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## (54) Apparatus and methods for air conditioning via a ceiling installation

(57) The invention relates to a method comprising moving a supply air terminal device (110) attachable to a ceiling of a space to be air conditioned at least partly above the ceiling between an operating position and a supported position. The terminal device is moved through an opening arranged in the ceiling in a position where a side of supply air inlet is towards the space to be air conditioned. The invention also relates to an air conditioning apparatus including a mechanism for dropping a terminal device through an opening arranged in a ceiling into a space to be air conditioned with a side of supply air inlet foremost. The invention also relates to a habitable room, such as a ship cabin or similar.

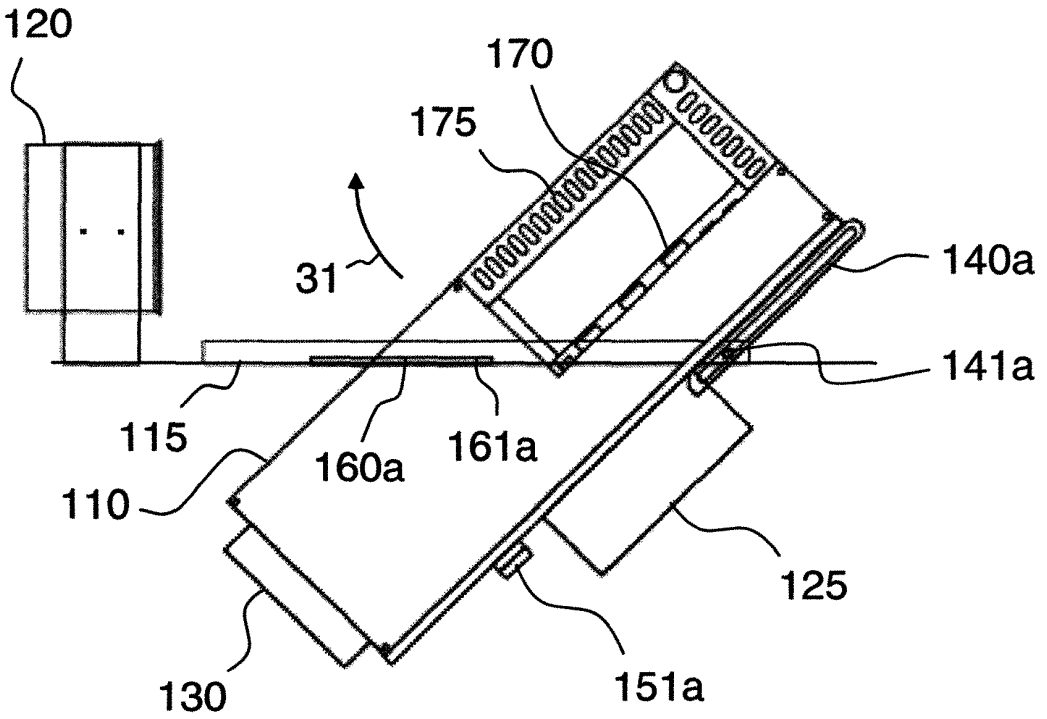


Fig. 3

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## Description

### TECHNICAL FIELD

**[0001]** The present invention generally relates to air conditioning. In particular, but not exclusively, the invention relates to the air conditioning of a ship cabin.

### BACKGROUND ART

**[0002]** In ships' cabins, air conditioning is generally provided by air conditioning systems where an air conditioning terminal device for supply air is installed above a cabin's ceiling and exhaust air is provided for by a separate duct, e.g., an outlet device installed above the ceiling. Filtered air is supplied to the terminal device through an inlet duct. The terminal device, in turn, feeds air through a supply air diffuser or similar attached to the ceiling of the cabin.

**[0003]** Depending on the system, a cabin passenger may also control the operation of the supply air terminal device by using an adjusting device installed on the cabin wall. Typically, the user may set the temperature of the cabin lower or higher, for example. The air flow supplied to the cabin (for example, the amount or temperature of flow or both) is adjusted on the basis of settings made by the user through the adjusting device, or potential other system settings so that the air conditioning conditions in the cabin meet the user's needs and desired requirements as well as possible.

**[0004]** The air conditioning terminal device is installed above the cabin's ceiling, either during the ship construction phase at the dock or, increasingly often, at a cabin plant in connection with cabin construction. Completed cabin modules are typically installed on the ship by pushing them in place on the ship's deck and attaching them to the ship's hull. Due to the very limited space in the vertical direction between the ship's decks and the cabin modules, the terminal device cannot, in practice, remain in place in its operating position when the cabin is being pushed into the ship. As the terminal device typically substantially protrudes into the space above the cabin's ceiling, the terminal device may hit a horizontal beam in the ship and be damaged while the cabin module is being pushed into the ship, or may even entirely prevent the installation of the cabin.

**[0005]** One known implementation has aimed to overcome the problem presented above by using a flexible hose as an inlet pipe at the end of the air inlet duct side of the supply air terminal device and by dropping the terminal device into the cabin while the cabin is installed. During the commissioning phase on the ship, the terminal device is lifted back in place above the cabin's ceiling. However, this solution presents a problem in that the flexible hose may be damaged while bending. It may exhibit a dent or be twisted so that it affects the flow of the terminal device's supply air and typically also temperature control.

### SUMMARY

**[0006]** According to a first aspect of the invention there is provided an apparatus comprising:

a terminal device adapted to be attached in an operating position to a ceiling of a space to be air conditioned, at least partly above the ceiling, the terminal device comprising

a side of supply air inlet for feeding supply air into the terminal device.

**[0007]** The apparatus comprises:

a mechanism for dropping the terminal device, with the side of supply air inlet foremost, into the space to be air conditioned through an opening arranged in the ceiling.

