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(54) **AIR DUCT WITH VARIABLE GEOMETRY HOLES AND RELATED PIPELINE**

LUFTKANAL MIT LÖCHERN VARIABLER GEOMETRIE UND ZUGEHÖRIGE ROHRLEITUNG

CONDUIT D'AIR AVEC TROUS À GÉOMÉTRIE VARIABLE ET CANALISATION
CORRESPONDANTE

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Description

TECHNICAL FIELD

[0001] The present invention relates to the sector of air diffusion systems and apparatus for civil and industrial installations, in particular to the sector of visible ventilation ducts used to heat and cool environments.

BACKGROUND ART

[0002] The state of the art includes various known solutions for choking the outcoming air flows from perforated air ducts. These perforated aeration ducts are pipes, generally of circular or oval section, which on the external surface have a plurality of holes suitable for allowing air to escape from the duct. Basically, the air is pushed into the ventilation duct and from this, through the surface holes, it escapes into an environment. Air ducts are known from DE 33 03 987 A1, DE 32 33 493 A1, US 2 423 241 A, DE 296 02 119 U1 and US 5 111 739 A.

[0003] Ideally, in an air duct which is attached to the ceiling of an environment, the hot air for the winter season and the cold air for the summer season come out in different directions, because the hot air, which tends to rise upwards, must be pushed downwards as much as possible, while the cold air must be blown almost horizontally. These types of aeration, illustrated in Fig. 1A and 1B, therefore make it possible to trigger two directions of air circulation in the environment, one for the winter illustrated in Fig. 1A and one for the summer illustrated in Fig. 1B.

[0004] In order to obtain this effect, there are some known solutions. One type of solution, illustrated in Fig. 1A and 1B, envisages making ducts 100 dedicated to winter ventilation and ducts 100' dedicated to summer ventilation. By means of flow diverters positioned upstream the ducts, it is possible to choose in which ducts the air has to pass through depending on the season, bypassing the other ducts. This solution is mainly used in large environments such as shopping centers or production factories. This solution involves a duplication of costs and two ducts are required for each room, one of which is always not in use.

[0005] Another type of known solution is the one described in document US9599362, in which a longitudinal membrane, positioned inside the duct, allows some holes in the duct to be closed and others to be opened. The membrane is pushed by the air to adhere to the upper side of the duct or, by gravity, to adhere to the lower side of the duct. This solution has the drawback that the air flow rate in the duct must always be higher than a certain value to allow the membrane to move upwards. In long ducts, the loss of flow rate due to air friction means that the membrane cannot move up in the distal portion of the duct.

[0006] A further solution is provided by the document EP0777841A1 which describes a perforated duct

equipped with a septum without holes that can be positioned inside the duct to shutter some holes and leave others free. This solution does not involve a septum actuation, but a stable placement of the septum in certain positions in order to use the same duct in various contexts, such as the corner of the room. In practice, the septum is fixed and serves to close certain holes. This solution allows to adapt a generic duct to various environments, but does not allow to move the partition and therefore to vary the air flows dynamically.

[0007] Finally, the possibility of rotating the entire duct to direct the flows in one direction or another is known in the state of the art. This solution, described in document EP2597392, in addition to being extremely expensive, is very complex because it requires a large actuator that is able to move the entire duct, which is very heavy.

[0008] Document DE3303987 describes a solution in which all the holes have the same shape and size that when they're totally overlapped, deliver an air flow having a first volumetric flow rate, while, when they're partially overlapped, they deliver an air flow having a volumetric flow rate lower than the first one, and, if they do not overlap, they do not deliver any air flow. This solution, as well as that of documents US2423241, DE29602119 and US5111739, describes a shutter with holes equal to those of the air duct, consequently, when these holes partially overlap, the section through which the air passes is a section having irregular and non-symmetrical area, which determines a change in the direction of the air flow leaving the duct and numerous turbulences which affect the delivery efficiency of the air duct.

[0009] In the state of the art there are therefore no ducts with holes having variable geometry, i.e. ducts whose holes can have a variable geometry over time to adapt to the different climatic requirements requested in the environment ventilated by the duct and to vary the air flow exiting the duct. Furthermore, there are no solutions capable of minimizing the losses through those holes which are closed during the variation of the geometry of the holes.

SUMMARY

[0010] A first object of the present invention is to solve the aforementioned drawbacks of the prior art by means of an air duct comprising a tube comprising a first plurality of holes for diffusing an air flow flowing through the duct into an environment; and a shutter coaxial with respect to the tube comprising at least a second plurality of holes. Wherein an actuator is configured to move the shutter relative to the pipe to align or misalign at least part of the first plurality of holes with the at least one second plurality of holes. This solution makes it possible to vary the geometry of the holes in the duct and therefore to dynamically adapt the section of some or all of the holes. Some holes in the duct can therefore be completely open, as in a traditional ventilation duct, and some holes can be partially or totally blocked to vary the flow of air passing

through them. The ventilation of the environment can therefore be customized according to the temperature required in the environment. Where the shutter partially covers all the holes in the tube, the air leaving the duct coincides with the air passing through the holes in the shutter.

[0011] Preferably, the holes of the second plurality of holes can be equal to or larger than the holes of the first plurality of holes. In this way, when the holes of the first and second plurality of holes are aligned, the air that comes out of the duct is the same that passes through the holes in the tube.

[0012] In particular, the first and second plurality of holes can have the same shape, but the same or different dimensions. This allows for complete alignment of the holes which avoids loss of flow.

[0013] Advantageously, the shutter may comprise a third plurality of holes having holes larger than the holes of the second plurality of holes. The third plurality of holes allows the flow to be choked with respect to the second plurality of holes, i.e. obtaining air flows with smaller flow rates through the shutter holes.

[0014] In particular, the holes of the third plurality of holes of the shutter can be smaller than the holes of the first plurality of holes of the tube. In this way, the alignment of the first and third plurality of holes generates a partialization of the air flows leaving the duct.

[0015] Furthermore, the second and third plurality of holes can have the same shape but different size. This allows to uniform air flowing out of the tube holes. Equal shapes of the holes in fact allow to avoid non-uniformity of the air flows along the edge of the holes of the second and third plurality of holes, in particular with respect to holes that overlap only partially.

[0016] In particular, the shutter can have a cylindrical shape. In this way, the longitudinal or rotational sliding of the shutter on the tube is facilitated. Preferably said cylindrical shape can have a diameter slightly different from that of the tube so as to slide on the tube. When the shutter has a slightly larger or slightly smaller diameter than the diameter of the tube, the sliding of the shutter on the tube is allowed without the shutter getting stuck or impinging on the tube. Advantageously, the shutter can assume one or more operating positions. It can assume an operating position in which the second plurality of holes is aligned with at least part of the first plurality of holes in the tube and the third plurality of holes is misaligned with said at least part of the first plurality of holes in the tube to maximize airflow through said at least part of the first plurality of bores of the tube. It can assume an operating position in which the third plurality of holes is aligned with said at least part of the first plurality of holes of the tube and the second plurality of holes is misaligned with said at least part of the first plurality of holes of the tube to choke the flow of outcoming air through said at least part of the first plurality of holes of the tube. It can assume an operating position in which the second plurality of holes and third plurality of holes are misaligned

with at least part of the first plurality of tube holes so that filled portions of the shutter close said at least part of the first plurality of tube holes. These operating positions make it possible to obtain three different volumetric flow rates of air leaving the duct. Thus obtaining a maximum flow rate, an intermediate flow rate or no flow rate through the holes in the duct.

[0017] Advantageously, the actuator can be configured to make the shutter slide longitudinally with respect to the tube. The longitudinal sliding of the shutter with respect to the tube reduces the probability of jamming of the shutter since the cylindrical shutter has a greater longitudinal compressive stiffness than its torsional stiffness. Preferably, the shutter can have a longitudinal length shorter than that of the tube. In this way, the shutter can slide with respect to the tube, otherwise if the shutter had a length equal to or greater than the tube, the sliding would be constrained by the elements arranged upstream and downstream of the duct.

[0018] Alternatively, the actuator can be configured to rotate the shutter relative to the tube. This version of the duct can be more comfortable and effective for short ducts, i.e. less than or equal to one and a half meters in length. In fact, if the duct is not very long, the risk of the shutter twisting decreases.

[0019] Preferably, the shutter can be arranged inside the tube. The optimal placement of the shutter is inside the duct, as the air pressure forces the shutter itself to adhere to the tube, minimizing losses through the portion between the tube and the shutter.

[0020] Advantageously, the duct can comprise two flanges arranged at the ends of the duct so as to form a gap with the tube within which the shutter moves. These two flanges are arranged at the ends of the duct and are shaped in such a way as to form two portions with the tube which, if seen in section, have the shape of a circular crown within which the shutter slides. These portions act as a guide for the shutter and ensure that it does not deform and follows a correct movement.

A second object of the present invention is an air pipeline comprising a plurality of air ducts according to the first object of the present invention. A set of ducts, according to the first object of the present invention, joined together forms an air pipeline. An air duct is therefore a single section of the air pipeline.

[0021] In particular, the air pipeline can comprise a plurality of air ducts comprising two flanges arranged at the ends of the duct so as to form a radial portion with the tube within which the shutter moves. This type of pipeline comprises a plurality of ceiling supports connected to the flanges. The flanges of the interconnection elements between contiguous ducts, protrude radially from the tube. It is therefore possible to connect a support to the flange to connect the duct, and therefore the pipeline, to the ceiling of an environment.

[0022] Preferably, the pipeline can comprise a control unit configured to manage one or more actuators belonging to respective air ducts. The control unit allows you to

manage and coordinate multiple actuators, or a single actuator that operates all the shutters, so that their movements are optimized to ventilate the environment.

[0023] A third object of the present invention is represented by a method of managing the air flows leaving a pipeline comprising a plurality of air ducts, each comprising a tube having a first plurality of holes and an shutter movable coaxially with respect to a tube comprising at least a second plurality of holes. The method comprises the step of moving the shutter of one or more air ducts with respect to the respective tube to align or misalign at least part of the holes of the first plurality of holes of the tube with the holes of the at least second plurality of holes of the shutter. This methodology makes it possible to optimize the air flows, by closing or opening certain holes in the tube during the hot season and opening them during the cold season or by closing certain ducts and leaving others open or according to the operating condition of the thermal machine, also called Heating. Ventilation and Air Conditioning (HVAC).

[0024] In particular, the step of moving one or more shutters can provide that the shutters are moved so that the sum of the volumetric flow rates leaving the first plurality of holes in the pipeline substantially corresponds to the volumetric flow rate entering the pipeline. In this way, the outcoming air flows are optimized at all times.

[0025] These and other advantages will become apparent in more detail from the description, given hereinafter, of an embodiment given by way of example and not of limitation with reference to the attached drawings.

