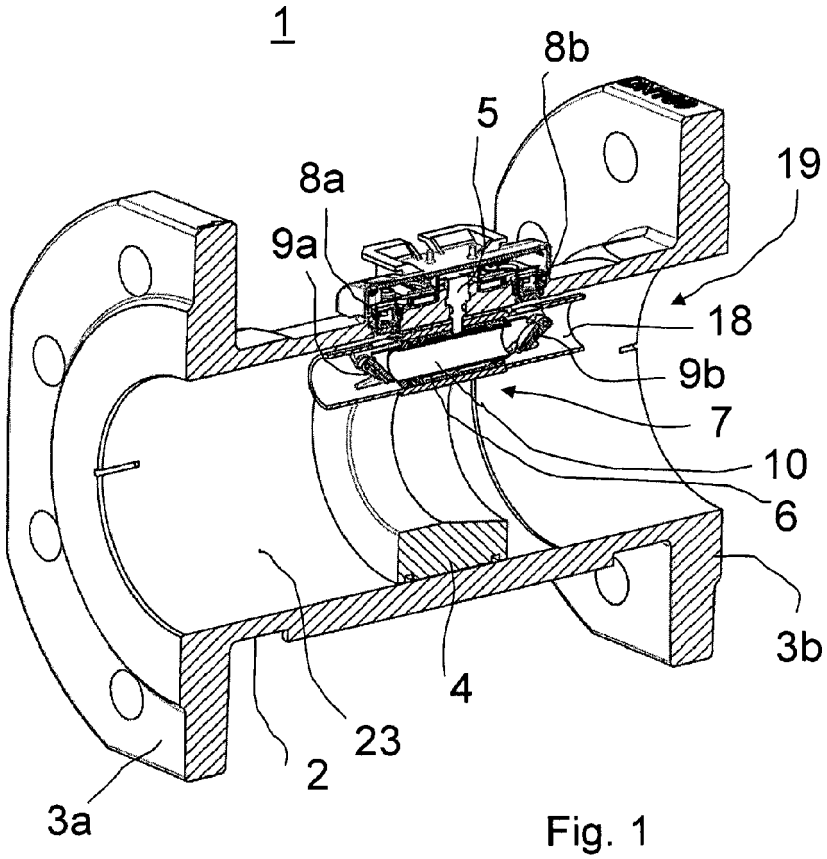

Fig. 1

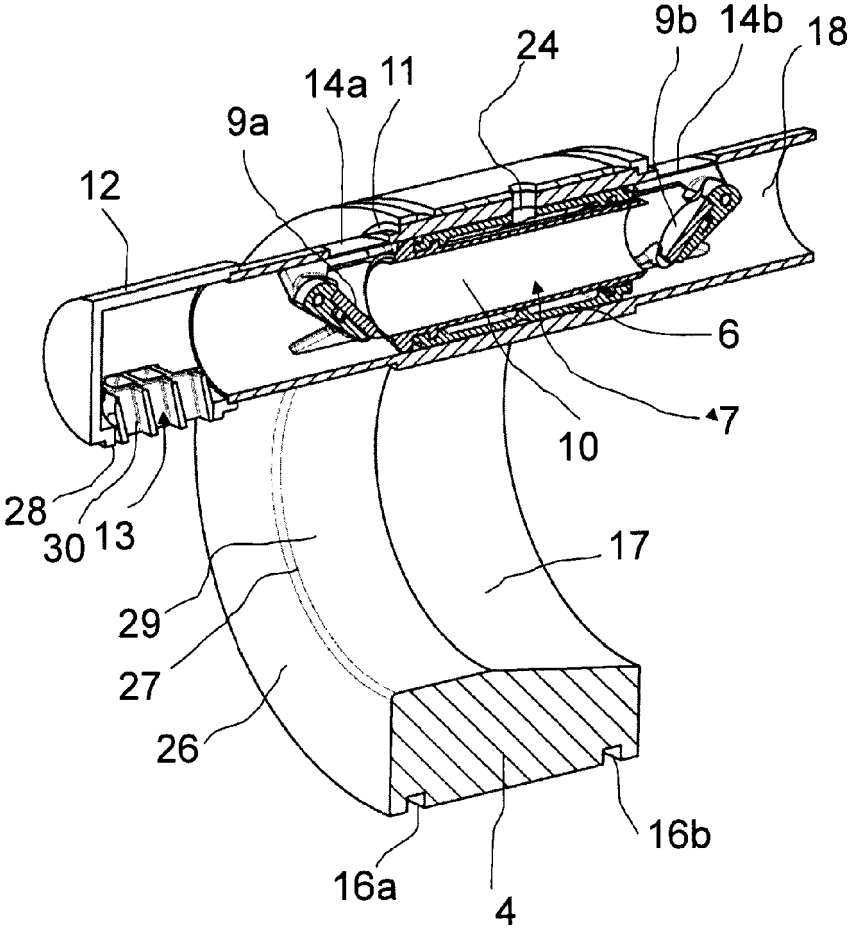

Fig. 2

