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- (73) Patenthaver: **Naber Holding GmbH & Co. KG, Enschedestrasse 24, 48529 Nordhorn, Tyskland**
- (72) Opfinder: **Friebel, Lennart Simon, Stauffenbergstraße 23b, 49134 Wallenhorst, Tyskland**
Naber, Hans-Joachim, Ootmarsumer Weg 220, 48527 Nordhorn, Tyskland
- (74) Fuldmægtig i Danmark: **Zacco Denmark A/S, Arne Jacobsens Allé 15, 2300 København S, Danmark**
- (54) Benævnelse: **Anordning til volumenstrømregulering i en luftkanal, i hvilken der forefindes en luftstrøm, der genereres af ventilationsindretninger eller lignende**
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Assembly for volume flow regulation in an air duct in which a flow of air is generated by ventilation devices or the like

The invention relates to an Assembly for volume flow regulation in an air duct in which a flow of air is generated by ventilation devices or the like, the assembly comprising a duct and at least one closure element arranged in the duct. The closure element has at least one pair of flaps which, in the direction of fluid flow through the duct, is mounted behind a web extending through the duct cross-section so as to be pivotable about a pivot axis between an open position, in which it at least partially clears the duct cross-section, and a closed position, in which it closes the duct. Such assemblies are used in particular for building ventilation and/or air extraction. An assembly for volume flow regulation is known from CN 203500511 U. Similar assemblies are also known from FR 2 337 840 A1, US 5,245,956 or DE 69 104 267 T2. US 5,245,956 shows an assembly with the features of the preamble of claim 1.

DE 20 2010 003 340 U1 describes a ventilation flap for closing an air duct, a ventilation line or the like, to which fans or other ventilation devices can be connected. A magnet on the flap housing of the ventilation flap is intended to close the ventilation flap securely and prevent unintentional opening and noise generation when there is no air flow generated by ventilation devices or the like. The device described has the disadvantage that it is only suitable for single flap closures and, in addition, a comparatively high flap opening pressure is required to move the flap out of the closed position when an air flow is introduced.

Furthermore, a wall box is known from EP 2 597 391 A1 in which a closure cover is linearly adjustable relative to a guide tube between an open position and a closed position. In the closed position, the cover closes a ventilation opening of the guide tube and is held in this position by magnets, so that the cover only moves out of the closed position if there is an internal tube pressure exceeding the magnetic holding force.

In closure assemblies in which the closure element is formed by a pair of flaps, as described in DE 10 2014 113 210 A1, it is envisaged that the two flaps of the pair of flaps are

pretensioned into the closed position via a leg spring, so that when the volume flow begins, the flaps must be pretensioned against the progressive characteristic curve of the leg spring, which results in a corresponding pressure loss in the channel.

It is therefore the object of the invention to propose an assembly of the type described at the beginning, which enables reliable volume flow regulation in a fluid channel.

This object is solved according to the invention by an assembly having the features of claim 1. The dependent claims each relate to advantageous embodiments of the invention.

Accordingly, the web has at least one first magnetic element, the flaps of the pair of flaps each having at least one second magnetic element that is magnetically coupled to the first magnetic element. The first and second magnetic elements may be, for example, a permanent magnet, a paramagnet, or an electromagnet, in particular an electromagnet with adjustable magnetic field strength. It may have a natural magnetic moment, or an induced magnetic moment. For example, one of the two magnetic elements may be a permanent magnet or an electromagnet, and the other may be a paramagnet that acquires a magnetic dipole moment only upon inductive interaction with the first magnetic element.

The attractive force between the magnetic elements and, accordingly, the closing torque acting on the flaps is at a maximum when the flaps are closed, since in this position the magnetic elements are the smallest distance apart. Opening the flaps increases the distance between the first and second magnetic elements, which leads to a sharp, non-linear drop in the magnetic force and thus also in the closing torque. This effect is amplified by the fact that opening the flaps changes the orientation of the first and second magnetic elements relative to each other. For example, the alignment of the magnetic elements can change from plane-parallel in the closed position to perpendicular in the open position.