DESCRIPTION OF THE DRAWINGS

[0026] In the drawings:

Fig. 1A illustrates a schematic view of two air ducts according to the known art, one configured for heating during the cold season, which is active, and one configured for cooling during the hot season, which is inactive;

Fig. 1B illustrates a schematic view of two air ducts according to the known art, one configured for heating during the cold season, which is inactive, and one configured for cooling during the hot season, which is active;

Fig. 2 illustrates a schematic view of an air duct and a detail relating to a schematic sectional view of a duct of the duct;

Fig. 3 illustrates a schematic sectional view of a first embodiment of duct when the shutter is in a first operating position;

Fig. 4 illustrates a schematic sectional view of a first embodiment of duct when the shutter is in a second operating position;

Fig. 5 illustrates a schematic sectional view of a first embodiment of duct when the shutter is in a third operating position;

Fig. 6 illustrates a schematic sectional view of a

second embodiment of duct when the shutter is in a first operating position;

Fig. 7 illustrates a schematic sectional view of a second embodiment of duct when the shutter is in a second operating position;

Fig. 8 illustrates a schematic sectional view of a second embodiment of duct when the shutter is in a fourth operating position;

Fig. 9 illustrates a schematic sectional view of a third embodiment provided with a shutter which is in a first operating position on one side and a second operating position on the other;

Fig. 10 illustrates a schematic sectional view of a third embodiment provided with a shutter which is in a second operating position on the one hand and a first operating position on the other;

Fig. 11 illustrates a schematic sectional view of a third embodiment provided with a shutter which is in a third operating position from both sides;

Fig. 12 illustrates a schematic view of a first type of pipeline;

Fig. 13 illustrates a schematic view of a second type of pipeline;

Fig. 14 illustrates a schematic sectional view of a duct equipped with a rotating shutter arranged in an operating position typical of heating during the cold season;

Fig. 15 illustrates a schematic sectional view of a duct equipped with a rotating shutter arranged in an operating position typical of cooling during the hot season;

Fig. 16 illustrates a schematic sectional view of a duct equipped with a translating shutter arranged in an operating position typical of heating during the cold season;

Fig. 17 illustrates a schematic sectional view of a duct equipped with a translating shutter arranged in an operating position typical of cooling during the hot season;

Fig. 18 illustrates a schematic view of a duct equipped with a shutter with two different pluralities of holes in the various operating positions that these pluralities of shutter holes can assume with respect to the holes in the tube.

DETAILED DESCRIPTION

[0027] The following description of one or more embodiments of the invention refers to the attached drawings. The same reference numbers in the drawings identify the same or similar elements. The object of the invention is defined by the attached claims. The technical details, structures or characteristics of the solutions described below can be combined with each other in any way.

[0028] In Fig. 2, the numerical reference 20 identifies an air pipeline for the transport and distribution of air in an environment 30. The pipeline 20 is configured to receive an incoming air flow 9A and to expelling various out-

coming air flows 9B through a first plurality of holes 4. The air pipeline 20 comprises one or more air ducts 1. By connecting various air ducts 1 together, the air pipeline 20 is obtained. In the following, for simplicity, the terms "air pipeline" and "air duct" can be respectively abbreviated as "pipeline" and "duct". In the following, the terminology "plurality of holes" can be abbreviated with the term "holes" to simplify the reading of the text.

[0029] With reference to the detailed drawing in Fig. 2, there is illustrated a duct 1 in longitudinal section. Duct 1 comprises a tube 2 and a shutter 3 movably disposed within the tube 2. Although not shown, the shutter 3 may lie outside the tube 2.

[0030] Shutter 3 is moved by an actuator 8. The actuator 8 in question can be chosen by the expert in the sector from those available in the state of the art. For example, the actuator 8 may be an electric linear actuator comprising a stem or arm configured to extend or contract. A fixed part 8A of the actuator 8 is connected to the duct 1 while a moving part 8B of the actuator 8 is connected to the shutter 3.

[0031] If the shutter 3 is arranged inside the tube 2 as shown in Fig. 2, the tube 2 has a slot 11 within which the moving part 8B of the actuator 8 can move to actuate the shutter 3. A flap gasket can be provided inside this slot 11 to minimize air leaks through it.

[0032] The actuator 8 can also be arranged inside the duct (not illustrated embodiment).

[0033] The actuator 8 can also be configured to move two or more shutters 3, as illustrated in the right-hand side of Fig. 2, in which the shutters 3 of two contiguous ducts 1 are operated by a single actuator 8. In this case, actuator 8 can be of the double-acting type and the shutters 3 can all move in the same direction or in opposite directions. In order to actuate multiple shutters 3 with a single actuator 8, the shutters 3 can be connected to each other. The connection in question (not shown) can lie inside the shutters 3 or pass from the outside of the duct 1. In the latter case, a bracket is fixed to the shutter 3 which protrudes from the tube 2 through a slot and connects to the adjacent shutter 3 passing through a second slot present on the tube 2 of the adjacent shutter 3.

[0034] The ducts 1 of Fig. 2 comprise flanges 10 which allow two ducts 1 to be connected together. The flanges 10 are connected to the tube 2 so as to create, between the tube 2 and the flange 10 itself, a gap G. This gap G prevents the shutter 3 from coming out in a radial or longitudinal direction.

[0035] The flange 10 has a cylindrical portion which penetrates the tube 2 and a disc-shaped portion connected to the cylindrical portion. The gap G is a space between the internal surface of the tube 2 and the external surface of the cylindrical portion of the flange 10. The longitudinal extension of the cylindrical portion of the flange 10 is a function of the longitudinal travel of the shutter 3.

[0036] Shutter 3 is configured to slide on the internal surface of tube 2 in order to limit losses. For this reason,

the shutter 3 is preferably made of a metallic material having a low thickness or with a low friction material such as nylon or PTFE. Alternatively, the tube 2 or the shutter 3 may comprise a layer or surface coating of low friction material, on the side where one faces the other.

[0037] The cylindrical portion of the flange 10 may include, on its outer surface, a gasket (not shown) to reduce flow losses between the flange 10 and the shutter 3. Alternatively, the internal diameter of the shutter 3 may substantially correspond to the outside diameter of the cylindrical portion of the flange 10.

[0038] The length L of the shutter 3 is shorter than the length L' of the tube 2 to allow a longitudinal movement of the shutter 3 without hitting against the flanges 10.

[0039] If the shutter 3 is configured to rotate with respect to the tube 2, the length L of the shutter 3 can be slightly shorter than the length L' of the tube 2, while the characteristics of the gap G substantially correspond to shape of the longitudinal embodiment just described.

[0040] The shutter 3 of Fig. 2, as well as those of Figs. 3-11 are cylindrical and are coaxial to the tube 2. As already mentioned, the diameter D of the shutter 3 is smaller than the diameter D' of the tube 2. In the figures, the difference in diameter is slightly emphasized to make different components clearly distinguishable from each other. It is preferable that the external surface of the shutter 3 slides on the internal surface of the tube 2.

[0041] Alternatively, the tubes 2 can have an oval or rectangular section (not shown). In this case, the shutter 3 also has an oval or rectangular shape, but can only translate and not rotate with respect to tube 2.

[0042] The tube 2 has a first plurality of holes 4 which can have a various arrangement. The holes of said first plurality 4 can for example be arranged along longitudinal or transverse lines or arranged in a less organized manner. The holes of the first plurality 4 can also have the same diameter or not.

[0043] With reference to Fig. 12, the tube 2 can be of the so-called smooth or flat type, i.e. constituted by a sheet metal closed on itself longitudinally, by means of rivets, seaming or welding. Alternatively, the tube 2 can be of the spiral type, i.e. wound into a spiral with the longitudinal edges seamed together, like the tubes 2 illustrated in Fig. 13.

[0044] The shutter 3 comprises a second plurality of holes 5 which is arranged for opening, closing or choking, at least a part of the holes of the first plurality of holes 4 of the tube 2, as better described with reference to Figs. 3-11. The holes of the second plurality of holes 5 of the shutter 3 are equal to or larger than the holes of the first plurality 5. The term greater or equal refers to the fact that the section of the hole of the shutter 3 is greater than or equal to the section of the hole of tube 2.

[0045] The shutter 3, in addition to the second plurality of holes 5, can comprise a third plurality of holes 6, as illustrated in Fig. 6-8. The holes of the second plurality 5 are larger than the holes of the third plurality 6. Basically, in a duct 1 with a shutter 3 comprising a second and a third

plurality of holes 5,6, the larger holes are used to maximize the flow rate, while the smaller ones to partialize it.

[0046] It is useful to remember that, when a hole in the tube of a duct is smaller, the volumetric flow rate decreases, but the speed of the air flow leaving the hole increases. Conversely, with the same incoming air flow rate, by increasing the diameter of the holes, the volumetric flow rate increases and the speed decreases. Furthermore, when the holes of the first and second plurality 4,5 and/or the holes of the first and third plurality 4,6 have the same shape, the edges of the holes through which the air exits from the air duct 1 are regular and symmetrical. Since the holes of the duct 1 have the same shape, both on the tube 2 and on the shutter 3, the edges are not irregular and symmetrical, consequently the air flows outcoming of the duct are uniform, no turbulence is created around the duct 1 and the ventilation efficiency is maximized. These effects occur in a particular when all the holes of the tube 2 and of the shutter 3 have a circular shape, because it has a symmetrical shape with edges equidistant from the centre of the shape.

[0047] As illustrated in Figs. 6 and 8, the trailing edge of holes 4,5,6 always remains circular, only changing in size, see holes 5 and holes 6 in the detailed images at the bottom left of Fig. 6 and Fig. 8. In this way, with the same volumetric flow rate entering the duct 1, the volumetric flow rate of air coming out from the holes 4,5,6 varies without changing the direction of the air flows coming out from the holes of the duct 1.

[0048] Depending on the size and arrangement of the holes of the shutter 3, therefore on the position of the holes of the second or third plurality of holes 5,6, it is possible to obtain various effects by moving the shutter 3 in the tube 2. For example, it is possible to make the air flows 9B exit from some holes of the duct 1 rather than from others, or to reduce/increase the volumetric flow of air 9B outcoming from the holes of the duct 1. Some of these possibilities are illustrated in Fig. 3- 11. Many other combinations are possible and fall within the scope of the invention although for the sake of conciseness they are not illustrated and described.

[0049] Figs. 3, 4 and 5 illustrate a first embodiment of duct 1 in which the tube 2 comprises a first plurality of holes 4 inside which a shutter 3 moves longitudinally equipped with a second plurality of holes 5. The shutter 3 is moved by a linear actuator 8 equipped with a fixed part 8A connected to tube 2 and a moving part 8B connected to shutter 3. Two flanges 10 are fitted to the ends of tube 2 and the shutter 3 slides between the tube 2 and the flanges 10. The holes of the first and second plurality of holes 4,5 have the same size.

[0050] Fig.3 shows the shutter 3 in a first operating position in which the holes of the second plurality of holes 5 are aligned with the holes of the first plurality of holes 4 of the tube 2. In this way, the outcoming air flow 9B reaches its maximum flow rate and is blown in a first direction, for example downwards as in Fig. 3. In the detail image at the bottom left of Fig. 3 a small portion

of the duct 1 seen from the outside is schematized, in which it is possible to note the alignment between the holes of the first and second plurality of holes 4,5. In this operating position, part of the incoming airflow 9A comes out of the holes of the tube 2 through the outcoming flows 9B and part of the air flow 9C continues towards the next duct 1.

[0051] When the linear actuator 8 moves the shutter 3 into its second operating position, the holes of the second plurality of holes 5 are completely misaligned with the holes of the first plurality of holes 4 of the tube 2. Consequently, the holes of the tube 2 are closed and the duct 1 is unable to expel air. In this configuration, the duct 1 behaves like a tube without holes and only allows the passage of an air flow 9A,9C, as illustrated in Fig. 4. In the detail image at the bottom center of Fig. 4 a small portion of the duct 1 seen from the outside is schematized, in which the complete misalignment between the holes of the first and second plurality of holes 4,5 can be observed.

