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(54) **DEVICE AND SYSTEM FOR SEPARATING SPACES BY AIR TECHNOLOGY**

(57) A device for separating adjoining spaces by air technology comprises means for generating and maintaining an air curtain at least at the position of a passage opening. These means comprise a blower device (20,40) placed on a first side of the passage opening and having blowing means extending at least substantially over a full height of a side of the passage opening. The blower device is in open communication with air displacing means (65) which impart an air stream thereto under overpressure. The blowing means comprise according to the invention a series of longitudinally successive blower units (21..23,41..43), each provided with a controllable air slit (24) from which the air stream exits during operation. In addition, the blower units are laterally orientable about a pivot axis (24). On an opposite side the system comprises a suction device (30,50) for the purpose of drawing in and recirculating the air stream received in the form of an air curtain from the blower device.

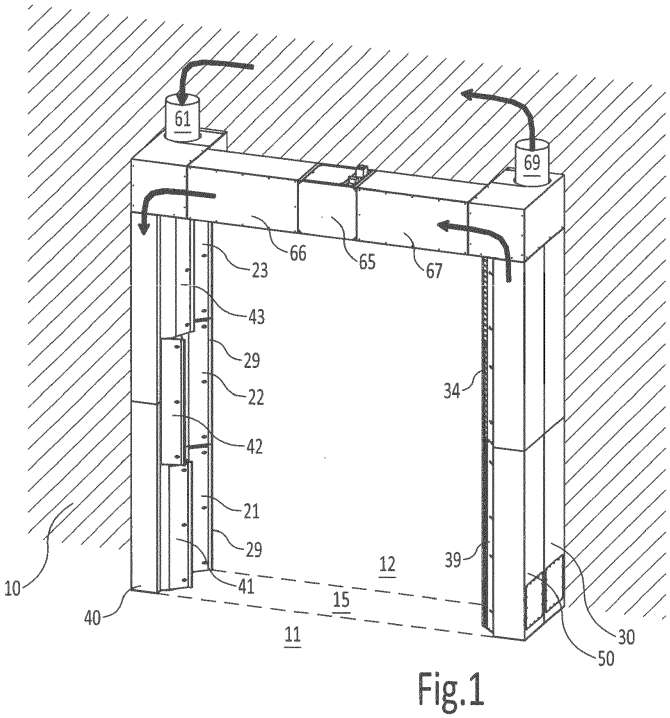

Fig.1

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Description

[0001] The present invention relates to a device for separating by air technology adjoining spaces which are connected to each other by a passage opening provided in a wall, comprising means for generating and maintaining an air curtain at least at the position of the passage opening, which means comprise a blower device placed on a first side of the passage opening and having blowing means extending at least substantially over a full dimension of the first longitudinal side, and the blower device is in open communication with air displacing means which impart an air stream under overpressure to the blowing means.

[0002] Such a device is for instance known from international patent application WO 2010/085861 and creates an effective air technological separation between separate climate zones. This involves not only a thermal separation of said spaces; a free exchange of flying insects, odours, substances and other air components between the spaces can hereby also be prevented without a physical barrier having to be installed for the purpose.

[0003] The device comprises a specially constructed blower device which is supplied by the air displacing means with a continuous air stream which exits at the blow mouth. The air stream blown out under pressure manifests itself as a thin laminar dynamic air curtain extending over the passage opening. This curtain forms an effective climatological separation between the adjoining spaces and functions as it were as a thin invisible door which hermetically seals the passage opening. Without use of such a device, or if the device is taken out of operation, a natural heat transport would by contrast occur in the case of a thermal gradient between the spaces. Warm air in that case flows on an upper side of the passage to the colder space, while cold air will flow on the underside to the warmer space. Wind or underpressure, for instance as a result of physical displacements via the passage, reinforce this phenomenon still further. This would then result in an inevitable and undesirable mixing of the air in the adjoining spaces, whereby costly energy is lost. The dynamic air curtain maintained with the device effectively prevents all of this.

[0004] The device according to the invention can be applied in new buildings, existing buildings and during renovation. Because every situation will be different, the device always has to be specifically adapted to the situation. Particularly in the case of applications in cold stores, where there is a great temperature difference between a cold storage area or refrigeration cell on the one hand and a normal ambient temperature in an adjoining space on the other, this is found to be a difficult problem. This is because, in addition to a temperature separation, the device here also has to form an impenetrable barrier to water vapour between the relatively warm moist air outside the cold storage area and the relatively cold dry air inside it. Without an effective separation undesirable condensation and icing could otherwise occur beyond the passage.