Another effect is that when the flap is open, the distance between the magnetic force line of action and the axis of rotation of the flaps is reduced. This leads to a further reduction in the closing torque. Thus, by suitable selection of the various parameters such as magnet type,

magnet strength, initial distance, permeability of the medium between the magnets, almost any desired characteristic of the damper closing torque can be realized.

By setting the desired solenoid parameters, the required cracking pressure can be individually adapted to the installation conditions (compensation of dynamic pressure differences; compensation of structurally induced inclination of the channel). Therefore, a variable setting of the parameters might be necessary. Automatic adjustment to compensate for the pressure dynamics is also conceivable (for example, via an electromagnet).

A fluid in the sense of the invention can in particular be a gas, a liquid or a gas-liquid mixture. The assembly described is particularly suitable for volume flow regulation of an exhaust air duct, for example for the removal of vapors from a fume extraction hood.

It may be provided that the first and second magnetic elements are arranged relative to each other so that they overlap at least proportionally in the closed position.

Further, the first and second magnetic elements may be spaced a minimum distance apart in the closed position, wherein the second magnetic element is guided on a circular path about the pivot axis when the closure element is pivoted from the closed position to the open position so that the second magnetic element is spaced a maximum distance from the first magnetic element in the open position.

In the case where the channel has the at least one first magnetic element, this may be arranged on the inner or outer periphery of the channel. However, such an assembly does not fall within the scope of protection of the claims. When the first magnetic element is arranged at the outer periphery of the channel, it may be provided that a pivot axis of at least one flap of the pair of flaps is passed through a wall of the channel, the pivot axis being connected to the second magnetic element at a distance outside the outer periphery of the channel. In this variant, the complete magnet assembly of the first and second magnetic elements is thus located outside the inner cross-section of the duct, further reducing the pressure drop caused by the closure element. In that case, the second shutter, whose axis is not guided to the outer circumference, would be

movable coupled to the first shutter. A preferred implementation form could be via an interlocking of the two axes.

The preferred cross-sectional shape is circular, although an oval, square or rectangular cross-section is also possible.

It may be provided that the distance of the at least one first magnetic element to the pivot axis is much smaller than a dimension of the flaps perpendicular to the pivot axis, the distance preferably being less than one fifth and particularly preferably less than one tenth of the dimension of the flaps. By reducing the distance to the pivot axis, the closing torque can be reduced. Therefore, an embodiment with variable adjustment of the closing torque via the center distance is also conceivable. In one embodiment, this can be achieved with the aid of magnetic elements mounted in movable slides.

The web can have at least one first magnetic element on opposite sides spaced from the pivot axis in each case, with both flaps of the pair of flaps having at least one of the second magnetic elements in each case. In this case, the first magnetic elements arranged on opposite sides of the web at a distance from the pivot axis can be further spaced apart from one another in the longitudinal direction of the web, preferably vertically spaced apart from one another.

The two flaps of the flap pair can be pivoted about a common pivot axis or via separate, parallel spaced pivot axes.

The web or the channel can have a stop against which at least one of the flaps of the pair of flaps rests in the open position, so that the first and second magnetic elements are arranged at a predetermined distance from each other in the open position. The stop can be arranged on the inner circumference of the channel, for example.

It may further be provided that the first and second magnetic elements each comprise a magnetic element having a magnetic field orientation, the two magnetic field orientations being substantially parallel to each other in the closed position such that the magnetic field

orientations include an angle corresponding to a displacement angle from the closed position to the open position in the open position.

In addition, the web can have a fluid-dynamically optimized contour on a first longitudinal side, which is flowed against when fluid flow is present, with the pivot axis, about which the flaps can be pivoted, being arranged on a second longitudinal side opposite the first longitudinal side and lying in the flow shadow of the web.

