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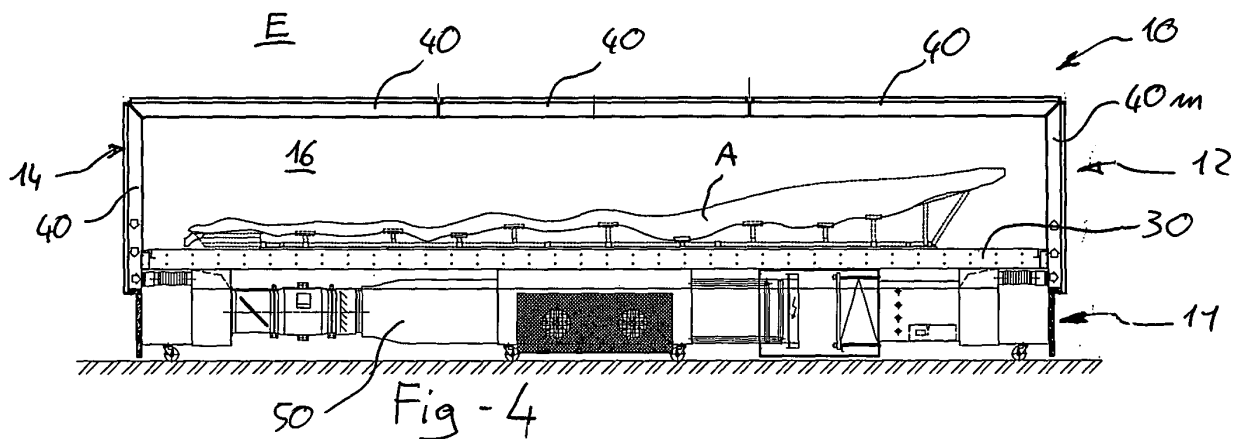
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(54) **Climate-controlled showcase**

(57) This climate-controlled showcase (10) comprises a climate-controlled inner volume (16) for the reception of a delicate object and an outer housing (14) which encloses the inner volume; the outer housing comprises a controlled-temperature intermediate chamber, separated from the inner volume and from the outside environment. The intermediate chamber in the housing al-

lows controlling the temperature in the inner volume in an indirect manner, i.e. technically treating the air of the inner volume by conduction, through the housing. The thermal treatment of the intermediate chamber is also directly reflected on the thermal conditions of the housing, which therefore improves its inner volume insulation and protection capacities, ensuring that there are more uniform thermal conditions in the inner volume.



Description

[0001] The present invention regards a climate-controlled showcase, comprising a climate-controlled inner volume for the reception of a delicate object, such as a work of art, an archaeological finding or the like, and an outer housing which encloses the entire volume.

[0002] It is well known that the conservation, display and also the transportation of delicate objects, such as those indicated above as examples, often require that they are maintained at very specific environmental conditions to avoid that the object is damaged. In particular, it is often necessary that the temperature and humidity is maintained within predetermined limits, depending on the specific object and its conditions, and/or that substances which are dangerous for the object are removed, such as particulate, biological contaminants, gases or vapours.

[0003] To obtain this, climate-controlled showcases are known in which the air of the inner volume is appropriately and continuously treated by a conditioning apparatus, normally housed in the base of the showcase.

[0004] Sometimes, the conditions requested by the particular object enclosed in the showcase may be very different from the outside environment conditions, and the object itself or the display equipment (typically the lighting) can generate alterations of the environment in which the object is inserted, for example due to a generation of heat, moisture or polluting substances. In these cases, the task of the conditioning apparatuses can be particularly difficult, and there may be the risk that the environmental conditions in the inner volume are locally different, from one point to another. The latter situation is evidently a source of danger for the integrity of the object and must therefore be avoided, or at least limited.

[0005] The problem at the basis of the present invention is that of providing a climate-controlled showcase, in which the stability of the environmental conditions in the inner volume is optimally ensured.

[0006] Such problem is resolved by a showcase according to claim 1. Preferred characteristics are reported in the dependent claims.

[0007] More in particular, the present invention regards a climate-controlled showcase comprising a climate-controlled inner volume for the reception of a delicate object and an outer housing which encloses the inner volume, characterised in that the outer housing comprises a controlled-temperature intermediate chamber, separated from the inner volume and from the outside environment.

[0008] The intermediate chamber in the housing permits controlling the temperature of the inner volume in an optimal manner, i.e. thermally treating the air of the inner volume by conduction through the housing. The thermal treatment of the inner chamber is also directly reflected on the thermal conditions of the housing, which therefore improves its capacities of insulating and protecting the inner volume, ensuring more uniform thermal

conditions in the inner volume.