**[0008]** Said mechanism (or means) may comprise means enabling sliding and swinging. The means may be attached or attachable to the terminal device or in connection with it, or partly to the terminal device and partly in connection with it. Depending on the embodiment, for example, special slide rails and/or slot parts and/or bars, pegs and/or protruding parts moving in them and/or attached/attachable to them may be installed either on the terminal device, the ceiling of the space to be air conditioned, and/or a special installation frame or rail or similar.

**[0009]** In some embodiments said mechanism is a dropping mechanism allowing dropping of the terminal device in a special supported position. The support may be provided in two manners of different types or a combination thereof. In the first manner, the terminal device is dropped in a supported position where the apparatus itself supports the terminal device. Thereby, the terminal device may, for example, remain hanging from the dropping mechanism. In the second manner, the terminal device is dropped directly off the dropping mechanism, whereby the apparatus itself does not support the terminal device, but, rather, the support is provided by a mechanic etc.

**[0010]** In some embodiments, the apparatus comprises a mechanism (or means) for moving or sliding the terminal device in the horizontal direction to or away from a pipe adapter. In some embodiments, the mechanism is adapted to release the terminal device from the mechanism when the terminal device has been moved or slid a certain distance from a pipe adapter.

**[0011]** In some embodiments, the apparatus comprises a combined sliding and rotating mechanism (or means) for dropping the terminal device by swinging it down to said supported position with the side of supply air inlet downwards. In some embodiments, the solution where the terminal device is swung down is called a swingdown mechanism. Such a swingdown mechanism may be implemented by using an installation frame, for

example, or by using separate installation rails. The swingdown mechanism may include support beams or rails that are attached to support beams above the ceiling of the space to be air conditioned (e. g. , a ship cabin). The terminal device may be swung down before the ship cabin is installed, for example, and, at the commissioning phase, the terminal device may be lifted back in place above the ceiling. The terminal device may be attached in place to a supply air pipe adapter, at whose other end a supply air duct will be or has been attached with a flexible hose etc.

**[0012]** In some embodiments, the apparatus comprises an installation frame made of an incombustible material attached to the ceiling, entirely surrounding said opening arranged in the ceiling. In some embodiments, an installation frame covers the ceiling above the opening for a certain range (e. g. , 25 mm) from each edge, which is in compliance with specific fire safety requirements.

**[0013]** In some embodiments, the apparatus comprises a mechanism comprising a sliding mechanism and a combined sliding and rotating mechanism, the sliding mechanism enabling sliding of the terminal device and the combined sliding and rotating mechanism enabling a combined sliding and rotating movement of the terminal device in a situation where the terminal device is disengaged from said sliding mechanism. Rotating movement may be allowed around a specific axis of rotation.

**[0014]** In some embodiments, the apparatus comprises a plurality of turbulence reduction plates in connection with the side of supply air inlet. The apparatus may comprise said turbulence reduction plates regardless of other embodiments and regardless of whether the device includes a mechanism for dropping the terminal device through an opening arranged in the ceiling to the side of the space to be air conditioned with the side of supply air inlet foremost. According to an aspect of the invention, accordingly, an apparatus for air conditioning is implemented, the apparatus comprising a plurality of turbulence reduction plates in connection with a side of supply air inlet. In some embodiments, the plates are parallel to the inlet direction of supply air, whereby they contribute to the generation of a laminar flow. When the plates are parallel to the inlet direction, the tangent to their surface is parallel to the inlet direction and the perpendicular to the surface is perpendicular to the inlet direction. The turbulence reduction plates may be located in a supply air pipe adapter, for example. They may be positioned side by side.

**[0015]** According to a second aspect of the invention there is provided a method comprising:

moving a supply air terminal device attachable to a ceiling of a space to be air conditioned, at least partly above the ceiling, between an operating position and a supported position, the method comprising:
moving the terminal device between said operating position and a supported position through an opening arranged in the ceiling in a position where a side of supply air inlet is towards the space to be air conditioned.

**[0016]** In some embodiments, the method comprises dropping the terminal device on the way from the operating position to said supported position through an opening arranged in the ceiling of the space to be air conditioned with the side of supply air inlet of the terminal device foremost.

**[0017]** In some embodiments, the method comprises lifting the terminal device on the way from said supported position to the operating position through an opening arranged in the ceiling of the space to be air conditioned with the side opposite to the side of supply air inlet of the terminal device foremost.

**[0018]** In some embodiments, the method comprises moving or sliding the terminal device substantially in the horizontal direction to a pipe adapter or away from a pipe adapter. In some embodiments, the method comprises swinging the terminal device down in said supported position with the side of supply air inlet downwards.

**[0019]** In some embodiments, the method allows sliding the terminal device by means of a sliding mechanism and allows a combined sliding and rotating of the terminal device around an axis of rotation by means of a terminal device sliding and rotating mechanism in a situation where the terminal device is disengaged from said sliding mechanism.

**[0020]** In some embodiments, the method comprises reducing the turbulence of the supply air by means of a plurality of turbulence reduction plates. The turbulence of the supply air can be reduced by means of a plurality of turbulence reduction plates regardless of other embodiments and regardless of whether the method comprises moving a supply air terminal device attachable to the ceiling of the space to be air conditioned, at least partly above the ceiling, between an operating position and a supported position. According to an aspect of the invention, accordingly, a method is implemented comprising reducing the turbulence of the supply air by means of a plurality of turbulence reduction plates located in connection with the air conditioning apparatus.

