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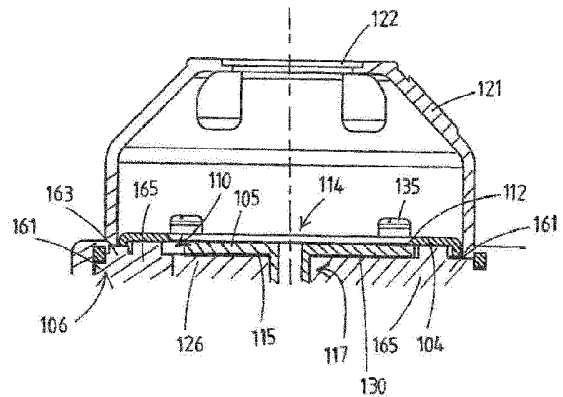
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Gemachtigde:

Ir. H.V. Mertens c.s. te Rijswijk.(54) **Gas flow measuring device.**

(57) A gas flow measuring device (101) has a housing (121, 123) comprising a gas inlet (124) and a gas outlet (122). A valve with an adjustable restriction (103) and an actuator (107) for adjusting the restriction (103) is arranged between the gas inlet (124) and the gas outlet (122) for restricting the gas flow from the gas inlet (124) to the gas outlet (122). The restriction (103) comprises a substantially circular-shaped rotatable disc (105) having a first and an opposite second disc surface, and at least one disc passage (110); and a mount (106) having a mount surface (126) facing and contacting the first disc surface (116), and a mount passage (111). At least one of the first disc surface (116) and the mount surface (126) comprises a ring-shaped area (130) extending above the surface thereof contacting the other one of the first disc surface (116) and the mount surface (126). The mount (106) further comprises a ring-shaped part (104) contacting the second disc surface (112).



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Gas flow measuring device

FIELD OF THE INVENTION

The invention relates to a gas flow measuring device or gas meter, and more specifically to a gas flow measuring device comprising a valve for restricting the gas flow through the device.

BACKGROUND OF THE INVENTION

Various embodiments of gas flow measuring devices or gas meters comprising a valve for restricting a gas flow through the gas meter are known.

Reference EP0370557 relates to a method and device for measuring a quantity of gas flowing through a pipe provided with an adjustable valve or restriction having a number of selectable restriction areas, each having associated therewith a pair of an upper limit pressure difference and a lower limit pressure difference, said pair of limits providing a range of measurable values of pressure difference. The method comprises: measurement of the pressure difference over the restriction, selecting a larger or smaller restriction area when the measured pressure difference is greater or smaller respectively than the upper limit pressure difference or lower limit pressure difference respectively of the presently selected restriction area, and determining the quantity of gas by computing the product of the actual pressure difference and a factor depending on the presently selected restriction area.

It will be apparent that in the calculation of the quantity of gas flowing through the restriction, the factor representing a presently selected restriction area plays a crucial role for precisely calculating the flow quantity. The plurality of these factors, each one for another selected restriction area, may also be referred to as valve-position constants K_n . For each selected restriction area, the corresponding K_n is required to be carefully defined during calibration of the gas flow measuring device.

The restriction according to EP0370557, however, is formed by a rotary disc sandwiched between two stationary discs, which results in considerable friction to be overcome when the rotary disc is moved from one angular position to another when selecting a restriction area. This gives rise to considerable inaccuracies in the desired angular positions, and poor repeatability and reproducibility of the angular positions, such that calibrating the gas flow measuring device takes considerable time.

Even if the valve-position constants K_n have been defined and stored in the calibration procedure, still, due to the variable friction factors during actual use and circumstances of the gas flow measuring device, the valve (restriction) of the gas flow measuring device may not be set to the anticipated or desired position predefined during the calibration procedure.

- 5 Accordingly, the accuracy of the measurement of the gas flow passing through the valve is impaired.

SUMMARY OF THE INVENTION

- 10 It would be desirable to provide a gas flow measuring device comprising a valve for restricting the gas flow through the gas meter to mitigate the disadvantages as mentioned above.

To better address one or more of these concerns, a gas flow measuring device having a housing comprising a gas inlet and a gas outlet is provided.

- 15 The gas flow measuring device comprises a valve arranged between the gas inlet and the gas outlet for restricting the gas flow from the gas inlet to the gas outlet. The valve comprises an adjustable restriction. The restriction comprises: a circular-shaped rotatable disc having a disc center, a disc radius, a first disc surface, an opposite second disc surface, and at least one disc passage extending near an outer circumference of the disc along a
20 predetermined angular section defined by a first angle, wherein the disc center is coupled to the actuator for setting an angular position of the disc; and a mount having a mount surface facing and contacting the first disc surface, and at least one mount passage extending along a predetermined angular section defined by a second angle. At least one of the first disc surface and the mount surface comprises a ring-shaped area extending above the surface
25 thereof contacting the other one of the first disc surface and the mount surface. The mount further comprises a ring-shaped part contacting the second disc surface.

- The ring-shaped area can be formed either at the mount surface, at the first disc surface, or at both the mount surface and the first disc surface. The ring-shaped area defines a first contact area between the mount and the disc. The remainder of any of the surfaces
30 may be recessed and not in contact with the other one of the first disc surface and the mount surface. Therefore, the first contact area between the mount surface and the first disc surface is relatively small. Any friction caused at the first contact area when moving the disc relative to the mount during calibration and actual use of the gas flow measuring device is low accordingly. The low friction results in a very good repeatability and reproducibility of a setting
35 of an angular position of the disc relative to the mount, and thus of a very good repeatability and reproducibility of a restriction area of a restriction formed by the disc and the mount. Accordingly, the valve-position constants used in determining a gas flow in the gas flow

measuring device remain stably and accurately related to the actual restriction area set in the device, without requiring any measurement and feedback of the disc position.

The ring-shaped area can also be provided by a separate ring-shaped element arranged between the mount surface and the first disc surface in order to obtain a small first
5 contact area between the mount surface and the first disc surface.

The ring-shaped area comprises an outer ring periphery and an inner ring periphery. A radius of the outer ring periphery is at most equal to the radius of the first disc surface. A radius of the inner ring periphery is smaller than both the radius of the outer ring periphery and the radius of the first disc surface. A radius of a recessed area may be substantially the
10 same as of the radius of the inner ring periphery.

A second contact area between the mount and the disc may be formed between a ring-shaped part of the mount and the second disc surface.

The second contact area comprises an outer periphery formed by an outer periphery of the rotatable disc contacted by the ring-shaped part of the mount, and an inner periphery
15 formed by an inner ring periphery of the ring-shaped part of the mount contacted by the rotatable disc.

As the radius of the rotatable disc is almost the same as of the inner ring periphery of the ring-shaped part of the mount, the second contact area between the ring-shaped part of the mount and the second disc surface is small. The friction generated in the second contact
20 area by moving the disc relative to the mount is low accordingly.

The ring-shaped part of the mount may be an independent element arranged in contact with the second disc surface.

Any of the first contact area and the second contact area can also be formed as a sealing for preventing gas from flowing through the first contact area and/or the second
25 contact area so as to allow a gas flow from the gas inlet to the gas outlet only through the disc passage and the mount passage.

In an embodiment, the first angle for defining the predetermined angular section of the disc is at most 180 degrees, thereby providing an optimum area for the disc passage.

In an embodiment, the disk passage has an edge, wherein the edge is located in an
30 area defined by a first radius, a second radius, and the first angle, wherein the second radius is larger than the first radius.

In an embodiment, the second radius is substantially the same as the disc radius.

In an embodiment, the mount passage has an edge, wherein the edge is located in an area defined by a third radius, a fourth radius, and the second angle, wherein the fourth
35 radius is larger than the third radius.

In an embodiment, the third radius is at most equal to the first radius, and the fourth radius is at least equal to the second radius, and the second angle is at least equal to the first angle.

Alternatively, in an embodiment, the first radius is at most equal to the third radius, and
5 the second radius is at least equal to the fourth radius, and the first angle is at least equal to the second angle.

In an embodiment, an orientation of the mount passage is the same as an orientation of the disc passage, when the mount passage and the disc passage are asymmetric.

In a further embodiment, the mount passage is congruent to the disc passage and the
10 mount passage is alignable with the disc passage in one angular position of the disc.

As defined in the above embodiments, the shape of the disc passage and the shape of the mount passage are formed in such a manner that when the rotatable disc is rotated to one or more predetermined positions, the disc passage is not restricted by the mount passage or vice versa. Thus, in said one or more predetermined positions, the gas can pass
15 through the full area of at least one of the disc passage and the mount passage.

In an embodiment, a radial width of at least one of the disc passage and the mount passage increases proportionally from a first angular position to a second angular position in the predetermined angular section of the disc and the predetermined angular section of the mount, respectively.

20 In an embodiment, the maximum radial width of at least one of the disc passage and the mount passage is about one third of the disc radius.

In an embodiment, at least one of the disc passage and the mount passage has substantially a shape of a side view of a disintegrating droplet curved around a central area of the disc or around a central area of the mount, respectively.

25 In an embodiment, the ring-shaped part of the mount contacts at least a portion of a circumferential edge of the second disc surface and the second disc surface at a radius which is greater than the second radius.

In an embodiment, the ring-shaped part contacts the second disc surface within a circular area defined by the first radius.