[0005] The known device is found to be able to satisfy such more stringent conditions to only a limited extent. The present invention therefore has for its object, among others, to provide a device for initiating and maintaining an air curtain between adjoining spaces which is better adaptable to a specific situation, so that an effective separation can also be guaranteed in the case of a large temperature gradient.

[0006] In order to achieve the stated object a device of the type described in the preamble has the feature according to the invention that the blowing means comprise a series of longitudinally successive blower units, each with a blow mouth which is provided with a controllable air slit from which the air stream exits during operation, that the blower units are individually laterally orientable about a pivot axis oriented at least substantially along the first longitudinal side, and that the blower units are provided with shared air inlet means. Owing to the multiple blower unit successive air curtains are thus created in the longitudinal direction which, because of the controllable air slit and individually laterally pivotable blower unit, can be separately adjusted and oriented. More dry air for instance can thus be blown out on the upper side of the passage in order to exclude relatively warm moist air compared to a part of the air curtain lying thereunder.

[0007] A preferred embodiment of the device according to the invention has the feature here that the blower units each have a length in the order of between 50 and 200 centimetres and together at least substantially wholly cover the first longitudinal side. A passage typically having a height of 2 to 6 metres can thus be spanned from two or more, in particular three or four such blower units. With three blower units it is then possible to opt for instance to blow 10% dry air into a lower region of the air curtain using the lower blower unit, 30% dry air into a zone located thereabove using the associated blower unit, and above this 60% dry air using the upper blower unit(s). The separate zones of the air curtain are adjustable here in thickness and flow velocity because of the controllable slit width, and are moreover laterally orientable. A demand for dry air can thus be accurately modified both horizontally and vertically to a specific situation.

[0008] In a particular embodiment the device according to the invention is characterized in that the air slit has a slit width which is adjustable between about 0 and 50 millimetres, in particular between 0 and about 12 millimetres. Such an adjustment range is found in practice to be sufficient to impart a satisfactory flow velocity and thickness to the air curtain within each zone.

[0009] From the viewpoint of ease and simplicity of installation it is desirable to provide the blower device with a single air inlet to which the air displacing means can be connected. In order to prevent suction mouths located closer to the air inlet hereby unintentionally being given a stronger air stream than more remote suction mouths, a further preferred embodiment of the device according

to the invention has the feature that the blower device comprises a primary air inlet in open communication with the air displacing means, that each of the blow mouths is provided upstream of the air slit with a secondary air inlet, and that distributing means are provided between the primary air inlet and the secondary air inlets in order to distribute an air stream exiting the primary air inlet substantially equally over the secondary air inlets. The distributing means comprise for instance an air resistance element which extends over the individual secondary inlets in order to distribute a primary air stream to at least greater extent more homogeneously thereover.

[0010] A particularly effective embodiment of the device according to the invention is characterized in this latter respect in that the distributing means comprise a plate body with a regular pattern of perforations which is arranged in an air stream path between the primary air inlet and the blow mouths and extends at least substantially over a full length of the series of blower units. Such a perforated plate body in that case functions as distributing grid over the secondary air inlets. A particularly practical embodiment of the device according to the invention has the feature here that the plate body comprises a wall of a tube body with a central cavity which comprises the primary air inlet at an open outer end and on an external side remote from the cavity is in open communication with the series of blower units, wherein the blower units are individually pivotable all around the tube body.

[0011] It is recommended in practice in many cases to extract the generated air curtain and optionally recirculate the air stream. With a view hereto a further preferred embodiment of the device according to the invention has the feature that on an opposite second side of the passage a suction device is placed with suction means which extend at least substantially over a full dimension of the second longitudinal side, that the suction device comprises at least one suction mouth with a substantially prismatic suction cavity which is bounded by flanks and which extends longitudinally, wherein one or more suction openings with an adjustable active cross-section are provided in the flanks of the suction cavity. The prismatic suction cavity provides a particularly effective means here for capturing the air curtain and discharging the air stream via the suction openings. The flanks thereof lie at an angle and the suction openings therein are individually adjustable for the purpose of being able to capture the air stream exiting the blower units, even in the extreme positions thereof.