**[0021]** When, according to some embodiments, the terminal device is moved above the ceiling of the space to be air conditioned backwards so that the device is swung down to a supported position with the side of the supply air inlet pipe foremost, it may be preferable in some embodiments that in such a solution the terminal device is able to drop to the side of the space to be air conditioned (e. g. , into a cabin) through an opening typically smaller than usual. This, in turn, typically enables a smaller diffuser size.

**[0022]** If said pipe adapter, for example, includes turbulence reduction plates (e. g. , lamellae) for evening out air turbulence, the adjustment of the air conditioning apparatus will be easier in some systems, especially such where the pressure of the supply air duct is measured or where adjustment is at least partly based on pressure

difference measurements.

**[0023]** According to a third aspect of the invention there is provided a habitable space comprising any apparatus comprised by the first aspect or its embodiments, wherein said habitable space is a hotel room or a cabin on a ship or other means of transport.

**[0024]** Said habitable room is otherwise constructed in the conventional manner, but it comprises an apparatus according to said first aspect or its embodiments, or installation means dedicated for such an apparatus (e. g. , an installation frame, installation rails or similar) attached to a ceiling of the habitable space.

**[0025]** Some embodiments of the present invention have been or will be described in the detailed description and dependent claims. Embodiments are described in connection with specific selected aspects of the invention. A person skilled in the art will appreciate that any of the embodiments may typically be combined with another embodiment or embodiments under the same aspect of the invention. Any of the embodiments may typically also be combined with another aspect or aspects of the invention, either alone or together with any other embodiment or embodiments.

## BRIEF DESCRIPTION OF THE FIGURES

**[0026]** The invention will be described in the following by way of example with reference to the appended drawings, wherein:

- Figure 1 shows an air conditioning apparatus in accordance with an embodiment;
- Figure 2 shows a cross-sectional side view of the apparatus shown in Figure 1 in a supported position;
- Figure 3 shows a cross-sectional side view of the apparatus shown in Figure 1 in another position;
- Figure 4 shows a cross-sectional side view of the apparatus shown in Figure 1 in an operating position;
- Figure 5 shows a cross-sectional view of an air conditioning apparatus in accordance with an embodiment;
- Figure 6 shows a movement of a terminal device of an air conditioning apparatus with respect to an installation frame in an embodiment;
- Figure 7 shows a side view of a pipe adapter in an embodiment; and
- Figure 8 shows a front view of a pipe adapter in an embodiment.

## DETAILED DESCRIPTION

**[0027]** The same reference numbers are used in the figures to refer to the same items or elements.

Figure 1 shows a three-dimensional view of an air conditioning apparatus in accordance with an embodiment. The air conditioning apparatus comprises a terminal device 110, an installation frame 115 and a pipe adapter 120. In Figure 1, the terminal device 110 is in a down position (e. g. , for maintenance), where it hangs with its slide parts 140a, 140b from pegs (or support bars) 141 a, 141b of the installation frame 115. The terminal device comprises a supply air inlet pipe 130, a supply air outlet pipe 125 and (plug-in) connectors 170, as well as a cable clamp 175 for electrical connections. Protruding parts 151a, 151b that fit into corresponding slot parts 160a, 160b are integrated into or attached to the terminal device 110. The protruding parts 151a, 151b may be moved into the slot parts 160a, 160b by lifting and swinging the terminal device 110 in the manner shown by arrows 11 and 12, whereby, when the terminal device approaches the up position, there is room for the protruding parts 151 a, 151 b to move into the slot parts 160a, 160b at their ends 161 a, 161 b, which include a widening or other arrangement enabling insertion. The protruding parts may be implemented, e. g. , by means of an installation beam 150 whose bent ends form said protruding parts 151 a, 151 b. In its up position the terminal device 110 may further be slid in the horizontal direction to its operating position, where the supply air inlet pipe 130 is attached to the pipe adapter 120. The pipe adapter 120, in turn, is attached to a supply air duct with, e. g. , a flexible hose or similar (not shown). In an embodiment, the pipe adapter 120 comprises lamellae 180 for reducing the turbulence of the supply air.

Figure 2 shows a cross-sectional side view of the apparatus shown in Figure 1 while the terminal device 110 is in the down position. The terminal device 110 hangs with its slide part 140a from the peg 141 a of the installation frame 115, which is detachably or fixedly attached to the ceiling 210 of the space to be air conditioned (e. g. , a ship cabin), whereby the terminal device 110 extends to the side of the space to be air conditioned through an opening arranged in the ceiling.

Figure 3 shows a cross-sectional side view of the apparatus shown in Figure 1 while the terminal device 110 is in an interim position between the down position and the operating position.

Figure 4 shows a cross-sectional side view of the apparatus shown in Figure 1 while the terminal device 110 is in the operating position. In its operating position, the terminal device 110 is at least partly, in some embodiments substantially entirely, above the ceiling of the space to be air conditioned.

**[0028]** The terminal device 110 may be moved be-

tween the down position and the operating position for the purpose of installation or maintenance, for example. Movement from the down position to the operating position takes place as follows, for example:

**[0029]** The terminal device 110 is lifted upwards from the down position shown in Figure 2 so that the peg 141 a in the installation frame 115 guides the lifting movement and slides from one end of the slide part 140a towards the other end. At the same time, the terminal device 110 is also rotated around the axis of rotation formed by the peg 141 a in the manner shown by arrow 31 (Figure 3). While the terminal device 110 is lifted and rotated in this way, the protruding part 151 a meets the end 161 a of the slot part 151 a farthest from the pipe adapter 120, where it is pushed into the slot part 160a. Now, while the terminal device 110 has come at least partly above the ceiling through the opening in the ceiling of the space to be air conditioned, the terminal device 110 is moved or slid in the horizontal direction towards the pipe adapter 120. The protruding part 151 a and the peg 141 a guide the horizontal movement of the terminal device 110 and move in the slot part 160a and the slide part 140a, respectively. The horizontal movement of the terminal device 110 is illustrated by arrow 41 in Figure 4. The slot part 160a together with the protruding part 151a prevents any vertical movement of the terminal device, whereby the terminal device also cannot rotate around the axis of rotation formed by the peg 141 a while the protruding part 151 a is within the slot part 161 a. When the terminal device 110 reaches the pipe adapter 120, the terminal device 110 is attached to the pipe adapter 120 in an appropriate manner, depending on the embodiment. Suitable sealing may be used in the attaching (not shown).