[0009] Preferably, the intermediate chamber is extended in the housing so to cover the inner volume over at least two separate sides thereof. Still more preferably, the intermediate chamber is extended in the housing so to cover the inner volume on each side, possibly with the exception of a lower side. The greater the extension of the intermediate chamber in the housing, the greater its indirect thermal treatment capacity and insulation capacity towards the inner volume.

[0010] Preferably, the inner volume is pressurised with respect to the intermediate chamber; preferably, the intermediate chamber is pressurised with respect to the outside environment. These conditions serve to block or at least obstruct possible infiltrations of outside air from entering the intermediate chamber and inner volume at uncontrolled temperatures and humidity, along with air travelling from the intermediate chamber into the inner volume, helping to preserve the expected conditions in the inner volume for the improved conservation of the object contained therein.

[0011] Preferably, the intermediate chamber contains a gas, such as, preferably, air; in some cases nitrogen or another modified atmosphere can also be employed. Alternatively, the intermediate chamber contains a liquid, preferably water; one such solution, while being more complex, can be preferred where it is necessary to ensure very high thermal exchanges, for example due to the great difference between the outside temperature and the temperature necessary for the improved conservation of the object or due to the presence of a large-quantity of heat generated in the inner volume.

[0012] The intermediate chamber can be made in various ways. Preferably, the housing comprises at least one complex wall, comprising an inner plate, an outer plate and a connection and support frame of the two plates, an interspace comprised in said intermediate chamber being defined between the inner and outer plates. With this conformation, the intermediate chamber can be extended over each side of the showcase, substantially over the entire side, thus ensuring the maximum extension and thus efficiency of the intermediate chamber itself. Moreover, the actual production is particularly easy.

[0013] Preferably, the housing comprises a plurality of adjacent complex walls, each comprising an inner plate, an outer plate and a connection and support frame between the two plates, an interspace being defined between the inner plate and outer plate of each complex wall, in which the frames of the adjacent complex walls comprise passage ports which connect the interspaces of said adjacent complex walls forming said intermediate chamber. In this manner, the maximum extension of the intermediate chamber can be obtained, without structural complications and maintaining the maximum design flexibility. In fact, with the same complex walls, it is possible to make showcases of different shape and size, according to specific requirements.

[0014] Preferably, said passage openings are formed in said frames so that the intermediate chamber is extended along a predetermined path inside said housing. This path can be more or less complex according to specific requirements. For example, in a parallelepiped showcase, the six sides can be formed by six complex walls and the interspace of each of such walls can be connected by passage openings to the interspaces of all four adjacent complex walls; in this manner, a "free" path is obtained, in which the fluid circulation present in the intermediate chamber is not driven in any particular manner. Further, in another example, the interspace of each complex wall is connected by passage openings only to the interspaces of two adjacent complex walls, so that the fluid arrives from one of these two complex walls and is sent to the other; it is thus possible to determine with a certain precision the path of the fluid in the intermediate chamber, and therefore better control the thermal conditions in the various zones of the showcase.

[0015] The interspaces of the complex walls must be sealed with respect to each other, so to ensure the separation of the intermediate chamber both from the outside environment and the inner volume. To such end, the showcase preferably comprises seals between said frames of adjacent complex walls, arranged so to seal the inner volume and the intermediate chamber from each other and with respect to the outside environment.

[0016] With a showcase equipped with one or more intermediate chambers according to the invention, it is possible to organize the control of the climate in the inner volume with the maximum flexibility, according to the specific requirements. For example, and preferably, the intermediate chamber can be the only means of control of the showcase temperature. In such case, the showcase comprises a thermal treatment apparatus in communication with said intermediate chamber and not with said inner volume. Still as an example, the showcase can comprise a hygrometric treatment apparatus and/or contamination control apparatus in communication with said inner volume and not with said intermediate chamber.

[0017] Preferably, the intermediate chamber not only has a controlled temperature but also controlled humidity; in this manner, the negative effects due to possible infiltrations from the intermediate chamber to the inner volume are minimised, and in some case the risks of forming surface condensate on the interspace walls are reduced. To this end, the showcase preferably comprises a thermal and hygrometric treatment apparatus in communication with said intermediate chamber and not with said inner volume.

[0018] As said, a showcase according to the invention can serve to receive a delicate object in various circumstances, such as conservation, display and transportation. In the case of transportation and conservation, the walls of the showcase and therefore the plates can be made of any material adapted for its own strength and thermal insulation characteristics. In the case of display, however, the plates will be transparent, preferably made

of glass. Thanks to the invention, the transparency of the walls of the showcase, does not negatively affect the thermal protection capacities with regard to the inner volume.