[0012] In order to enable fine adjustment of the air curtain on the suction side as well as on a blow-in side, and moreover enable variation in longitudinal direction, a further particular embodiment of the device according to the invention has the feature that the one or more suction openings are each adjustable by means of a controllable closing valve, in particular by means of an adjustable slide, and more particularly that at least a number of the suction openings are provided per flank with a shared closing valve which is jointly adjustable for the associated suction openings. The first mentioned embodiment provides here for an optimal adjustability of the suction openings, while the latter allows a simpler construction and operation.

[0013] The suction device is preferably also equipped with a shared connection for the air displacing means which impart an underpressure thereto. In order to also distribute this underpressure uniformly over the longitudinal side a further particular embodiment of the device according to the invention is characterized in that the suction device comprises a primary air outlet in open communication with the air displacing means, and that distributing means are provided between the primary air outlet and the suction openings in order to distribute an underpressure imparted to the primary air outlet substantially equally over the suction openings.

[0014] The invention also relates to a system for thermally separating a relatively cold, optionally closed first space and a relatively warm, optionally closed second space which are separated from each other by a wall but connected to each other by a passage, wherein a first device according to the present invention is disposed on a side of the passage facing toward the second space, followed by a second device according to the present invention adjacently thereof, wherein the first device is provided with first air displacing means for air from the first space and the second device is provided with second air displacing means for air from the second space, and wherein the first air displacing means comprise an air drier which is able and configured to separate moisture from the air. Such a system is particularly suitable for application in cold storage areas and other situations wherein a considerable difference in temperature and climate prevails between the adjoining spaces.

[0015] Because the system comprises at least two connected devices for generating and maintaining an air curtain, two separate air curtains are thereby generated successively during operation with an air sluice therebetween for the purpose of a further reaching separation of the two climates. Each of the curtains is preferably supplied here with an air stream which is extracted from the adjoining space. In the unlikely event that relatively warm and moist air should be entrained in the cold curtain, the air drier will extract a possible surplus of water vapour from the air before recirculating it. Condensation or icing can thus be counteracted.

[0016] The invention will be further elucidated hereinbelow on the basis of an exemplary embodiment and an accompanying drawing. In the drawing:

figure 1 shows a perspective view of an exemplary embodiment of a system and device according to the invention;

figure 1A shows a cross-section of the blower device as applied in the system of figure 1;

figure 1B shows a cross-section of the suction device as applied in the system of figure 1;

figure 2A shows a section through a blower device as applied in the device of figure 1;
figure 2B shows a section through a suction device as applied in the device of figure 1;
figure 2C shows a detail of the section of the blower unit of the blower device of figure 2A; and
figure 2D shows a detail of the section of the suction mouth of the suction device of figure 2B.

[0017] The figures are otherwise purely schematic and not drawn to scale. Some dimensions in particular may be exaggerated to greater or lesser extent for the sake of clarity. Corresponding parts are generally provided with the same reference numeral.

[0018] Shown schematically in figure 1 is a wall 10 which separates a relatively warm space 11 from a cold storage area or refrigeration cell 12 which is located behind it and where a considerably cooler climate prevails. The two spaces 11,12 are connected to each other via a passage opening 15 in the wall. For the purpose of an air technological and thermal separation of the two spaces 11,12 a system according to the invention is provided at the position of the passage for the purpose of generating and maintaining an air curtain which closes the opening effectively in thermal and air technological manner.

[0019] The installation shown in figure 1 comprises a first blower device 20 in combination with a first suction device 30 which are placed against wall 10 on opposite longitudinal sides of the opening and form a first air curtain device according to the invention. Placed connecting to the first blower device 20 and the first suction device 30 are a further blower device 40, with a series of individually laterally pivotable blower units 41..43, and a further suction device 50 which together form a further air curtain device according to the invention.

[0020] The shown installation is assembled mainly from hollow tubular parts of galvanized or otherwise preserved steel. The vertical tubular parts have a roughly rectangular section with an external size of about 300 x 600 millimetres, while the horizontal parts have a more square section in the order of about 600 x 600 millimetres,. An exceptionally compact arrangement is thus achieved as shown in the figure.

[0021] The first blower device 20 and first suction device 30 are in open communication with first air displacing means, which are not shown in the figure, via connections 61,69 provided for the purpose. In addition to a fan for the purpose of initiating and maintaining an air stream therewith between blower device 20 and suction device 30, these air displacing means also comprise an air drier with which a surplus of water vapour can be separated from the air. The first air curtain device will thus circulate mainly relatively dry air which has here been extracted from the cold storage space.