If the first and/or the second magnetic elements are designed as electromagnets, this offers the possibility to adjust the restoring torques of the flaps of the pair of flaps and thus to control the volume flow through the duct. Consequently, all that is then required to determine the volume flow is to measure the magnetic force and determine the difference between the internal duct pressure upstream of the closure element and downstream of the closure element. The magnetic force can then be used to determine the opening angle and thus also the pressure loss coefficient (zeta value) of the flaps. With a previously recorded calibration curve, the volume flow in the pipeline can then be calculated with control electronics from the zeta value of the flaps and the pressure difference upstream and downstream of the closing element and controlled accordingly by changing the magnetic force. The electrical lines for controlling the electromagnets can be routed through the web.

It may therefore be provided that at least the first magnetic element comprises an electromagnet with adjustable magnetic field strength, the assembly further comprising a measuring and control unit which determines the volume flow through the channel in dependence on a magnetic attraction force between the first and the second electromagnet and a pressure loss caused by the closure element.

Furthermore, the measuring and control unit can be designed to vary the magnetic field strength to adjust the magnetic attraction force and thus the actuating angle of the flaps in such a way that a predetermined volume flow is established for a given pressure loss. In addition, the measuring and control unit can be designed to determine a pressure loss from a first fluid pressure in the flow direction upstream of the closure element and a fluid pressure in the flow direction downstream of the closure element by forming a difference. The measurement and

control unit can have a database or access a database in which device characteristics are stored, via which a drive current of the electromagnet and a measured pressure loss are set in relation to the resulting volume flow.

Further details of the invention are explained with reference to the figures below. Thereby shows:

- Figure 1 a schematic representation of an embodiment of a closure element according to the invention in the closed position of the flaps;
- Figure 2 a schematic representation of the design according to Figure 1, with one of the flaps in the open position and the other in the closed position;
- Figure 3 a schematic representation of an embodiment of the assembly according to the invention; and
- Figure 4 a schematic representation of an assembly which is not covered by the scope of protection of the claims.

Figures 1 and 2 schematically illustrate the closure element 2 essential for implementing an assembly according to the invention. The closure element 2 essentially consists of a pair of flaps 3, 3' which can be folded about a common pivot axis x from the closed position shown in Figure 1 towards each other into an open position. Instead of a common pivot axis x, the flaps 3, 3' can also be mounted via separate pivot axes spaced parallel to one another.

The swivel axis x is arranged immediately downstream of the web 4 in the direction of fluid flow indicated by the arrow. The swivel axis x can be formed directly on the web 4 or independently of it at a distance, as shown in Figures 1 and 2. The pivot axis x is located in the lee of the web 4. The web 4 has two first magnetic elements 5, each of the first elements 5 being associated with one of the second elements 6. The first and the second elements 5, 6 are arranged at a distance from the pivot axis x. This distance of the first and second elements 5, 6 from the pivot axis x is such that it is very much smaller than a dimension of the flaps 3, 3' perpendicular

to the pivot axis x. For example, the distance of the elements 5, 6 from the pivot axis x can be less than one fifth of the dimension of the flaps 3, 3' perpendicular to the pivot axis x.

In order to avoid mutual interference of the magnet pairs 5, 6, the magnet pairs 5, 6 can be arranged offset, for example at the opposite ends of the web 4 respectively.

The attractive force of the magnetic elements 5, 6 causes the maximum closing torque when the flaps 3, 3' are closed, since in this position the elements 5, 6 have the smallest distance. Opening the flaps 3, 3' increases the distance between the elements 5, 6, which leads to a strong, non-linear drop in the magnetic attraction force and thus also in the closing torque. This effect is further enhanced by the fact that the opening of the flaps 3, 3' changes the orientation of the magnetic elements 5, 6, for example from plane-parallel to perpendicular. Another effect is that when the flap 3, 3' is open, the distance of the magnetic attraction action line (indicated in Fig. 2 by the semicolon lines passing through the pairs of magnets 5, 6) from the pivot axis x of the flaps 3, 3' is reduced. This leads to a further reduction of the closing torque. Thus, by suitable selection of the magnet type, the magnet strength, the initial distance in the closed position, the permeability of the medium between the magnets, etc., almost any desired characteristic of the flap closing torque can be realized.