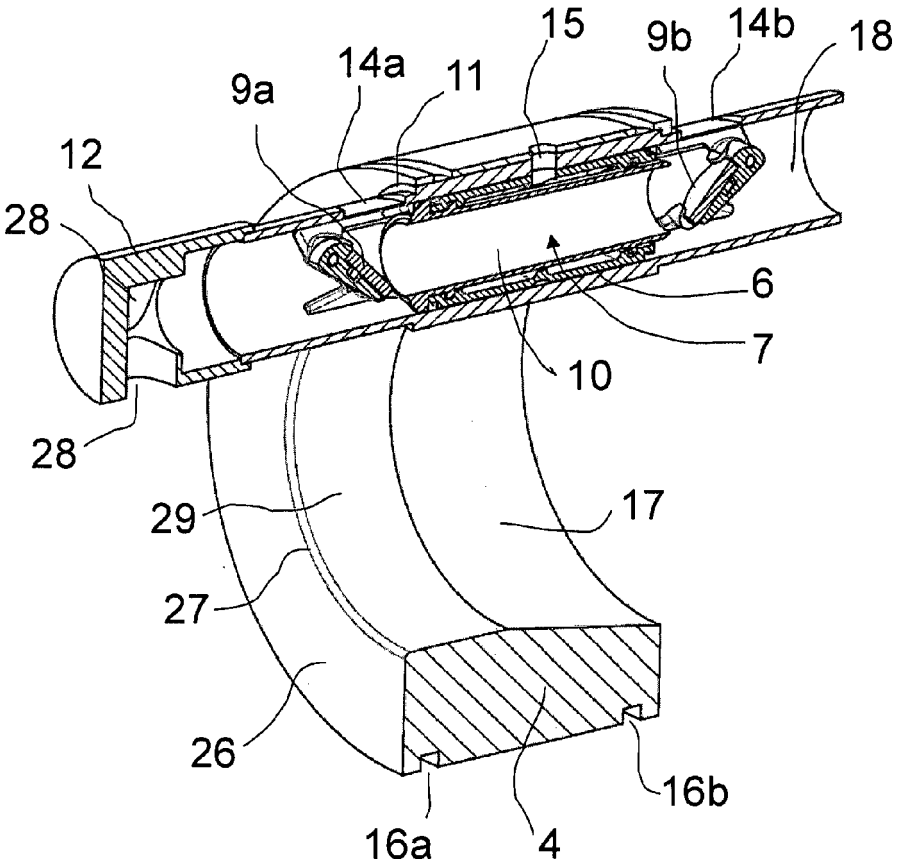
15
9b
14b
18
14a
11
9a
12
28
6
7
10
28
29
17
27
26
16b
16a
4

