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(54) **Title:** FLANGE AND METHOD FOR LIQUID SAMPLING

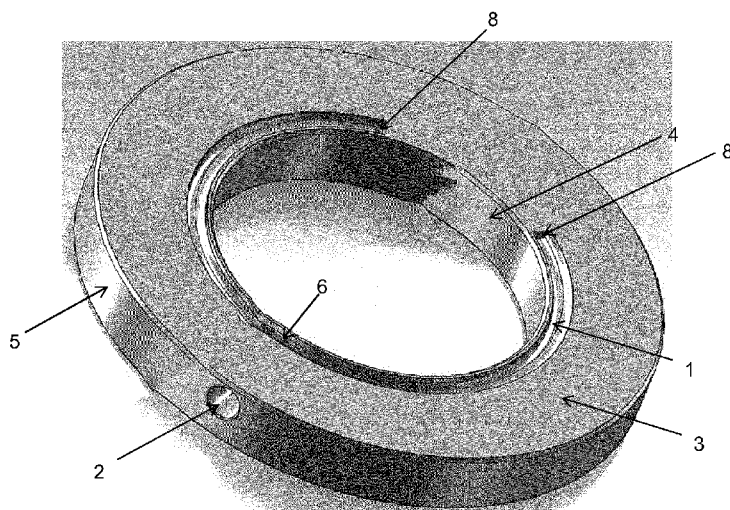


Fig. 1

(57) **Abstract:** The present invention relates to a flange for sampling a liquid flow from a substantially vertical liquid flow path comprising a trench located on the flange rim and adapted for collecting and/or housing a liquid sample and a channel for collecting or extracting said liquid sample, said channel extending transversely through at least a part of the side of the flange in liquid communication with said trench.

**Declarations under Rule 4.17:**

- *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*
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Published:

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Flange and method for liquid sampling

The present invention relates to a flange and a method for sampling liquid from a liquid flow path. In particular the invention enables liquid sampling from a flow path of gas
5 and liquid without gas pressure loss.

Background of invention

10 It can be a challenge to extract a representative sample from a vertical liquid flow path. Due to the vertical direction of the liquid flow the liquid sample must be extracted in a substantially horizontal direction. An example of a prior art device is shown in fig. 6 where a part of the flange is shown. The prior art flange shown in fig. 6 is adapted to be part of a vertical column for accommodating a vertical flow path. At the inside of the
15 flange a half-pipe extends transversely and this half-pipe is supposed to work as liquid sampler for a vertical liquid flow with a flow direction from top to bottom. The half-pipe is therefore inside the liquid flow with the open side facing the liquid flow. A channel extends horizontally through the side of the flange and is connected to the half-pipe. Liquid gathered in the half-pipe can thereby be extracted through the channel.

20 This known liquid sampling technique has shown to be very inefficient as extraction of just a small sample may last up to 15 min. A further problem arises if gas is present in the liquid flow path because a substantial pressure loss is observed during the sampling time because gas leaks out through the extraction channel during sampling
25 thereby ruining any steady state condition. And if the gas is toxic any gas leak must be prevented to guarantee safe surroundings. And yet a further problem is that only a small part of the cross-section of the liquid flow path is sampled, whereby a concentration gradient across the liquid flow path may result in samples that are not representative of the liquid flow.

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Summary of invention

A purpose of the invention is therefore to provide a representative sample from a
35 vertical liquid flow, which is both quick and easy and capable of avoiding pressure loss.

This is achieved by a flange for sampling a liquid flow comprising a trench in the flange rim adapted for collecting and/or housing a liquid sample and a channel inside the flange in liquid communication with said trench. One embodiment relates to a flange for sampling a liquid flow from a substantially vertical liquid flow path comprising a trench located on the flange rim and adapted for collecting and/or housing a liquid sample and a channel for collecting or extracting said liquid sample, said channel extending transversely through at least a part of the side of the flange in liquid communication with said trench.

10 Detailed description of the invention

A flange typically comprises two flange rims and typically these flange rims are plane. The trench is preferably located on the inner flange rim. The trench is preferably provided in the flange rim that is adapted to face the liquid flow. However, the flange may be provided with a trench in both flange rims thereby being more independent of the orientation of the flange in relation to the liquid flow. An additional channel will then typically be provided for the additional trench.

The channel extends transversely through at least a part of the side of the flange. Typically the trench is connected to the channel which extends transversely in the side of the flange from the point where the channels connects with the trench to the outer side of the flange. Thus, preferably the channel does not extend all the way through the side of the flange.

In the preferred embodiment of the invention the trench extends along at least a part of the circumference of the flange rim, preferably adjacent to the inner circumference of the flange thereby being on the inner flange rim. By having the trench close to the inner circumference of the flange the trench is closest to the liquid flow. And with a trench extending along the circumference of the flange a greater part of the cross-section of the liquid flow is sampled and a more representative sample is thereby provided.

In the preferred embodiment of the invention the depth of the trench is gradually increasing towards the channel. If the flange is mounted with the flange rim horizontal an increasing depth of the trench will ensure that gravity guides the liquid in the trench

towards the deep end, and thereby towards the channel. If the sample is extracted through the channel this facilitates a quicker sampling.