In particular, the closing torque in the illustrated embodiment is many times smaller when the flap 3, 3' is wide open than in a comparable backwater flap from the prior art, in which the flaps are pretensioned via a leg spring with an identical initial closing torque. For the same volume flow, the closure element 2 of the assembly according to the invention therefore opens significantly wider than in a conventional, spring-actuated backwater flap. In contrast to the progressive characteristic curve of a leg spring, the described magnetic drive of the flaps has a degressive characteristic curve.

The web 4 can further have the function of providing a stop 7 against which the flaps 3, 3' rest in the open position of the closure element 2 and thus assume a defined orientation.

In the embodiment shown in Figure 3, the web 4 has a fluid-dynamically optimized contour 8 on the longitudinal side which is flowed against by the volume flow, so that the first magnetic elements 5 and the second magnetic elements 6 are arranged in the slipstream of the web 4.

The first magnetic elements 5 are designed as electromagnets which can be controlled via a measuring and control unit 9. For this purpose, the measuring and control unit 9 is electrically connected to the first electromagnets 5 via a power line 13, which is routed through a cable duct extending in the longitudinal direction of the web 4. Furthermore, the measuring and control unit 9 is designed to determine the pressure difference caused by the closure element 2. For this purpose, a pressure sensor 12 is arranged in each case in front of the closure element 2 and behind the closure element 2 in the direction of fluid flow, which outputs a corresponding pressure signal to the measuring and control unit 9. Alternatively, the pressure sensors can also be part of the measuring and control unit 9, in which case the measuring and control unit 9 has two pressure lines 10, one of which measures the internal duct pressure in the direction of fluid flow upstream of the closure element 2 and the other measures the internal duct pressure in the direction of fluid flow downstream of the closure element 2.

Figure 4 shows an assembly in which the first and second magnetic elements 5, 6 are arranged outside the inner cross-section of the duct 1 and form part of a measuring and control unit 9 arranged on the outer circumference of the duct. For this purpose, it can be provided, for example, that the pivot axis x of the flaps 3, 3' is passed through the outer circumference of the duct 1 into the measuring and control unit 9 via a rotary bushing, wherein in the measuring and control unit 9 the second magnetic element 6 is connected to the pivot axis x at a distance from the pivot axis x. The assembly according to Figure 4 has the advantage that the use of a web extending through the inner cross-section of the duct 1 is dispensable, so that a further reduction of the pressure loss inside the duct 1 due to the closure element can be realized.

In addition, the flaps 3, 3' can have a flow-optimized contour, which is also designed to reduce the pressure loss caused by the closing element. When using permanent magnets as the first and second magnetic elements 5, 6, it is also possible to set the flap opening pressure to a desired value by varying the distance between the magnets. Furthermore, it is not absolutely necessary that the pairs of magnets 5, 6 are arranged plane-parallel when the flaps 3, 3' are closed. Rather,

it is sufficient that they are sufficiently effect-coupled, which can also be achieved, for example, by an overlapping assembly of the magnetic elements 5, 6. Furthermore, it is expedient to arrange the two pairs of magnetic elements 5, 6 in relation to each other in such a way that they do not substantially magnetically influence each other. This can be achieved, for example, by arranging the two first magnetic elements 5 associated with the web 4 at opposite ends of the web 4 and, correspondingly, the associated second magnetic elements 6 at opposite ends of the flaps 3, 3'.

If the flaps 3, 3' are designed as hollow flaps, for example to exhibit improved thermal insulation, the second magnetic elements 6 can be accommodated in a cavity within the flaps. As described in the republished DE 10 2014 113 210 A1, several of the closure elements 2 according to the invention can also be arranged in series in the channel in order to form a heat-insulating cavity between them in the closed position.