[0022] The second air curtain device 40,50 is likewise provided with air displacing means. This is a fully closed system wherein the air displacing means take the form of a powerful fan arranged in a fan housing 65 provided for this purpose between the further blower device 40 and further suction device 50. A conduit system in the form of hollow tubes 66,67 connect the separate components to each other. The air streams circulating during operation are indicated schematically in the figure with arrows. Tubular part 67 between fan housing 65 and suction unit 50 is provided internally with a splitter silencer.

[0023] Blower devices 20,40 applied according to the present invention each comprise a series of successive blower units 21..23,41..43 in longitudinal direction which are each individually laterally pivotable about a longitudinally oriented axis, see also figure 2A, and are supplied per device from a shared air inlet 61,66 of the associated blower device.

[0024] At an outer end the blower units 21..23,41..43 debouch into an air slit 24 from which the air stream can exit in the form of a relatively thin laminar air curtain which is constantly maintained during operation by a continuous feed and recirculation of the air stream generated with air displacing means 65. The air slit typically has a length 1, see figure 2C, of between 30 and 50 millimetres in order to impart such a form to the exiting air stream. The individual blow units 21..23,41..43 typically each have a height of between 50 and 200 centimetres, also depending on a height of the passage to be spanned therewith. In this embodiment the blower units are each about 145 centimetres high so that they together cover a passage with a height of about 4.35 metres and a width of 3.30 metres.

[0025] Air slit 24 of each of the blower units 21..23,41..43 is controllable according to the invention, i.e. a width thereof is adjustable so that the air curtain in the present embodiment has three successive zones which are each individually adjustable in respect of thickness, air velocity and direction. An effective air technological separation can hereby be obtained between adjoining spaces, wherein an air stream velocity of between 5 and 25 m/s will typically prevail in each curtain.

[0026] This adjustability is achieved in the present embodiment in that the constituent parts 29A, 29B, see figure 2A, are mounted by means of carriage bolts and nuts 28 in laterally oriented slotted holes and can thus be moved toward each other in order to narrow the air slit 24 and moved away from each other in order to widen the slit 24. The slit width, and thereby a thickness of the zone of the air curtain exiting therefrom, can thus be precisely varied and set between 0 and 15 millimetres. Thus applied in this embodiment is a slit width between 8 and 12 millimetres, whereby a good balance is achieved between air flow rate and air resistance on the one hand and air velocity on the other. A higher passage can be closed by air technology in similar manner by applying more blower units or by selecting a greater height per blower unit. Fewer blower units or blower units with a smaller individual height will conversely suffice for a lower passage.

[0027] Blower units 21,22,23 are each formed from

shell parts 26 and are mounted in the blower device for rotation about a vertical axis 27 and thereby pivotable over an optionally equal angle α, β to the left and right respectively, see figure 2A. The separate zones of the air curtain can moreover hereby be oriented laterally to enable, in combination with the adjustable curtain thickness, the installation to be adapted optimally to a specific situation. In the present embodiment wherein the first air curtain device 20,30 is supplied mainly with relatively cold and dry air from the cold storage area lying behind the wall and the second air curtain device 40,50 extracts the air stream mainly from the warmer front space, it is thus possible to take the best possible advantage of these climate zones differing considerably from each other. The air is supplied here via a central tube body 25, a wall of which is perforated at least over a part of its periphery with a regular pattern of openings. The hereby created grid ensures that the air stream will be distributed (more) uniformly over the successive blower units 21..23,41..43. The tube body is closed on an underside, while a body cavity therein opens on an upper side into air inlet 61 of the associated blower device. Blower units 21..23,41..43 are each individually pivotable around tube body 25, as shown in further detail in figure 2A.

[0028] In order to create an optimal air technological and thermal separation between the spaces it is for instance possible to opt to blow for instance 10% dry air into a lower region of the air curtain with the lower blower unit 21, 30% dry air into a zone located thereabove with the associated blower unit 22 and 60% dry air above this with the upper blower unit 23. The individual zones of the air curtain are adjustable here in respect of thickness and flow velocity owing to the adjustable slit width and are moreover laterally orientable. By orienting a blower unit respectively toward and away from the other air curtain a determined mixing between the two air curtains can if desired be respectively realized and prevented. A requirement for dry air can thus be adapted accurately both horizontally and vertically to a specific situation.