30 In an embodiment, the actuator comprises a stepping motor coupled to the disc for setting an angular position of the disc relative to the mount.

These and other aspects of the invention will be more readily appreciated as the same becomes better understood by reference to the following detailed description and considered in connection with the accompanying drawings in which like reference symbols designate like
35 parts.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 schematically and partially in cross-section illustrates an embodiment of a gas flow measuring device, or gas meter, and its functioning.

Fig. 2 shows a graph, illustrating the operation of the gas meter shown in fig. 1, of the pressure difference dP over a restriction in a housing as a function of a quantity Q of gas flowing through the housing, depending on the restriction area.

Fig. 3 shows an exploded view of a gas meter according to an embodiment of the invention.

Fig. 4a shows a side view of a mount of a gas meter according to an embodiment of the invention.

Fig. 4b shows a top view of a mount of a gas meter according to an embodiment of the invention.

Fig. 5a shows a cross-sectional view of a substantially circular-shaped rotatable disc of a restriction of a gas meter according to an embodiment of the invention.

Fig. 5b shows a top view of a substantially circular-shaped rotatable disc of a restriction of a gas meter according to an embodiment of the invention.

Fig. 5c shows a side view of a substantially circular-shaped rotatable disc of a restriction of a gas meter according to an embodiment of the invention.

Fig. 5d shows a bottom view of a substantially circular-shaped rotatable disc of a restriction of a gas meter according to an embodiment of the invention.

Fig. 6a shows a cross-sectional view of a ring-shaped part of a mount of a restriction of a gas meter according to an embodiment of the invention.

Fig. 6b shows a top view of a ring-shaped part of a mount of a restriction of a gas meter according to an embodiment of the invention.

Fig. 6c shows a side view of a ring-shaped part of a mount of a restriction of a gas meter according to an embodiment of the invention.

Fig. 6d shows a bottom view of a ring-shaped part of a mount of a restriction of a gas meter according to an embodiment of the invention.

Fig. 7 shows an exploded view of a valve (restriction) of a gas meter according to an embodiment of the invention.

Fig. 8a shows a top view of a valve (restriction) assembly of a gas meter according to an embodiment of the invention.

Fig. 8b shows a cross-sectional view of a valve (restriction) assembly of a gas meter according to an embodiment of the invention.

DETAILED DESCRIPTION OF EMBODIMENTS

In the Figures, first a method of measuring a gas flow through an adjustable restriction will be explained by reference to Figures 1, 2, 3a and 3b. Then, an improved restriction construction will be explained by reference to the remaining Figures.

5 In Figure 1, the gas flow measuring device, briefly indicated as gas meter, comprises a housing 1 through which gas can flow in the direction indicated by the arrows 2. The housing 1 has a restriction 3 comprising a mount 4 and a rotatable disc 5 which contact each other and are disposed at right angles to the direction 2 of the flow of gas in the housing 1. The mount 4 rests in sealing fashion against the inside wall of the housing 1, and the disc 5 is rotatable by means of a stepping motor 7, which is disposed in the housing 1 in such a way
10 (not shown) that it does not rotate, and comprises a shaft 8 which is coupled to the centre of the disc 5. The mount 4 and the disc 5 each have a passage 9 and 10, respectively. Through suitable control of the stepping motor 7 the passage 10 can be turned more or less, or completely, opposite the passage 9 (as will be illustrated in further detail below), so that the area, which will also be called restriction area below, of the common passage of the mount 4
15 and the disc 5 can be set for the gas. For this, the stepping motor 7 is connected to a processing circuit 13, which is also connected to an absolute temperature sensor 14 disposed in the housing 1, an absolute pressure sensor 15 disposed in the housing 1, a differential pressure sensor 16, which is connected by means of pipes 17 and 18 to the spaces on either side of the restriction 3, a control panel 19, a display panel 20, and a memory 21.

20 Figure 2 depicts a graph showing relationships between pressure differences dP, up to a maximum pressure difference (dP max). As can be seen from the graph shown in Figure 2 by way of example, a pressure difference dP measured by the pressure difference meter 16 is zero when the gas is at a standstill in the housing 1 and the quantity Q of gas flowing through the housing 1 per unit of time thus is zero. At a particular restriction area, the
25 pressure difference will change in approximately linear fashion as a function of the quantity Q of gas flowing through the housing 1. This applies to each of the areas which can be set for the restriction 3. In Figure 2, the line parts indicated by A1, A2 and A3 correspond to respective increasing restriction areas. With a particular restriction area it is therefore the case that the quantity Q of gas flowing through the housing 1 is approximately equal to the
30 product of the pressure difference dP and the selected restriction surface A_i ($i = 1, 2, \dots$), as represented in the following formula (1):

$$Q = dP \cdot A_i \quad (1)$$

35 The quantity Q must, however, be adjusted for the absolute temperature T_a in the housing 1, the absolute pressure P_a in the housing 1, and the properties of the gas, as represented in the following formula (2):

$$Q = dP \cdot k \quad (2)$$

in which k is a function of A_i , T_a , P_a and the gas properties.

It is also desirable to refer the quantity of gas measured per unit time to a standard quantity for a standard temperature T_n and a standard pressure P_n , as represented in the following formula (3):

$$Q = dP \cdot (P_a/T_a) \cdot K_n \quad (3)$$

in which K_n is a function of k and T_n and P_n .

In accordance with the formula (3) given above, the quantity of gas flowing through the housing 1 per unit time is thus determined depending on the current pressure difference dP .

If, as shown in Figure 2, the pressure difference dP for a selected restriction area rises above a certain value, in Figure 2 chosen equal to $(dP \text{ max})$ for all restriction areas, the processing circuit 13 through appropriate control of the stepping motor 7 selects a greater restriction area, and the processing circuit 13 selects a smaller restriction area when the pressure difference falls below a minimum pressure difference corresponding to the current restriction area. The transition for the choice between two different restriction surfaces may have a hysteresis, as shown in Figure 2 by the vertical lines provided with arrows. This counteracts oscillation of the measurement.

Through use of the mount 4 and the disc 5 for the restriction, and by taking into account the pressure difference dP when determining the quantity Q of gas flowing through the housing 1, a large measuring range for the gas quantity is obtained.

A different, more extensive, representation of the calculations to be made is as follows. The symbols used are:

D_p = pressure difference over valve (restriction)

P_a = absolute pressure of medium (gas)

T_a = absolute temperature of medium

Vol = the amount of medium passed in a certain time

$K_1 \dots K_n$ = valve-position constants for positions 1 through n

Q = amount of flow of medium through valve

Q_n = idem in respect to 273.15 K and 1013.33 mbar

Exp = exponent between 0.5 and 1, depending on the shapes of the valve

Rho = density of medium, compensated for P_a and T_a

R_{gas} = a density constant of a certain medium (gas)

v = velocity of the medium in the valve.

C = constant depending on Kn.

t = time passed between two calculations of Vol

The velocity of the medium inside the valve is:

5

$$v = C \cdot (2 \cdot \text{Rho} \cdot Dp)^{\text{Exp}}$$

with $\text{Rho} = R_{\text{gas}} \cdot P_a / T_a$.

The flow Q is:

10

$$Q = K_n \cdot v$$

To normalize the flow, we use the well-known formula:

15

$$Q_n = Q \cdot (P_a / P_n) \cdot (T_n / T_a)$$

with $P_n = 1013.33$ mbar and $T_n = 273.15$ K.

Then, the passed amount of medium is:

20

$$\text{Vol} = Q_n \cdot t$$

Thus, the complete formula is:

$$\text{Vol} = K_n \cdot C \cdot (2 \cdot \text{Rho} \cdot Dp)^{\text{Exp}} \cdot t \cdot (P_a / P_n) \cdot (T_n / T_a) \quad (4)$$

25

The total delivered volume of medium is:

$$\text{Vol}(\text{new}) = \text{Vol}(\text{old}) + \text{Vol}$$

30

From the above formula (4) it will be apparent that the calculation of the volume is dependent on the characteristics of the gas actually to be measured and several constraints. Therefore, the positions of the valve and thus the restriction areas to be selected with associated upper and lower limits of the pressure difference ranges will be defined during calibration of the gas meter for the actual circumstances.

35

The first position of the valve has a lower limit of zero for both flow and pressure. The upper pressure limit is equal for all positions. The lower pressure limit is higher for higher flow-ranges. This is because of the exponent in the formula for the flow, which causes less

accuracy with lower pressure. So it is important to increase the lower pressure limit with increasing flow.

Also a certain hysteresis is necessary to prevent the valve to oscillate between two adjacent positions. There are two ways to establish this hysteresis: by pressure or by flow.

- 5 The hysteresis is only calculated when the position has to be decreased. Increasing the position happens always when the pressure difference exceeds the upper limit.

Figure 3 shows an exploded view of a gas meter according to an embodiment of the invention. In Figure 3, the gas meter 101 comprises a housing comprising housing parts 121, 123. The housing part 123 comprises a gas inlet 124 (not shown in detail in Figure 3), and the
10 housing part 121 comprises a gas outlet 122, through which the gas can flow in the direction indicated by the arrows as shown on the housing parts 121, 123 at a place close to the gas inlet 124 and the gas outlet 122. The housing part 121 comprises a plurality of protrusions 190. The housing part 123 comprises a plurality of recesses 192.