[0019] Preferably, the frame is of low thermal conductivity material, such as a polymer material; in this manner, the capacity to transfer heat by conduction through the frame, passing over the intermediate chamber, is minimised.

[0020] Further characteristics and advantages of the invention will be clearer from the following detailed description of a preferred embodiment thereof, made with reference to the attached drawings. In such drawings:

- Figure 1 is a front view of a showcase according to a first embodiment of the invention;
- Figure 2 is a side view of the showcase of figure 1;
- Figure 3 is a top view of the showcase of figure 1;
- Figure 4 is a front section view of the showcase of figure 1;
- Figure 5 is a cross section view of the showcase of figure 1;
- Figure 6 is a top section view of the showcase of figure 1;
- Figures 7 and 8 are enlarged scale section views of details of figure 5;
- Figure 9 is a front section view of a showcase according a second embodiment of the invention;
- Figure 10 is a cross section view of the showcase of figure 9.

[0021] In figures 1 - 8, a showcase 10 is shown, intended for protected display of a delicate object, indicated schematically with A. The showcase 10 comprises a base 11 and a display structure 12 mounted on the base 11. The display structure 12 comprises an outer housing 14 which encloses an inner volume 16, where the object A is housed. The outer housing 14 of the showcase has a substantially parallelepiped shape, and thus comprises a bottom side 20, top side 21, two vertical front sides 22 and 23 and two vertical transverse sides 24 and 25.

[0022] The bottom side 20 comprises a thermal-insulation panel 30, for example a single panel made of polymer material or a complex panel with a metal load bearing structure, to which an expanded polymer insulating material is associated.

[0023] The other sides 21-25 are made with one or more complex walls, having different size and shape but essentially equivalent structure; below and in the drawings, each of such walls is indicated with the same reference number 40, as well as their details are indicated with the same reference numbers, even if these are walls which differ from each other by size. Only when it is desired to highlight the relation between details of different walls 40, specific indications will be given (a, b, etc.) for the details of different walls 40.

[0024] Each wall 40 comprises an inner plate 41 and an outer plate 42, connected and supported one to the other by a frame 43. The plates 41 and 42 are both trans-

parent, in glass or the like. The inner plate 41 is formed with simple panel 411 while the outer plate 42 is formed with a double panel, or a so-called glass chamber, with two panels 421 and 422 mounted on a spacer frame 423 with the formation of a thin, sealed interspace 424; a vacuum can be made in the interspace 424, or the interspace 424 can contain an inert gas without impurities which can obstruct the transparency of the plate, typically nitrogen. Each of the panels 411, 421 and 422 can be formed by a simple glass sheet, or preferably (as better shown in figure 8) by a multilayer structure with alternating sheets of glass and transparent polymer material, according to per se known techniques, in order to confer specific strength or break control characteristics to the panel itself.

[0025] The frame 43 is preferably made with a low thermal conductivity material, for example a polymer material. Each plate 41 or 42 is integrally fixed and sealed to the frame 43; for example, and preferably, each plate 41 or 42 is glued to the frame 43 at seats 431 and 432, respectively, shaped so to case the seal contact between the plate and the frame.

[0026] Between the plate 41 and 42 and the frame 43, an interspace 44 is defined, separated both from the inner volume 16 of the showcase 10 and from the outside environment, indicated with E in the drawings.

[0027] As better shown in figure 8, two adjacent, complex walls 40a and 40b are fit with each other at the respective frames 43a and 43b, with the interposition of seals 45. The respective interspaces 44a and 44b can be separated from each other or (as in the case shown in figure 8) they can be in communication with each other through passage openings 46 (46a and 46b) formed in the frames 43a and 43b.

[0028] In showcase 10, the interspaces 44 connected with each other by the passage openings 46 form an intermediate chamber, separated both from the inner volume 16 and from the outside environment E; the intermediate chamber is extended along a predetermined path inside the outer housing 14 and covers the inner volume 16, it being extended over different sides of the showcase 10 (all sides except for the bottom side). The conformation of such path can be more or less complex according to the specific protection needs. In a simple case, the interspace 44 of every wall 40 is connected with the interspaces 44 of all adjacent walls; in particular more complex cases, the interspace 44 of every wall is only connected to the interspaces of some of the adjacent walls 40.

[0029] In the showcase 10, an opening is provided for accessing the inner volume 16. Said opening is obtained by providing that at least one of the complex walls 40m is movable, as schematically shown in figures 3-6. Upon opening, if the wall 40m is connected to the adjacent walls 40, the intermediate chamber is open and its functionality is therefore suspended, until the movable wall 40m is closed.