[0029] On an opposite side of the passage each of the air curtains from respectively the first blower device 20 and second blower device 40 is received by a suction device 30,50 of its own. Just as the blower device, the suction device is formed substantially as hollow tubular parts of a rectangular section. In the case of the suction device this section is typically in the order of about 360 x 600 millimetres externally. Such a suction device is further shown in cross-section in figure 2B.

[0030] On a side facing toward blower device 20,40 the suction device 30 comprises a prismatic suction mouth 39 with flanks 39A,39B in which one or more suction openings 34 are provided. This embodiment has in this respect a single elongate continuous opening 34 extending over substantially the whole longitudinal length of the unit, see also figure 2D. The opening is closable here with an adjustable valve in the form of a slide 36 which can be pushed to greater or lesser extent over the opening in order to close an opening 34 as desired between 0 and 100%, see also figure 2D. Slotted holes and carriage bolts protruding therein with nuts 38 provide for this lateral adjustability of the plate parts forming the slides. This is possible in both flanks, whereby a resulting suction action of the suction unit can be given a lateral direction, adapted for instance to a direction of the air curtain which has been imparted thereto by a blower unit. In order to distribute an underpressure prevailing in the suction device more uniformly over opening(s) 34 a perforated plate body, which in this case also forms part of a wall of a tube body 35 placed centrally in the suction device, is placed in similar manner as in the case of the blower device between the outlet 69 of the unit and the individual opening(s) 34.

[0031] Although the invention has been further elucidated on the basis of only a single exemplary embodiment, it will be apparent that the invention is by no means limited thereto. On the contrary, many variations and embodiments are still possible within the scope of the invention for a person with ordinary skill in the art.

Claims

1. Device for separating by air technology adjoining spaces which are connected to each other by a passage opening provided in a wall, comprising means for generating and maintaining an air curtain at least at the position of the passage opening, which means comprise a blower device placed on a first side of the passage opening and having blowing means extending at least substantially over a full dimension of the first longitudinal side, and the blower device is in open communication with air displacing means which impart an air stream under overpressure to the blowing means, **characterized in that** the blowing means comprise a series of longitudinally successive blower units, each with a blow mouth which is provided with a controllable air slit from which the air stream exits during operation, that the blower units are individually laterally orientable about a pivot axis oriented at least substantially along the first longitudinal side, and that the blower units are provided with shared air inlet means.

2. Device as claimed in claim 1, **characterized in that** the blower units have a length in the order of 50 to 200 centimetres and together at least substantially wholly cover the first longitudinal side.

3. Device as claimed in claim 1 or 2, **characterized in that** the air slit has a slit width which is adjustable between about 0 and 50 millimetres, in particular between 0 and about 12 millimetres.

4. Device as claimed in one or more of the foregoing claims, **characterized in that** the blower device comprises a primary air inlet in open communication

with the air displacing means, that each of the blow mouths is provided upstream of the air slit with a secondary air inlet, and that distributing means are provided between the primary air inlet and the secondary air inlets in order to distribute an air stream exiting the primary air inlet substantially equally over the secondary air inlets.

5. Device as claimed in claim 4, **characterized in that** the distributing means comprise a plate body with a regular pattern of perforations which is arranged in an air stream path between the primary air inlet and the blow mouths and extends at least substantially over a full length of the series of blower units.

6. Device as claimed in claim 5, **characterized in that** the plate body comprises a wall of a tube body with a central cavity which comprises the primary air inlet at an open outer end and on an external side remote from the cavity is in open communication with the blow mouths, wherein the blower units are individually pivotable all around the tube body.

7. Device as claimed in one or more of the foregoing claims, **characterized in that** on an opposite second side of the passage a suction device is placed with suction means which extend at least substantially over a full dimension of the second longitudinal side, that the suction device comprises at least one suction mouth with a substantially prismatic suction cavity which is bounded by flanks and which extends longitudinally, wherein one or more suction openings with an adjustable active cross-section are provided in the flanks of the suction cavity.

8. Device as claimed in claim 7, **characterized in that** the one or more suction openings are each adjustable by means of a controllable closing valve, in particular by means of an adjustable slide.

9. Device as claimed in claim 8, **characterized in that** at least a number of the suction openings are provided per flank with a shared closing valve which is jointly adjustable for the associated suction openings.