The gas meter 101 comprises a valve located between the inlet 124 and the outlet
15 122. The valve comprises an adjustable restriction 103 and a stepping motor 107 with a drive shaft 108 for adjusting the restriction 103, as will be explained in more detail below.

The restriction 103 comprises a substantially circular-shaped rotatable disc 105 and a mount 106 having a ring-shaped part 104. The mount 106 has a hole 117. The disc 105 may be coupled to the shaft 108 through the hole 117 of the mount 106. The mount 106 comprises
20 a mount passage 111. The disc 105 comprises a disc passage 110. The mount passage 111 is congruent to the disc passage 110 and the mount passage 111 is alignable with the disc passage 110 in one angular position of the disc 105. Both the disc passage 110 and the mount passage 111 have essentially a shape of a side view of a disintegrating droplet curved around a central area 114 (Figure 9) of the disc 105 and around a central area 117 of the
25 mount surface 126, respectively. The ring-shaped part 104 may be mounted on mount 106, and may be in contact with each other in a sealed fashion. The disc 105 is in contact with both the mount 106 and the ring-shaped part 104 and may be driven in rotation by the stepping motor 107.

The stepping motor 107 comprises a cylinder-shaped body and a square-shaped
30 mounting plate 184. The plate 184 is coupled to the restriction 103, more specifically, to the mount 106. The shaft 108 protrudes through the plate 184.

The gas meter 101 comprises a substantially cubic-shaped box 125 provided to enclose the stepping motor 107.

The restriction 103 is used for restricting the gas flow from the gas inlet 124 to the gas
35 outlet 122. More specifically, via suitable control of the stepping motor 107, the disc passage 110 can be rotated in one or more predefined positions which are not aligned with the mount passage 111 so as to overlap part of the mount passage 111. Therefore, an adjustable

restriction area can be formed by the combined disc passage 110 and the mount passage 111 to restrict the gas flow.

5 The protrusions 190 of the housing 121 and the recesses 192 of the housing 123 are used for placing a plate forming, together with the housing part 121, an enclosure for the circuitry and power supply and other structures as illustrated in Figure 1.

Figures 4a and 4b show a side view and a top view, respectively, of a mount of a gas meter according to an embodiment of the invention as depicted in Figure 3.

10 In Figure 4a, the mount 106 comprises a base 161 and a ring-shaped part 165. The ring-shaped part 165 is located on top of the base 161. A protrusion 129 is located on top of the base 161 and is outside the ring-shaped part 165.

The ring-shaped part 165 is configured to be coupled to the ring-shaped part 104 of the mount 106, and may be coupled in a sealed fashion.

The protrusion 129 is provided to prevent the ring-shaped part 104 relative to the mount 106 against rotation.

15 According to Figure 4b, the ring-shaped part 165 comprises four holes 127. The four holes 127 are located on top of the ring-shaped part 165. More specifically, the four holes 127 are evenly distributed, and located on top of the ring-shaped part 165. A mounting surface 126 is formed on top of the base 161. The mounting surface 126 is surrounded by an inner wall of the ring-shaped part 165. The hole 117 is formed at the center of the mount surface 126 of the mount 106. The mount passage 111 is formed in the mount surface 126 extending along a predetermined angular section of the mount surface 126 defined by an angle a_2 . The angle a_2 is about 180 degrees, and may be less than 180 degrees. The mount passage 111 has an edge 142. The edge 142 is located in an area 144 (as delimited by a dashed line as shown in Figure 4b) defined by a third radius R_3 , a fourth radius R_4 and the angle a_2 . The 20 fourth radius R_4 is larger than the third radius R_3 . The fourth radius R_4 is substantially the same as the radius of the mount surface 126, as measured from the center of the hole 117. The edge 142 has essentially the shape of a side view of a disintegrating droplet curved around the hole 117 of the mount surface 126.

25 The holes 127 are used for connecting the mount 106 with the ring-shaped part 104 through bolting.

Figures 5a, 5b, 5c and 5d show a cross-sectional view, a top view, a side view and a bottom view, respectively, of a substantially circular-shaped rotatable disc of a gas meter according to an embodiment of the invention as depicted in figure 3.

35 According to Figures 5a-5d, the rotatable disc 105 comprises a hole 114, a first disc surface 116, a second disc surface 112, and a ring-shaped area 130. The first disc surface 116 is opposite to the second disc surface 112. The disc 105 further comprises a disc center 113. A hole 114 is located at the center of the disc 105 and is inside the disc center 113. A

recessed area 115 is formed by the remainder of the first disc surface 116 other than the ring-shaped area 130.

The first disc surface 116 is used for coupling the disc 105 to the mount surface 126. The second disc surface 112 is used for coupling the disc 105 to the ring-shaped part 104 of the mount 106. The disc center 113 is used for coupling the disc 105 to the shaft 108 of the stepping motor 107 for setting an angular position of the disc 105, where the shaft 108 is arranged to penetrate through the hole 117 of the mount surface 126. The ring-shaped area 130 is used for contacting the mount surface 126. Thus, the recess area 115 is not in contact with the mount surface 126.

According in particular to Figure 5b, the disk 105 comprises a disc passage 110 extending near an outer circumference 136 of the disc 105 along a predetermined angular section of the disc 105 defined by an angle α_1 . The angle α_1 is about 180 degrees. The disk passage 110 has a first edge part 132 and a second edge part 133. The first edge part 132 and the second edge part 133 are located in an area 134 (the dashed area as shown in Figure 5b) defined by a first radius R1, a second radius R2 and the angle α_1 . The second radius R2 is larger than the first radius R1. The second radius R2 is substantially the same as the radius of the rotatable disc 105. The edge parts 132, 133 substantially have the shape of a side view of a part of a disintegrating droplet curved around the hole 114. The first edge part 132 is a semi-circular curve with a radius relatively larger than R1. The second edge part 133 is a substantially semi-circular curve with a diameter that is about one third of the radius of the second disc surface 112. The shape of the edge parts 132, 133 of the disc passage 110 is congruent to the shape of the edge of the mount passage 111.

According to Figure 5d, the radius of the recessed area 115 is smaller than the first radius R1.

Figures 6a, 6b, 6c and 6d show a cross-sectional view, a top view, a side view and a bottom view, respectively, of a ring-shaped part 104 of a mount of a gas meter according to an embodiment of the invention as depicted in Figure 3.

According to Figure 6a, the ring-shaped part 104 comprises a first ring-shaped surface 194, an opposite second ring-shaped surface 195 and a ring-shaped periphery 199. Four holes 125 are located at the first ring-shaped surface 194. A recess 128 is located at the ring-shaped periphery 199. The first ring-shaped surface 194 comprises a circular outer edge 193 and a circular inner edge 154. The second ring-shaped surface 195 comprises a circular inner edge 156. An oblique surface 196 is formed by extending circumferentially from the inner edge 154 of the first ring-shaped surface 194 towards the inner edge 156 of the second ring-shaped surface 195. The ring-shaped periphery 199 comprises a circular outer edge 198 and a circular inner edge 197. The radius of the inner edge 197 of the periphery 199 is the same as of the outer edge 193 of the first ring-shaped surface 194.

According to Figure 6b, the holes 125 are evenly distributed and located at the first ring-shaped surface 194. An outer surface 201 of the hole 125 is interiorly contacted with the ring-shaped outer edge 193. The second ring-shaped inner edge 156 forms a circular hole 150 at the second ring-shaped surface 194.

5 According to Figure 6d, a circular recess 152 is formed by the periphery 199 and the second ring-shaped surface 195. The outer radius of the circular recess 152 is the same as of the inner edge 197.

The holes 125 are used for coupling the ring-shaped part 104 to the mount 106 through a bolt connection and holes 127. The second ring-shaped surface 195 is used for
10 contacting with the second disc surface 112. The circular hole 150 is used for reducing a contact area between the ring-shaped part 104 and disc 105. The circular recess 152 is used for contacting the ring-shaped part 165 of the mount 106. The recess 128 is used for coupling to the protrusion 129 of the mount 106 to rotationally lock the connection between the mount 106 and the ring-shaped part 104 of the mount 106.

15 Figure 7 shows an exploded view in perspective of a valve (restriction) of a gas meter according to an embodiment of the invention as depicted in Figure 3.

According to Figure 7, the disc 105 is located on top of the mount 106. The ring-shaped part 104 is located on top of the disc 105 and the mount 106. The holes 125 in the ring-shaped part 104 are aligned with the holes 127 in the mount 106. The hole 114 in the
20 disc 105 is co-axial with the hole 117 in the mount 106. The recess 128 in the ring-shaped part 104 is in contact with the protrusion 129 of the mount 106. The orientation of the mount passage 111 in the mount 106 is the same as the orientation of the disc passage 110 in the disc 105.

Figures 8a and 8b show a top view and a cross-sectional view of a valve (restriction)
25 assembly of a gas meter according to an embodiment of the invention.

According to Figure 8a, the holes 125 in the ring-shaped part 104 are aligned with the holes 127 in the mount 106, and bolts 135 are used to couple the ring-shaped part 104 and the mount 106. The recess 128 in the ring-shaped part 104 is in contact with the protrusion 129 in the mount 106. The disc passage 110 is congruent with the mount passage 111.

30 In some embodiments, the edge of the restriction area may be partly formed by the inner edge 156 of the ring-shaped part 104.