**[0030]** Movement of the terminal device 110 from the operating position to the down position, e. g. , for maintenance purposes, takes place as follows, for example:

**[0031]** First the terminal device 110 is detached from the pipe adapter 120. The terminal device 110 is slid or moved in the horizontal direction away from the pipe adapter 120. The protruding part 151 a and the peg 141 a guide the horizontal movement of the terminal device 110 and move in the slot part 160a and the slide part 140a, respectively. The slot part 160a together with the protruding part 151 a prevents any vertical movement of the terminal device, whereby the terminal device also cannot rotate around the axis of rotation formed by the peg 141a while the protruding part 151 a is within the slot part 161 a. However, when the protruding part 151 a has moved to the end 161 a of the slot part 160a, the protruding part 151 a drops (or can otherwise be detached) from the slot part 160a, whereby the terminal device 110 drops by means of the slide part 140a and swings downwards by rotating around the axis of rotation formed by the peg 141 a to the down position shown in Figure 2 with the side of supply air inlet of the terminal device 110 foremost. This type of movement mechanism may be called a swingdown mechanism.

Figure 5 shows a cross-sectional side view of an air conditioning apparatus in accordance with an embodiment. A supply air diffuser 590 is installed in place, for example, by pushing it flush with a terminal device 110 according to arrows 55 and attaching it with screws, quick clamping or a similar attaching mechanism. The supply air flows from a supply air duct through a pipe adapter 120 and a supply air inlet pipe 130 to the terminal device 110 in the direction of arrow 51. The supply air appropriately treated in the terminal device 110 is conveyed from the terminal device 110 through a supply air outlet pipe 125 to the supply air diffuser 590 in the direction of arrow 52. The supply air is conveyed from the supply air diffuser 590 to the space to be air conditioned typically from the sides of the supply air diffuser 590. Arrows 53a and 53b illustrate this flow.

Figure 6 shows the movement of a terminal device 110 of the air conditioning apparatus with respect to an installation frame in an embodiment. Arrow 61 illustrates the horizontal direction in which the terminal device 110 may be moved or slid towards or away from a pipe adapter 120. In the position shown in Figure 6, protruding parts 151 a, 151 b are at ends 161 a, 161 b of slot parts 160a, 160b at a position where they can be detached from the slot parts 160a, 160b to enable a downswing of the terminal device 110.

Figure 7 shows a side view of a pipe adapter 120 in an embodiment. The pipe adapter 120 may be attached to an installation frame 115 or the ceiling of the space to be air conditioned with screws or similar.

Figure 8 shows a front or rear view of a pipe adapter 120 in an embodiment. The pipe adapter may comprise two, three, four or more lamellae or turbulence reduction plates 180, which extend from one edge or from close to the edge of the pipe adapter 120 to the other edge or close to the other edge of the pipe adapter 120 in the longitudinal direction of the pipe adapter 120. The turbulence reduction plates 180 even out turbulences of the air, which makes it easier to adjust the air conditioning apparatus.

**[0032]** In some variations of the embodiments presented above, the slide parts 140a, 140b may be open at the side opposite to the side of supply air inlet, whereby the terminal device 110 will easily drop away from the installation frame 115 if it is desired to replace the entire terminal device 110. In some other variations, the terminal device is detachable from the installation frame while in a supported down position by means of quick clamping or similar. In some variations, the slide parts 141 a, 141b are located on the installation frame 115 instead of the terminal device, and the pegs (or support bars/beams) are located on the terminal device 110 instead of the

installation frame. In some variations, the terminal device is, instead of sliding, moved using wheels installed on the terminal device 110 and/or the installation frame 115 so that the wheels may run in a suitable groove or on a suitable rail. In some variations, installation rails or similar, instead of an installation frame, are used for installing the terminal device 110 on or above the ceiling of the space to be air conditioned. In some variations, an additional support (e. g. , a support wire or wires) is attached or attachable to the terminal device. Such an additional support or a support wire or wires may be installed at one point in a suitable place on the terminal device (e. g. , around the middle or close to the cable clamps 175 or the connectors 170), for example, and at another point on the installation frame 115, for example, at its edge at or close to the end at the side of the pipe adapter 120, for example. The additional support enables supporting the downswing movement of the terminal device 110.

**[0033]** The description presented above provides non-limiting examples of some embodiments of the invention. However, a person skilled in the art will appreciate that the invention is not confined to the details presented, but, rather, the invention may also be implemented in other, equivalent ways. As used in this document, the terms 'comprise' and 'include' are open-ended expressions, and not intended to be restrictive.

**[0034]** Some characteristics of the embodiments presented may be utilized without using other characteristics. The description presented above must be considered as a descriptive presentation of the concepts of the invention and not be construed as restrictive. The scope of the invention is exclusively restricted by the appended claims.

## Claims

**1.** An apparatus comprising:

a terminal device adapted to be attached in an operating position to a ceiling of a space to be air conditioned, at least partly above the ceiling, the terminal device comprising
a side of supply air inlet for feeding supply air to the terminal device, **characterized in that** the apparatus comprises:
a mechanism for dropping the terminal device, with the side of supply air inlet foremost, through an opening arranged in the ceiling into the space to be air conditioned.