10. Device as claimed in one or more of the claims 7 to 9, **characterized in that** the suction device comprises a primary air outlet in open communication with the air displacing means, and that distributing means are provided between the primary air outlet and the suction openings in order to distribute an underpressure imparted to the primary air outlet substantially equally over the suction openings.

11. Separating system for thermally separating a relatively cold, optionally closed first space and a relatively warm, optionally closed second space which are separated from each other by a wall but connected to each other by a passage, wherein a first device according to one or more of the foregoing claims is disposed on a side of the passage facing toward the second space, followed by a second device according to one or more of the foregoing claims adjacently thereof, wherein the first device is provided with first air displacing means for air from the first space and the second device is provided with second air displacing means for air from the second space, and wherein the first air displacing means comprise an air drier which is able and configured to separate moisture from the air.

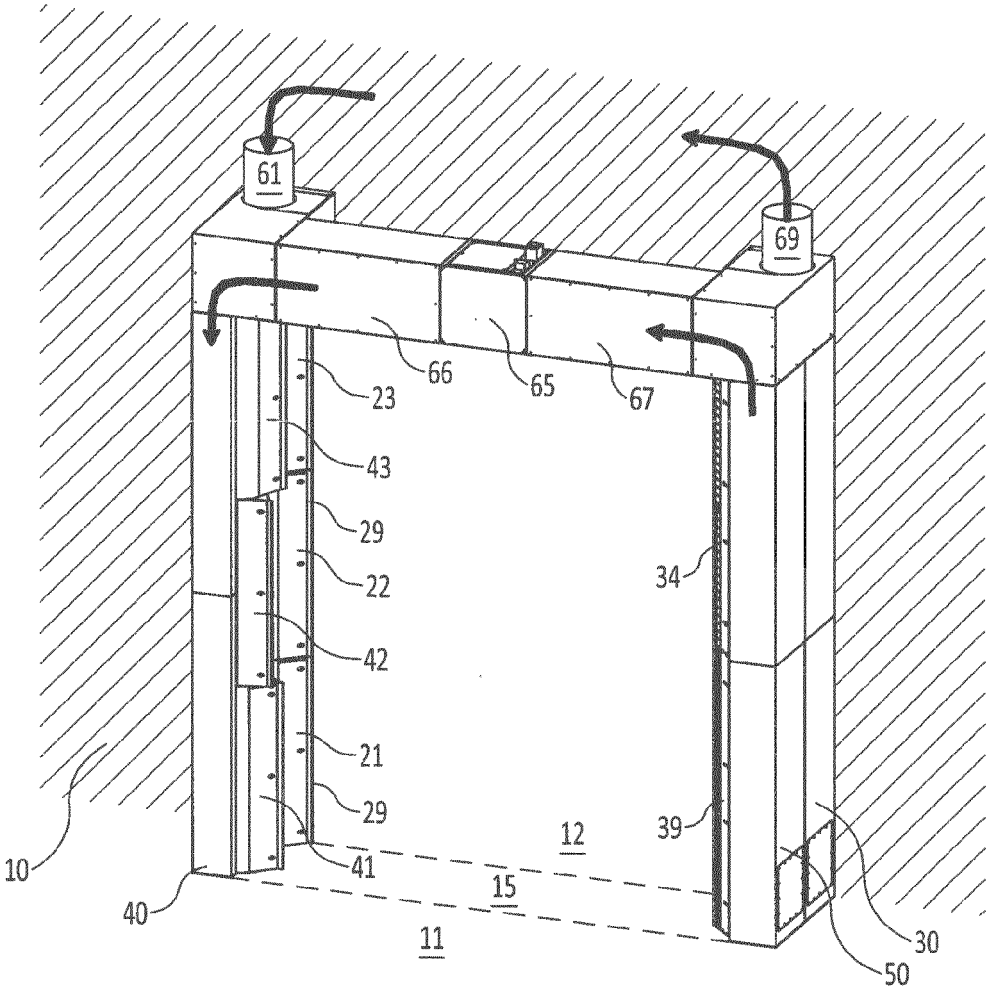

Fig.1

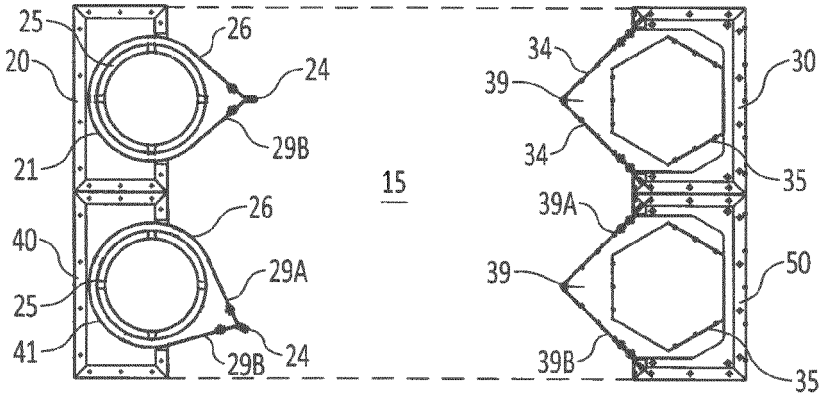

Fig.1A

Fig.1B

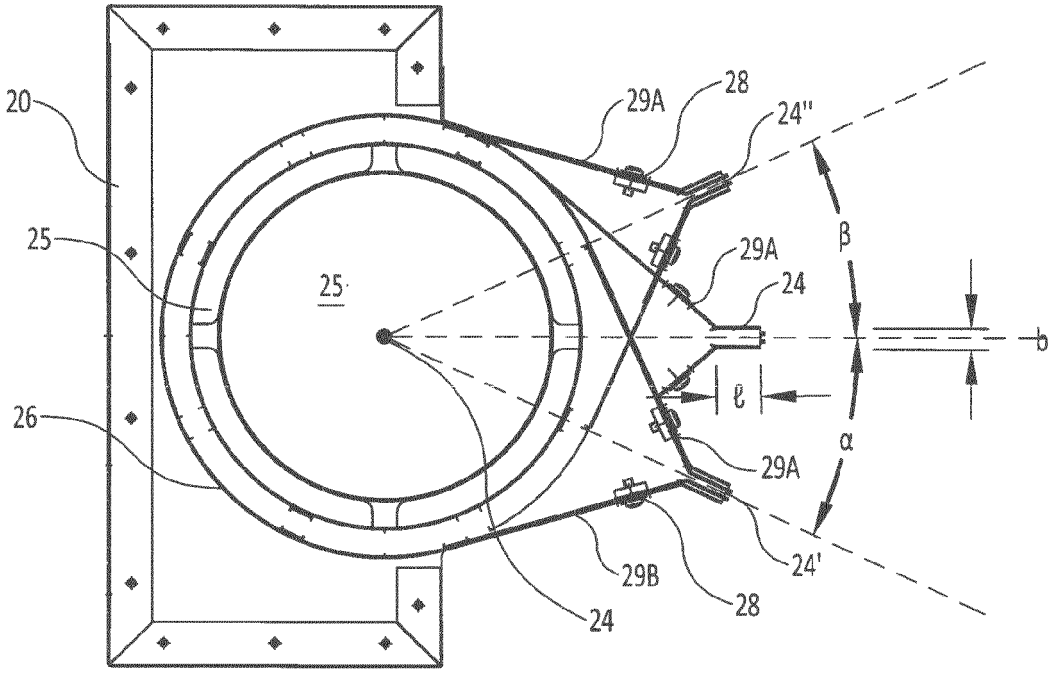
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Fig.2A

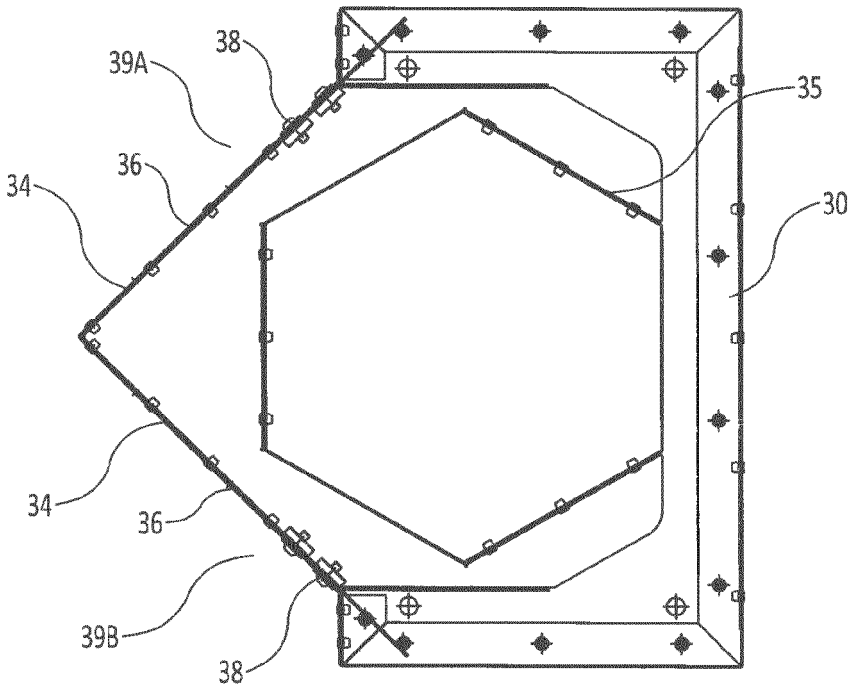
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Fig.2B