5 In one embodiment of the invention the channel is adapted for extracting said liquid sample, or at least a part of said liquid sample. The channel may for example extend transversely through the side of the flange thereby facilitating extraction of a liquid sample from the liquid flow path and to the outside. The channel thereby has the function of a duct, passage or the like facilitating the transport of liquid from inside the liquid flow path to the outside. The channel may be adapted for direct connection to
10 sample analysis equipment.

In yet another embodiment of the invention the channel is adapted for permanent or temporary storage of a liquid sample. I.e. the liquid sample is not necessarily extracted to the outside but the channel functions as a storage chamber, such as a cuvette, and
15 measurements can be conducted on the liquid portion which is stored in the channel. Measurements, such as spectroscopic measurements, pH, temperature, salt content, etc. Further, the channel may be adapted for permanent or temporary recirculation of at least a part of the liquid sample back to the liquid flow. I.e. the liquid sample is led back into the liquid flow. With a permanent recirculation a small sample flow, such as a micro
20 flow, may be established in the flange which can be monitored online. I.e. the liquid flow is sampled by means of the trench and led through the channel and back into the liquid flow in a controlled manner.

If the liquid sample is not extracted to the outside it may be necessary to establish
25 some kind of liquid flow inside the channel, or at least a possibility of exchanging the liquid inside the channel, in order to make sure that the current/present liquid sample is representative of the current/present liquid in the liquid flow. The liquid sample is collected in the trench and subsequently flows into the channel. Thus, in order to establish a flow inside the channel can be adapted to be in direct liquid communication
30 with the liquid flow. The liquid sample is thereby collected in the trench, guided into and through the channel and further out of the channel and into the liquid flow path again. The connection between the channel and the liquid flow may preferably be controlled from the outside.

In the preferred embodiment of the invention the trench and the channel are configured such that when liquid is present in the trench the connection between the trench and the channel is air-tight. This configuration ensures that if gas is present in the liquid flow only the liquid sample passes through the channel and whereas no gas passes through the channel.

In one embodiment of the invention the channel is preferably located below the trench when the flange rim is oriented horizontally. This is one example of how to provide for an air-tight connection between the trench and the channel. When liquid is present in the trench and the channel is below the trench the liquid in the connection between the trench and the channel will provide a substantial air-tight blockage.

In the preferred embodiment of the invention the channel extends from the trench to the outside of the flange. Further, the channel is preferably adapted for accommodating extraction means such as a tap valve. The channel can thereby be closed when not in use. In a further embodiment of the invention extraction means, such as a tap valve, is an integral part of the flange, e.g. attached to the outer side of the flange and/or the channel and configured to be in liquid communication with the channel and/or the trench.

In one embodiment of the invention the channel comprises a first section in liquid communication with the trench and a second section extending between the first section of the channel and the outer side of the flange and wherein the cross-sectional area of the first section is smaller than the cross-sectional area of the second section. The second section may be adapted for accommodating extraction means such as a tap valve.

If the liquid sample is not extracted to the outside monitoring of the sample must be conducted inside. Thus, in a further embodiment of the invention the flange and the channel are adapted for accommodating sensing means for monitoring, preferably online monitoring, of the liquid sample. The sensing means may be incorporated in the flange, i.e. the flange may comprise sensing means.

Further, the flange or the channel may be adapted for accommodating a cuvette. The cuvette may also be incorporated in the flange and the cuvette is preferably in liquid

communication with the trench or the channel. A cuvette is a device which is designed to hold samples for conducting experiments, such as spectroscopic experiments. In further embodiments of the invention the cuvette is a flow cuvette such as a through flow cuvette. The liquid sample may then enter the flow cuvette from the trench and the liquid sample is subsequently recirculated back into the liquid flow from the flow cuvette.

The flange may advantageously manufactured primarily in a corrosion resistant material, such as stainless steel. However, the function of the present flange is not dependent on the material. The same effect and functionality may be obtained if the flange is manufactured in a plastics material.

The flange is preferably adapted for sampling of a liquid being delivered along a substantially vertical flow path wherein the trench extends in a substantially horizontal plane. In a substantially vertical flow path with the liquid flowing downwards the flange will typically be oriented in a substantially horizontal plane with the trench facing upwards. The flange rim and the liquid flow will then be oriented substantially perpendicular to each other. However, the flange according to the present invention may also be used for sampling a liquid flow in general. But the trench of the present flange must somehow face the liquid flow in order for liquid to collect in the trench, i.e. the liquid flow must be incident on the trench.

The present invention furthermore relates to the use of the flange in a substantially vertical liquid flow path, in particular to the use of the flange for sampling liquid in a substantially vertical liquid flow path. And the invention further relates to the use of the flange in a substantially vertical flow path with both liquid and gas, in particular the use of the flange in a vertical flow path with liquid flowing downwards and gas flowing upwards, in particular the use of the flange for sampling liquid in a vertical flow path with liquid flowing downwards and gas flowing upwards.

Many tubes or pipes for use in flow paths are provided with flanges at one or both ends. The present flange may be incorporated to be a part of such a tube or pipe. Thus, a further embodiment of the invention relates to a tube or pipe comprising at least one of said flange.