[0030] The showcase 10 further comprises a thermal

and/or hygrometric treatment device, *per se* conventional and indicated with 50 in its entirety, housed in the base 11 and in communication with the intermediate chamber formed by the interspaces 44. A transparent fluid is present in the intermediate chamber formed by the interspaces 40; in a particularly simple embodiment, such fluid is air, but it is also possible that environmental conditions and particular conservation conditions favour the use of other gases (typically nitrogen) or even a liquid, such as water, capable of transporting and thus removing much greater quantities of heat.

[0031] By means of the intermediate chamber which surrounds the inner volume 16, it is therefore possible to thermally condition the inner volume 16 in an indirect manner, avoiding or reducing the need that the air or fluid present in the inner volume 16 be made to pass through a heating or cooling device.

[0032] The showcase 10 finally comprises a treatment device 60 of the inner volume 16, which can therefore be only dedicated to hydrometric or purification treatments of the air or fluid present in the inner volume 16.

[0033] The intermediate chamber formed by the interspaces 40 is maintained at a lower pressure than that of the inner volume 16, and at a greater pressure than that of the outside environment E, to prevent impurities or polluting agents from infiltrating from the outside environment E to the intermediate chamber and from this to the inner volume.

[0034] The plate 42, and in particular its outer panel 422, can be equipped with heating means, such as a heating element embedded in the multilayer structure (not shown in the figures), to avoid the formation of condensate which could obstruct the visibility of the object A from the outside E. In fact, particular climate conditions (for example hot and humid outside environment E, with respect to the inner volume 16) could favour the deposit of condensate on the plate 42, if it is too cool. On the other hand, in the exemplified case a (however limited) heating of the plate 42 does not affect the inner volume 16, which is insulated from the intermediate chamber formed by the interspaces 40.

[0035] In figures 9 and 10, a showcase 1010 is shown which is analogous to showcase 10, only intended specifically for the transportation of an object B and not for its display. In showcase 1010, therefore, the sides do not have to be transparent and thus it has a simpler structure.

[0036] The showcase 1010 has a base 1011 with wheels 1111 and comprises an inner volume 1016 enclosed by an outer cover 1014, formed by an inner wall 1041 and an outer wall 1042, separated by an intermediate chamber 1044. The intermediate chamber 1044 is extended in the housing 1014 so to cover the inner volume 1016 on at least two sides thereof. On one side, an access door 1070 is provided to the inner volume 1016.

[0037] The showcase 1010 further comprises two thermal treatment apparatuses 1050, mounted on the outer wall 1042 and in communication with the intermediate chamber 1044. The showcase 1010, unlike the show-

case 10, does not comprise an apparatus of hygrometric or purification treatment of the inner volume 1016; in fact, being intended for transport, the showcase 1010 must not house the object B for very long periods of time, and it is normally sufficient to control the humidity at its interior by means of passive systems, such as hygroscopic salts, not shown in the figures.

[0038] With a showcase according to the invention, excellent protection conditions are obtained of the inner volume where the delicate object is housed, with a very stable temperature over the entire inner volume. On the other hand, the fluid volume to be thermally treated is relatively limited.

[0039] Finally, another important advantage of a showcase according to the invention is that the air (or fluid) of the inner volume must not pass continually into a thermal treatment apparatus, and therefore it is easier to maintain the expected conditions of humidity and purity.

Claims

1. Climate-controlled showcase, comprising a climate-controlled inner volume for the reception of a delicate object and an outer housing which encloses the inner volume, **characterised in that** the outer housing comprises a controlled-temperature intermediate chamber, separated from the inner volume and from the outside environment.

2. Showcase according to claim 1, wherein the intermediate chamber is extended in the housing so to cover the inner volume over at least two separate sides thereof.

3. Showcase according to claim 1, wherein the intermediate chamber is extended in the housing so to cover the inner volume over every side, with the possible exception of a lower side.

3. Showcase according to claim 1, wherein the inner volume is pressurised with respect to the intermediate chamber.

4. Showcase according to claim 1, wherein the intermediate chamber is pressurised with respect to the outside environment.

5. Showcase according to claim 1, wherein the intermediate chamber contains a gas.

6. Showcase according to claim 5, wherein said gas is air.

7. Showcase according to claim 5, wherein said gas is nitrogen.

8. Showcase according to claim 1, wherein the in-

termediate chamber contains a liquid.

9. Showcase according to claim 8, wherein said liquid is water.

10. Showcase according to claim 1, wherein the housing comprises at least one complex wall, comprising an inner plate, an outer plate and a connection and support frame of the two plates, an interspace being defined between the two inner and outer plates, comprised in said intermediate chamber.