[0052] When the linear actuator 8 moves the shutter 3 to an intermediate position (third operating position) between that of Fig. 3 and that of Fig. 5, the holes of the second plurality of holes 5 are partially aligned with those of the first plurality of holes 4 of tube 2. In this operating condition, the holes of the first plurality of holes 4 of tube 2 are choked, i.e. with a smaller section, as illustrated in the detail image at the bottom left of Fig. 5, in which a partial alignment between the holes of the first and second plurality of holes 4,5 can be noted. Since the section is smaller, the outcoming air flows 9B are expelled with greater speed although the volumetric flow rate is lower. In this operating position, part of the incoming air flow 9A comes out of the holes of the tube 2 with outcoming flows 9B and part of the air flow 9C continues towards the next duct 1.

[0053] Figs. 6, 7 and 8 illustrate a second embodiment of the duct 1, in which the operating conditions are substantially equivalent to those respectively illustrated in Figs. 3, 4 and 5. The difference consists in the fact that the shutter 3 comprises a third plurality of holes 6 with a smaller section than that of the second plurality of holes 5 and the holes of the first plurality of holes 4. The condition of choked outflow is obtained by aligning the holes of the third plurality of holes 6 with the holes of the first plurality of holes 4 of the tube 2, as illustrated in Fig. 8. This operating position is called the fourth operating position.

[0054] Basically, the operating condition of Fig. 6 corresponds, in terms of result, to that of Fig. 3, and the holes of the tube 2 are aligned with the holes of the first plurality of holes 5 of the shutter 3. On the contrary, the holes of the third plurality of holes 6 are completely misaligned from those of the first plurality of holes 4 of the tube 2. What has just been said is clear from the detail image at the bottom left of Fig. 6, in which a total misalignment of the holes 6 and a total alignment of the holes 5 with those 4 of the tube 2 can be noted. This condition allows to maximize the outcoming airflows 9B. In this operating position, part of

the incoming airflow 9A comes out of the holes of the tube 2 with the outcoming flows 9B and part of the air flow 9C continues towards the next duct 1.

[0055] The operating condition of Fig. 7 corresponds, in terms of result, to that of Fig. 4, and the holes of the tube 2 are misaligned with respect to the holes of the second and third plurality of holes 5,6. The air therefore does not come out of duct 1, but only passes through it. The total misalignment of the holes 4 of the tube 2 with the holes 5, 6 of the shutter 3 can be seen in the detail image at the bottom center of Fig. 7.

[0056] As shown in Fig. 8, the operating condition of choked outcoming flows 9B, called in this case fourth operating position, is obtained by aligning the holes of the third plurality of holes 6 with the holes of the first plurality of holes 4. In this way, the holes of the duct 1 are narrower and the outcoming air flows 9B have a lower volumetric flow rate and a higher speed. The misalignment of holes 5 with holes 4 of tube 2 and the alignment of holes 6 with holes 4 of tube 2 is better illustrated in the detail image at the bottom left of Fig. 8.

[0057] The duct 1 of Figs. 9, 10 and 11 instead combines the use of the holes of the second and third plurality of holes 5,6 of the shutter 3 to obtain outcoming air flows 9B in different directions according to the alignment or misalignment of the holes of the first plurality of holes 4 of the tube 2 with the holes of the second and/or third plurality of holes 5,6 of the shutter 3.

[0058] Basically, the shutter 3 of Fig. 9 allows to simultaneously obtain the first operating position for the holes arranged at the bottom in Fig. 9 and the second operating position for the holes arranged at the top in Fig. 9. This operating condition can also be obtained with a shutter 3 comprising also a third plurality of holes 6.

[0059] Conversely, when the shutter 3 is in the position shown in Fig. 10, the first operating condition is obtained for the holes arranged at the top in Fig. 10 and the second operating condition for the holes arranged at the bottom in Fig. 10.

[0060] By positioning the shutter 3 in an intermediate position between that of Fig. 9 and that of Fig. 10, a partialization of the outcoming air flows 9B is obtained both on the upper side and on the lower side of the tube 2, as illustrated in Fig.11. Further intermediate positions allow to progressively increase the outcoming air flows 9B at the bottom to the detriment of those outcoming at the top or vice versa, depending on how the shutter 3 is moved. This operating condition can also be obtained with a shutter 3 comprising also a third plurality of holes 6.

[0061] As schematized in Fig. 18, when the shutter 3 comprises a second and a third plurality of holes 5,6 and the holes 6 of third plurality are smaller than those of the second plurality of holes 5, it is possible to obtain differentiated flows on two portions of the duct 1, by suitably misaligning of the second plurality of holes 5 with respect to the third plurality of holes 6 on the shutter 3. In this way, when the first plurality of holes 4 is aligned with the second plurality of holes 5 in a portion of the duct 1, in

another portion of the duct 1 it is possible that the first plurality of holes 4 is aligned with the third plurality of holes 6, misaligned with the second and third plurality of holes 5,6 or aligned with the second plurality of holes 5. Similarly, when the first plurality of holes 4 is aligned with the third plurality of holes 5 in a portion of the duct 1, in another portion of the duct 1 it is possible that the first plurality of holes 4 is aligned with the second plurality of holes 5, misaligned with the second and third plurality of holes 5,6 or aligned with the third plurality of holes 6. Finally, when the first plurality of holes 4 is misaligned with the second and third plurality of holes 5,6 in a portion of the duct 1, in another portion of the duct 1 it is possible that the first plurality of holes 4 is aligned with the second plurality of holes 5, misaligned with the second and third plurality of holes 5,6 or aligned with the third plurality of holes 6.

[0062] In the operating conditions of Figs. 9, 10 and 11, part of the incoming air flow 9A comes out of the holes of the tube 2 with the outcoming flows 9B and part of the air flow 9C continues towards the next duct 1.

[0063] In Figs. 9, 10 and 11, the outcoming air flows 9B are illustrated downwards or upwards, but this does not mean that they can only exit upwards or downwards. The same operating principle also applies if we are dealing with outcoming air flows 9B towards the right or towards the left, or towards the bottom and towards the sides, as illustrated in Figs. 14-15 or 16-17.

[0064] The duct 1 of the third embodiment of Fig. 9-11 is therefore similar to that of the second embodiment of Fig. 6-8 apart from the fact that the tube 2 has a first plurality of holes 4 both on a side and on the other. The further difference consists in the fact that the holes of the third plurality of holes 6 of the shutter 3 do not have a smaller section than those of the second plurality of holes 5, but rather have a substantially equal section. Furthermore, the holes of the third plurality of holes 6 are slightly offset with respect to those of the second plurality of holes 5, so that the holes 5 and the holes 6 can never be completely aligned simultaneously with the holes of the first plurality of holes 4 of the tube 2. In this way, the effect of closing or choking some holes of the tube 2 and opening or choking others is obtained, modifying the direction and the volumetric flow rate of the outcoming air flows 9B, as shown in Figs. 16, 17 .

[0065] The embodiments described above are only some of the possible architectures of holes 5,6 of the shutter 3 and of holes 4 of the tube 2. The characteristics of the embodiments can be combined with each other to create other embodiments not illustrated although included in the present invention.

[0066] The duct 1, in one of the embodiments described above or in a variant thereof, can be used to make a pipeline 20 as illustrated in Figs. 12 or 13.

[0067] Basically, by connecting various ducts 1 together, an air pipeline 20 is obtained.

[0068] The air ducts 1 can be connected to each other in a linear manner, as illustrated in Fig. 12 or have various

lateral branches as in Fig. 13. In an alternative not illustrated, the ducts 1 can have different diameters and can have reducers between one duct and another, when the diameter changes.

[0069] The tubes 2 of the air ducts 1 can be smooth or flat tubes, as shown in Fig. 12, or spiral tubes, as shown in Fig. 13.

[0070] The ducts 1 are connected to each other through their flanges 10. In practice, the flange 10 of a duct 1 is connected to the flange 10 of the adjacent duct 1. Alternatively, the flanges 10 can be clamped together via retaining rings.

[0071] Alternatively, the duct 1 are connected to each other via a duct connection 23, such as those in Fig. 13. At the bottom, the pipeline 20 is closed by a duct cap 24, as illustrated in Fig. 13.

[0072] The ducts 1 of the pipeline 20 can all be used at the same time or at different times. For example, in the pipeline 20 of Fig. 12 the outgoing air flows 9B are regulated so as to have progressively decreasing air flow rates. In practice, the amount of air that comes out of the upstream duct 1A is greater than the amount of air that comes out of the downstream air duct 1C.

[0073] The operating position of the shutters 3 can be varied individually or globally in a dynamic manner by acting on the actuators 8 through the control unit 22 which manages them.

[0074] For example, the central duct 1B of the pipeline 20 of Fig. 12 can be closed by moving its shutter 3 during a certain period of the year, as happens in the fruit and vegetable department of supermarkets, where in winter it is advisable to interrupt the hot air flow to preserve food. The outgoing air flows 9B from the ducts 1A and 1C can also be varied by moving the shutter 3 by means of the control unit 22.

[0075] The control unit 22 is configured to send one or more command signals to the one or more actuators 8, so as to move them in the desired manner.

[0076] The pipeline 20 is connected upstream to a thermal machine (not shown) configured to deliver the incoming air flow 9A to the pipeline 20 at a given temperature and flow rate. Since the ducts known in the state of the art have holes with a fixed section or in any case not variable in a dynamic way, the section of the holes is defined or set on a given volumetric flow rate of the thermal machine. If the volume flow is reduced, for example because the desired room temperature has been reached and therefore less air is required, the pipeline becomes inefficient. In fact, the holes in the duct further upstream will deliver more air, while those further downstream will deliver less air and the heating/cooling of the environment will become uneven. With the pipeline 20 according to the present invention, this problem is solved. In fact, if the thermal machine delivers a smaller volumetric air flow rate, the section of the holes of the ducts 1 is reduced so that all the holes deliver the same air flow rate 9B. For example, if the volumetric flow of air delivered by the thermal machine is reduced by 50%, the

control unit 22 commands the actuators 8 so that the shutters 3 close the holes of the tubes 2 by 50%. In this way, the whole system made up of the thermal machine and the pipeline 20, is scaled according to the volumetric flow rate required.

[0077] The volumetric flow rate of the incoming air flow 9A in the pipeline 20 is substantially equal to the sum of the volumetric flow rates of the outgoing air flows 9B through the holes of the various ducts 1. If the ducts 1 are a several, the outgoing volumetric flow from them can be adjusted so that their sum equals the incoming volumetric flow.

[0078] Alternatively, for the same volumetric flow rate, it may be necessary to divide it in a different way among the various ducts 1, as illustrated in Fig. 12 or 13. In a given season or circumstance, it may in fact be necessary to use all the ducts 1, while in another some ducts 1 can be closed or partially closed.

[0079] In the example illustrated in Fig. 13, a branch of the pipeline 20 comprising the duct 1F can be used to ventilate a first environment 30A, for example a meeting room, while the other ducts 1D, 1E and 1G can be used to ventilate a second environment 30B, for example an open space with desks. As the meeting room is not used continuously, the duct 1F can only be activated when necessary, by moving its shutter 3 so as to open the holes of the tube 2.

[0080] Being able to open, close or choke the holes of the tube 2 of each duct 1 by means of the respective shutter 3, the possible configurations of outgoing air flows 9B from the ducts 1 obtainable are potentially infinite.

[0081] Furthermore, the geometry of the open or closed holes of the tube 2 of each duct 1 can also be varied. For example, each duct 1A-1G can allow to outflow air flows 9B optimized for the hot season, like the one shown in Figs. 14 and 16, or air flows 9B optimized for the cold season, like the one shown in Figs. 15 and 17. An outgoing air flow 9B is directed substantially vertically with respect to the duct 1, when the outgoing air flow 9B is hot and serves to heat an environment 30. An outgoing air flow 9B is directed laterally to duct 1, when the outgoing air flow 9B is cold and serves to cool an environment. In this way it is possible to create a movement of the air in the environment 30 like the one illustrated in Fig. 1A and 1B.