According to Figure 8b, the base 161 of the mount 106 is in contact with the housing 121. The ring-shaped part 165 of the mount 106 is in contact with the second ring-shaped surface 195, where this contact may be in a sealing manner. The ring-shaped area 130 at the
35 first disc surface 116 is in contact with the mount surface 126, which contact may be in a sealed manner. The recess area 115 is not in contact with the mount surface 126. The second disc surface 112 is in contact with the second ring-shaped surface 195 of the ring-

shaped part 104, which contact may be in a sealing manner. The hole 114 of the disc 105 is co-axial with the housing 121 and the hole 117 of the mount 106. The disc center 113 penetrates through the hole 117 of the mount 106.

When rotating the disc 105 relative to the mount 106 and the ring-shaped part 104, a friction occurring between the disc 105 and the mount 106, on the one hand, and between the disc 105 and the ring-shaped part 104 is relatively low. Contact surface areas are small. Accordingly, an angular position set by the stepping motor 107 driving the disc 105 may be very accurate and repeatable, thus contributing to a long-time accurate operation of the restriction of which the disc and the mount form part.

As required, detailed embodiments of the present invention are disclosed herein; however, it is to be understood that the disclosed embodiments are merely exemplary of the invention, which can be embodied in various forms. Therefore, specific structural and functional details disclosed herein are not to be interpreted as limiting, but merely as a basis for the claims and as a representative basis for teaching one skilled in the art to variously employ the present invention in virtually any appropriately detailed structure. Further, the terms and phrases used herein are not intended to be limiting, but rather, to provide an understandable description of the invention.

The terms "a" or "an", as used herein, are defined as one or more than one. The term plurality, as used herein, is defined as two or more than two. The term another, as used herein, is defined as at least a second or more. The terms including and/or having, as used herein, are defined as comprising (i.e., open language, not excluding other elements or steps). Any reference signs in the claims should not be construed as limiting the scope of the claims or the invention.

The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to advantage.

The term coupled, as used herein, is defined as connected, although not necessarily directly, and not necessarily mechanically.

CONCLUSIES

1. Gasstroommeetinrichting (101) met een huis (121, 123) omvattende een gasinlaat (124) en een gasuitlaat (122), en omvattende een klep die is opgesteld tussen de gasinlaat (124) en de gasuitlaat (122) voor het beperken van de gasstroom van de gasinlaat (124) naar de gasuitlaat (122), waarbij de klep een instelbare restrictie (103) en een actuator (107) voor het instellen van de restrictie (103) omvat,

met het kenmerk, dat de restrictie (103) omvat:

een in hoofdzaak cirkelvormige roteerbare schijf (105) met een schijfcentrum (113), een schijfradius, een eerste schijfoppervlak (116), een tegenoverliggend tweede schijfoppervlak (112), en ten minste een schijfdoorgang (110) die zich uitstrekt nabij een buitenomtrek van de schijf (105) over een vooraf bepaalde hoeksectie die is gedefinieerd door een eerste hoek (α_1), waarbij het schijfcentrum (113) is gekoppeld met de actuator (108) voor het instellen van een hoekpositie van de schijf (105); en

een steun (106) met een steunoppervlak (126) dat is gericht naar, en contact maakt met het eerste schijfoppervlak (116) en ten minste een steundoorgang (111) die zich uitstrekt over een vooraf bepaalde hoeksectie die is gedefinieerd door een tweede hoek (α_2),

waarbij ten minste een van het eerste schijfoppervlak (116) en het steunoppervlak (126) een ringvormig gebied (130) omvat dat zich uitstrekt boven het oppervlak daarvan en contact maakt met het andere van het eerste schijfoppervlak (116) en het steunoppervlak (126) en

waarbij de steun (106) verder een ringvormig deel (104) omvat dat contact maakt met het tweede schijfoppervlak (112).

2. Gasstroommeetinrichting volgens conclusie 1, waarbij de eerste hoek (α_1) ten hoogste 180 graden is.

3. Gasstroommeetinrichting volgens conclusie 1 of 2, waarbij de schijfdoorgang (110) een rand (132, 133) heeft, en waarbij de rand (132, 133) zich bevindt in een gebied (134) dat is gedefinieerd door een eerste radius (R_1), een tweede radius (R_2) en de eerste hoek (α_1), waarbij de tweede radius (R_2) groter dan de eerste radius (R_1) is.

4. Gasstroommeetinrichting volgens conclusie 3, waarbij de tweede radius (R_2) in hoofdzaak dezelfde als de schijfradius is.

5. Gasstroommeetinrichting volgens een of meer van de conclusies 1 – 4, waarbij de

steundoorgang (111) een rand (142) heeft, en waarbij de rand (142) zich bevindt in een gebied (144) dat is gedefinieerd door een derde radius (R3), een vierde radius (R4) en de tweede hoek (α_2), waarbij de vierde radius (R4) groter dan de derde radius (R3) is.

- 5 6. Gasstroommeetinrichting volgens conclusies 3 en 5, waarbij de derde radius (R3) ten hoogste gelijk aan de eerste radius (R1) is, en de vierde radius (R4) ten minste gelijk aan de tweede radius (R2) is, en de tweede hoek (α_2) ten minste gelijk aan de eerste hoek (α_1) is.
- 10 7. Gasstroommeetinrichting volgens conclusies 3 en 5, waarbij de eerste radius (R1) ten hoogste gelijk aan de derde radius (R3) is, en de tweede radius (R2) ten minste gelijk aan de vierde radius (R4) is, en de eerste hoek (α_1) ten minste gelijk aan de tweede hoek (α_2) is.
- 15 8. Gasstroommeetinrichting volgens een of meer van de conclusies 1 – 7, waarbij een oriëntatie van de steundoorgang (111) dezelfde als een oriëntatie van de schijfdoorgang (110) is.
- 20 9. Gasstroommeetinrichting volgens een of meer van de conclusies 1 – 8, waarbij de steundoorgang (111) congruent met de schijfdoorgang (110) is, en de steundoorgang (111) in lijn kan worden gebracht met de schijfdoorgang (110) in een hoekpositie van de schijf (105).
- 25 10. Gasstroommeetinrichting volgens een of meer van de conclusies 1 – 9, waarbij een radiale breedte van ten minste een van de schijfdoorgang (110) en de steundoorgang (111) evenredig toeneemt vanaf een eerste hoekpositie naar een tweede hoekpositie in de vooraf bepaalde hoeksectie van de schijf (105) respectievelijk de vooraf bepaalde hoeksectie van de steun (106).
- 30 11. Gasstroommeetinrichting volgens conclusie 10, waarbij de maximale radiale breedte van ten minste een van de schijfdoorgang (110) en de steundoorgang (111) ongeveer een derde van de schijfradius is.
- 35 12. Gasstroommeetinrichting volgens een of meer van de conclusies 1 – 11, waarbij ten minste een van de schijfdoorgang (110) en de steundoorgang (111) in hoofdzaak een vorm van een zijaanzicht van een desintegrerende druppel die is gekromd rond een centraal

gebied (114) van de schijf (105) respectievelijk rond een centraal gebied (117) van de steun (106) heeft.

13. Gasstroommeetinrichting volgens een of meer van de conclusies 2 – 10, waarbij het
5 ringvormige deel (104) van de steun contact maakt met ten minste een gedeelte van een
omtreksrand (136) van het tweede schijfoppervlak (112) op een radius die groter dan de
tweede radius (R_2) is.
14. Gasstroommeetinrichting volgens een of meer van de conclusies 1 – 13, waarbij het
10 ringvormige deel (104) contact maakt met het tweede schijfoppervlak (112) binnen een
cirkelvormig gebied dat is gedefinieerd door de eerste radius (R_1).
15. Gasstroommeetinrichting volgens een of meer van de conclusies 1 – 14, waarbij de
actuator een stappenmotor (107) omvat die is gekoppeld met de schijf 105) voor het
15 instellen van een hoekpositie van de schijf (105) ten opzichte van de steun (106)

