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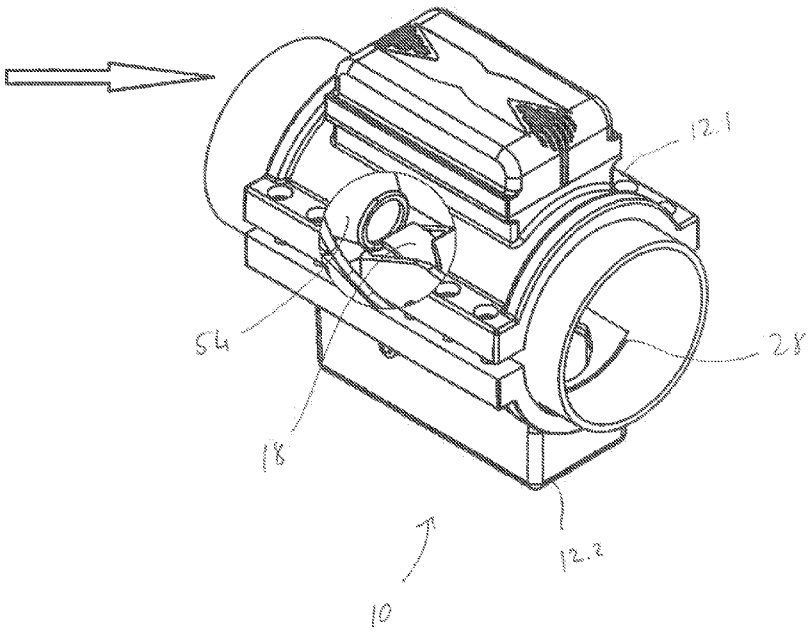
(54) Title: FLOW METER

FIGURE 13



(57) Abstract: According to the invention there is provided a flow meter (10) which includes a mounting member (12) for mounting the flow meter (10) about a pipeline aperture (13), an impeller housing (16) connectable to the mounting member (12) for housing an impeller (18) such that at least a peripheral region of the impeller (18) extends into the pipeline (14), the impeller housing (16) having a leading end region (20) defined upstream the fluid flow, and, a trailing end region (22) defined downstream the fluid flow, respectively, wherein the leading end region (20) is dimensioned to have a decreased degree of fluid flow resistance relative the trailing end region (22), when in use, and, a fluid flow path arrangement defined about a sidewall of the impeller housing (16), when in use, facilitate the outflow of fluid entering the impeller housing (16).

[Continued on next page]

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FLOW METER

Field of the invention

The invention relates to a flow meter for measuring flow rate of fluid in a pipeline. More particularly the invention relates to an in-line flow meter mountable about a pipeline.

Background to the invention

Various kinds of conventional flow meters for measuring flow rate of fluid in a pipeline is freely available on the market and generally operates by measuring the rotations of the impeller or turbine and translate these to fluid volume. The disadvantage associated with turbine type meters, generally known for their accuracy, is that small stones or hard objects easily obstruct the rotating turbine and is specifically a problem associated in farming operations where unfiltered water is pumped through the pipeline.

Paddle type meters are not accurate in low fluid flow conditions, especially in leak detection exercises where the rate of fluid flow rate is dependant on the size of the leak. Typical, when closing all fluid outlets one can determine if a leak exist if detecting any flow rate in these circumstances.

The applicant having considered the above proposes the invention hereunder wherein a robust paddle type meter is disclosed which is accurate is measuring flow rate under high, as well as low fluid flow conditions.

Summary of the invention

According to the invention there is provided a flow meter which includes:

a mounting member for mounting the flow meter about a pipeline aperture;

an impeller housing connectable to the mounting member for housing an impeller such that at least a peripheral region of the impeller extends into the pipeline;

the impeller housing having a leading end region defined upstream the fluid flow, and, a trailing end region defined downstream the fluid flow; and

a fluid flow path arrangement defined about a sidewall of the impeller housing for, when in use, facilitate the outflow of fluid entering the impeller housing towards downstream the pipeline.

The mounting member may include an impeller housing receiving zone shaped and sized to receive at least a portion of the impeller housing complementarily therein.

The impeller housing receiving zone may include a securing member for securing the impeller housing therein.

The mounting member may include two mounting portions, the operative connectable surface of each shaped and sized to complementarily fit about the pipeline.

The two mounting portions may be to be secured together on opposing sides of the pipeline so as to, when assembled, extend circumferentially about the pipeline substantially in register with the pipeline aperture, the impeller and / or impeller housing extending into the pipeline, when in use.

The mounting member may include a seal which is dimensioned to fit about the pipeline for sealing off a gap defined between the pipeline and the mounting member, when in use.

The impeller may be in the form of a paddle wheel including a plurality of paddle blades extending radially away from a central portion thereof. The paddle blades may be arcuate shaped in side view.

The central portion may include an axle receiving zone defined centrally therein for receiving an axle, the axle extending into the impeller housing on opposed sides of the impeller for rotationally supporting the impeller in the impeller housing.

The impeller may be arranged in the impeller housing such that a peripheral region thereof extends beyond an upper surface of the impeller housing.

The impeller may include a registering means for registering the number of rotations, when in use. The registering means may include a magnet, sensor or the like. The registering means may be configured to translate and communicate impeller rotations to volumetric fluid flow.

The leading end region of the impeller housing may be dimensioned to have a decreased degree of fluid flow resistance relative the trailing end region, when in use, such as to create a flow drag an / or flow turbulence downstream the impeller housing when in use.

The impeller housing leading end region may include a leading wall extending upward away from a base portion of the impeller housing, and terminating in a leading upward sloping surface directed downstream the fluid flow, when in use.

The impeller housing trailing end region in turn may include a trailing wall extending away from the base portion of the impeller housing and terminating in a trailing upward sloping surface directed upstream the fluid flow, when in use.

The leading wall may have a height dimension less than that of the trailing wall.

The leading and / or trailing wall may be arcuate shaped in top view.