11. Showcase according to claim 10, wherein the housing comprises a plurality of adjacent complex walls, each comprising an inner plate, an outer plate and a connection and support frame of the two plates, an interspace being defined between the two inner and outer plates of each complex wall, in which the frames of the adjacent complex walls comprise passage openings which connect the interspaces of said adjacent complex walls forming said intermediate chamber.

12. Showcase according to claim 11, wherein said passage openings are formed in said frames in a manner such that the intermediate chamber is extended along a predetermined path inside said housing.

13. Showcase according to claim 11, comprising seals between said frames of adjacent complex walls, arranged so to seal the inner volume and the intermediate chamber from each other and with respect to the outside environment.

14. Showcase according to claim 1, comprising a thermal treatment apparatus in communication with said intermediate chamber and not with said inner volume.

15. Showcase according to claim 5, wherein the intermediate chamber has a controlled humidity.

16. Showcase according to claim 15, comprising a thermal and hygrometric apparatus in communication with said intermediate chamber and not with said inner volume.

17. Showcase according to claim 1, comprising a hygrometric treatment and/or contamination control apparatus, in communication with said inner volume and not with said intermediate chamber.

18. Showcase according to claim 10, wherein the plates are transparent.

19. Showcase according to claim 18, wherein the plates are made of glass.

20. Showcase according to claim 10, wherein the frame is made of material with low thermal conductivity.

21. Showcase according to claim 20, wherein the material with low thermal conductivity is a polymer material.

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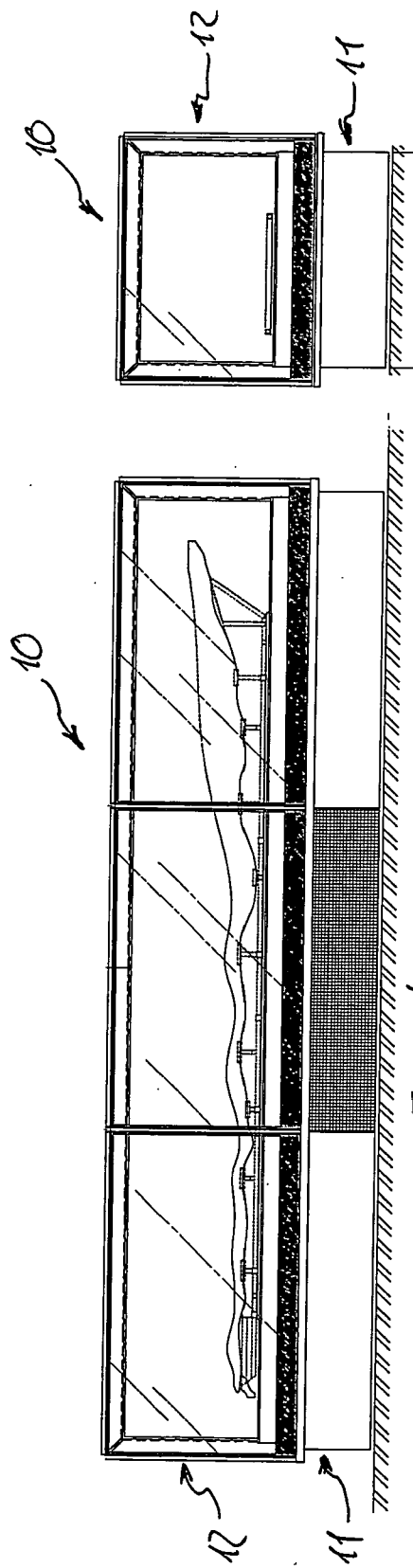