The present invention furthermore relates to a method for sampling liquid from a substantially vertical liquid flow path comprising the steps of:

- collecting a liquid sample in a horizontal trench located in a horizontal flange in the flow path, and
- 5 - extracting the liquid sample through a channel in the side of the flange, and/or
- monitoring the liquid flow.

The flange may comprise any of the herein mentioned features.

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Description of Drawings

The present invention will now be described in greater detail with reference to the drawings in which

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- Fig. 1 shows a perspective illustration of a flange according to the invention,
- Fig. 2 shows a photo of the flange,
- Fig. 3 shows a cross-sectional perspective illustration of the flange where the
- 20 transverse channel is visible,
- Fig. 4 is a cross-sectional close-up illustration of the channel,
- Fig. 5 shows the gas pressure loss in a liquid-gas flow when using a flange according to the present invention,
- Fig. 6 is a photo of a prior art liquid sampler, and
- 25 Fig. 7 shows the gas pressure loss in a liquid-gas flow when using the prior art liquid sampler in fig. 5.

Detailed description of the drawings

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One embodiment of the flange according to the present invention is illustrated in figs. 1-4. The illustration in fig. 1 shows a perspective illustration of a flange comprising a trench 1 in the flange rim 3. The trench is substantially circular and extends partly around the inner circumference of the flange close to the inner side 4, i.e. the trench is located on the inner flange rim. The trench 1 is connected to a channel 2 (visible in fig.

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3 and 4) which extends transversely in the side of the flange from the trench at the connection point 6 to the outer side 5 of the flange. Thus, the channel 2 does not extend all the way from the outer side 5 to the inside 4. The inside 4 and the outer side 5 is termed like that because if the flange is used in a liquid flow path the inside 4 will be inside the liquid flow path where the outer side 5 will be outside the liquid flow path. The trench 1 and the connecting channel 2 thereby constitute the (liquid) connection from the inside of the flow path to the outside.

From figs. 1-4 the depth of the trench 1 is seen to vary with the deepest part of the trench at the connection point 6. When the flange is oriented with the flange rim 3 in the horizontal plane the bottom of the trench 1 thereby constitutes two downhill slopes from the start points 8 of the trench towards the connection point 6. Any liquid in the trench 1 will thereby be forced towards the connection point 6, i.e. towards the channel 2. As seen from fig. 3 and 4 the channel 2 is situated below the trench 1, thus liquid will be guided into the channel 2 from the trench.

If the flange is used in a non-vertical flow path the flange rim 3 is possibly not oriented in the horizontal plane. It will then be advantageous to orient the flange such that the channel 2 is located in the part of the flange that is situated lowest. Any liquid in the trench 1 will then naturally be guided towards and into the channel 2. Thus, the flange according to the present invention can be used for providing liquid samples from a liquid flow path oriented in substantially any direction.

From figs. 3 and 4 it is seen that the channel 2 comprises two sections 2', 2''. The first narrow section 2' is the part of the channel that connects to the trench 1. The second broader section 2'' is the part of the channel 2 that connects to the outer side 5. A tap valve fits into the second section 2''. The photo in fig. 2 shows extraction means 7 attached in the channel 2.

The illustrated embodiments in figs. 1-5 of the flange according to the invention are all adapted for extraction of liquid samples from inside the liquid flow path to the outside. However, monitoring of the liquid sample inside the flange is possible with minor changes of the illustrated channel.

The present flange may be adapted such that both extraction of liquid samples to the outside in combination with inside (online) monitoring of liquid samples may be provided.

5 The combined configuration of the increasing depth of the trench 1, the location of the channel 2 below the trench 1 and the narrow first section 2' of the channel 2 help to provide an air-tight connection between the trench 1 and the channel 2 when there is liquid in the trench 1. This helps to ensure a liquid tight connection between the inside and the outside of a flow path when the flange is used in a flow path. And the flange
10 according the present invention can thereby be used for extracting liquid samples from a flow of both liquid and gas without influencing the pressure of the gas inside the flow path. This is demonstrated in fig. 5 showing the gas pressure (in mbarg) vs. time (in minutes) in a vertical flow of liquid and gas where liquid samples are provided by a three different vertical positions by means of three flanges according to the present
15 invention. As seen from fig. 5 there are no abrupt changes in the pressure while sampling the liquid.

This is in contrast to the prior art liquid sampler which is shown in a photo in fig. 6. This prior art liquid sampler consist of a flange with a flange rim 63 and a half-pipe shaped
20 liquid sampler 61 connected to a channel 62 at the inside wall 64 of the flange. This liquid sampler 61 functions as a "spoon" collecting small amounts of liquid emanating upon the half-pipe and subsequently led through the channel 62 to the outer side of the flange. The gas pressure vs. time for the prior art liquid sampler is shown in fig. 7. These graphs are equivalent with the graphs shown in fig. 5 and shows that when
25 liquid sample are extracted with the prior art liquid sampler there is a significant gas pressure loss in the flow thereby ruining any steady state condition. If the gasses inside the flow are toxic this release of gas during sampling constitutes a health hazard. The flange according to the present invention thereby constitutes a significant improvement over the prior art.