List of reference signs

- | | |
|-------|---------------------------------------|
| 1 | Duct |
| 2 | Closure element |
| 3, 3' | Pair of flaps |
| 4 | Web |
| 5 | First magnetic element |
| 6 | Second magnetic element |
| 7 | Stop |
| 8 | Contour |
| 9 | Measuring and control unit |
| 10 | Pressure line |
| 11 | Cable channel |
| 12 | Pressure sensor/pressure line opening |
| 13 | Power line |
| x | Pivot axis |

P a t e n t k r a v

- 5 **1.** Anordning til volumenstrømregulering i en luftkanal, i hvilken der forefindes en luftstrøm, der genereres af ventilationsindretninger eller lignende, hvor anordningen omfatter en kanal (1) og mindst et lukkeelement (2), der er anbragt i kanalen (1), hvor lukkeelementet (2) omfatter mindst et klappar (3, 3'), der er monteret drejeligt omkring en drejeakse (x) i fluidstrømningsretningen gennem kanalen (1) bag et forbindelsesstykke (4), der strækker sig gennem kanaltværsnittet, mellem en åben stilling, hvori det i det mindste delvist frigiver kanaltværsnittet, og en lukket stilling, hvori det lukker kanalen (1), **kendetegnet ved, at** forbindelsesstykket (4) omfatter mindst et første magnetisk element (5), hvor klapparrets (3, 3') klapper hver især omfatter mindst et andet magnetisk element (6), der er magnetisk koblet med det første magnetiske element (5).
- 10 **2.** Anordning ifølge krav 1, hvor det første og andet magnetiske element (5, 6) er anbragt således i forhold til hinanden, at de i det mindste delvist overlapper hinanden i den lukkede stilling.
- 15 **3.** Anordning ifølge et af de foregående krav, hvor det første og andet magnetiske element (5, 6) indtager en minimal afstand i den lukkede stilling, hvor det andet magnetiske element (6), når lukkeelementet (2) drejes fra den lukkede stilling til den åbne stilling er ført på en cirkelbane omkring drejeaksen (x), således at det andet magnetiske element (6) i den åbne stilling har en maksimal afstand til det første magnetiske element (5).
- 20 **4.** Anordning ifølge et af de foregående krav, hvor afstanden mellem det mindst ene første magnetiske element (5) og drejeaksen (x) er meget mindre end en dimension af klapperne (3, 3') vinkelret på drejeaksen (x), hvor afstanden fortrinsvis er mindre end en femtedel og særligt foretrukket mindre end en tiendedel af klapperne (3, 3') dimension.
- 25 **5.** Anordning ifølge et af de foregående krav, hvor forbindelsesstykket (4) på modsatte sider med afstand til drejeaksen (x) i hvert tilfælde omfatter mindst det første magnetiske element (5), hvor begge klapper af klapparret (3, 3') hver
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- 35

især omfatter mindst et af de andre magnetiske elementer (6).

5 **6.** Anordning ifølge krav 5, hvor de første magnetiske elementer (5), der på modsatte sider af forbindelsesstykket (4) er anbragt med afstand til drejeaksen (x), endvidere har indbyrdes afstand i den forbindelsesstykkets langsgående retning, fortrinsvis har vertikal indbyrdes afstand.

10 **7.** Anordning ifølge et af de foregående krav, hvor de to klapper af klapparret (3, 3') kan drejes omkring en fælles drejeakse (x) eller via separate drejeakser (x) med parallel indbyrdes afstand.

15 **8.** Anordning ifølge et af de foregående krav, hvor forbindelsesstykket (4) eller kanalen (1) omfatter et anslag (7), som mindst en af klapparrets (3, 3') klapper ligger an mod i den åbne stilling, således at det første og andet magnetiske element (5, 6) er anbragt i den åbne stilling i en forudbestemt indbyrdes afstand.

20 **9.** Anordning ifølge et af de foregående krav, hvor det første og/eller andet magnetiske element (5, 6) omfatter en permanentmagnet eller en elektromagnet med indstillelig magnetfeltstyrke.

25 **10.** Anordning ifølge et af de foregående krav, hvor det første og andet magnetiske element (5, 6) hver især omfatter et magnetisk element med en magnetfeltorientering, hvor de to magnetfeltorienteringer i den lukkede stilling i det væsentlige er orienteret parallelt med hinanden, således at magnetfeltorienteringerne i den åbne stilling har en vinkel, der svarer til en indstillingsvinkel fra den lukkede stilling til den åbne stilling.