[0082] It is also an object of the present invention to provide a method for dynamically varying the outgoing air flows 9B from various ducts 1, by acting on the shutters 3 of the same, so as to optimize the diffusion of air in the environment 30 with the same incoming air flow 9A.

[0083] As illustrated in Figs. 12 and 13, a control unit 22 is electrically connected to various actuators 8 and this allows them to be controlled in real time on the basis of the desired temperature or the desired ventilation level in the environment 30.

[0084] The pipeline 20 can be operatively connected to one or more temperature sensors, electrically connected

to the control unit 22, and located inside the duct 1 and/or in the environment 30, or associated with the thermal machine. In this way, as the volumetric flow entering the pipeline 20 or the desired temperature in the environment 30 varies, it is possible to align or misalign the holes of the tube 2 and of the shutter 3 of each duct 1, commanding the actuators 8. The control unit 22 is configured to implement this methodology.

[0085] The ducts 1 of the pipeline 20 can be connected to the ceiling 31 of the environment 30 by means of a connection support 21. The connection support 21 is connected on one side to the ceiling 31 and on the other side to the flange 10 of one or more ducts 1, as illustrated in Figs. 14-17.

[0086] Figs. 14-15 show a type of duct 1, and relative pipeline 20, in which the shutter 3 is configured to rotate with respect to the tube 2. The shutter 3 and the tube 2 are coaxial and the shutter 3 lies inside the tube 2. The tube comprises a rack 26 on the external side of the shutter 3. The rack 26 interacts with the moving part 8B of the actuator 8, which in this case is a pinion able to cooperate with the rack 26. Other types of mechanical interactions between the actuator 8 and the shutter 3 are possible.

[0087] Fig. 14 shows the shutter 3 in a first angular position in which some holes of the first plurality of holes 4 of the tube 2 are aligned with all the holes of the second plurality of holes 5 of the shutter 3. In this operating position, the outcoming air flows 9B exit laterally with respect to the duct 1 (hot season).

[0088] In Fig. 15 the shutter 3 is shown in a second angular position in which other holes of the first plurality of holes 4 of the tube 2 are aligned with some holes of the second plurality of holes 5 of the shutter 3, while the other holes 4.5 are misaligned with each other. In this operating position, the outcoming air flows 9B exit from under the duct 1 (cold season).

[0089] With reference to Figs. 16 and 17, a duct 1 and a related pipeline 20 are shown in section, in which a shutter 3 is configured to move longitudinally inside the tube 2, as illustrated in Figs. 2-11. The architecture of duct 1 of Fig. 16-17 is substantially the same as that of duct 1 of Fig. 14-15. The difference consists in the fact that the shutter 3 translates longitudinally in the tube 2, i.e. along a direction coming out of the sheet, therefore some holes of the second plurality of holes 5, represented with a solid line, are aligned with the holes of the first plurality of holes 4, while other holes of the second plurality of holes 5, represented with a dotted line, are misaligned with the holes of the first plurality of holes 4, thus preventing an outflow of air, as illustrated in Fig. 16.

[0090] In Fig. 17, other holes of the second plurality of holes 5, represented with a continuous line, are aligned with some holes of the first plurality of holes 4, while the holes which in Fig. 16 are aligned with the holes of the first plurality of holes 4 are no longer aligned and therefore they are shown with a dotted line.

[0091] The air duct 1 and/or the air pipeline 20 in accordance with the present invention can also be used

as a duct or pipeline for the recovery of the air from the environment 30.

[0092] In conclusion, it is clear that the invention thus conceived is susceptible to numerous modifications or variations, all covered by the invention; moreover all the details can be replaced by technically equivalent elements. In practice, the quantities may be varied according to technical requirements.

10 Legend:

[0093]

- 1 air duct
- 2 tube
- 3 shutter
- 4 first plurality of holes (of the tube)
- 5 second plurality of holes (of the shutter)
- 6 third plurality of holes (of the shutter)
- 7 full portions (of the shutter)
- 8 actuator
- 8A fixed part (actuator)
- 8B moving part (actuator)
- 9A airflow (incoming)
- 9B airflow (outcoming)
- 9C airflow (outcoming axially)
- 10 flange
- 11 slot (of the tube)
- 20 air pipeline
- 21 connection support
- 22 control units
- 23 duct connection
- 24 duct cap
- 25 seaming
- 26 rack
- 30 environment
- 31 ceiling (of the environment)
- 100 air duct for the hot season of prior art
- 100' air duct for the cold season of prior art
- D shutter diameter
- D' tube diameter
- L shutter length
- L' tube length
- G gap

Claims

1. Air duct (1) including:

- a tube (2) comprising a first plurality of holes (4) for diffusing air in an environment (30);
- a shutter (3) coaxial with respect to the tube (2) comprising at least a second plurality of holes (5);
- an actuator (8) configured to move the shutter (3) with respect to the tube (2) to align or misalign at least part of the first plurality of holes (4) with

- the at least a second plurality of holes (5);
 - two flanges (10) arranged at the ends of the tube (2), **characterized in that** the two flanges (10) are arranged so as to form a gap (R) together with the tube (2) in which the shutter (3) can move.
2. Air duct (1) according to claim 1, wherein the holes of the second plurality of holes (5) are equal to or larger than the holes of the first plurality of holes (4).
3. Air duct (1) according to claim 2, wherein the first plurality of holes (4) and the second plurality of holes (5) have the same shape but different size.
4. Air duct (1) according to any one of the preceding claims, wherein the shutter (3) comprises a third plurality of holes (6), wherein the holes of the second plurality of holes (5) are larger than the holes of the third plurality of holes (6).
5. Air duct (1) according to claim 4, wherein the holes of the third plurality of holes (6) of the shutter (3) are smaller than the holes of the first plurality of holes (4) of the tube (1).
6. Air duct (1) according to claim 4 or 5, wherein the second plurality of holes (5) and the third plurality of holes (6) have the same shape but different size.
7. Air duct (1) according to any one of the preceding claims, wherein the shutter (3) has a cylindrical shape, preferably said cylindrical shape has a diameter (D) slightly different from a diameter (D') of the tube (2) so as to slide on the tube (2).
8. Air duct (1) according to any one of claims 5 to 7, wherein the shutter (3) is configured to assume one or more of the following operating positions:
- an operating position in which the second plurality of holes (5) is aligned with at least part of the first plurality of holes (4) of the tube (2) and the third plurality of holes (6) is misaligned with said at least part of the first plurality of holes (4) of the tube (2) to maximize the air outflow (9B) through said at least part of the first plurality of holes (4) of the tube (2);
 - an operating position in which the third plurality of holes (6) is aligned with said at least part of the first plurality of holes (4) of the tube (2) and the second plurality of holes (5) is misaligned with said at least part of the first plurality of holes (4) of the tube (2) to choke the air outflow (9B) through said at least part of the first plurality of holes (4) of the tube (2);
 - an operating position in which the second plurality of holes (5) and third plurality of holes (6) are misaligned with at least part of the first plurality of holes (4) of the tube (2) so that full portions of the shutter (3) close said at least part of the first plurality of holes (4) of the tube (2).
9. Air duct (1) according to any one of the preceding claims, wherein the actuator (8) is configured to slide the shutter (3) longitudinally relative to the tube (2), preferably the shutter (3) has a longitudinal length (L) which is less than the length (L') of the tube (2).
10. Air duct (1) according to any one of claims 1 to 8, wherein the actuator (8) is configured to rotate the shutter (3) relative to the tube (2).
11. Air duct (1) according to any one of the preceding claims, wherein the shutter (3) is arranged inside the tube (2).
12. Air pipeline (20) comprising a plurality of air ducts (1) according to any one of the preceding claims.
13. Air pipeline (20) comprising a plurality of air ducts (1) according to claim 10, comprising a plurality of ceiling supports (21) connected to the flanges (10).
14. Air pipeline (20) according to claim 12 or 13, comprising a control unit (22) configured to manage one or more actuators (8) belonging to respective air ducts (1).

Patentansprüche

1. Luftkanal (1) umfassend:
- ein Rohr (2), das eine erste Vielzahl von Löchern (4) zum Diffundieren von Luft in eine Umgebung (30) umfasst;
 - einen Verschluss (3), der koaxial zum Rohr (2) angeordnet ist und mindestens eine zweite Vielzahl von Löchern (5) umfasst;
 - einen Aktuator (8), der dazu konfiguriert ist, den Verschluss (3) relativ zum Rohr (2) zu bewegen, um zumindest einen Teil der ersten Vielzahl von Löchern (4) mit der zweiten Vielzahl von Löchern (5) auszurichten oder zu verstellen;
 - zwei Flansche (10), die an den Enden des Rohrs (2) angeordnet sind, **dadurch gekennzeichnet, dass** die beiden Flansche (10) so angeordnet sind, dass sie mit dem Rohr (2) einen Raum (R) bilden, in dem sich der Verschluss (3) bewegen kann.
2. Luftkanal (1) nach Anspruch 1, wobei die Löcher der zweiten Lochanzahl (5) gleich groß oder größer als die Löcher der ersten Lochanzahl (4) sind.

3. Luftkanal (1) nach Anspruch 2, wobei die erste Vielzahl von Löchern (4) und die zweite Vielzahl von Löchern (5) die gleiche Form, aber unterschiedliche Abmessungen aufweisen.
4. Luftkanal (1) nach einem der vorhergehenden Ansprüche, wobei der Verschluss (3) eine dritte Vielzahl von Löchern (6) umfasst, wobei die Löcher der zweiten Vielzahl von Löchern (5) größer sind als diejenigen der dritten Vielzahl von Löchern (6).
5. Luftkanal (1) nach Anspruch 4, wobei die Löcher der dritten Vielzahl von Löchern (6) der Verschluss (3) kleiner sind als diejenigen der ersten Vielzahl von Löchern (4) des Rohrs (1).
6. Luftkanal (1) nach Anspruch 4 oder 5, wobei die zweite Vielzahl von Löchern (5) und die dritte Vielzahl von Löchern (6) die gleiche Form, aber unterschiedliche Abmessungen aufweisen.
7. Luftkanal (1) nach einem der vorhergehenden Ansprüche, wobei der Verschluss (3) eine zylindrische Form aufweist, vorzugsweise mit einem Durchmesser (D), der sich geringfügig vom Durchmesser (D') des Rohrs (2) unterscheidet, um auf dem Rohr (2) gleiten zu können.
8. Luftkanal (1) nach einem der Ansprüche 5 bis 7, wobei der Verschluss (3) dazu ausgebildet ist, eine oder mehrere der folgenden Betriebspositionen einzunehmen:

- eine Betriebsposition, in der die zweite Vielzahl von Löchern (5) mit zumindest einem Teil der ersten Vielzahl von Löchern (4) des Rohrs (2) ausgerichtet ist und die dritte Vielzahl von Löchern (6) relativ zu dem zumindest einen Teil der ersten Vielzahl von Löchern (4) des Rohrs (2) versetzt ist, um den Luftstrom (9B) durch den zumindest einen Teil der ersten Vielzahl von Löchern (4) des Rohrs (2) zu maximieren;
- eine Betriebsposition, in der die dritte Vielzahl von Löchern (6) mit zumindest einem Teil der ersten Vielzahl von Löchern (4) des Rohrs (2) ausgerichtet ist und die zweite Vielzahl von Löchern (5) relativ zu dem zumindest einen Teil der ersten Vielzahl von Löchern (4) des Rohrs (2) versetzt ist, um den Luftstrom (9B) durch den zumindest einen Teil der ersten Vielzahl von Löchern (4) des Rohrs (2) zu behindern;
- eine Betriebsposition, in der die zweite Vielzahl von Löchern (5) und die dritte Vielzahl von Löchern (6) relativ zu zumindest einem Teil der ersten Vielzahl von Löchern (4) des Rohrs (2) versetzt sind, so dass ganze Teile des Verschlusses (3) zumindest einen Teil der ersten Vielzahl von Löchern (4) des Rohrs (2) ver-

schließen.