The leading upward sloping surface may have a sloping degree exceeding that of the trailing upward sloping surface.

The fluid flow path arrangement defined about the sidewall of the impeller housing for facilitating the outflow of fluid entering the impeller housing may include a channel defined about an outer surface of the sidewall, the channel extending parallel the fluid flow.

The channel may include a blind end defined upstream the channel, and an open end defined downstream the channel.

The fluid flow arrangement may also include an aperture defined in the sidewall about the blind end such that fluid or trapped air flow through the aperture from inner the impeller housing and is directed downstream the channel towards the open end.

The impeller housing and impeller housing receiving zone may be dimensioned such that the channel abuts against an inner surface of the impeller housing receiving zone, when in use.

The flow meter may further include a fluid flow director mountable inside the pipeline and upstream the impeller for directing the flow of fluid towards an exposed region of the impeller, when in use.

The fluid flow director may be configured to reduce fluid turbulence.

The fluid flow director may be configured to promote laminar fluid flow.

The fluid flow director may take the shape of a truncated cone.

The fluid flow director may have an outlet opening with inner dimensions smaller than the inner diameter of the pipeline in which it is mounted.

The fluid flow director may be orientated at an angle relative the fluid flow path.

The fluid flow director may further include securing arrangement for securing the fluid flow director in the pipeline.

The securing arrangement may include a flange defined circumferentially about a base portion of the truncated cone, the flange extending transversally the base portion. The flange may be manufactured from a resilient material.

The securing arrangement may further include a pair of plates arranged on opposing sides of the flange, wherein when the plates are directed towards one another, the flange expands beyond the outer surfaces of the plates and abuts against an inner surface of the pipeline.

The flow meter may further include a fluid analyser for measuring and communicating the salt content of the fluid.

The flow meter may also include a pressure sensor for detecting a change in pressure in the fluid flowing in the pipeline.

Brief description of the drawings

The invention will now be described with reference to the accompanying drawings wherein:-

Figure 1 shows a perspective view of an embodiment of the flow meter;

Figure 2 shows a cross sectional top view of the flow meter shown in figure 1;

Figure 3 shows a cross sectional side view of the flow meter shown in figures 1 and 2;

Figure 4 shows a perspective view of the mounting member;

Figure 5 is a cross sectional front view of the mounting member shown in figure 4;

Figure 6 illustrates an embodiment of the seal

Figure 7 is a top perspective rear view of the impeller housing;

Figure 8 is a cross sectional rear view of the impeller housing shown in figure 7;

Figure 9 is top perspective rear view of the impeller;

Figure 10 is a side view of the impeller shown in figure 9;

Figure 11 is a top perspective rear view of the fluid flow director;

Figure 12 is a rear view of the fluid flow director shown in figure 11; and

Figure 13 is a top perspective rear view of the flow meter with a broken out enlarged view to illustrate the orientation of the fluid flow director relative the impeller, in accordance with the invention.

Specific description of the invention

The invention will now be described by means of the following non limiting example wherein reference numeral 10 refers to an exemplary embodiment of the flow meter.

According to the invention, more clearly shown in figures 1, 2, 3 and 13, there is provided a flow meter 10 which includes mounting member 12 comprising two interconnectable mounting portions 12.1 and 12.2, for mounting the flow meter about an aperture 13 in a pipeline 14 an impeller housing 16 connectable to the mounting member 12.2, for housing an impeller 18 such that at least a peripheral region of the impeller 18 extends into the pipeline 14, the impeller housing 16 having a leading end region 20 defined upstream the fluid flow, and, a trailing end region 22 defined downstream the fluid flow, respectively, wherein the leading end region 20 is dimensioned to have a decreased degree of fluid flow resistance relative the trailing end region 22, when in use, and a fluid flow path arrangement 24 defined about a sidewall 25 of the impeller housing 16 for facilitating the outflow of fluid entering the impeller housing 16, when in use.

The mounting portion 12.2 includes an impeller housing receiving zone 26 defined therein, shaped and sized to receive at least a portion of the impeller housing 16 complementarily therein, see figures 4 and 5.

In use, the impeller housing receiving zone 26 will include a securing member (not shown) for securing the impeller housing 16 in the impeller housing receiving zone 26.

The operative connectable surface of each mounting portion 12.1 and 12.2, is shaped and sized to complementarily fit about the pipeline 14.

The two mounting portions 12.1 and 12.2 will be secured together on opposing sides of the pipeline 14 so as to, when assembled, extend circumferentially about the pipeline 14 and substantially in register with the pipeline aperture 13, the impeller 18 and / or impeller housing 16 extending into the pipeline 14, when in use.

The mounting member 12 further includes a seal 28 which is dimensioned to fit about the pipeline 14 for sealing off a gap about the pipeline aperture 13, defined between the pipeline 14 and the mounting portion 12.2, when in use.

In the embodiment shown the pipeline aperture 13 is defined at a downward side of the pipeline 14, the impeller 18 extending beyond the pipeline aperture 13. It is to be appreciated that the flow meter 10 can also be mounted about an upside of the pipeline 14 to extend downward into the pipeline 14.

The mounting of the flow meter 10 to extend upward into the pipeline 14 from a lower side of the pipeline 14 allows the impeller 18 to be disposed in fluid flowing in the pipeline 14 even at low flow rates, when the level of the fluid flowing in the pipeline will typically only fill a lower portion of the pipeline 14.

The impeller 18 can be in the form of a paddle wheel including a plurality of paddle blades extending radially away from a central portion thereof. The paddle blades being arcuate shaped in side view, see figures 8 and 9. The central portion includes an axle receiving zone 30 defined centrally therein for receiving an axle (not shown), the axle extending into the impeller housing 16 on opposed sides of the impeller 18 for rotationally supporting the impeller 18 in the impeller housing 16.

The impeller 18 will be arranged in the impeller housing 16 such that a peripheral region thereof extends beyond an upper surface of the impeller housing 16, more clearly shown in figure 3.