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Examples

A flange according to one embodiment of the invention was manufactured in stainless steel. It is shown in the photo in fig. 2. The outer diameter of the flange is 17 cm, the
35 height is 1.9 cm, and the distance between inside and outer side is 3.7 cm. The trench

is dug out in the flange rim and the depth varies between 5 mm and 9 mm with the deepest end at the channel. The trench extends approx. 340° of the 360° total flange circumference. The width of the trench is 6 mm and the trench starts 2 mm from the inside circumference of the flange rim. The total volume of the trench is approx. 8 ml.

5 This exemplary flange has shown to be suitable for quickly providing liquid samples of 10 ml from a liquid flow of 2000 ml/min.

Further details of the invention

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The invention will now be described in further detail with reference to the following items:

15

1. A flange for sampling a liquid flow comprising a trench in the flange rim adapted for collecting and/or housing a liquid sample and a channel inside the flange in liquid communication with said trench.

20

2. f The flange according to any of preceding items, wherein the trench is located on the flange rim, such on the inner flange rim.

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3. The flange according to any of preceding items, wherein the trench extends along at least a part of the circumference of the flange rim.

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4. The flange according to any of preceding items, wherein the depth of the trench is gradually increasing towards the channel.

5. The flange according to any of preceding items, wherein the channel is adapted for collecting or extracting said liquid sample.

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6. The flange according to any of preceding items, wherein the channel extends transversely through at least a part of the side of the flange.

7. The flange according to any of preceding items, wherein the trench and the channel are configured such that when liquid is present in the trench the

connection between the trench and the channel is air-tight.

- 5
8. The flange according to any of preceding items, wherein the channel is located below the trench when the flange rim is oriented horizontally.
9. The flange according to any of preceding items, wherein the channel extends from the trench to the outside of the flange.
- 10
10. The flange according to any of preceding items, wherein the channel is adapted for accommodating extraction means such as a tap valve.
11. The flange according to any of preceding items, further comprising extraction means, such as a tap valve, attached to the outer side of the flange and/or the channel and configured to be in liquid communication with the channel and/or the trench.
- 15
12. The flange according to any of preceding items, wherein the channel comprises a first section in liquid communication with the trench and a second section extending between the first section of the channel and the outer side of the flange and wherein the cross-sectional area of the first section is smaller than the cross-sectional area of the second section.
- 20
13. The flange according to item 12, where the second section of the channel is adapted for accommodating extraction means such as a tap valve.
- 25
14. The flange according to any of preceding items, wherein the channel is adapted to for direct connection to sample analysis equipment.
15. The flange according to any of preceding items, wherein the channel is adapted for permanent or temporary storage of at least a part of the liquid sample.
- 30
16. The flange according to any of preceding items, wherein the channel is adapted for permanent or temporary recirculation of at least a part of the liquid sample back to the liquid flow.
- 35

17. The flange according to any of preceding items, wherein the flange and the channel are adapted for accommodating sensing means for online monitoring of the liquid sample.
- 5 18. The flange according to any of preceding items, further comprising sensing means for online monitoring of the liquid sample.
19. The flange according to any of preceding items, wherein the flange or the channel is adapted for accommodating a cuvette.
- 10 20. The flange according to any of preceding items, further comprising a cuvette incorporated in the flange, preferably in the channel, and in liquid communication with the trench or the channel.
- 15 21. The flange according to any of items 19 or 20, wherein the cuvette is a flow cuvette such as a through flow cuvette.
22. The flange according to item 21, wherein the liquid sample enters the flow cuvette from the trench and the liquid sample is subsequently recirculated back
- 20 into the liquid flow from the flow cuvette.
23. The flange according to any of preceding items, wherein the channel is in liquid communication with the liquid flow.
- 25 24. The flange according to any of preceding items, wherein the flange is primarily manufactured in a corrosion resistant material, such as stainless steel.
25. The flange according to any of preceding items, wherein the flange is primarily manufactured in a plastics material.
- 30 26. The flange according to any of preceding items, wherein the flange is adapted for sampling of a liquid being delivered along a substantially vertical flow path wherein the trench extends in a substantially horizontal plane.

27. The flange according to any of preceding items for use in sampling liquid in a substantially vertical liquid flow path.

5 28. A tube or a pipe comprising at least one flange according to any of preceding items.

29. A method for sampling liquid from a substantially vertical liquid flow path comprising the steps of:

- 10
- collecting a liquid sample in a horizontal trench located in a horizontal flange in the flow path, and
 - extracting at least a part of the liquid sample through a channel in the side of the flange,
 - 15 and/or
 - monitoring the liquid flow .