**2.** An apparatus as claimed in claim 1, comprising

a mechanism for moving or sliding the terminal device in the horizontal direction to and away from a pipe adapter.

**3.** An apparatus as claimed in claim 2, wherein said mechanism for moving or sliding the terminal device is adapted to release the terminal device from said mechanism when the terminal device has been moved or slid a certain distance from the pipe adapter.

**4.** An apparatus as claimed in any one of the preceding claims, comprising:

a combined sliding and rotating mechanism for swinging the terminal device down to said supported position with the side of supply air inlet downwards.

**5.** An apparatus as claimed in any one of the preceding claims, comprising a plurality of turbulence reduction plates parallel to the supply air inlet direction in connection with the side of supply air inlet.

**6.** An apparatus as claimed in claim 1 or 5, comprising turbulence reduction plates in a supply air pipe adapter.

**7.** An apparatus as claimed in any one of the preceding claims, comprising an installation frame made of incombustible material to be attached to the ceiling, entirely surrounding said opening arranged in the ceiling.

**8.** An apparatus as claimed in claim 1, wherein said mechanism comprises:

a sliding mechanism and a combined sliding and rotating mechanism, the sliding mechanism allowing sliding of the terminal device and the combined sliding and rotating mechanism allowing a combined sliding and rotating movement of the terminal device in a situation where the terminal device is disengaged from said sliding mechanism.

**9.** A method comprising

moving a supply air terminal device attachable to a ceiling of a space to air conditioned, at least partly above the ceiling, between an operating position and a supported position, **characterized in that** the method comprises:
moving the terminal device between said operating position and supported position through an opening arranged in the ceiling in a position where a side of supply air inlet is towards the space to be air conditioned.

**10.** A method as claimed in claim 9, comprising:

dropping the terminal device, on the way from the operating position to said supported posi-

tion, through an opening arranged in the ceiling of the space to be air conditioned with the side of supply air inlet foremost.

**11.** A method as claimed in claim 9 or 10, comprising:

lifting the terminal device, on the way from said supported position to the operating position, through the opening arranged in the ceiling of the space to be air conditioned with the side opposite to the side of supply air inlet foremost.

**12.** A method as claimed in any one of the preceding claims 9 to 11, comprising:

moving or sliding the terminal device in a substantially horizontal direction to or away from a pipe adapter.

**13.** A method as claimed in any one of the preceding claims 9 to 12, comprising:

swinging the terminal device down to said supported position with the side of supply air inlet downwards.

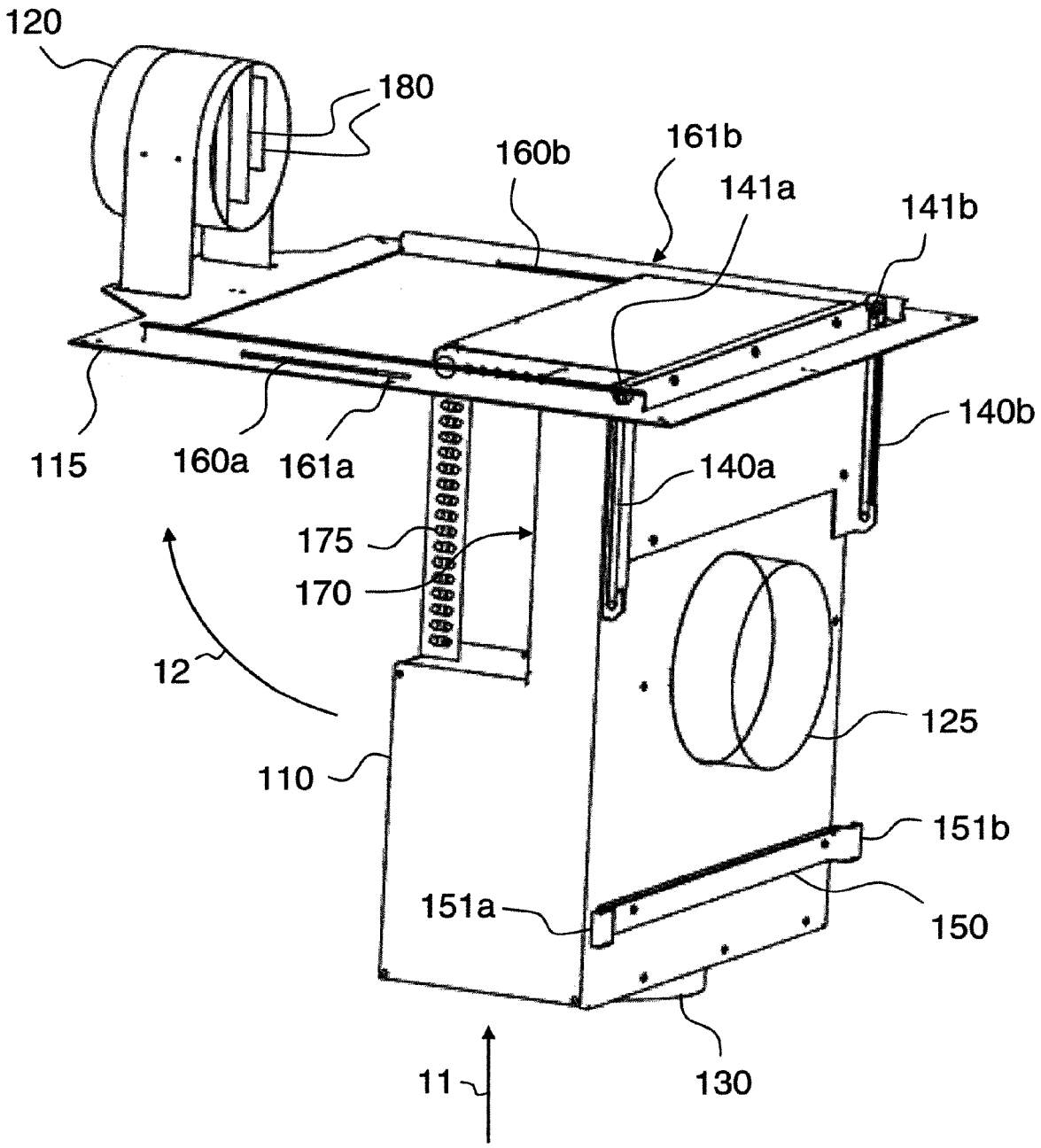
**14.** A method as claimed in any one of the preceding claims 9 to 13, comprising:

reducing the turbulence of the supply air by means of a plurality of turbulence reduction plates.

**15.** A method as claimed in any one of the preceding claims 9 to 13, comprising:

allowing sliding of the terminal device by means of a sliding mechanism; and
allowing a combined sliding and rotating of the terminal device around an axis of rotation by means of a combined terminal device sliding and rotating mechanism in a situation where the terminal device is disengaged from said sliding mechanism.

**16.** A habitable room comprising an apparatus as claimed in any one of claims 1 to 8, wherein said habitable space is for example a ship cabin.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141a
141b
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12
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151b
151a
150
11
130

Fig. 1

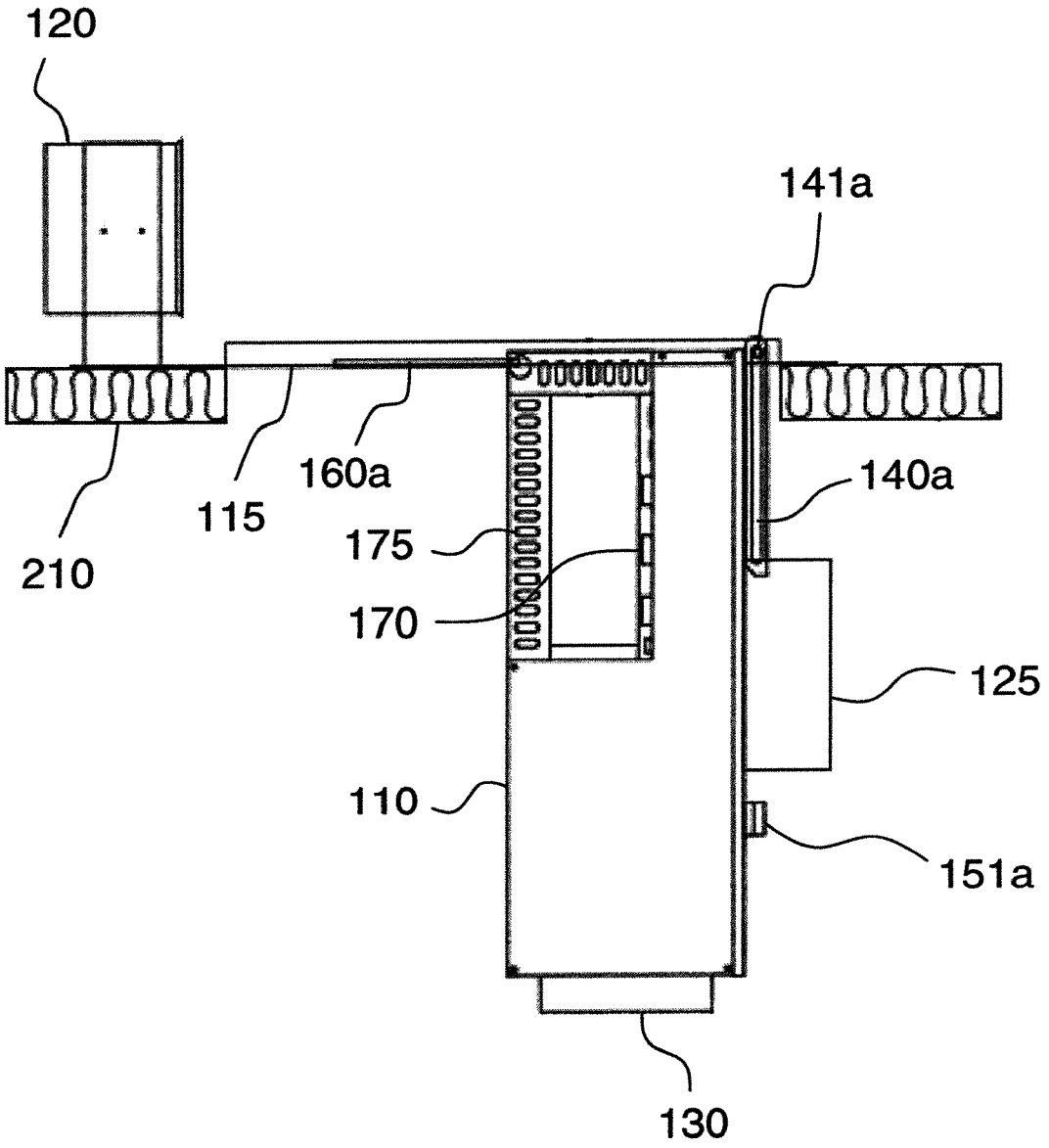


Fig. 2

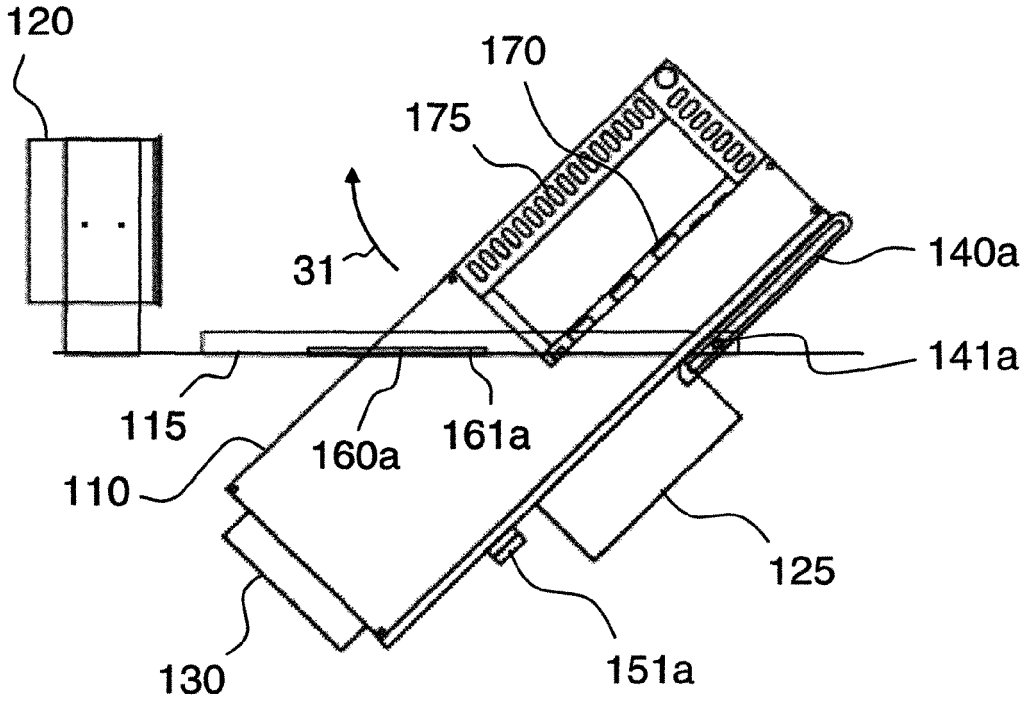
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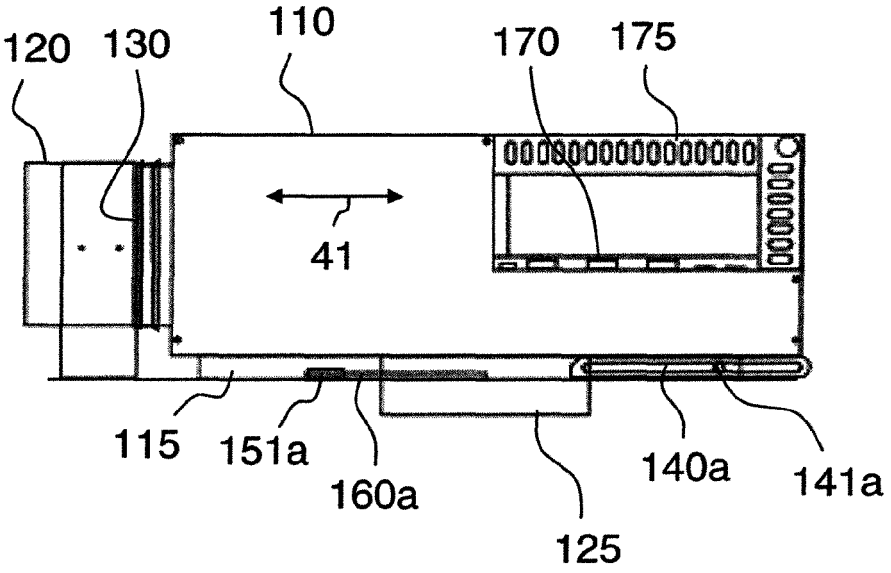
Fig. 3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141a
125

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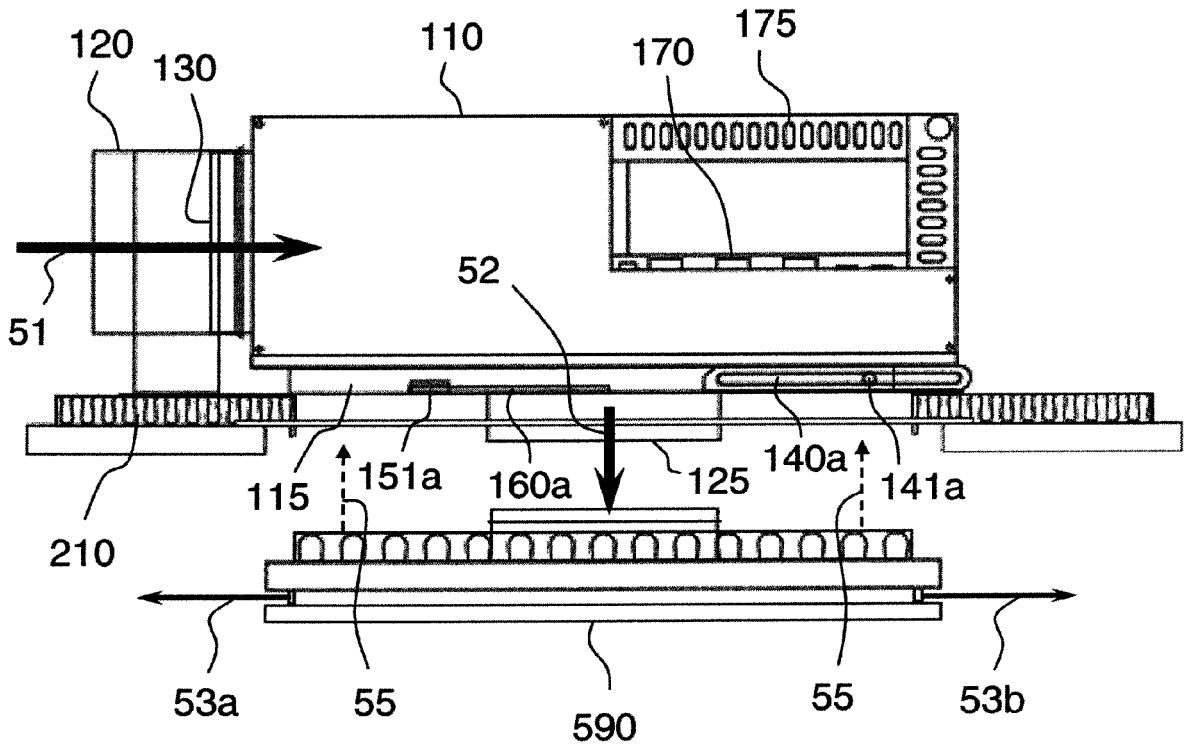
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Fig. 5