9. Luftkanal (1) nach einem der vorhergehenden Ansprüche, wobei der Aktuator (8) dazu ausgebildet ist, den Verschluss (3) in Längsrichtung relativ zum Rohr (2) zu verschieben, wobei der Verschluss (3) vorzugsweise eine Längslänge (L) aufweist, die kleiner ist als die Länge (L') des Rohrs (2).
10. Luftkanal (1) nach einem der Ansprüche 1 bis 8, wobei der Aktuator (8) dazu ausgebildet ist, der Verschluss (3) relativ zum Rohr (2) zu drehen.
11. Luftkanal (1) nach einem der vorhergehenden Ansprüche, wobei der Verschluss (3) innerhalb des Rohrs (2) angeordnet ist.
12. Luftleitung (20) mit mehreren Luftkanälen (1) nach einem der vorhergehenden Ansprüche.
13. Luftleitung (20) mit mehreren Luftkanälen (1) nach Anspruch 10, die mehrere mit den Flanschen (10) verbundene Deckenstützen (21) aufweisen.
14. Luftleitung (20) nach Anspruch 12 oder 13, die eine Steuereinheit (22) umfasst, die dazu konfiguriert ist, einen oder mehrere Aktuatoren (8) zu steuern, die zu den jeweiligen Luftkanälen (1) gehören.

Revendications

1. Conduit d'air (1) comprenant :

- un tube (2) comportant une première pluralité de trous (4) pour la diffusion de l'air dans un environnement (30) ;
- un obturateur (3) coaxial au tube (2) comportant au moins une deuxième pluralité de trous (5) ;
- un actionneur (8) configuré pour déplacer l'obturateur (3) par rapport au tube (2) afin d'aligner ou de désaligner au moins une partie de la première pluralité de trous (4) avec la deuxième pluralité de trous (5) ;
- deux brides (10) disposées aux extrémités du tube (2), **caractérisées en ce que** les deux brides (10) sont disposées de manière à former avec le tube (2) un espace (R) dans lequel l'obturateur (3) peut se déplacer.

2. Conduit d'air (1) selon la revendication 1, dans lequel les trous de la deuxième pluralité de trous (5) sont égaux ou supérieurs à ceux de la première pluralité de trous (4).

3. Conduit d'air (1) selon la revendication 2, dans lequel la première pluralité de trous (4) et la deuxième

pluralité de trous (5) ont la même forme mais des dimensions différentes.

4. Conduit d'air (1) selon l'une quelconque des revendications précédentes, dans lequel l'obturateur (3) comprend une troisième pluralité de trous (6), les trous de la deuxième pluralité de trous (5) étant plus grands que ceux de la troisième pluralité de trous (6). 5
5. Conduit d'air (1) selon la revendication 4, dans lequel les trous de la troisième pluralité de trous (6) de l'obturateur (3) sont plus petits que ceux de la première pluralité de trous (4) du tube (1). 10
6. Conduit d'air (1) selon la revendication 4 ou 5, dans lequel la deuxième pluralité de trous (5) et la troisième pluralité de trous (6) ont la même forme mais des dimensions différentes. 15
7. Conduit d'air (1) selon l'une quelconque des revendications précédentes, dans lequel l'obturateur (3) présente une forme cylindrique, de préférence un diamètre (D) légèrement différent du diamètre (D') du tube (2) afin de coulisser sur le tube (2). 20
8. Conduit d'air (1) selon l'une quelconque des revendications 5 à 7, dans lequel l'obturateur (3) est configuré pour adopter une ou plusieurs des positions de fonctionnement suivantes : 25
 - une position de fonctionnement dans laquelle la deuxième pluralité de trous (5) est alignée avec au moins une partie de la première pluralité de trous (4) du tube (2) et la troisième pluralité de trous (6) est décalée par rapport à ladite au moins une partie de la première pluralité de trous (4) du tube (2) afin de maximiser le flux d'air (9B) à travers ladite au moins une partie de la première pluralité de trous (4) du tube (2) ; 30 35
 - une position de fonctionnement dans laquelle la troisième pluralité de trous (6) est alignée avec au moins une partie de la première pluralité de trous (4) du tube (2) et la deuxième pluralité de trous (5) est décalée par rapport à ladite au moins une partie de la première pluralité de trous (4) du tube (2) afin d'obstruer le flux d'air (9B) à travers ladite au moins une partie de la première pluralité de trous (4) du tube (2) ; 40 45
 - une position de fonctionnement dans laquelle la deuxième pluralité de trous (5) et la troisième pluralité de trous (5) sont décalées par rapport à au moins une partie de la première pluralité de trous (4) du tube (2), de sorte que des portions entières de l'obturateur (3) obturent ladite au moins une partie de la première pluralité de trous (4) du tube (2). 50 55

9. Conduit d'air (1) selon l'une quelconque des reven-

dications précédentes, dans lequel l'actionneur (8) est configuré pour faire coulisser l'obturateur (3) longitudinalement par rapport au tube (2), de préférence l'obturateur (3) présente une longueur longitudinale (L) inférieure à la longueur (L') du tube (2).

10. Conduit d'air (1) selon l'une quelconque des revendications 1 à 8, dans lequel l'actionneur (8) est configuré pour faire tourner l'obturateur (3) par rapport au tube (2).
11. Conduit d'air (1) selon l'une quelconque des revendications précédentes, dans lequel l'obturateur (3) est disposé à l'intérieur du tube (2).
12. Conduite d'air (20) comprenant une pluralité de conduits d'air (1) selon l'une quelconque des revendications précédentes.
13. Conduite d'air (20) comprenant une pluralité de conduits d'air (1) selon la revendication 10, comprenant une pluralité de supports de plafond (21) reliés aux brides (10).
14. Conduite d'air (20) selon la revendication 12 ou 13, comprenant une unité de commande (22) configurée pour gérer un ou plusieurs actionneurs (8) appartenant à des respectifs conduits d'air (1).