30. The method according to item 29, wherein said flange comprises the features according to any of items 1 to 26.

Claims

- 5 1. A flange for sampling a liquid flow from a substantially vertical liquid flow path comprising a trench located on the flange rim and adapted for collecting and/or housing a liquid sample and a channel for collecting or extracting said liquid sample, said channel extending transversely through at least a part of the side of the flange in liquid communication with said trench.
- 10 2. The flange according to claim 1, wherein the trench extends along at least a part of the circumference of the flange rim.
3. The flange according to any of preceding claims, wherein the trench is located on the inner flange rim.
- 15 4. The flange according to any of preceding claims, wherein the depth of the trench is gradually increasing towards the channel.
- 20 5. The flange according to any of preceding claims, wherein the trench and the channel are configured such that when liquid is present in the trench the connection between the trench and the channel is air-tight.
6. The flange according to any of preceding claims, wherein the channel is located below the trench when the flange rim is oriented horizontally.
- 25 7. The flange according to any of preceding claims, wherein the channel extends from the trench to the outside of the flange.
8. The flange according to any of preceding claims, wherein the channel is adapted for accommodating extraction means such as a tap valve.
- 30 9. The flange according to any of preceding claims, wherein the channel is adapted for permanent or temporary storage of at least a part of the liquid sample.

10. The flange according to any of preceding claims, wherein the channel is adapted for permanent or temporary recirculation of at least a part of the liquid sample back to the liquid flow.
- 5 11. The flange according to any of preceding claims, wherein the flange or the channel is adapted for accommodating a cuvette, such as a flow cuvette, such as a through flow cuvette.
- 10 12. The flange according to any of preceding claims, wherein the flange is adapted for sampling of a liquid being delivered along a substantially vertical flow path wherein the trench extends in a substantially horizontal plane.
13. A tube comprising at least one flange according to any of preceding claims.
- 15 14. A pipe comprising at least one flange according to any of preceding claims.
15. A method for sampling liquid from a substantially vertical liquid flow path comprising the steps of:
- 20 – collecting a liquid sample in a horizontal trench located on the rim of a horizontal flange in the flow path, and
- extracting at least a part of the liquid sample through a channel extending transversely through the side of the flange, and/or
- 25 – monitoring the liquid flow .
16. The method according to claim 15, wherein said flange comprises the features according to any of claims 1 to 12.

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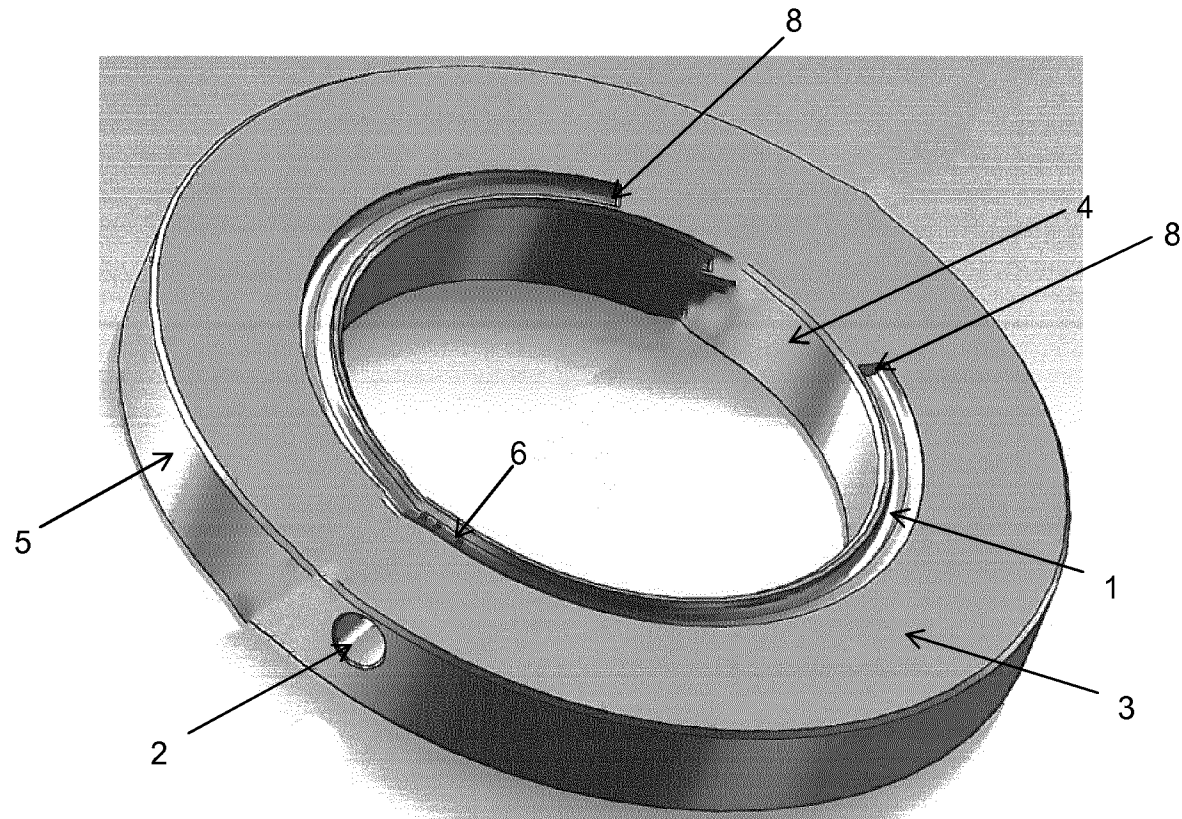