Fig-2

Fig-1

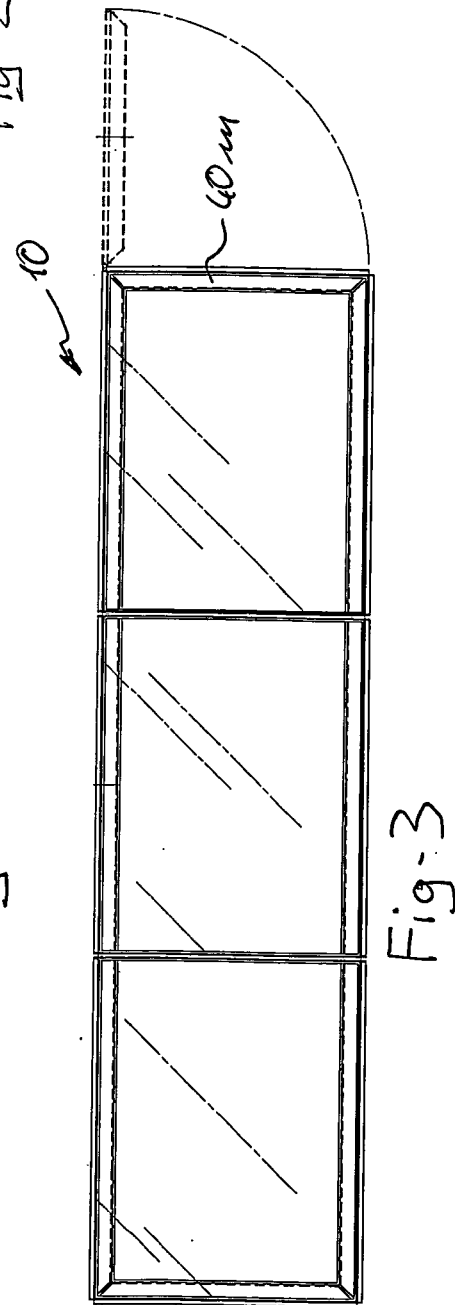
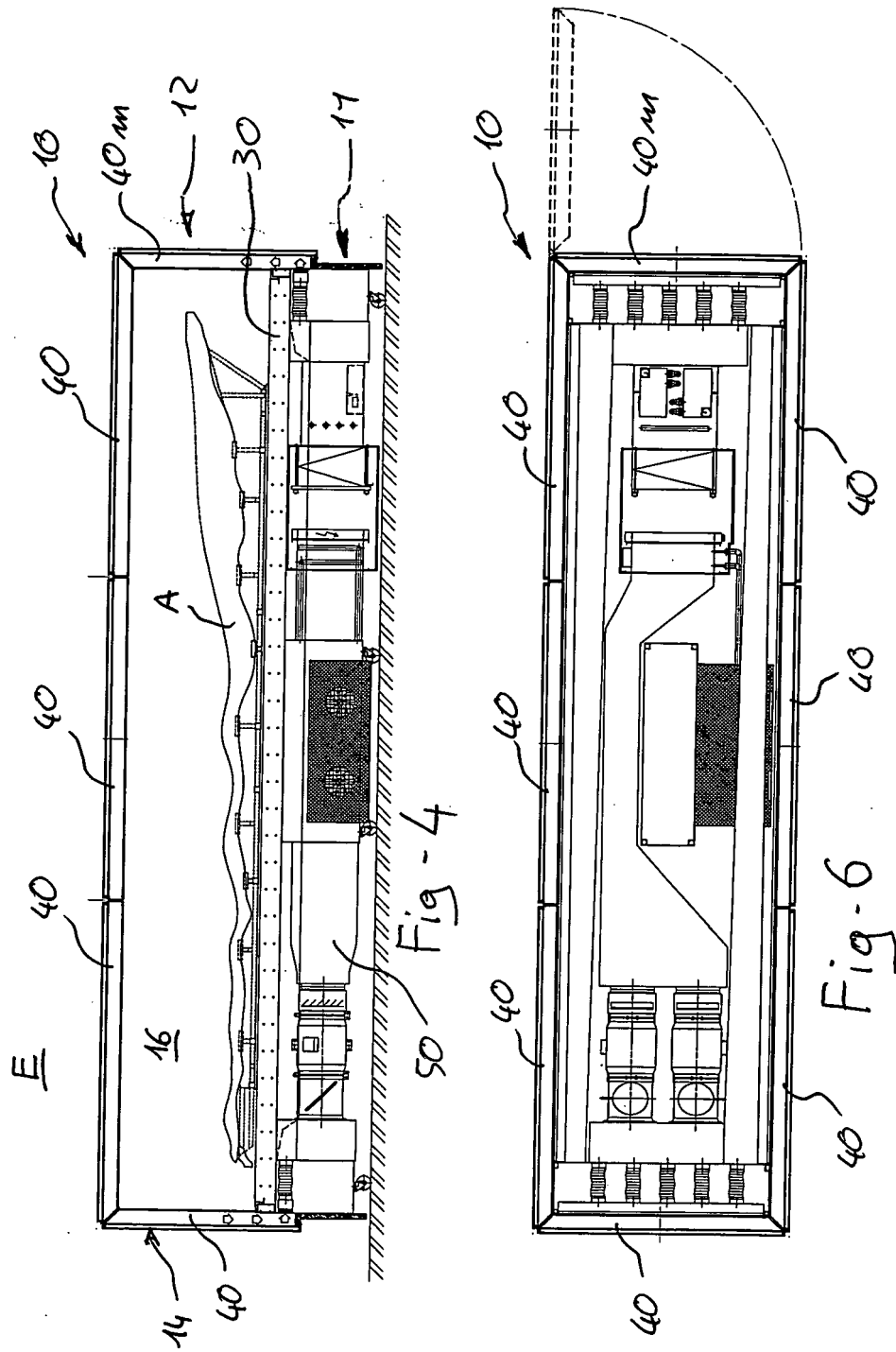