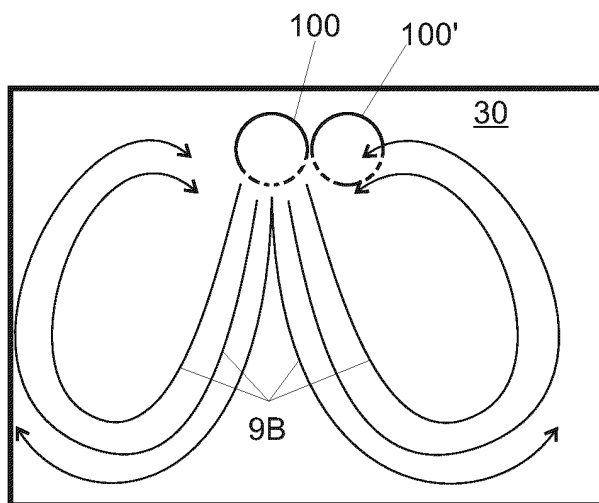


Fig. 1A

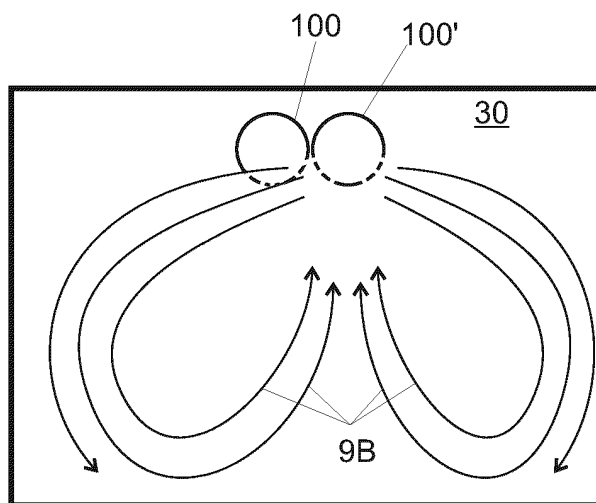


Fig. 1B

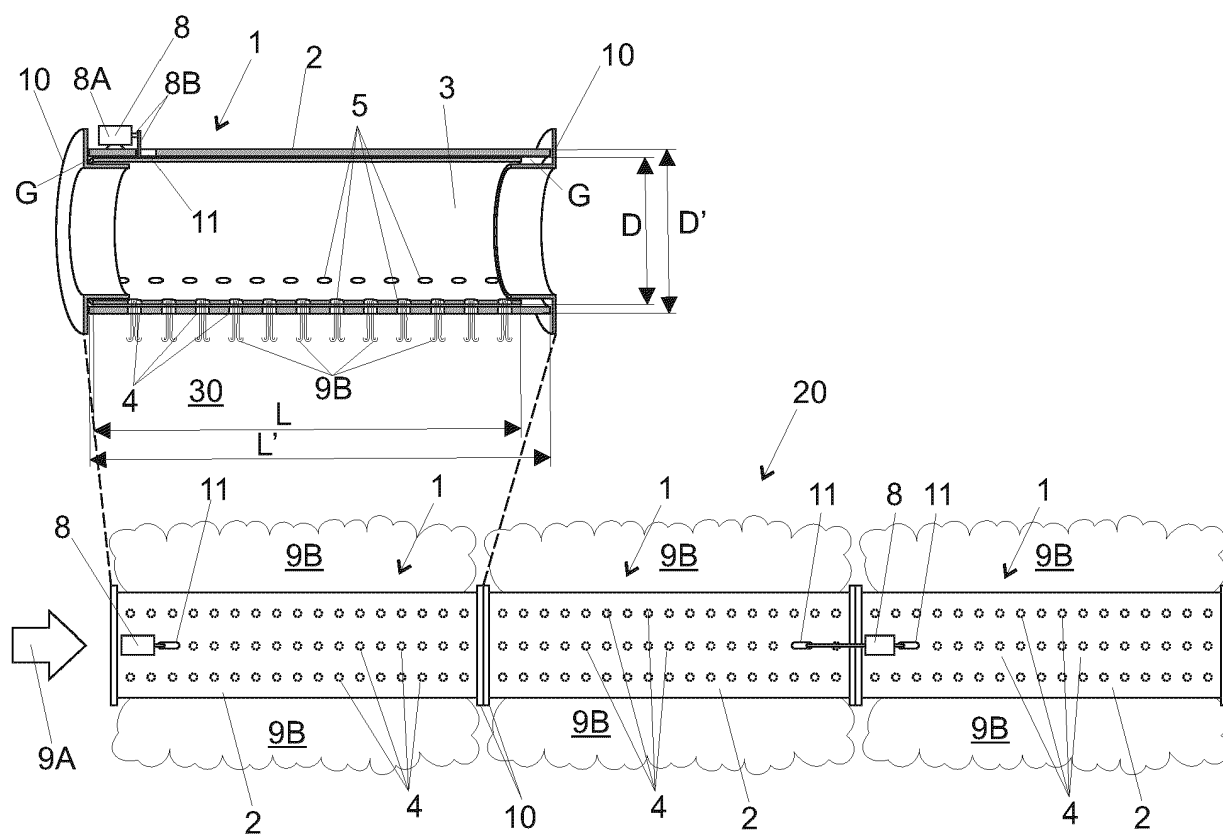


Fig. 2

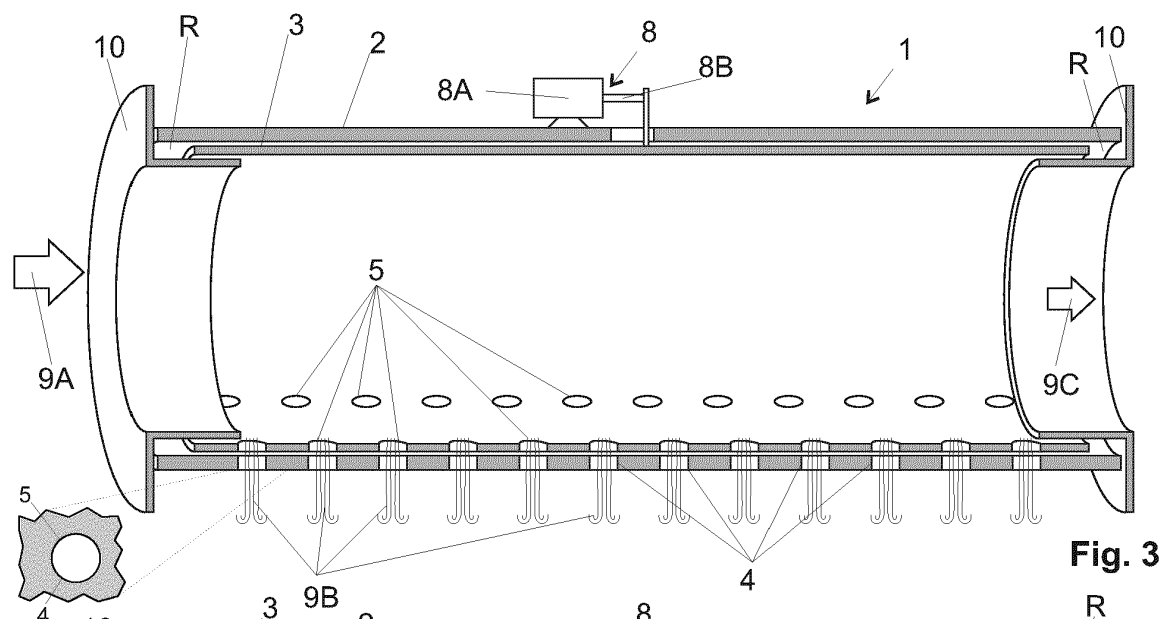


Fig. 3

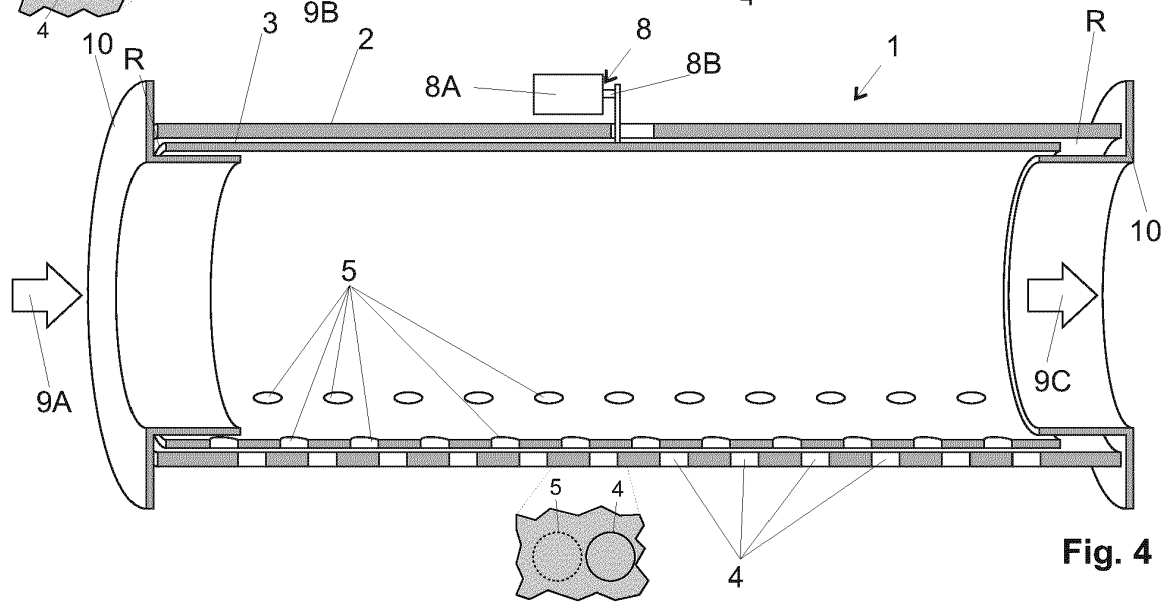


Fig. 4

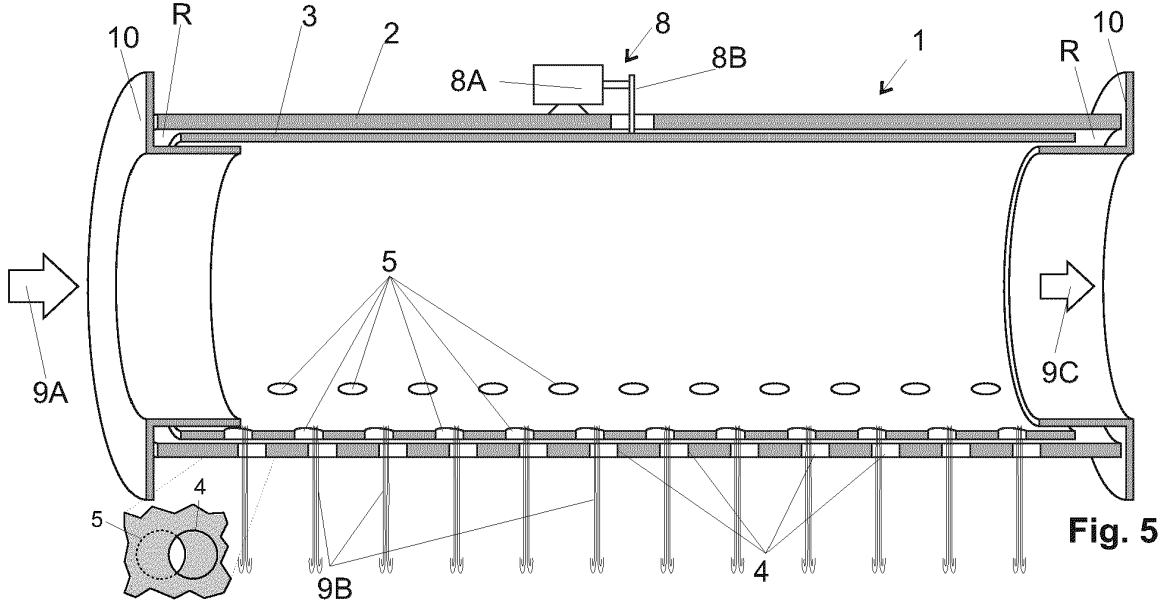
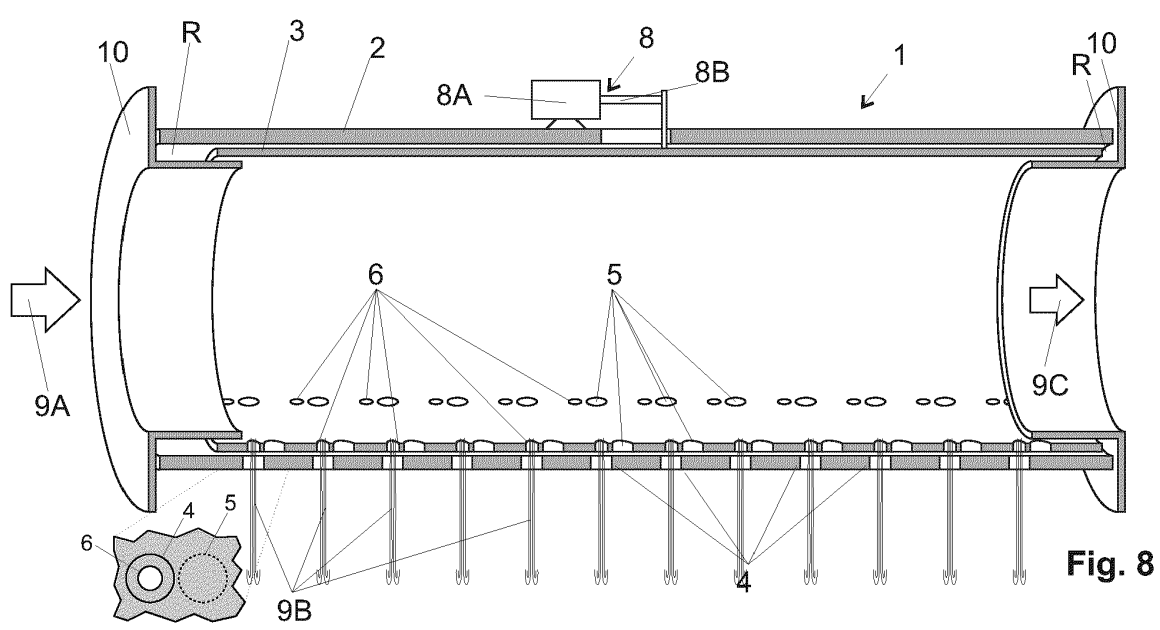
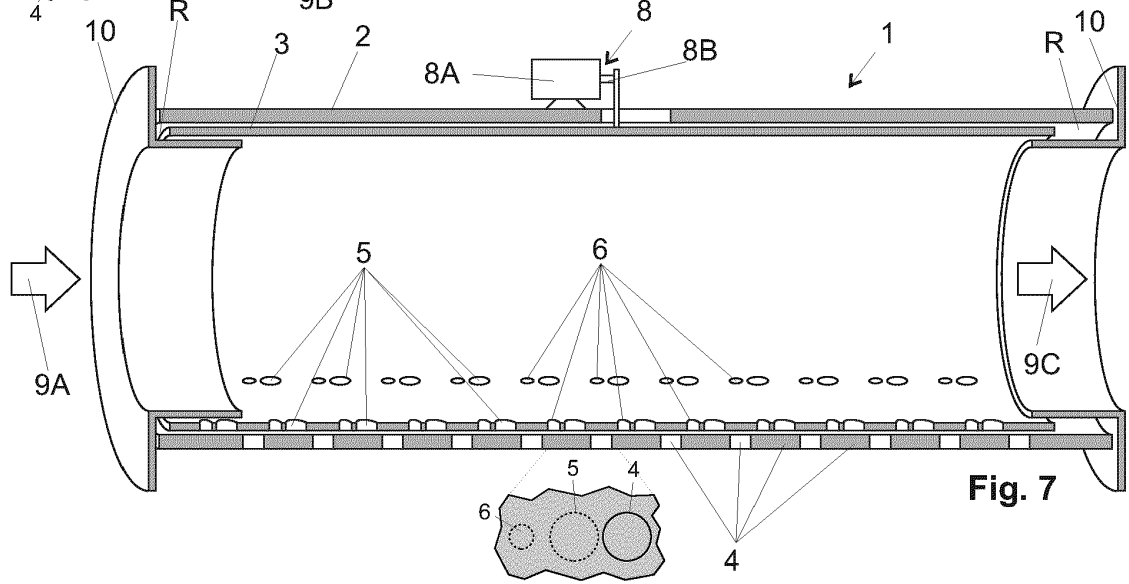
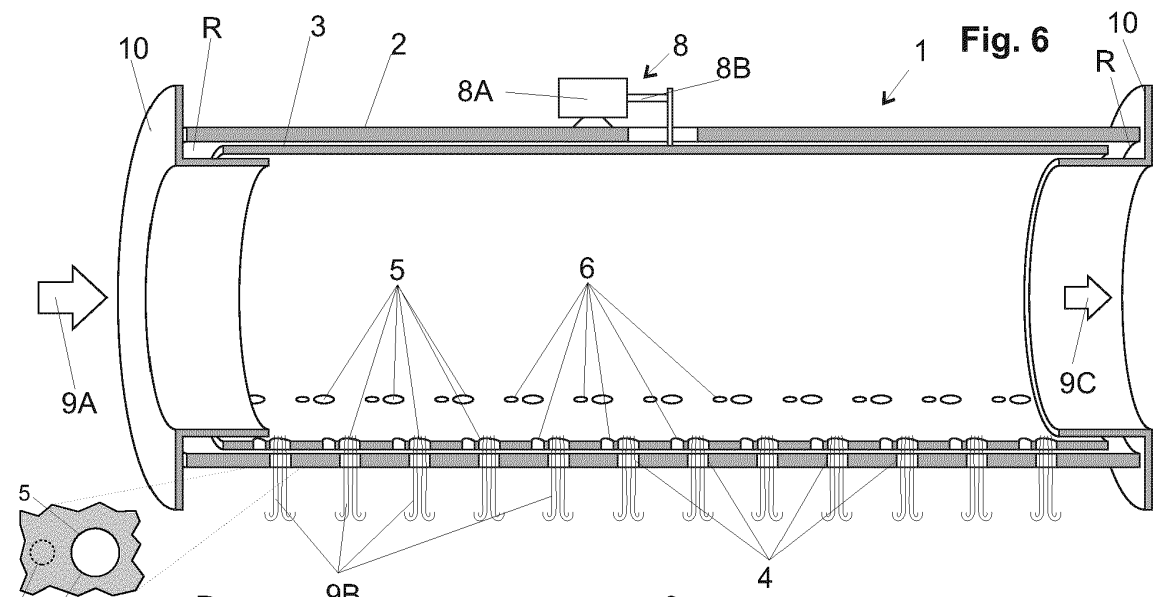