Fig. 1

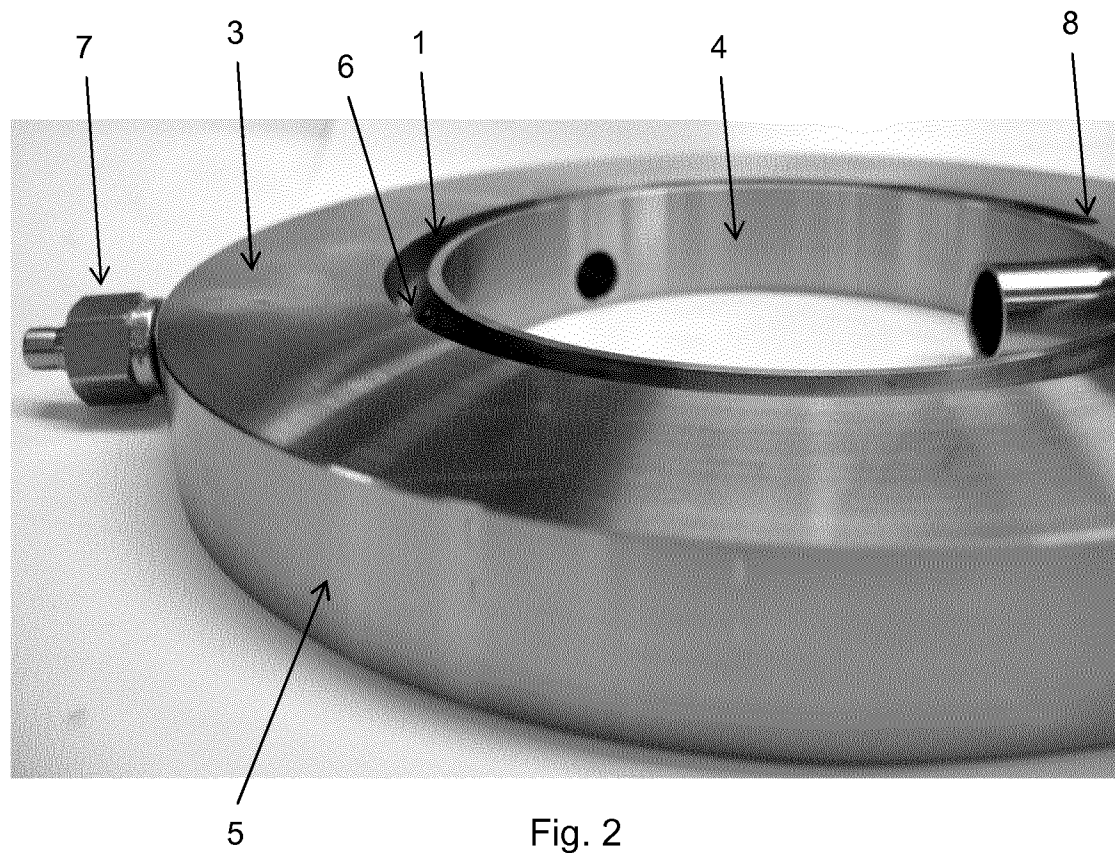