Fig. 3

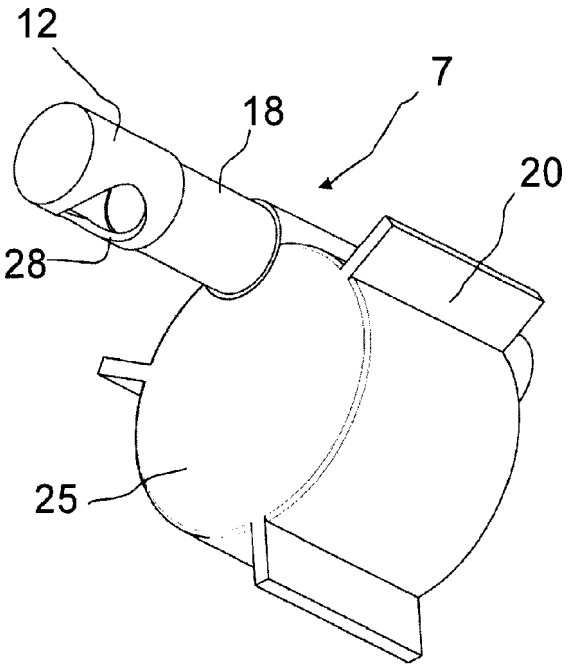
12
7
18
20
28
25

Fig. 4

5

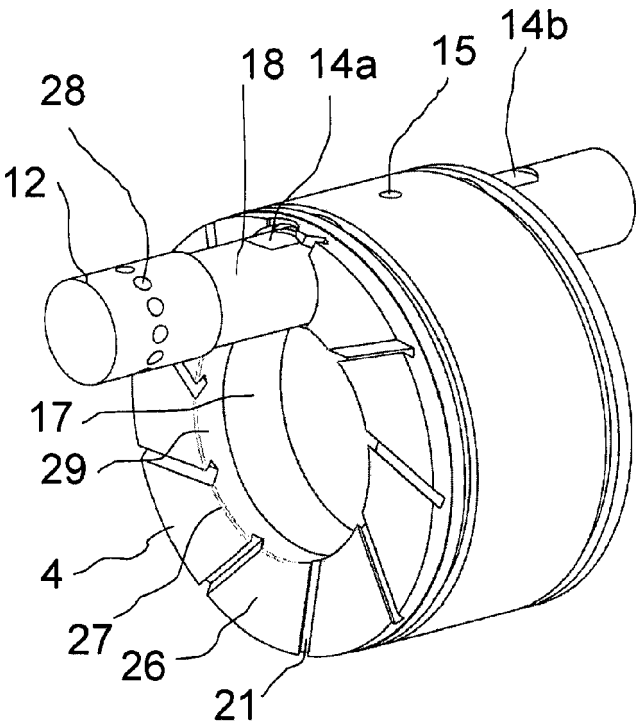

Fig. 5

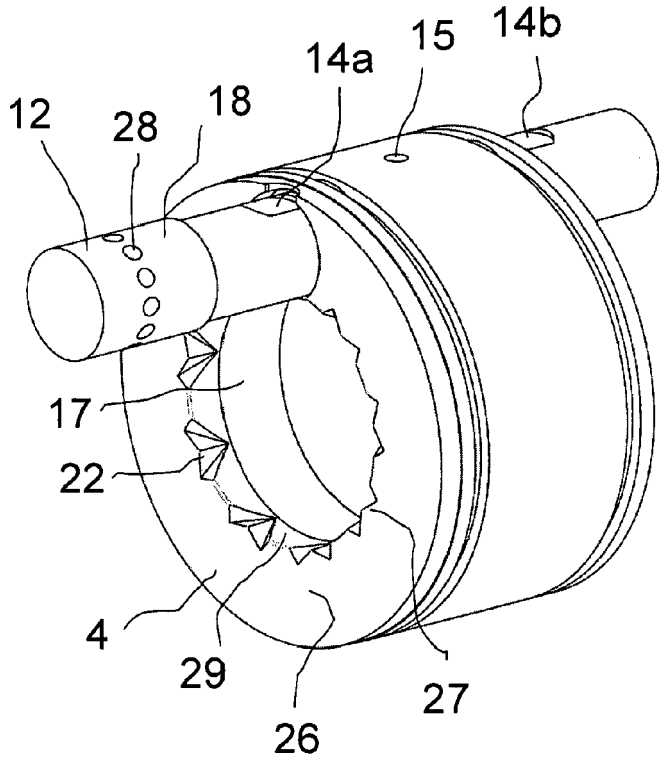

Fig. 6