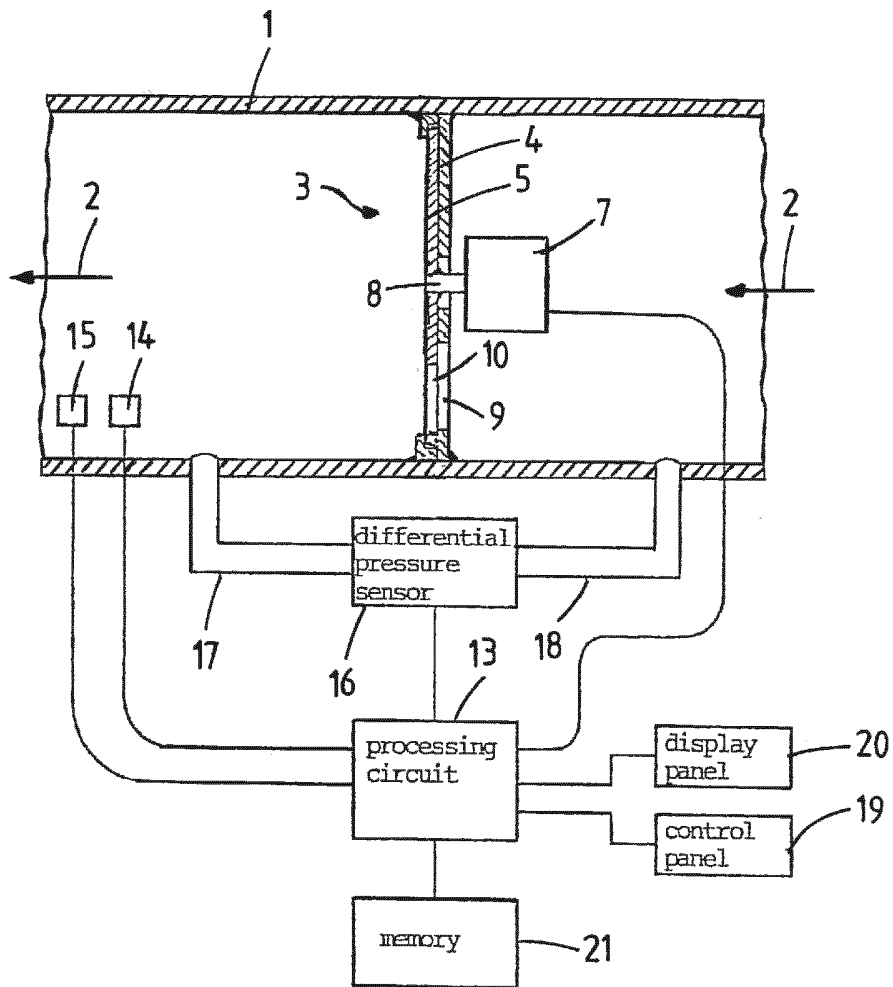


Fig.1

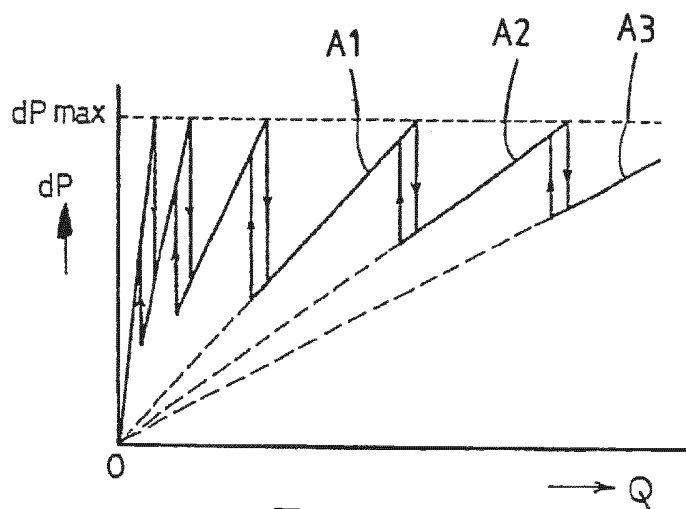
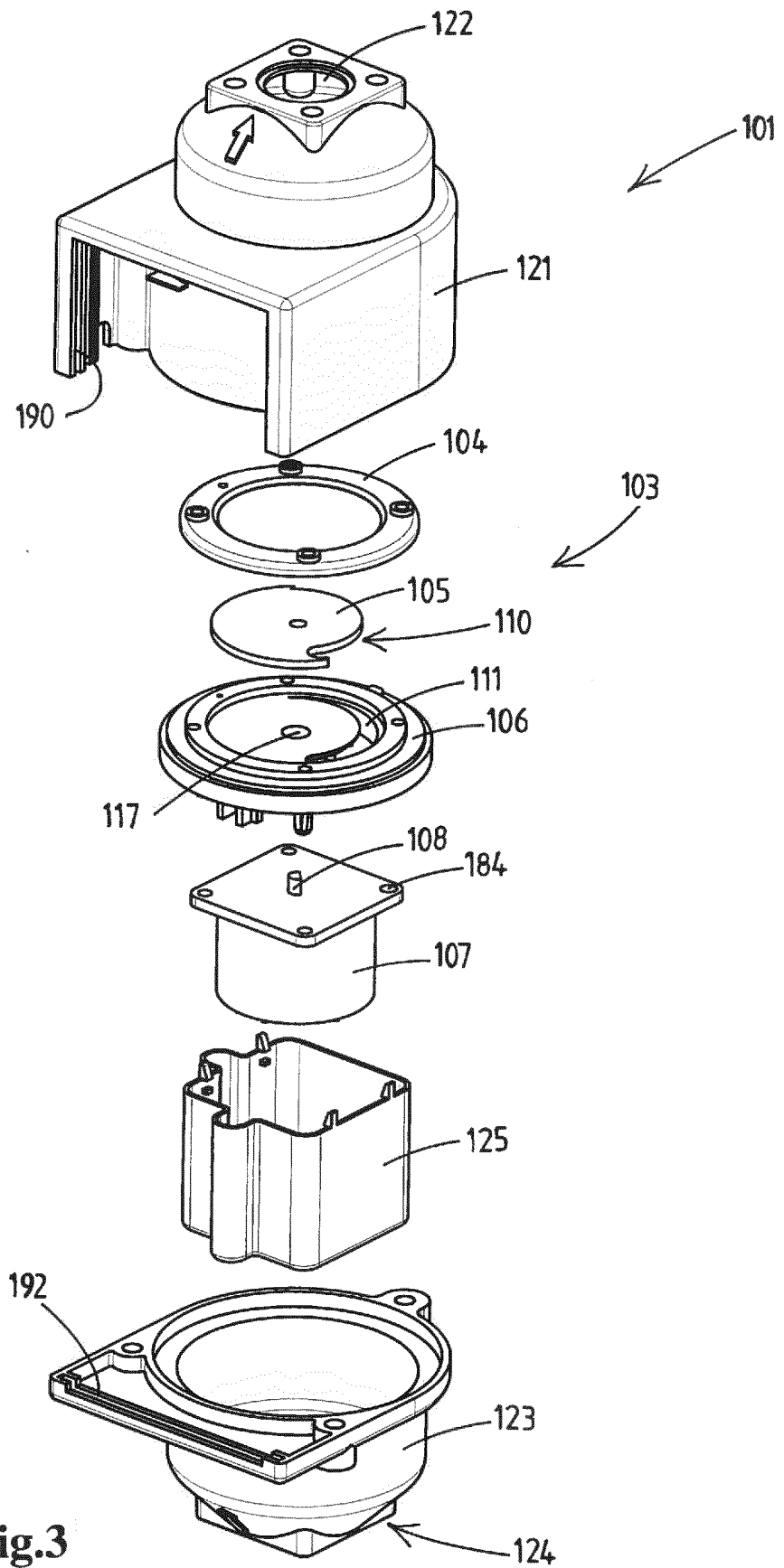
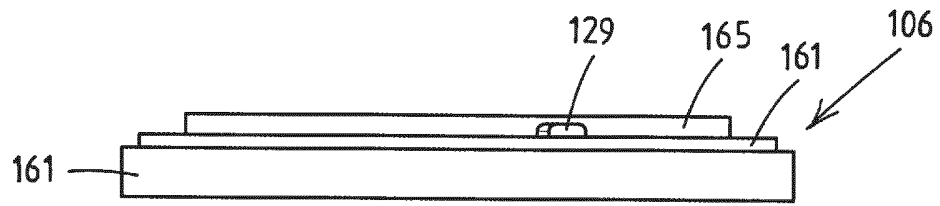
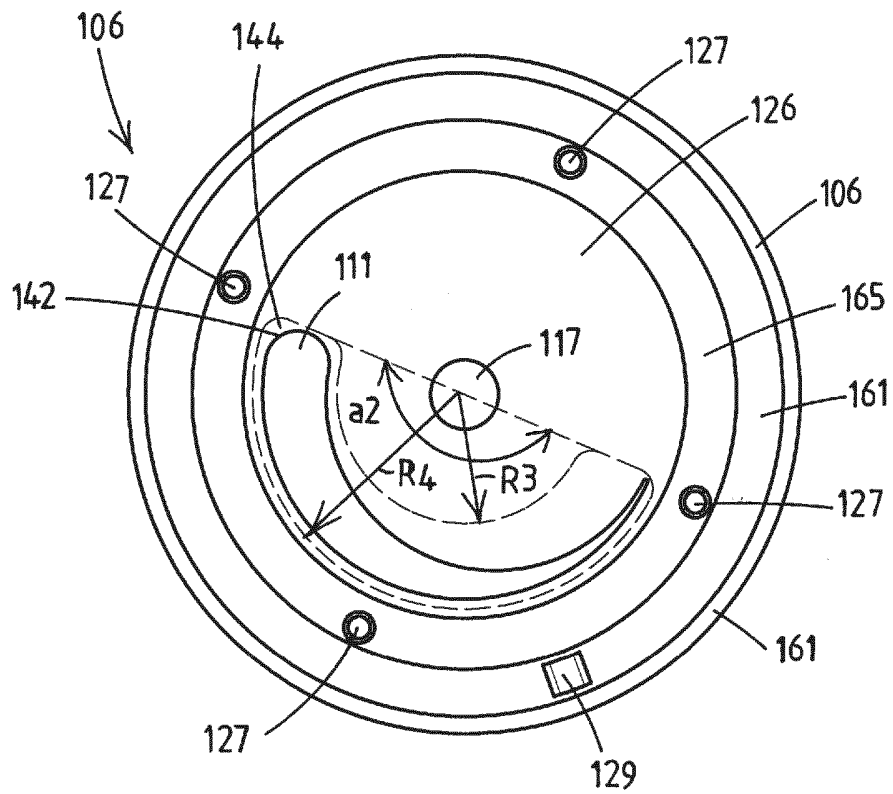
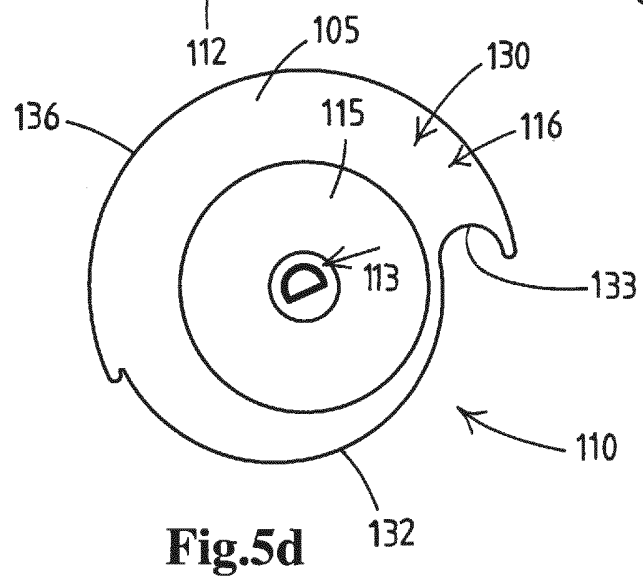