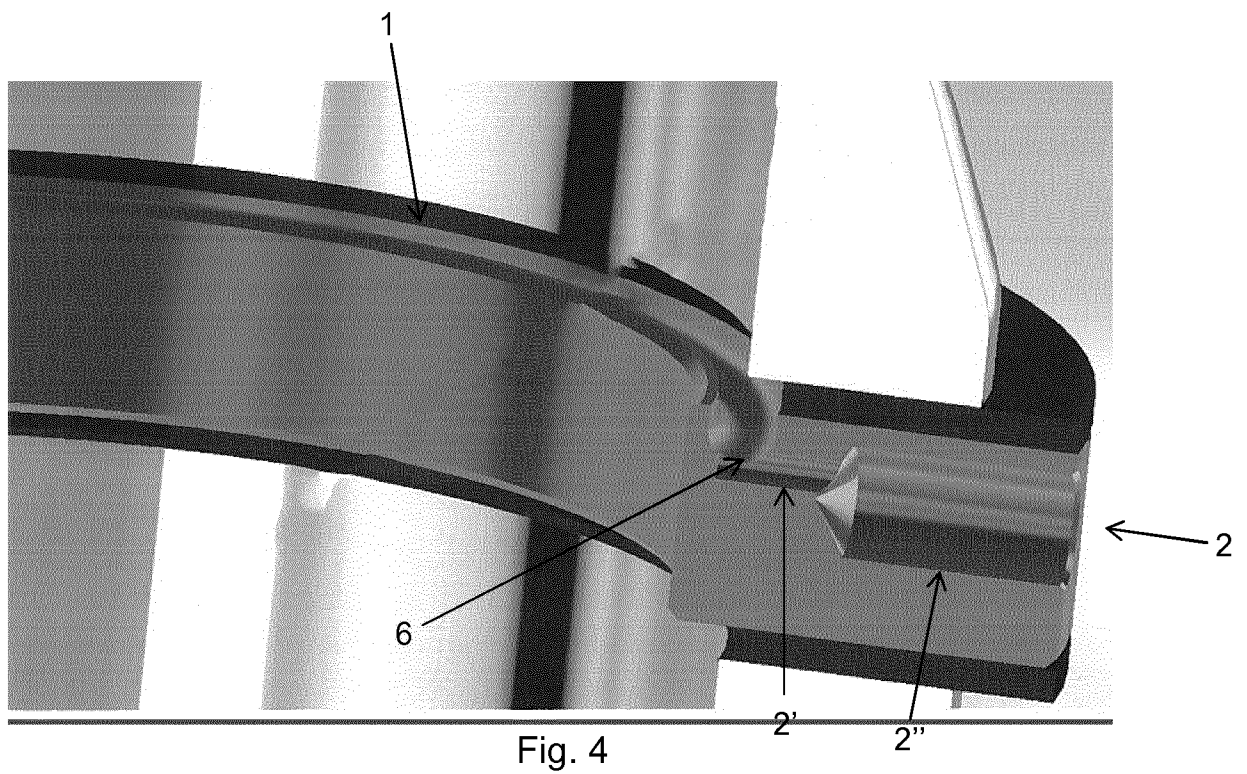
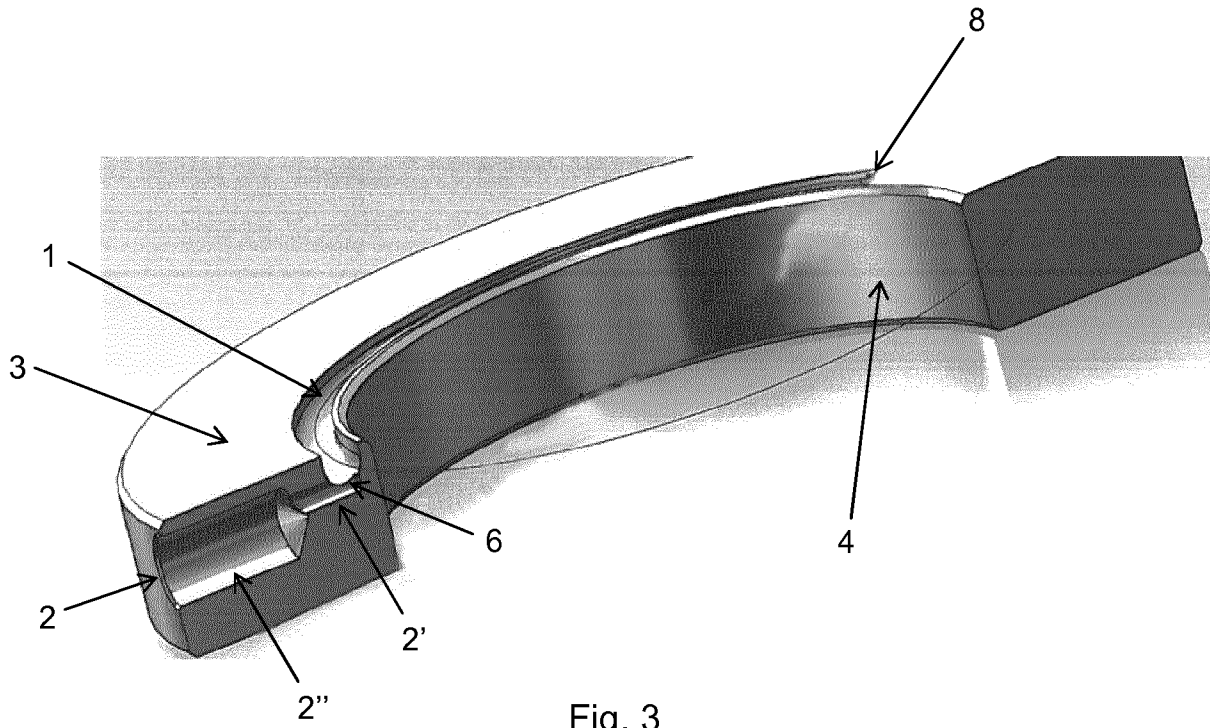