Fig-3



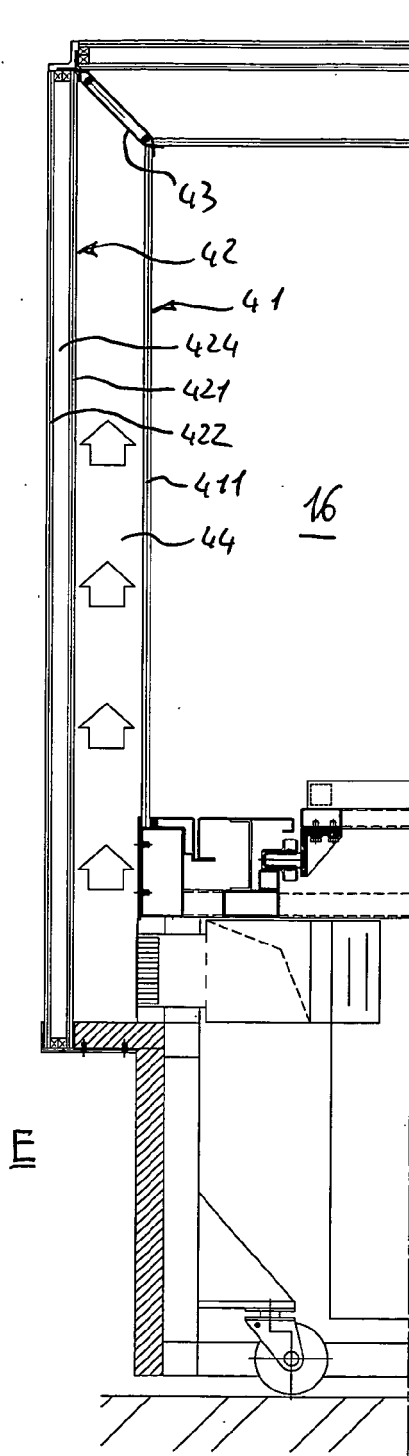


Fig-7

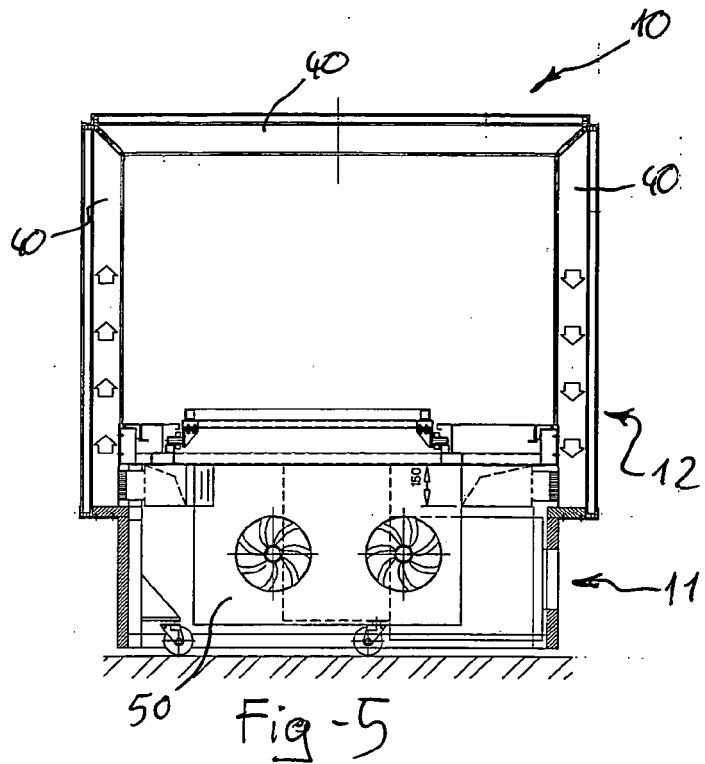
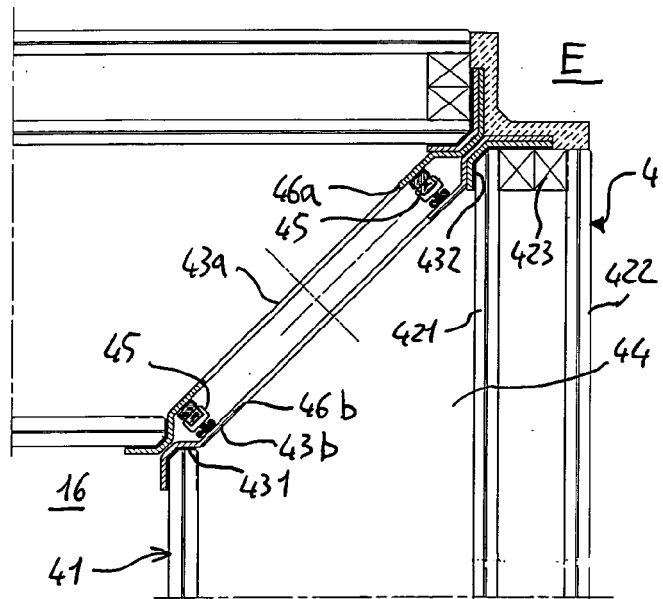
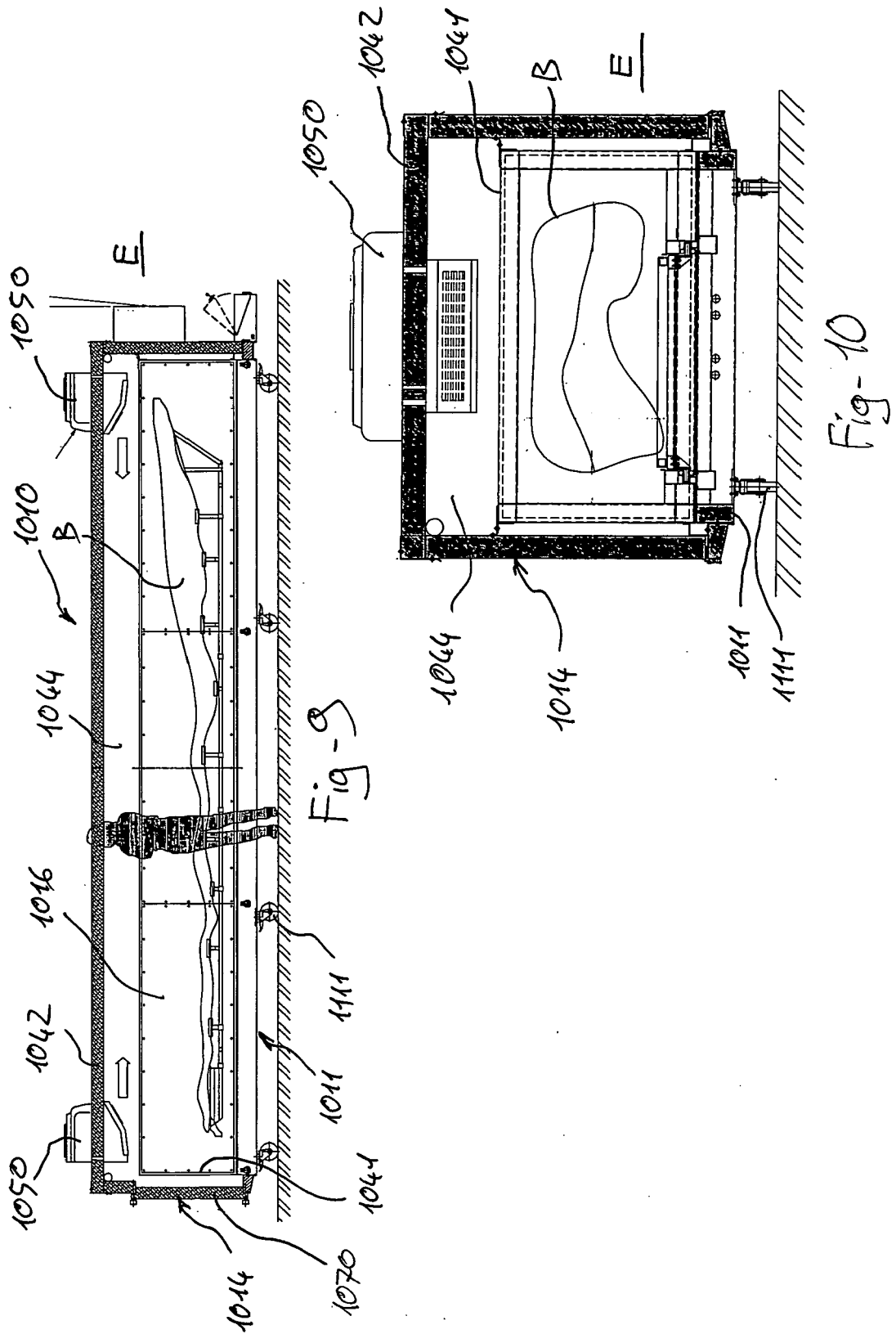


Fig-8







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EUROPEAN SEARCH REPORT

Application Number
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**ANNEX TO THE EUROPEAN SEARCH REPORT
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