In use, the impeller 18 will include a registering means for registering the number of rotations, when in use. The registering means will typically include a magnet, sensor or the like and will be configured to translate and communicate impeller rotations to volumetric fluid flow.

Figures 2, 3, 6 and 7 illustrates the impeller housing leading end region 20 including a leading wall 32 extending upward away from a base portion 34 of the impeller housing 16, and terminating in a leading upward sloping surface 36 directed downstream the fluid flow, when in use. The impeller housing trailing end region 22 in turn includes a trailing wall 38 extending away from the base portion 34 of the impeller housing 16 and terminating in a trailing upward sloping surface 40 directed upstream the fluid flow, when in use, the arrow indicating direction of fluid flow.

The leading wall 32 have a height dimension less than that of the trailing wall 38.

The leading 32 and trailing wall 38 is further arcuate shaped in top view to accommodate the impeller blades.

The sloping degree of the leading upward sloping surface 36 further exceeds that of the trailing upward sloping surface 40.

The fluid flow path arrangement 24 defined about the sidewall 25 includes a channel 42 defined about an outer surface of the sidewall 25, the channel extending parallel the fluid flow.

The channel 42 further includes a blind end 44 defined upstream the channel 42, and an open end 46 defined downstream the channel 42.

The fluid flow path arrangement 24 further includes an aperture 48 defined in the sidewall 25 about the blind end 44 such that fluid, or trapped air, can flow through the aperture 48 from inner the impeller housing 16 and is directed downstream the channel 42 towards the open end 46.

The impeller housing 16 and impeller housing receiving zone 26 is further dimensioned such that the channel 42 abuts against an inner surface of the impeller housing receiving zone 26, when in use.

The flow meter 10 further includes a fluid flow director 50 mountable inside the pipeline 14 and upstream the impeller 18 for directing the flow of fluid towards an exposed region of the impeller 18, when in use, more clearly illustrated in figure 13.

The fluid flow director 50 is further configured to reduce fluid turbulence, promote laminar fluid flow and in the embodiment shown takes the shape of a truncated cone 54, see figures 11, 12 and 13.

The fluid flow director 50 have an outlet opening with inner dimensions smaller than the inner diameter of the pipeline 14 in which it is mounted and will be orientated at an angle relative the fluid flow path.

The fluid flow director 50 further includes securing arrangement for securing the fluid flow director 50 in the pipeline 14, the securing arrangement include a flange 52 defined circumferentially about a base portion of the truncated cone 54, the flange 52 extending transversally the base portion. The flange and or truncated cone 54 will be manufactured from a resilient material.

The securing arrangement further includes a pair of plates 56 arranged on opposing sides of the flange 52, wherein, when the plates 56 are directed towards one another, the flange 52 expands beyond the outer surfaces of the plates 56 and abuts against an inner surface of the pipeline 14.

The flow meter 10 can further include a fluid analyser (not shown) for measuring and communicating the salt content of the fluid.

The flow meter may also include a pressure sensor (not shown) for detecting a change in pressure in the fluid flowing in the pipeline.

The applicant considers the invention advantageous in that a paddle flow meter is provided which is operable under low fluid flow conditions due to the fluid flow director directing the flow of fluid onto the impeller, the creation of a drag and / or turbulence downstream the trailing end region of the impeller housing creating a low pressure

zone which promotes the sucking of fluid out of the impeller housing through the fluid flow path arrangement defined about the impeller housing.

Where conventional paddle impellers of the kind struggle to rotate in low fluid flow conditions, the invention, due to the synergistic effect of the fluid flow director, creation of a low pressure zone downstream the impeller housing, which, due to being in flow communication with the open end of the channel, extracts fluid out of the impeller housing thereby facilitating rotation of the impeller even in low flow conditions.

Claims

1. A flow meter which includes:

a mounting member for mounting the flow meter about a pipeline aperture;

an impeller housing connectable to the mounting member for housing an impeller such that at least a peripheral region of the impeller extends into the pipeline, the impeller housing having a leading end region defined upstream the fluid flow, and, a trailing end region defined downstream the fluid flow; and

a fluid flow path arrangement defined about a sidewall of the impeller housing for, when in use, facilitate the outflow of fluid entering the impeller housing towards downstream the pipeline.

2. A flow meter as claimed in a claim 1 wherein the mounting member includes an impeller housing receiving zone shaped and sized to receive at least a portion of the impeller housing complementarily therein.

3. A flow meter as claimed in any one or more of the preceding claims wherein the impeller housing receiving zone include a securing member for securing the impeller housing therein.

4. A flow meter as claimed in claim 3 wherein the mounting member includes two mounting portions, the operative connectable surface of each shaped and sized to complementarily fit about the pipeline.

5. A flow meter as claimed in claim 4 wherein the two mounting portions is secured together on opposing sides of the pipeline so as to, when assembled, extend circumferentially about the pipeline substantially in register with the pipeline aperture, the impeller and / or impeller housing extending into the pipeline, when in use.

6. A flow meter as claimed in any one or more of the preceding claims wherein the mounting member includes a seal which is dimensioned to fit about the pipeline

for sealing off a gap defined between the pipeline and the mounting member, when in use.

7. A flow meter as claimed in any one or more of the preceding claims wherein the impeller is in the form of a paddle wheel including a plurality of paddle blades extending radially away from a central portion thereof.

8. A flow meter as claimed in claim 7 wherein the paddle blades are arcuate shaped in side view.

9. A flow meter as claimed in any one or more of the preceding claims wherein the impeller is arranged in the impeller housing such that a peripheral region thereof extends beyond an upper surface of the impeller housing.

10. A flow meter as claimed in any one or more of the preceding claims wherein the impeller includes a registering means for registering the number of rotations and to translate impeller rotations to volumetric fluid flow.

11. A flow meter as claimed in any one or more of the preceding claims wherein the leading end region of the impeller housing is dimensioned to have a decreased degree of fluid flow resistance relative the trailing end region, so as to, when in use, create a flow drag downstream the impeller housing.