Fig. 2

2 / 3



3 / 3

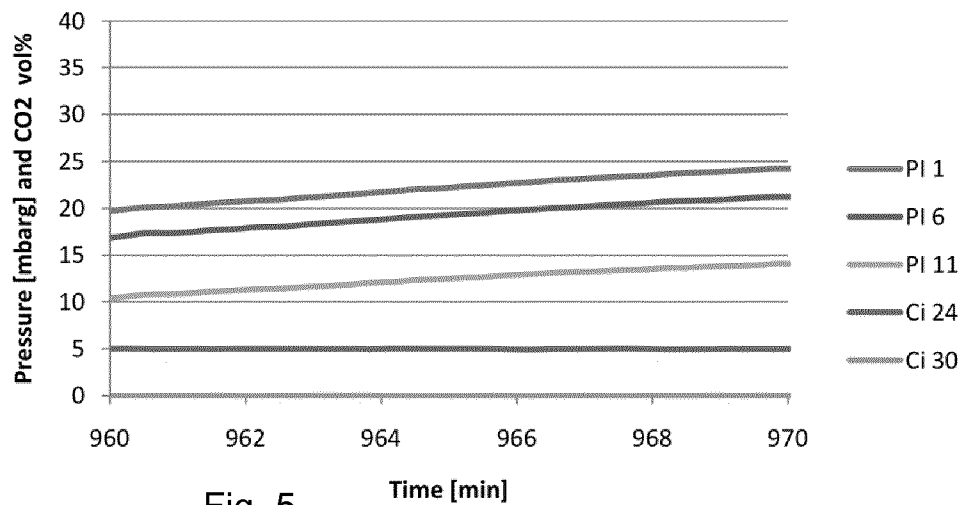


Fig. 5

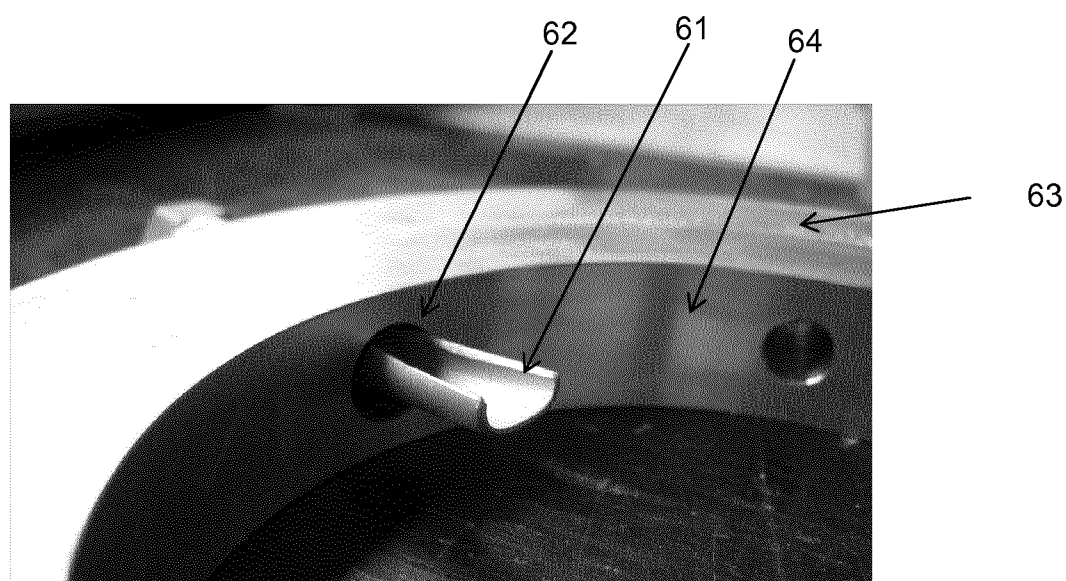


Fig. 6 – PRIOR ART

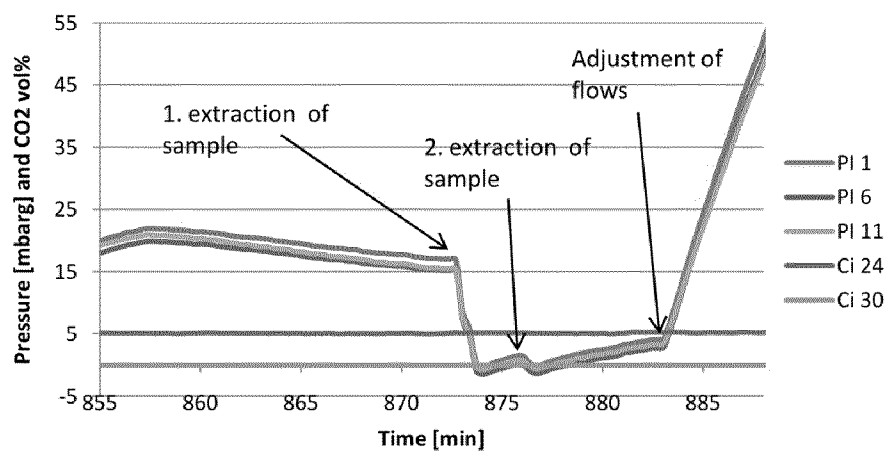


Fig. 7 – PRIOR ART

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2012/061951

A. CLASSIFICATION OF SUBJECT MATTER
INV. G01N1/20
ADD.

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)
G01N

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)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
L	Sønderby, Tim Lyng; Carlsen, Kim Braad; Kjørboe, Lars Georg: "Optimal operation of pilot plant for absorbing CO2 from power plant flue gases using MEA (Bachelor Thesis)", Orbit Result Page 31 December 2010 (2010-12-31), XP002663792, Technical University of Denmark (DTU): Kgs. Lyngby, Denmark Retrieved from the Internet: URL: http://orbit.dtu.dk/All,resultSetTable.recordLink.sdirect?sp=266357 [retrieved on 2011-11-24] the whole document ----- -/--	1-16



Further documents are listed in the continuation of Box C.



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Date of the actual completion of the international search

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INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2012/061951

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	AF HENRIK KRISTENSEN ET AL: "Fjernelse af kuldioxid fra røggaser", DANSK KEMI, vol. 90, no. 2, 9 February 2009 (2009-02-09), pages 10-13, XP055009498, Glostrup, DK ISSN: 0011-6335 figures page 12 -----	1-16
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