30 **11.** Anordning ifølge et af de foregående krav, hvor forbindelsesstykket (4) på en første langsgående side, der ved en forekommende fluidstrømning modtager strømmen, har en fluiddynamisk optimeret kontur (8), hvor drejeaksen (x), som klapperne (3, 3') kan drejes omkring, er anbragt på en anden langsgående side, der er modsat den første langsgående side og ligger i forbindelsesstykkets (4) strømningsskygge.

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5 **12.** Anordning ifølge et af de foregående krav, hvor mindst det første magnetiske element (5) omfatter en elektromagnet med indstillelig magnetfeltstyrke, hvor anordningen endvidere omfatter en måle- og reguleringsenhed (9), der afhængigt af en magnetkraft mellem den første og anden elektromagnet (6) og af et tryktab, der forårsages af lukkeelementet (2), bestemmer volumenstrømmen gennem kanalen (1).

10 **13.** Anordning ifølge krav 12, hvor måle- og reguleringsenheden (9) er udformet til ved hjælp af variation af magnetfeltstyrken at indstille magnetkraften og dermed klappernes (3, 3') indstillingsvinkel således, at en forudbestemt volumenstrøm indstiller sig ved et givet tryktab.

15 **14.** Anordning ifølge krav 12 eller 13, hvor måle- og reguleringsenheden (9) er udformet til ud fra et første fluidtryk i strømningsretningen foran det mindst ene lukkeelement (2) og et andet fluidtryk i strømningsretningen bag det mindst ene lukkeelement (2) ved hjælp af differencedannelse at bestemme tryktabet.