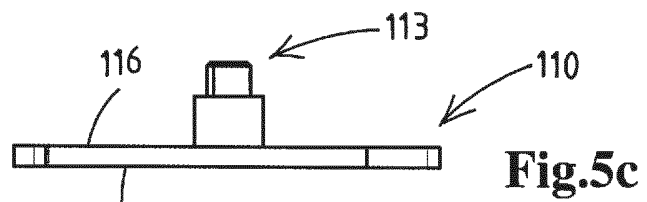
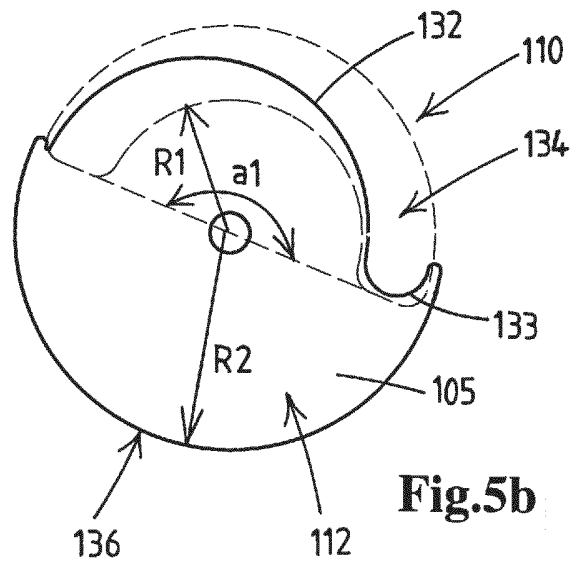
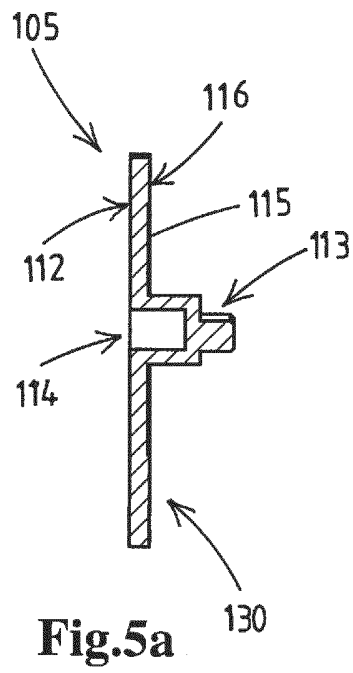
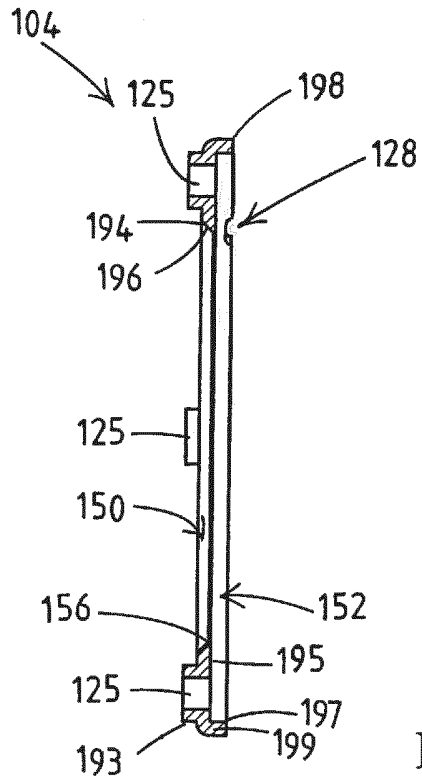
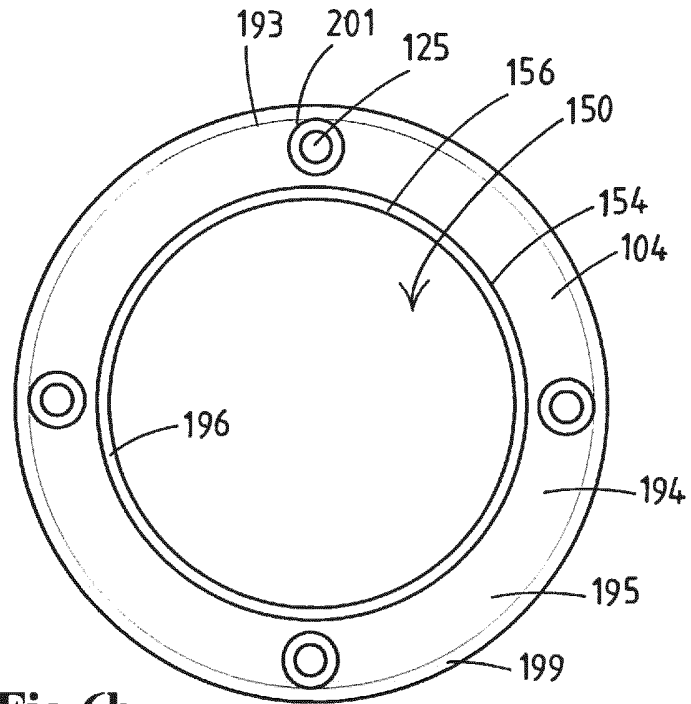
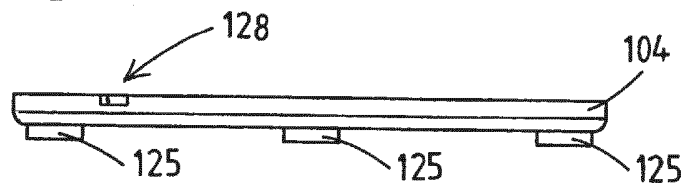
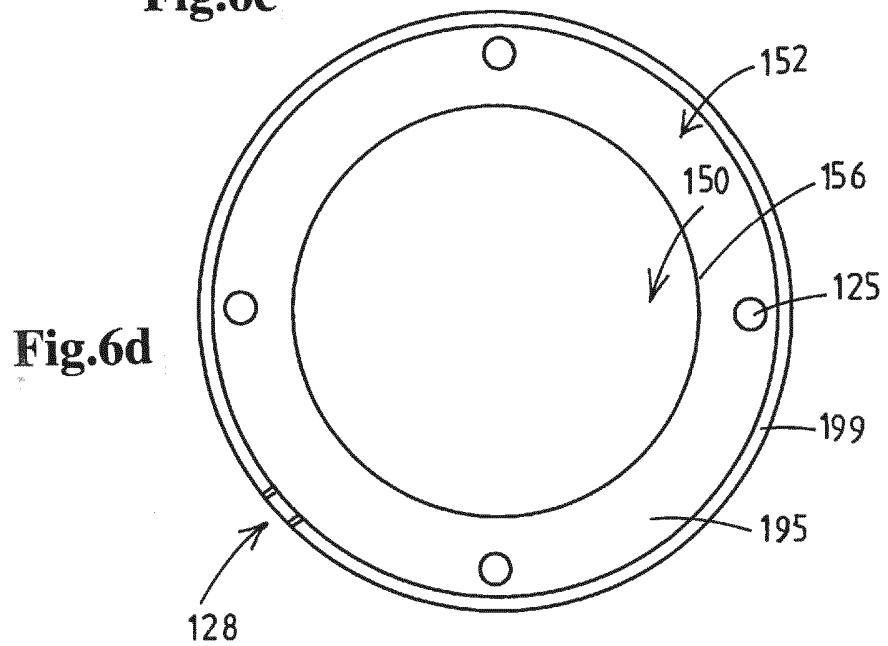