Fig. 5



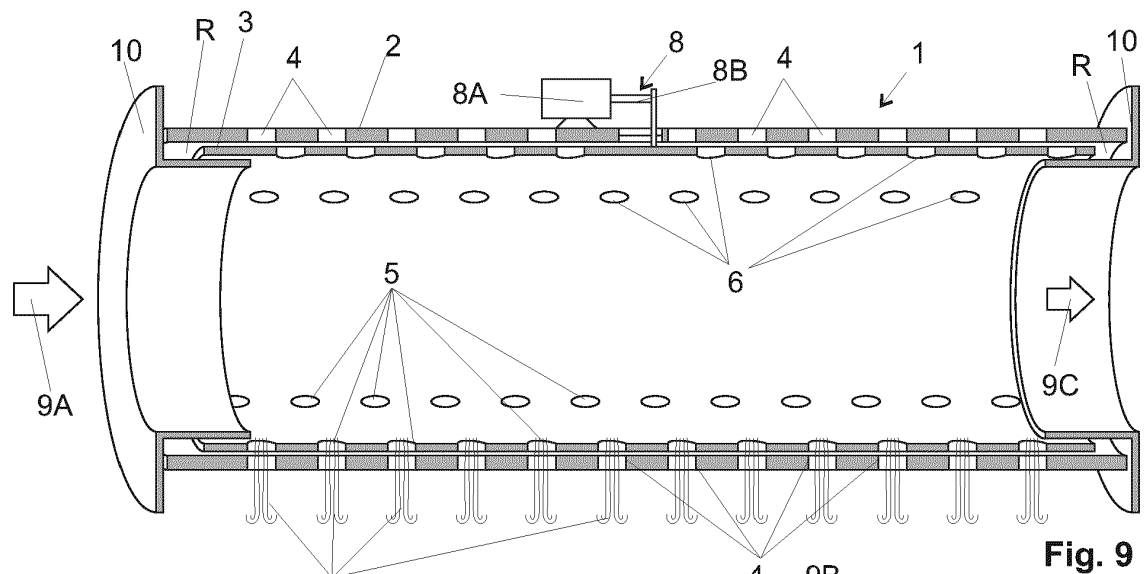


Fig. 9

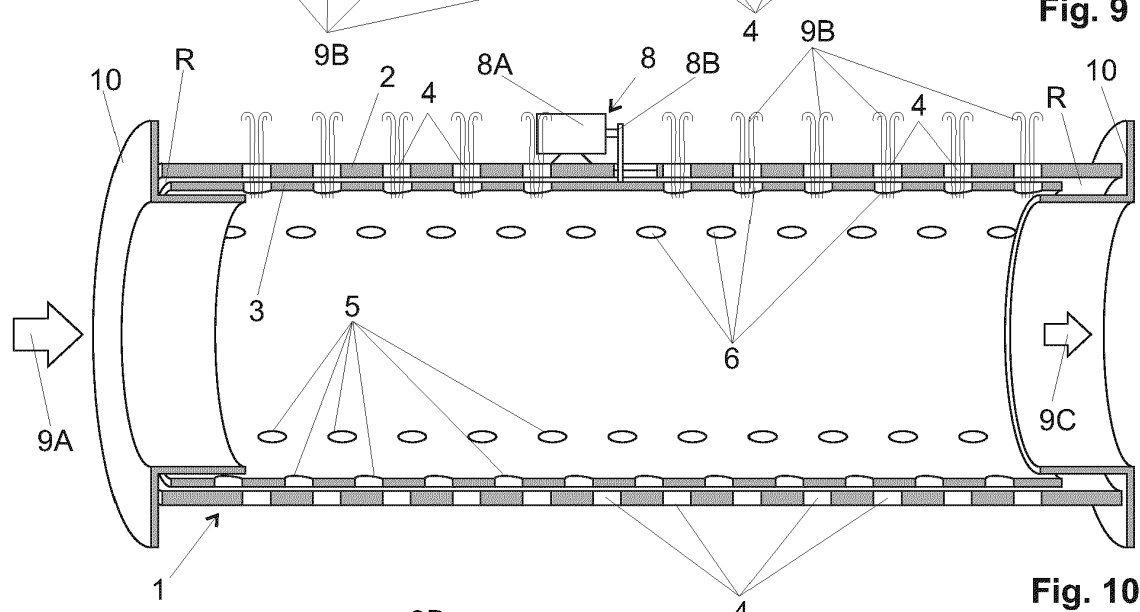


Fig. 10

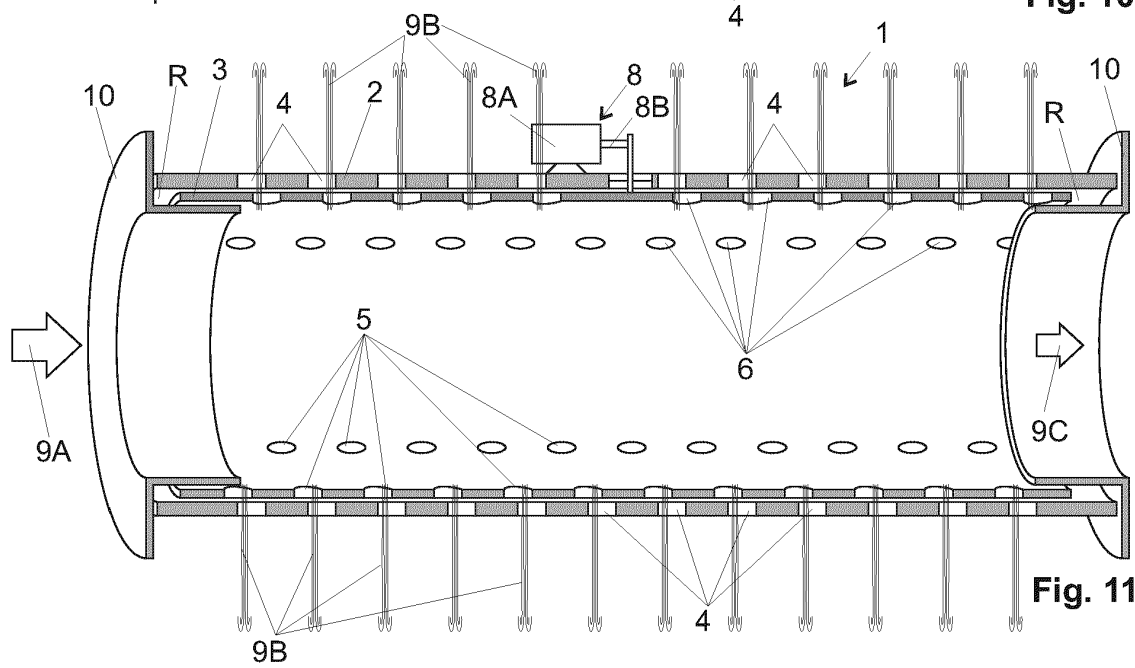
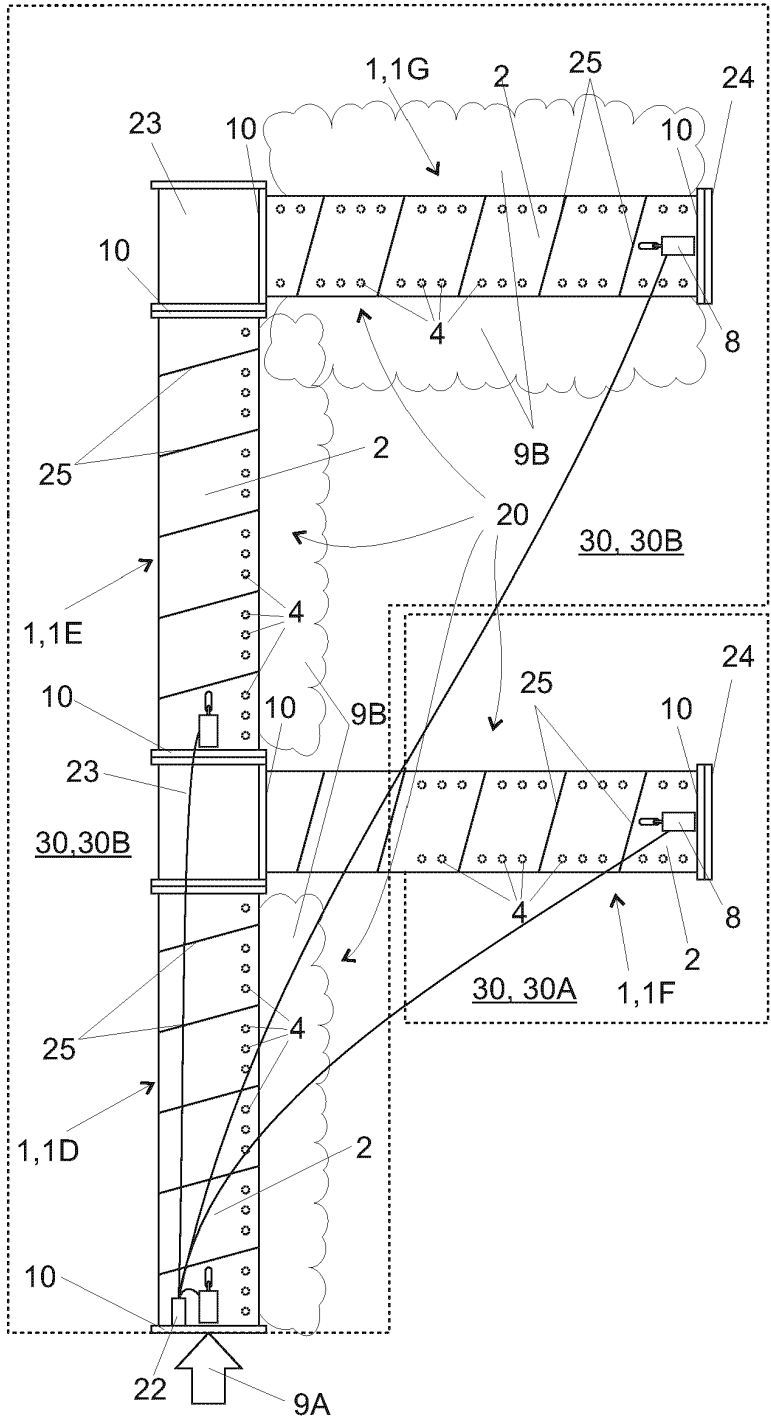
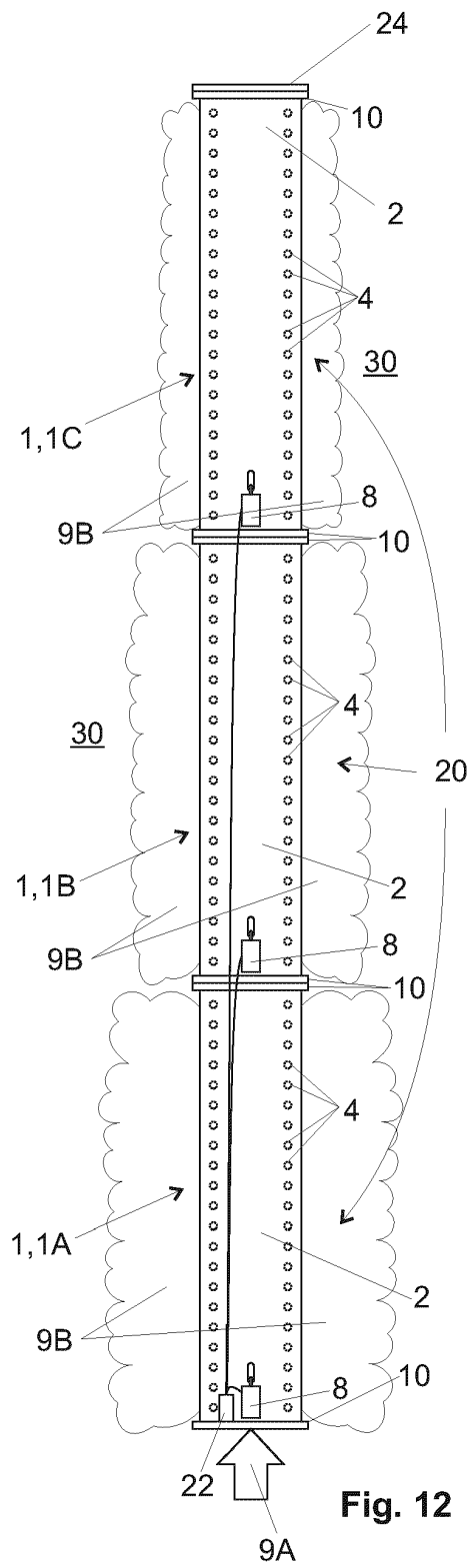