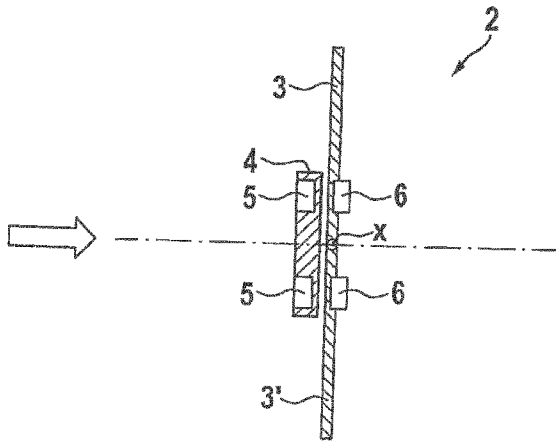


Fig. 1

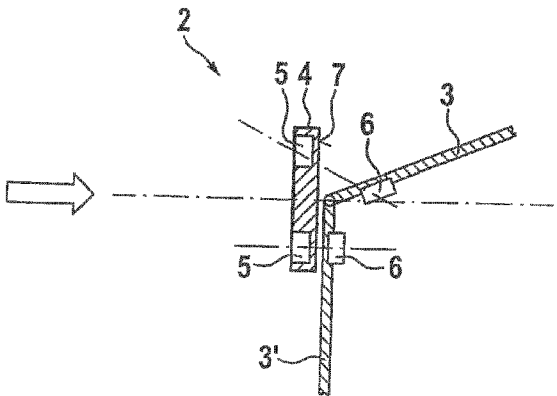


Fig. 2

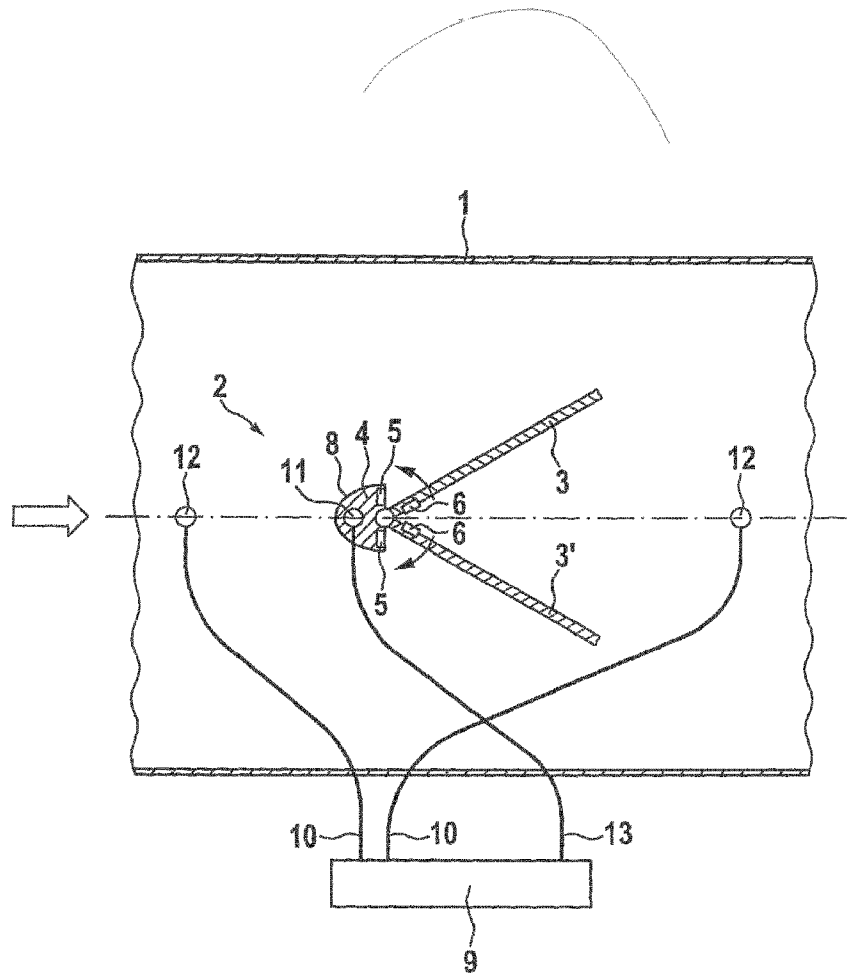


Fig. 3

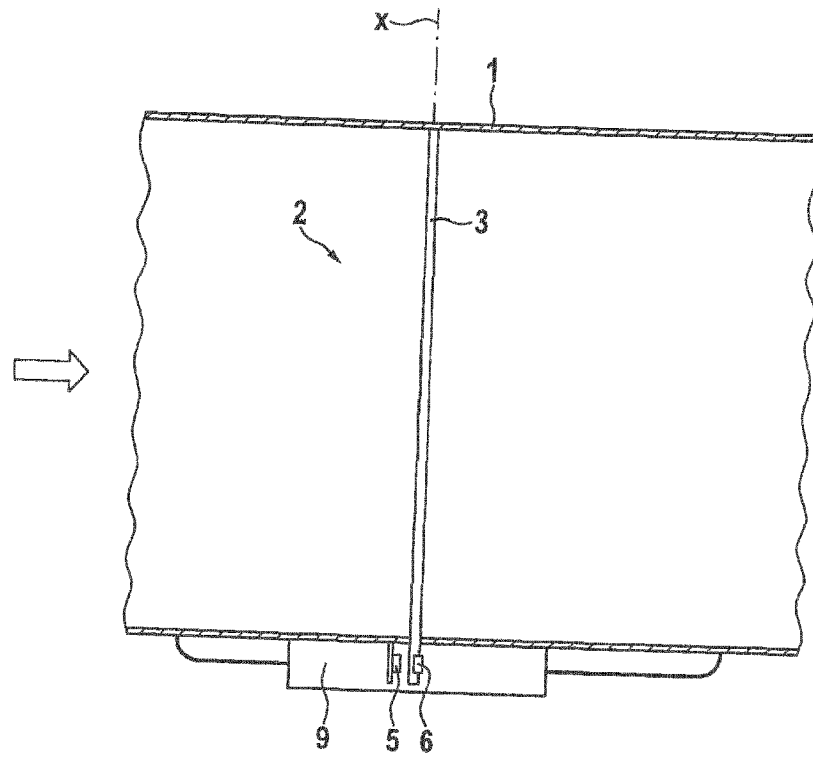


Fig. 4