12. A flow meter as claimed in any one or more of the preceding claims wherein the impeller housing leading end region includes a leading wall extending upward away from a base portion of the impeller housing, and terminating in a leading upward sloping surface directed downstream the fluid flow, when in use.

13. A flow meter as claimed in any one or more of the preceding claims wherein the impeller housing trailing end region includes a trailing wall extending away from the base portion of the impeller housing and terminating in a trailing upward sloping surface directed upstream the fluid flow, when in use.

14. A flow meter as claimed in any one or more of the preceding claims wherein the leading wall has a height dimension less than that of the trailing wall.

15. A flow meter as claimed in any one or more of the preceding claims wherein the leading wall is arcuate shaped in top view.

16. A flow meter as claimed in any one or more of the preceding claims wherein the trailing wall is arcuate shaped in top view.

17. A flow meter as claimed in any one or more of the preceding claims wherein the leading upward sloping surface have a sloping degree exceeding that of the trailing upward sloping surface.

18. A flow meter as claimed in any one or more of the preceding claims wherein the fluid flow path arrangement includes a channel defined about an outer surface of the impeller housing, the channel extending parallel the fluid flow.

19. A flow meter as claimed in any one or more of the preceding claims wherein the channel includes a blind end defined upstream the channel, and an open end defined downstream the channel, when in use.

20. A flow meter as claimed in any one or more of the preceding claims wherein the fluid flow arrangement includes an aperture defined in the outer surface of the impeller housing about the blind end such that fluid, or trapped air, flow through the aperture from inner the impeller housing and is directed downstream the channel towards the open end.

21. A flow meter as claimed in any one or more of the preceding claims wherein the impeller housing and impeller housing receiving zone is dimensioned such that the channel abuts against an inner surface of the impeller housing receiving zone, when in use.

22. A flow meter as claimed in any one or more of the preceding claims wherein the flow meter includes a fluid flow director mountable inside the pipeline and upstream the impeller for directing the flow of fluid towards an exposed region of the impeller, when in use.

23. A flow meter as claimed in any one or more of the preceding claims wherein the fluid flow director takes the shape of a truncated cone.

24. A flow meter as claimed in any one or more of the preceding claims wherein the fluid flow director has an outlet opening with inner dimensions smaller than the inner diameter of the pipeline in which it is mounted.

25. A flow meter as claimed in any one or more of the preceding claims wherein the fluid flow director is orientated at an angle relative the fluid flow path.

26. A flow meter as claimed in any one or more of the preceding claims wherein the fluid flow director includes a securing arrangement for securing the fluid flow director in the pipeline.

27. A flow meter as claimed in any one or more of the preceding claims wherein the securing arrangement includes a flange defined circumferentially about a base portion of the truncated cone, the flange extending transversally the base portion.

28. A flow meter as claimed in any one or more of the preceding claims wherein the securing arrangement further includes a pair of plates arranged on opposing sides of the flange, wherein when the plates are directed towards one another, the flange expands beyond the outer surfaces of the plates and abuts against an inner surface of the pipeline.

29. A flow meter as claimed in any one or more of the preceding claims which includes a fluid analyser for measuring and communicating the salt content of the fluid.

30. A flow meter as claimed in any one or more of the preceding claims which includes a pressure sensor for detecting a change in pressure in the fluid flowing in the pipeline.