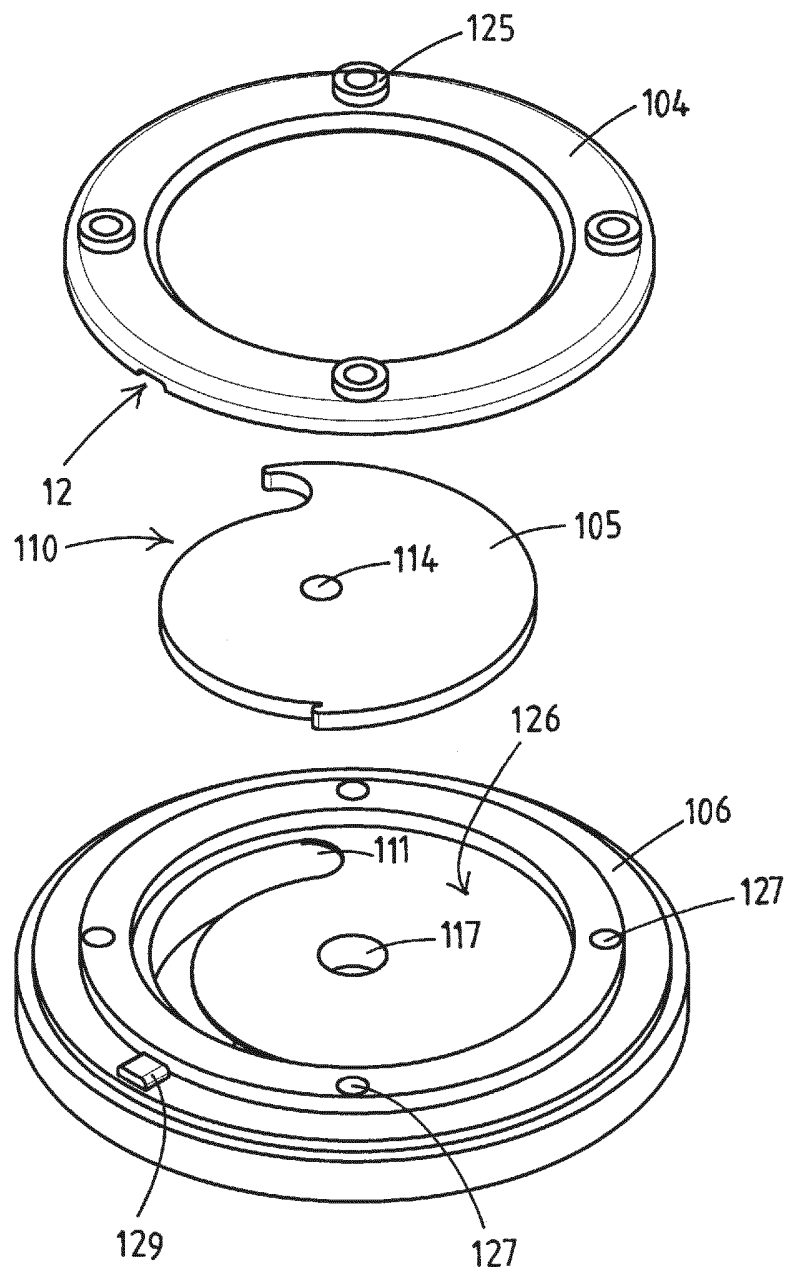
Fig.2

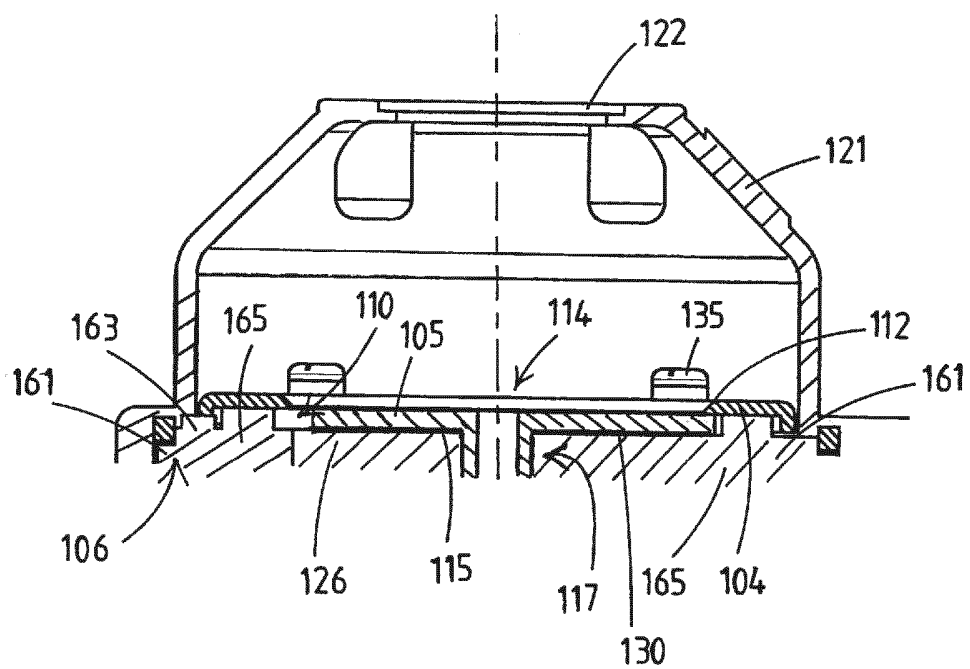
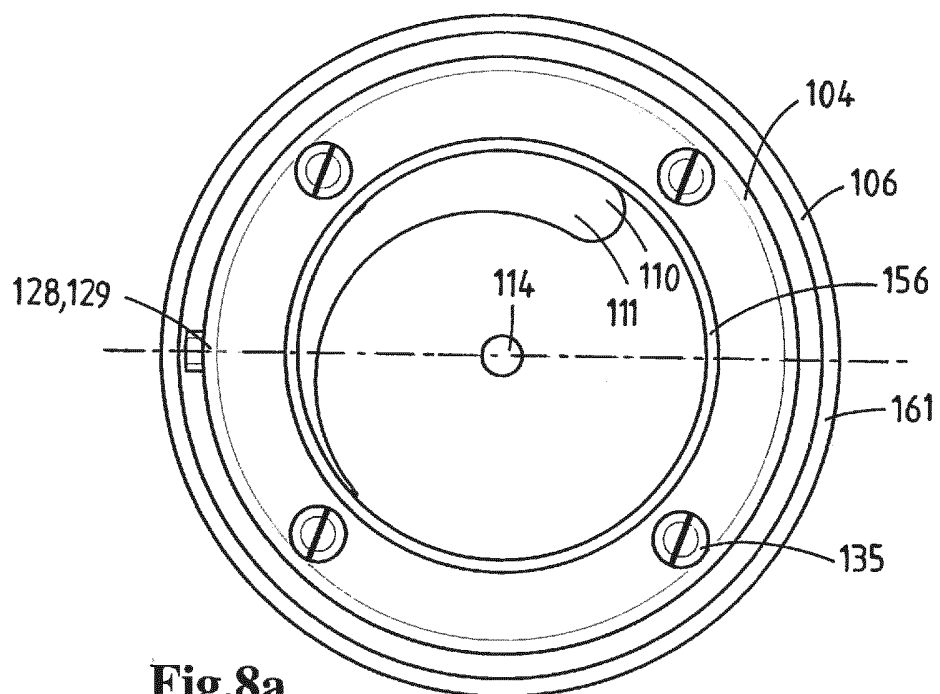
**Fig.3**

**Fig.4a****Fig.4b**



**Fig. 6a****Fig. 6b****Fig. 6c****Fig. 6d**

**Fig.7**





Agentschap NL
Ministerie van Economische Zaken,
Landbouw en Innovatie

OCTROOIAANVRAAG NR.:
NO 138232
NL 2008249

ONDERZOEKSRAPPORT

BETREFFENDE HET RESULTAAT VAN HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK

RELEVANTE LITERATUUR			
Categorie ¹	Literatuur met, voor zover nodig, aanduiding van tekstgedeelten of figuren.	Van belang voor conclusie(s) nr:	Classificatie (IPC)
Y,D	EP 0 370 557 A1 (EMS HOLLAND BV [NL]) 30 mei 1990 (1990-05-30) * het gehele document *	1-15	INV. F16K3/08 G01F1/42
Y	GB 2 064 727 A (BROEN ARMATUR AS) 17 juni 1981 (1981-06-17) * het gehele document *	1-15	
A	WO 97/01807 A1 (MASCO CORP [US]; KNAPP ALFONS [DE]) 16 januari 1997 (1997-01-16) * figuren 1-5 *	1-15	
A	US 2006/011876 A1 (BIESTER KLAUS [DE]) 19 januari 2006 (2006-01-19) * samenvatting; figuren 2,3 *	1-15	
A	DE 34 17 604 C1 (BAT CIGARETTENFAB GMBH) 12 september 1985 (1985-09-12)	1-15	
A	EP 0 325 200 A2 (HITACHI LTD [JP]) 26 juli 1989 (1989-07-26)	1-15	
A	EP 0 406 046 A1 (CICE SA [FR]) 2 januari 1991 (1991-01-02)	1-15	Onderzochte gebieden van de techniek
A	EP 0 373 123 A2 (GALATRON SRL [IT]) 13 juni 1990 (1990-06-13)	1-15	F16K G01F
A	US 4 944 330 A (SAKAKIBARA KOHEI [JP] ET AL) 31 juli 1990 (1990-07-31)	1-15	
Indien gewijzigde conclusies zijn ingediend, heeft dit rapport betrekking op de conclusies ingediend op:			
Plaats van onderzoek: 's-Gravenhage		Datum waarop het onderzoek werd voltooid: 24 oktober 2012	Bevoegd ambtenaar: Verbandt, Yves
¹ CATEGORIE VAN DE VERMELDE LITERATUUR			
X: de conclusie wordt als niet nieuw of niet inventief beschouwd ten opzichte van deze literatuur Y: de conclusie wordt als niet inventief beschouwd ten opzichte van de combinatie van deze literatuur met andere geciteerde literatuur van dezelfde categorie, waarbij de combinatie voor de vakman voor de hand liggend wordt geacht A: niet tot de categorie X of Y behorende literatuur die de stand van de techniek beschrijft O: niet-schriftelijke stand van de techniek P: tussen de voorrangsdatum en de indieningsdatum gepubliceerde literatuur T: na de indieningsdatum of de voorrangsdatum gepubliceerde literatuur die niet bezwarend is voor de octrooiaanvraag, maar wordt vermeld ter verheldering van de theorie of het principe dat ten grondslag ligt aan de uitvinding E: eerdere octrooi(aanvraag), gepubliceerd op of na de indieningsdatum, waarin dezelfde uitvinding wordt beschreven D: in de octrooiaanvraag vermeld L: om andere redenen vermelde literatuur &: lid van dezelfde octrooifamilie of overeenkomstige octrooipublicatie			