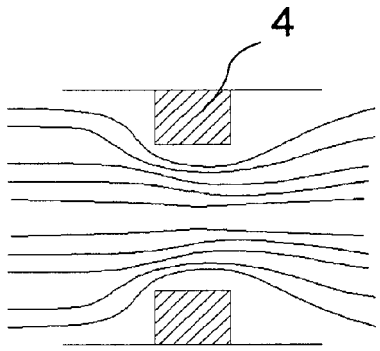

Fig. 7A

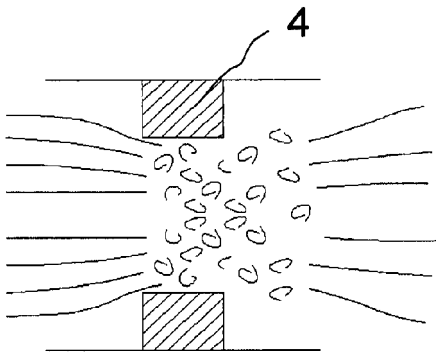

Fig. 7B

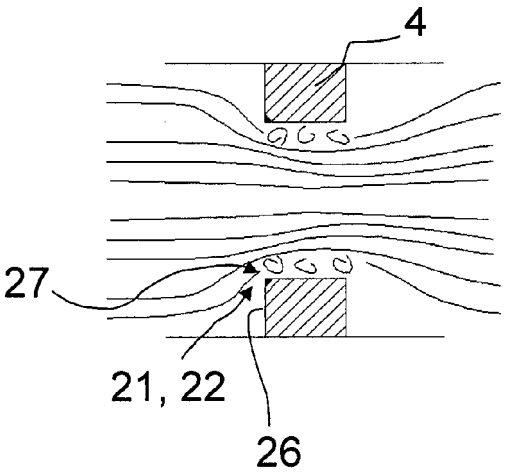

Fig. 7C

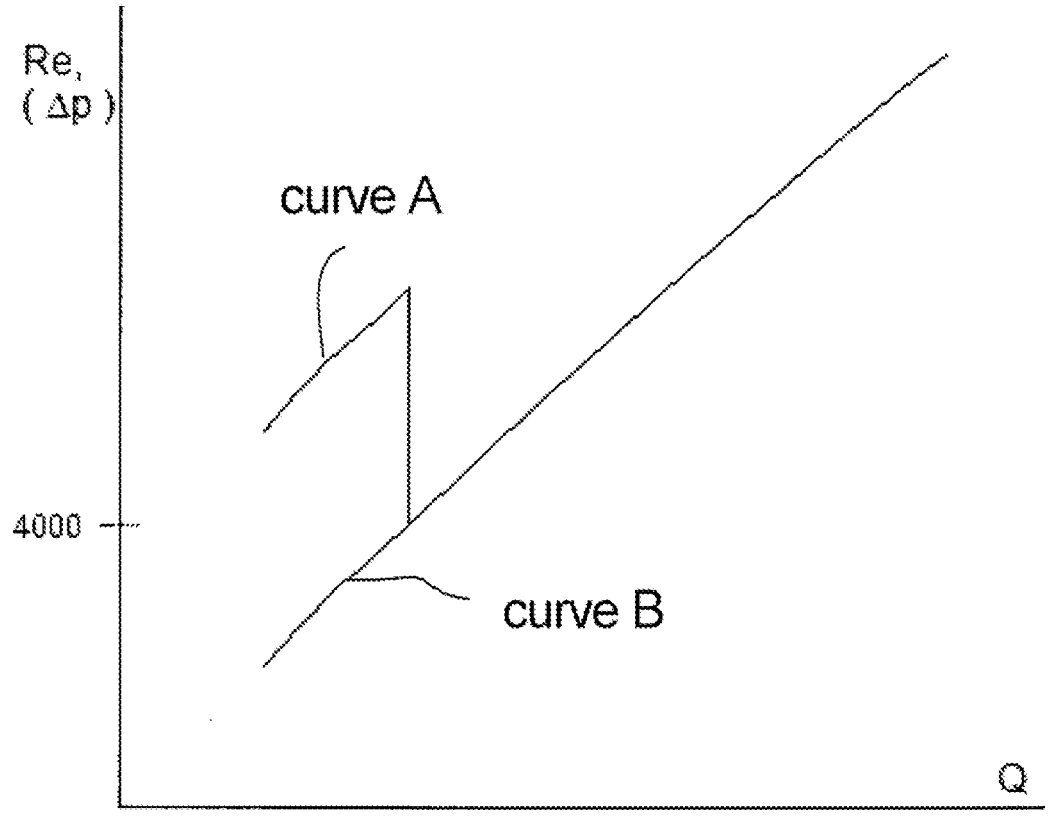

Fig. 8