FIGURE 1

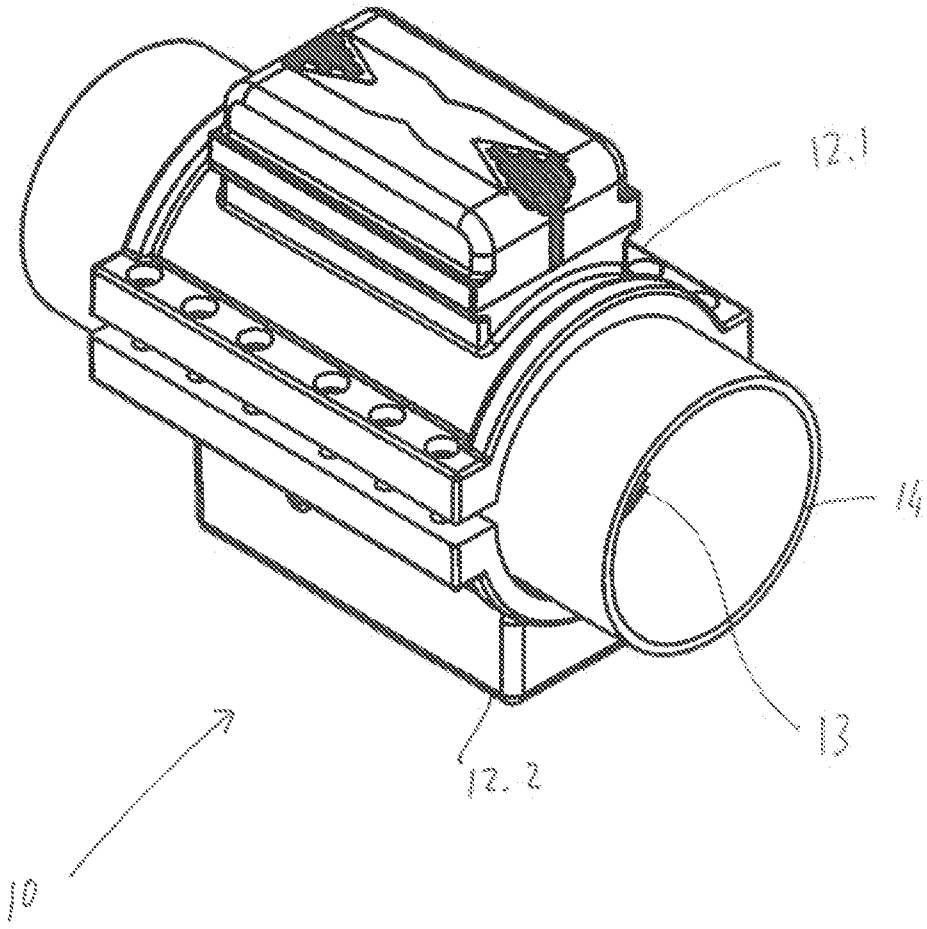


FIGURE 2

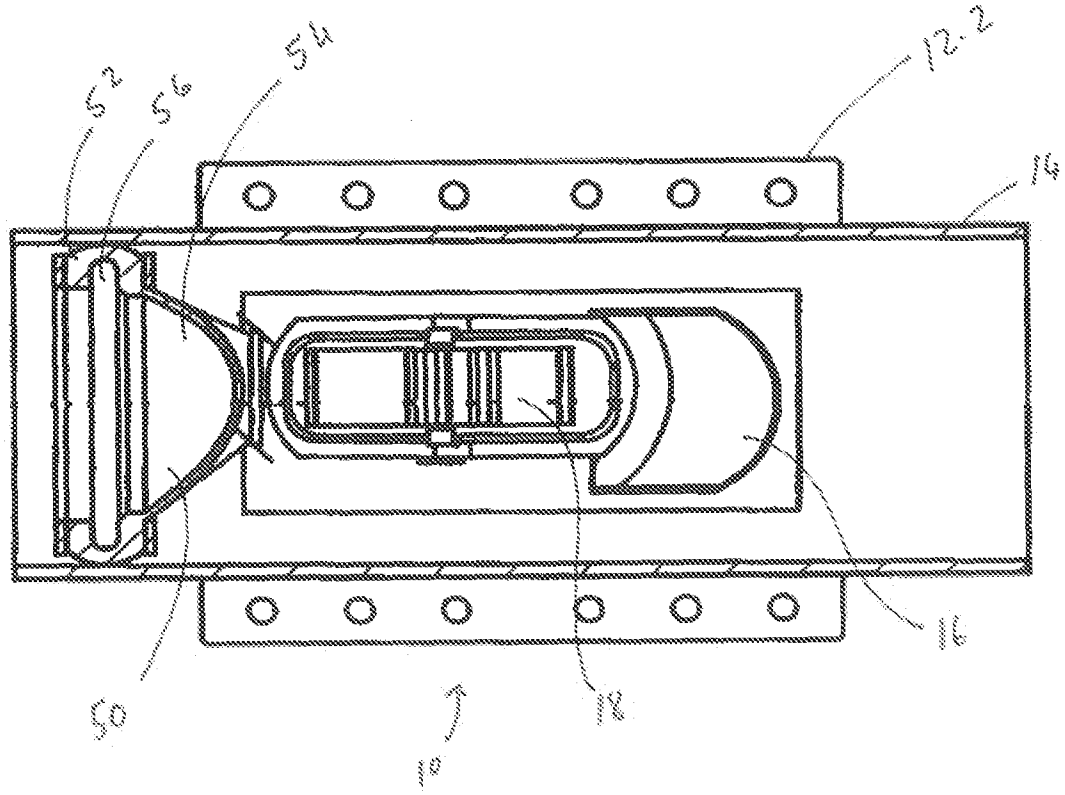


FIGURE 3

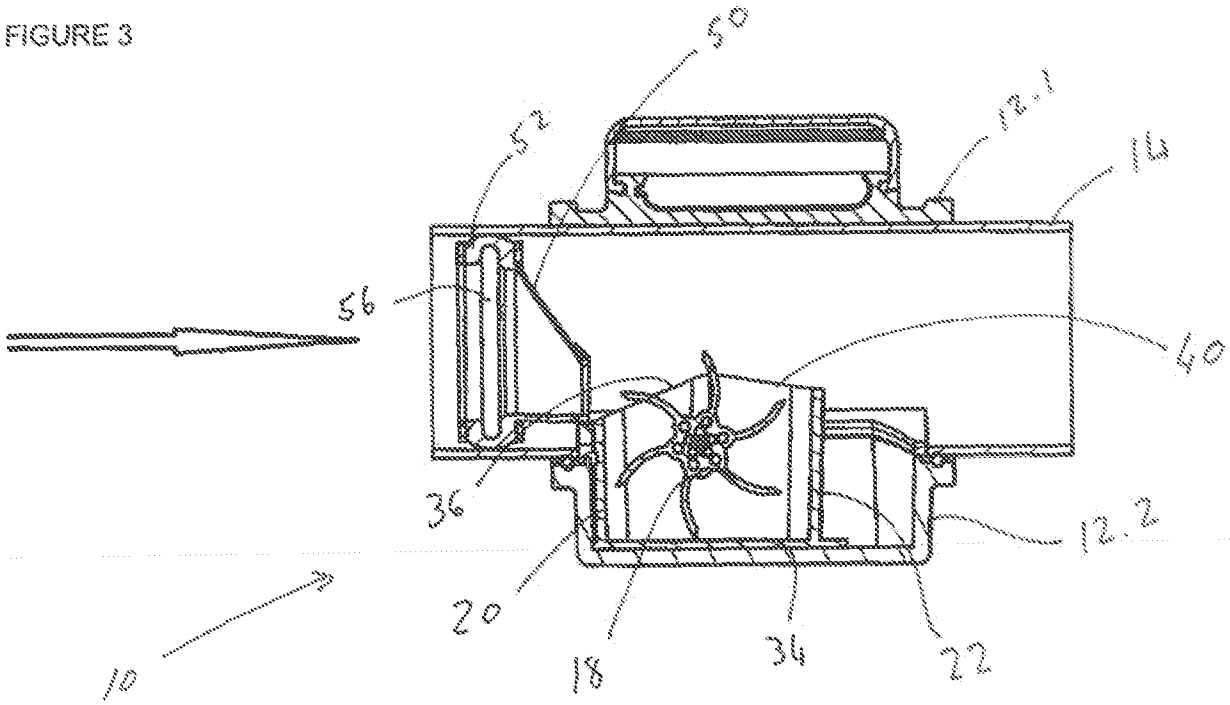


FIGURE 4

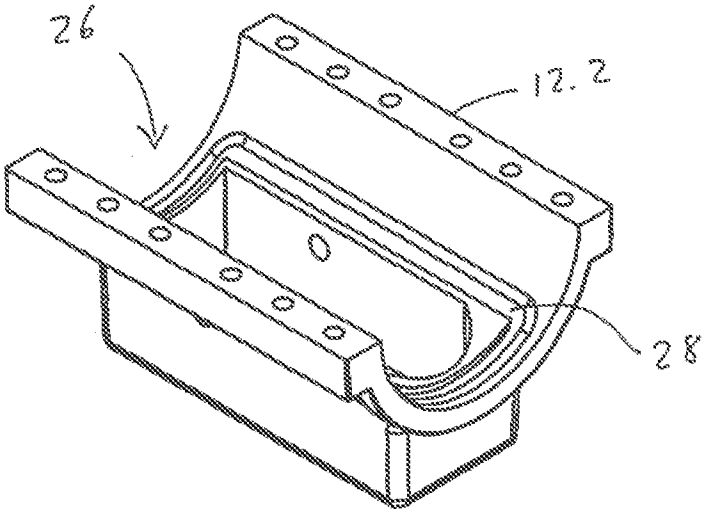


FIGURE 5

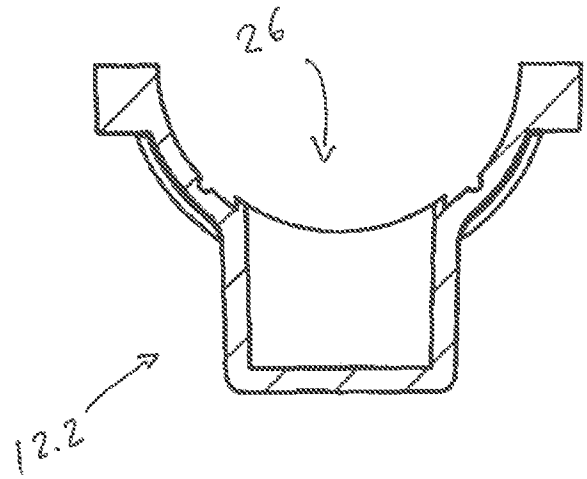


FIGURE 6

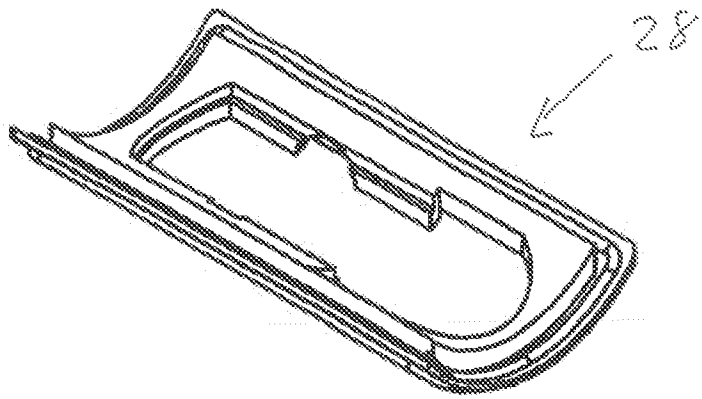


FIGURE 7

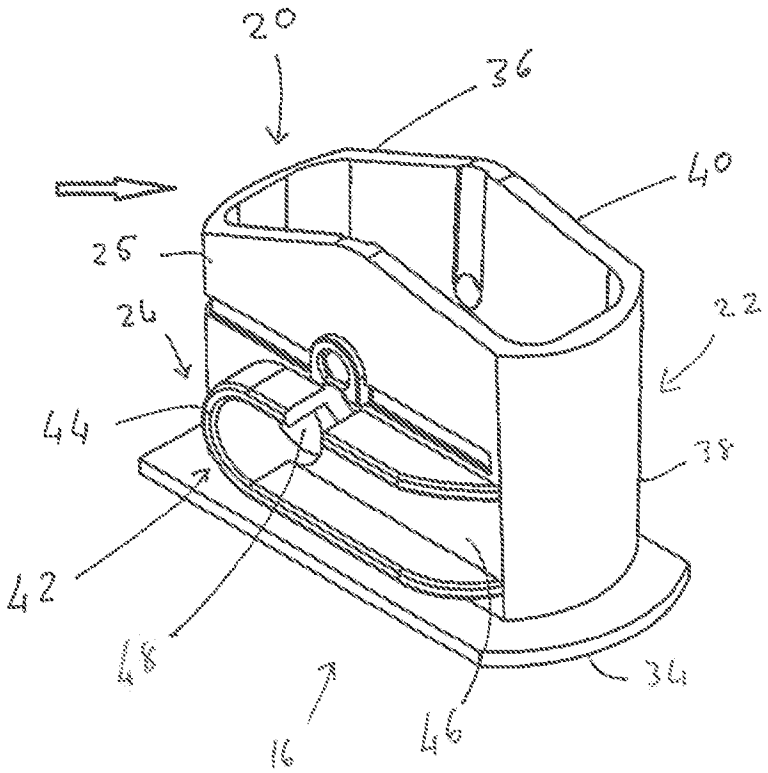


FIGURE 8

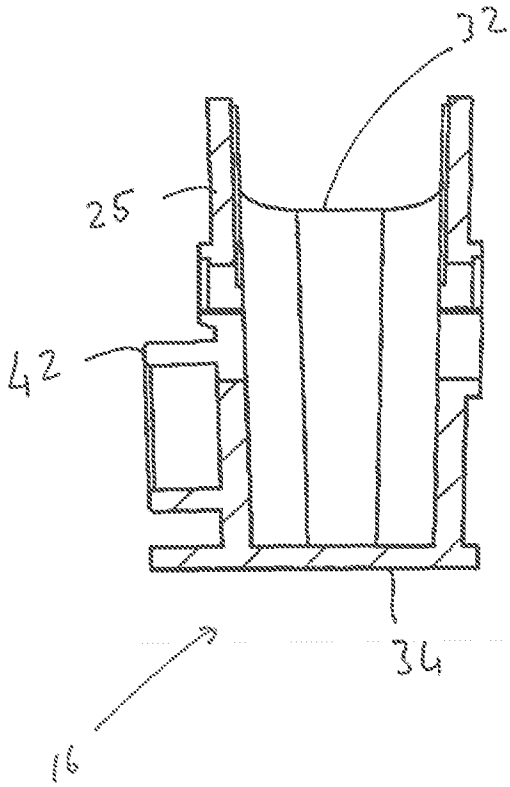


FIGURE 9

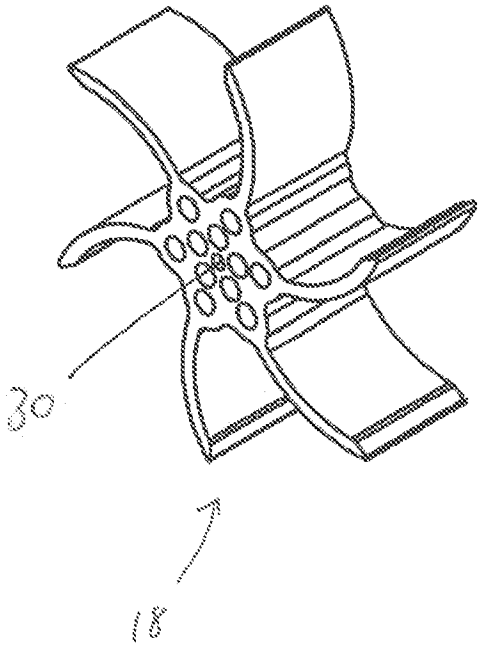


FIGURE 10

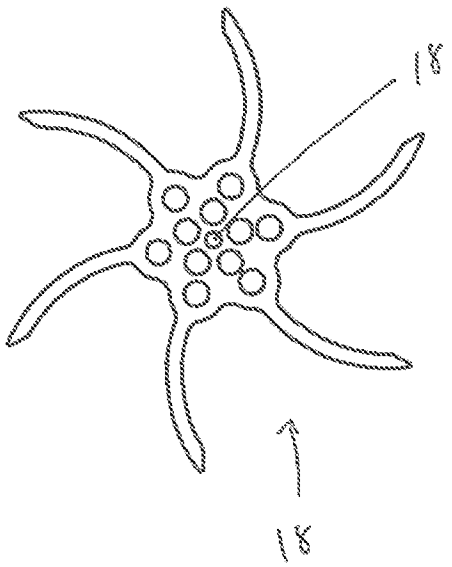


FIGURE 11

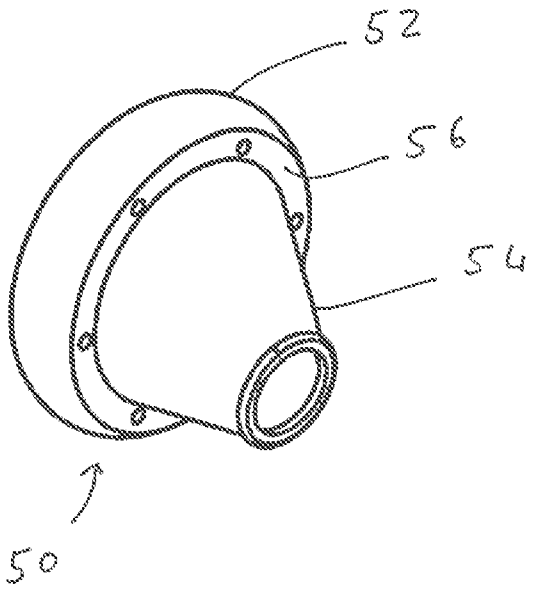


FIGURE 12

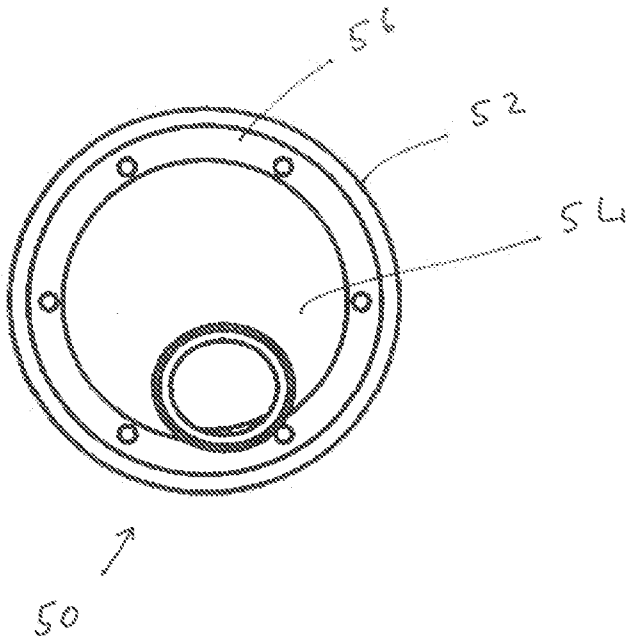
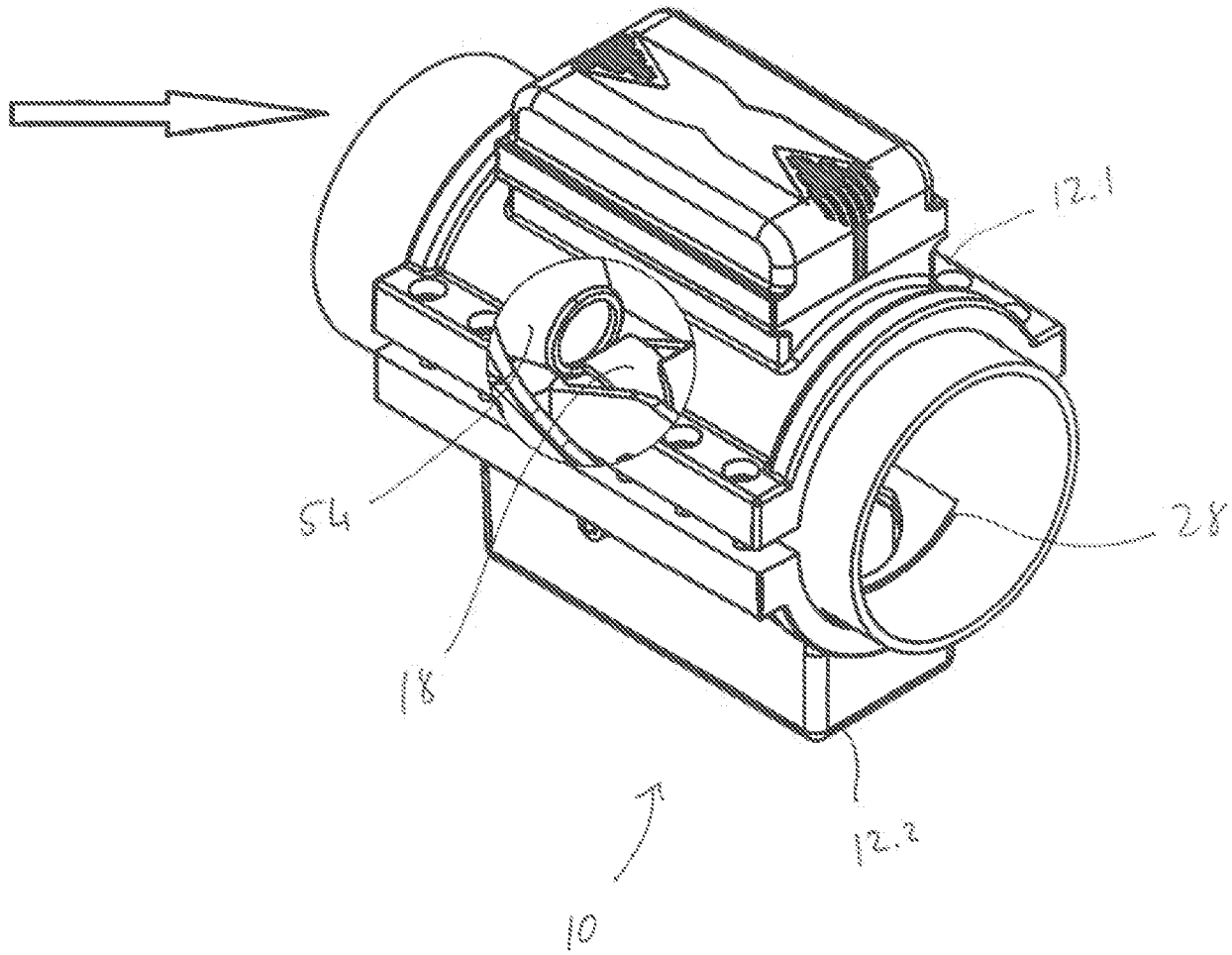


FIGURE 13



INTERNATIONAL SEARCH REPORT

International application No.