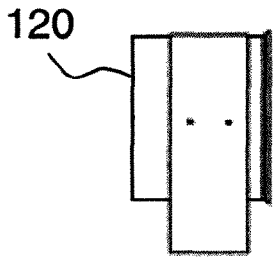


Fig. 7

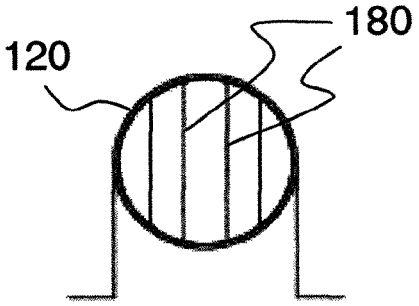


Fig. 8

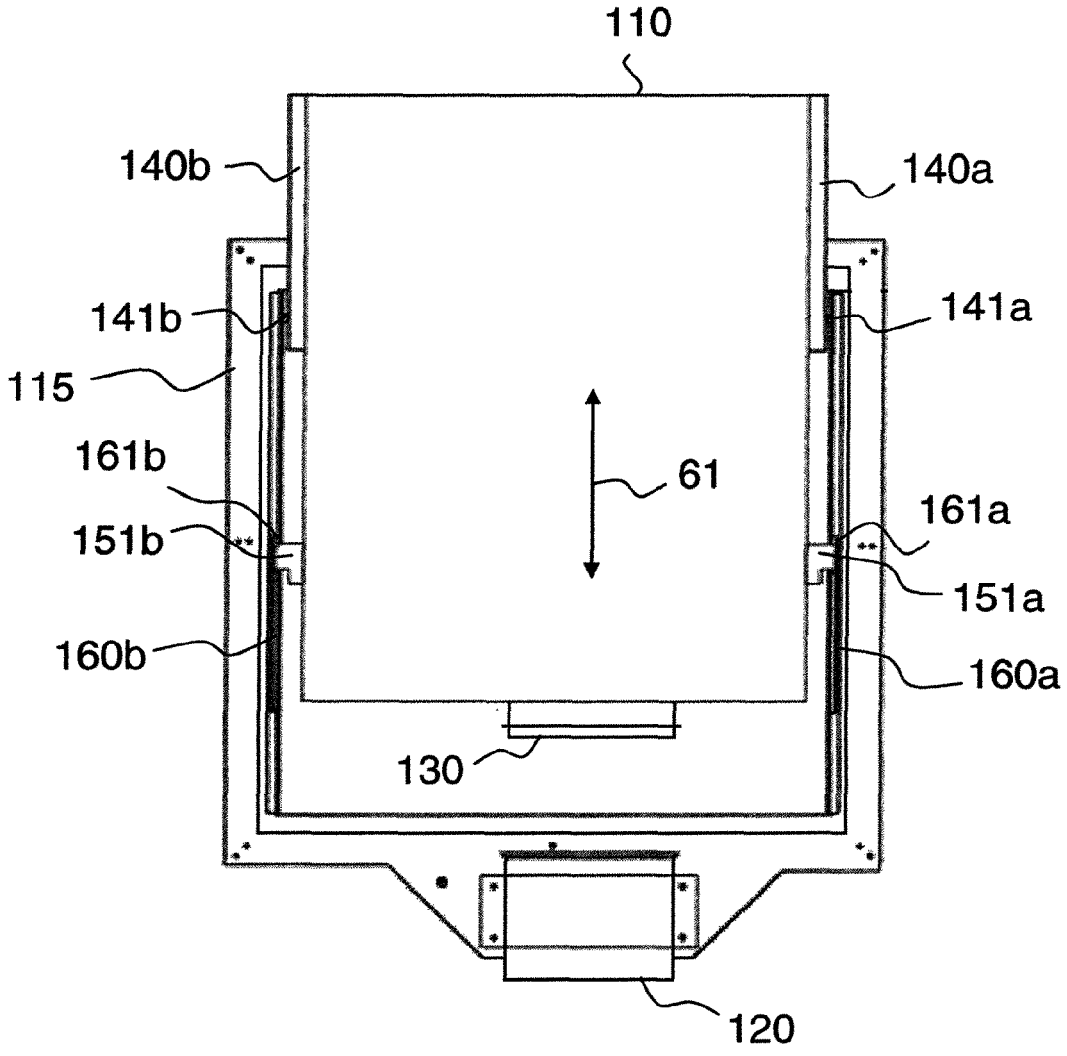


Fig. 6