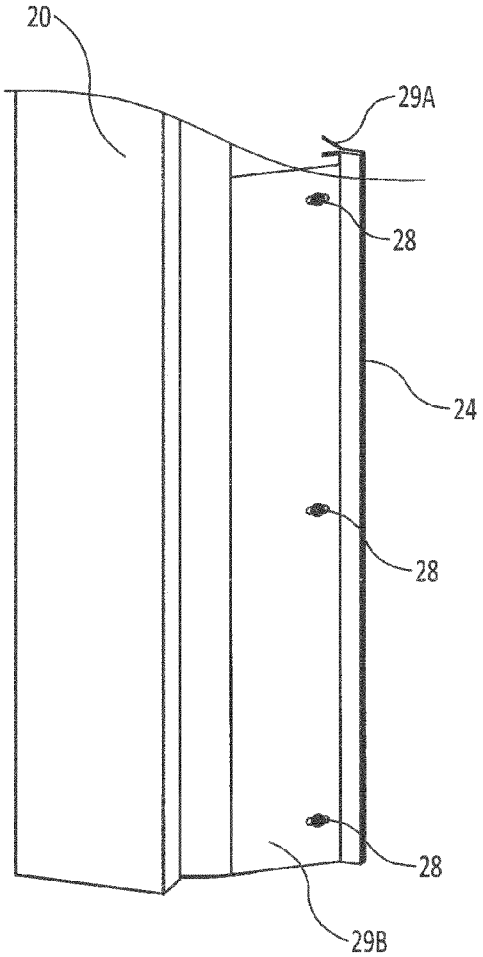

Fig.2C

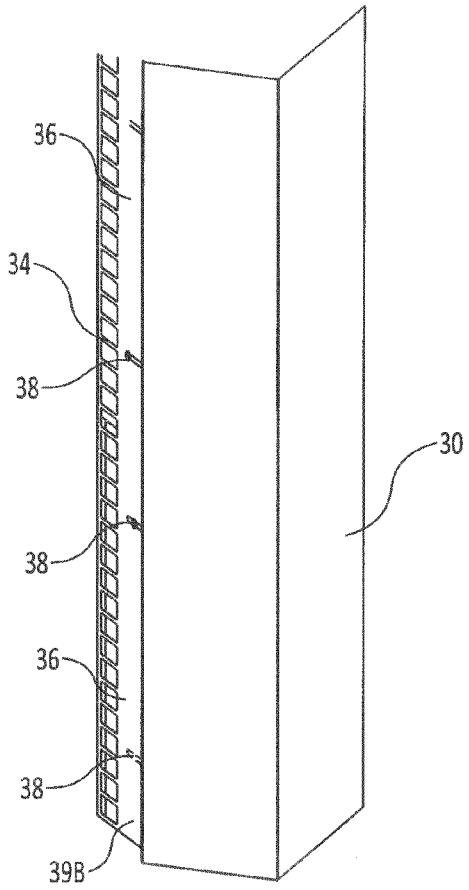

Fig.2D

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EUROPEAN SEARCH REPORT

Application Number
EP 15 16 6083

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Y	WO 2009/051482 A1 (HANDELSMIJ WILLY DEWEERDT BVBA [BE]; BERBEN ERNEST JOZEF ELIAS [NL]; D) 23 April 2009 (2009-04-23) * page 16, line 30 - page 17, line 13; figures 15a, 15b, 17 *	7-11	TECHNICAL FIELDS SEARCHED (IPC) F24F
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	1 October 2015	Valenza, Davide

CATEGORY OF CITED DOCUMENTS

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- WO 2010085861 A **[0002]**