Fig. 11



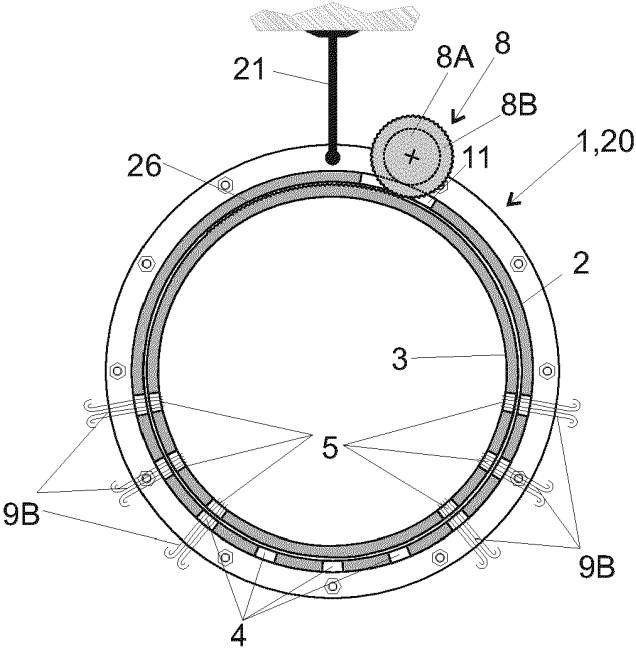


Fig. 14

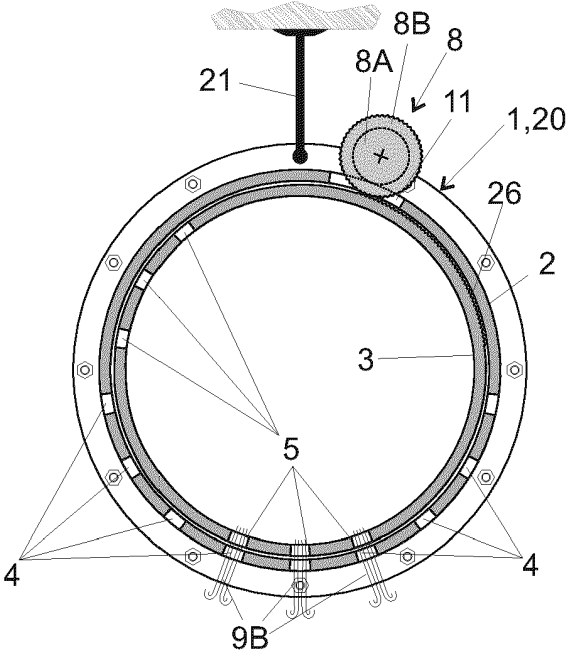


Fig. 15

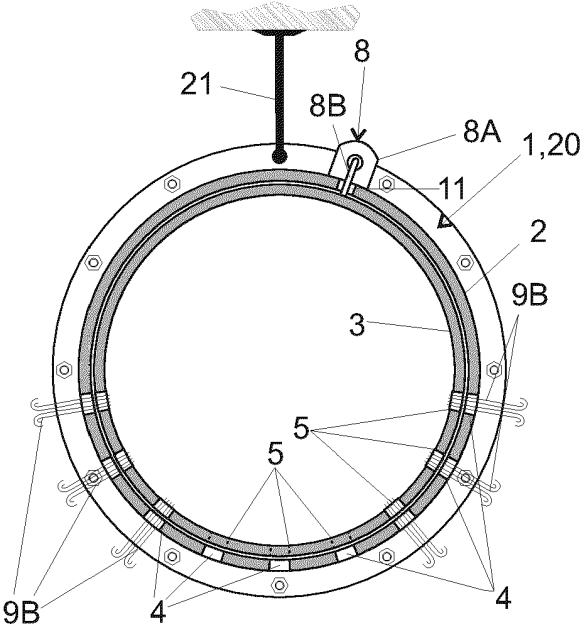


Fig. 16

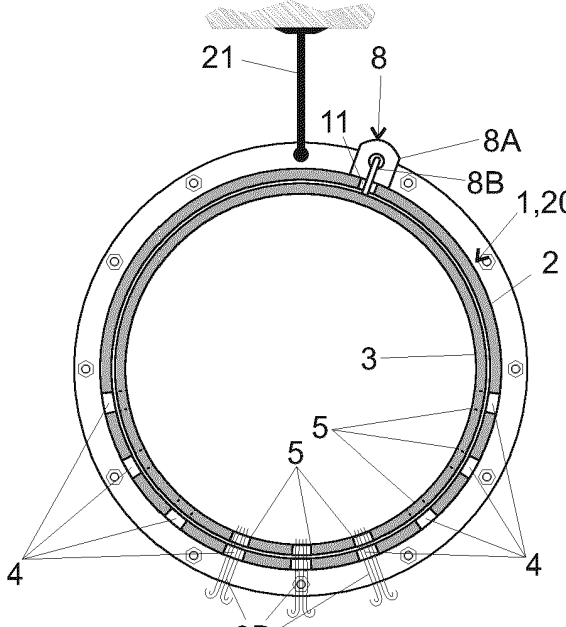


Fig. 17

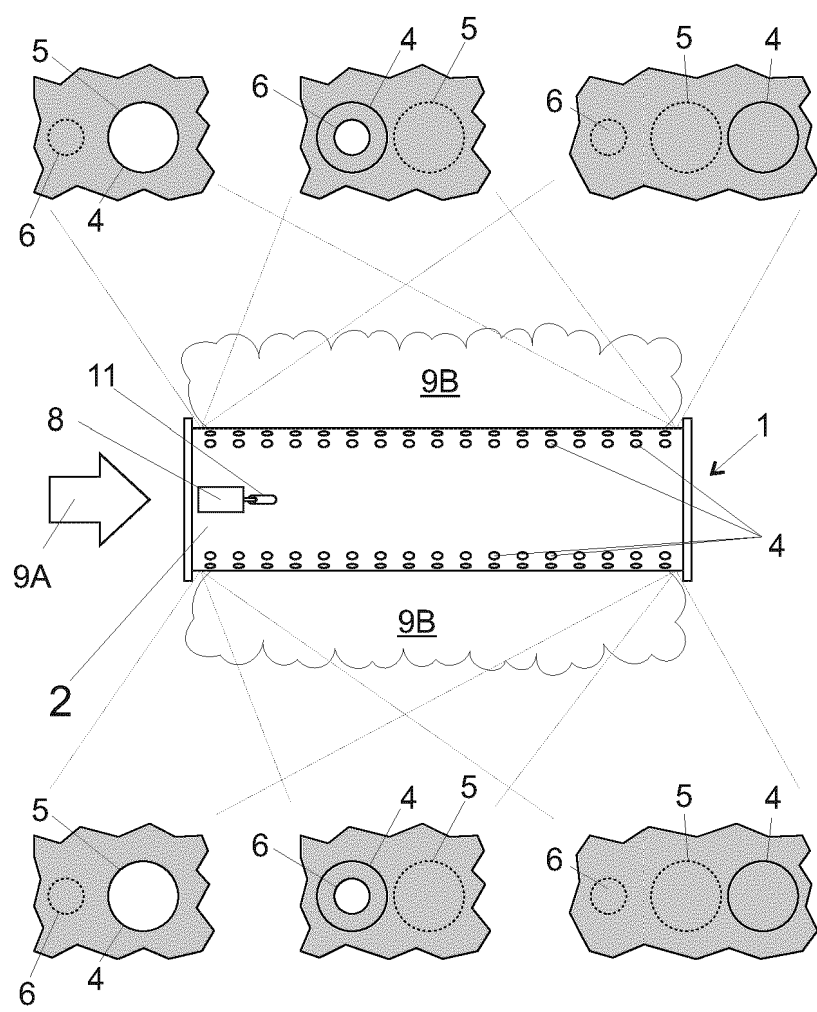


Fig. 18

REFERENCES CITED IN THE DESCRIPTION

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