**AANHANGSEL BEHORENDE BIJ HET RAPPORT BETREFFENDE
HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK,
UITGEVOERD IN DE OCTROOIAANVRAGE NR.**

NO 138232
NL 2008249

Het aanhangsel bevat een opgave van elders gepubliceerde octrooiaanvragen of octrooien (zogenaamde leden van dezelfde octrooifamilie), die overeenkomen met octrooischriften genoemd in het rapport.

De opgave is samengesteld aan de hand van gegevens uit het computerbestand van het Europees Octrooibureau per
De juistheid en volledigheid van deze opgave wordt noch door het Europees Octrooibureau, noch door het Bureau voor de Industriële eigendom gegarandeerd; de gegevens worden verstrekt voor informatiedoeleinden.

24-10-2012

In het rapport genoemd octrooigeschrift		Datum van publicatie	Overeenkomend(e) geschrift(en)	Datum van publicatie
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EPO FORM P0486

Algemene informatie over dit aanhangsel is gepubliceerd in de 'Official Journal' van het Europees Octrooibureau nr 12/82 blz 448 ev

**AANHANGSEL BEHORENDE BIJ HET RAPPORT BETREFFENDE
HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK,
UITGEVOERD IN DE OCTROOIAANVRAGE NR.**

NO 138232
NL 2008249

Het aanhangsel bevat een opgave van elders gepubliceerde octrooiaanvragen of octrooien (zogenaamde leden van dezelfde octroofamilie), die overeenkomen met octrooischriften genoemd in het rapport.
De opgave is samengesteld aan de hand van gegevens uit het computerbestand van het Europees Octrooibureau per
De juistheid en volledigheid van deze opgave wordt noch door het Europees Octrooibureau, noch door het Bureau voor de Industriële eigendom gegarandeerd; de gegevens worden verstrekt voor informatiedoeleinden.

24-10-2012

In het rapport genoemd octrooigeschrift		Datum van publicatie	Overeenkomend(e) geschrift(en)	Datum van publicatie
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Agentschap NL
Ministerie van Economische Zaken,
Landbouw en Innovatie

SCHRIFTELIJKE OPINIE

DOSSIER NUMMER NO138232	INDIENINGSDATUM 07.02.2012	VOORRANGSDATUM	AANVRAAGNUMMER NL2008249
CLASSIFICATIE INV. F16K3/08 G01F1/42			
AANVRAGER Bertoni Project Development Ltd.			

Deze schriftelijke opinie bevat een toelichting op de volgende onderdelen:

- ☒ Onderdeel I Basis van de schriftelijke opinie
- ☐ Onderdeel II Voorrang
- ☐ Onderdeel III Vaststelling nieuwheid, inventiviteit en industriële toepasbaarheid niet mogelijk
- ☐ Onderdeel IV De aanvraag heeft betrekking op meer dan één uitvinding
- ☒ Onderdeel V Gemotiveerde verklaring ten aanzien van nieuwheid, inventiviteit en industriële toepasbaarheid
- ☐ Onderdeel VI Andere geciteerde documenten
- ☒ Onderdeel VII Overige gebreken
- ☐ Onderdeel VIII Overige opmerkingen

	DE BEVOEGDE AMBTENAAR Verbandt, Yves
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SCHRIFTELIJKE OPINIE

Aanvraag nr.:
NL2008249

Onderdeel I Basis van de Schriftelijke Opinie

1. Deze schriftelijke opinie is opgesteld op basis van de meest recente conclusies ingediend voor aanvang van het onderzoek.
2. Met betrekking tot **nucleotide en/of aminozuur sequenties** die genoemd worden in de aanvraag en relevant zijn voor de uitvinding zoals beschreven in de conclusies, is dit onderzoek gedaan op basis van:
 - a. type materiaal:
 - ☐ sequentie opsomming
 - ☐ tabel met betrekking tot de sequentie lijst
 - b. vorm van het materiaal:
 - ☐ op papier
 - ☐ in elektronische vorm
 - c. moment van indiening/aanlevering:
 - ☐ opgenomen in de aanvraag zoals ingediend
 - ☐ samen met de aanvraag elektronisch ingediend
 - ☐ later aangeleverd voor het onderzoek
3. ☐ In geval er meer dan één versie of kopie van een sequentie opsomming of tabel met betrekking op een sequentie is ingediend of aangeleverd, zijn de benodigde verklaringen ingediend dat de informatie in de latere of additionele kopieën identiek is aan de aanvraag zoals ingediend of niet meer informatie bevatten dan de aanvraag zoals oorspronkelijk werd ingediend.
4. Overige opmerkingen:

SCHRIFTELIJKE OPINIE

Aanvraag nr.:
NL2008249

Onderdeel V Gemotiveerde verklaring ten aanzien van nieuwheid, inventiviteit en industriële toepasbaarheid

1. Verklaring

Nieuwheid	Ja: Conclusies 1-15 Nee: Conclusies
Inventiviteit	Ja: Conclusies Nee: Conclusies 1-15
Industriële toepasbaarheid	Ja: Conclusies 1-15 Nee: Conclusies

2. Citaties en toelichting:

Zie aparte bladzijde

Onderdeel VII Overige gebreken

De volgende gebreken in de vorm of inhoud van de aanvraag zijn opgemerkt:

Zie aparte bladzijde

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

- 1 Reference is made to the following documents:
 - D1 EP 0 370 557 A1 (EMS HOLLAND BV) 30 mei 1990
 - D2 GB 2 064 727 A (BROEN ARMATUR AS) 17 juni 1981
- 2 The present application does not meet the criteria of patentability, because the subject-matter of claim 1 does not involve an inventive step.
- 2.1 D1 may be regarded as being the prior art closest to the subject-matter of claim 1, and discloses (the references between parenthesis refer to this document) :

Gasstroommeetinrichting (Fig. 1) met een huis (1) omvattende een gasinlaat (2) en een gasuitlaat (2), en omvattende een klep (3) die is opgesteld tussen de gasinlaat en de gasuitlaat voor het beperken van de gasstroom van de gasinlaat naar de gasuitlaat, waarbij de klep een instelbare restrictie (3) en een actuator (7) voor het instellen van de restrictie omvat. De restrictie omvat:

 - een in hoofdzaak cirkelvormige roteerbare schijf (5) met een schijfcentrum (8), een schijfradius, een eerste schijfoppervlak, een tegenoverliggend tweede schijfoppervlak, en ten minste een schijfdoorgang (10) die zich uitstrekt nabij een buitenomtrek van de schijf over een vooraf bepaalde hoeksectie, waarbij het schijfcentrum is gekoppeld met de actuator (see Fig. 1) voor het instellen van een hoekpositie van de schijf; en
 - een steun (4) met een steunoppervlak dat is gericht naar, en contact maakt met het eerste schijfoppervlak (see Fig. 1) en ten minste een steundoorgang (9) die zich uitstrekt over een vooraf bepaalde hoeksectie.
- 2.2 The subject-matter of claim 1 therefore differs from this known flow meter and flow restriction device in that rotating disk (5) is configured as an inlay inside support disk (4).
- 2.3 The problem to be solved by the present invention may therefore be regarded as eliminating friction between two stationary support disks (4 and 6 in D1) by eliminating the second stationary disk of the sandwich structure.
- 2.4 The solution proposed in claim 1 of the present application cannot be considered as involving an inventive step for the following reasons: D2 discloses a valve which consists of an inlay disk (10) inside a collar (9) which

is part of a housing (1). Hence, the skilled person would apply the solution of D2 in the flow meter of D1 without the use of inventive skills when faced with the problem of obtaining a smooth flow control.

- 3 Dependent claims 2-15 do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of novelty and/or inventive step, because they specify obvious design options for the skilled person.

Re Item VII

Certain defects in the application

4.1 Claim 1 of the present application is not adequately supported by the description with respect to the following features:

- The inlay disk has a cut-out section (array 134 in Figure 5). The wording "een schijfdoorgang (10) die zich uitstrekt nabij een buitenomtrek van de schijf" does not clearly and unambiguously specify this feature.
- The disclosed gas flow meter is a differential pressure gas flow meter. There is no support for any other flow meter which is also comprised in the wording "Gasstroommeetinrichting".

4.2 On page 13, lines 18-23 a number of grammatically nonsensical specifications are given, which render the application unclear as a whole.