PCT / ZA 2019/050020

A. CLASSIFICATION OF SUBJECT MATTER

IPC: ***G01F 1/06*** (2006.01)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

G01F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPODOC; TXT NN

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 102005042579 A1 (M & FC HOLDING LLC) 29 March 2007 (29.03.2007) Abstract; Figs. 1-5	1, 2, 7, 8, 10, 18, 22, 24
X	DE 102011110023 A1 (HYDROMETER GMBH) 14 February 2013 (14.02.2013) Abstract; Figs. 1-7	1, 2, 7, 8, 10, 18, 22, 24
X	US 3518880 A (KULLMANN ET AL) 07 July 1970 (07.07.1970) Abstract; Figs. 1-5	1, 2, 7, 8, 10, 18, 22, 24
A	WO 2006010713 A1 (LODOLO) 02 February 2006 (02.02.2006) Abstract; Figs. 1-4	1-30

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

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Date of the actual completion of the international search	Date of mailing of the international search report
02 July 2019 (02.07.2019)	09 July 2019 (09.07.2019)
Name and mailing address of the ISA/AT Austrian Patent Office Dresdner Straße 87, A-1200 Vienna Facsimile No. +43 / 1 / 534 24-535	Authorized officer BABUREK G. Telephone No. +43 / 1 / 534 24-352

INTERNATIONAL SEARCH REPORT

International application No.

PCT / ZA 2019/050020

C. (Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2023587 A (HAZARD) 10 December 1935 (10.12.1935) Figs. 1-3	1-30

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT / ZA 2019/050020

Patent document cited in search report			Patent family member(s)			Publication date
DE	A1	102005042579	DE	A1	102005042579	2007-03-29
			EP	A2	1922526	2008-05-21
			CN	A	101258384	2008-09-03
			BR	A2	PI0615660	2011-05-24
			UA	C2	88237	2009-09-25
			RU	A	2008113382	2009-11-20
			AT	T	419514	2009-01-15
			US	A1	2009126508	2009-05-21
			HK	A1	1123601	2011-07-29
			IL	A	189977	2013-11-28
			WO	A2	2007028567	2007-03-15
			KR	A	20080039483	2008-05-07
DE	A1	102011110023	DE	A1	102011110023	2013-02-14
US	A	3518880	US	A	3518880	1970-07-07
WO	A1	2006010713	IT	A1	MI20041505	2004-10-26
			EP	A1	1774266	2007-04-18
			AU	A1	2005266363	2006-02-02
			US	A1	2009151473	2009-06-18
			WO	A1	2006010713	2006-02-02
			ES	T3	2708548	2019-04-10
			MX	A	2007000782	2007-03-21
US	A	2023587	US	A	2023587	1935-12-10