



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
23.10.2019 Bulletin 2019/43

(51) Int Cl.:
F17C 13/08 (2006.01)

(21) Application number: **18020166.7**

(22) Date of filing: **20.04.2018**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

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(54) **TRANSPORTATION MODULE FOR TRANSPORTING A PLURALITY OF GAS CYLINDERS**

(57) The present invention pertains to a transportation module (1), a modular transportation system (200), and a method for providing said system (200) for transporting a plurality of gas cylinders (2) and which facilitates and increases the safety of the transportation of gas cylinders while at the same time being compatible with automated solutions and a variety of standardized transportation methods. Accordingly, a transportation module (1) is suggested, comprising a support (3) for adjacently accommodating a plurality of gas cylinders (2) in a first direction (R1), and a first (10) and second sidewall (12), which are arranged in parallel, wherein the support (3) is arranged between the sidewalls (10, 12) and connected to the sidewalls (10, 12). Each of the sidewalls (10, 12) comprises a first (100) and second surface (120) on opposing sides in a second direction (R2) perpendicular to the first direction (R1), wherein the first surface (100) is configured to provide a stackable interface (140) with the second surface (120) of a second transportation module (1) in the second direction (R2).

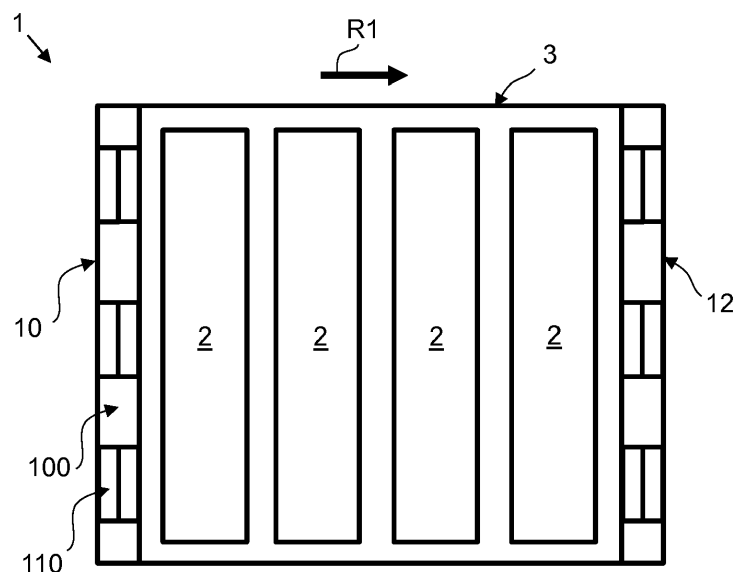


Fig. 1A

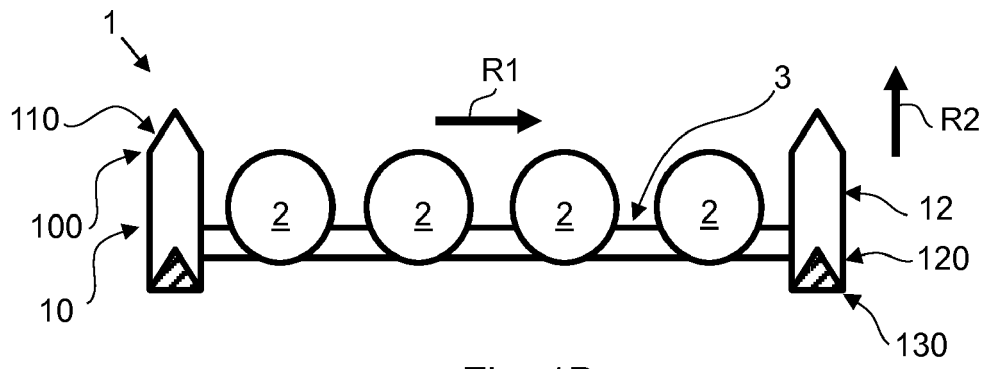


Fig. 1B

Description

Technical Field

[0001] The invention relates to a transportation module, a modular transportation system, and a method, which facilitate the transportation of a plurality of gas cylinders and provides an adaptable arrangement to meet various needs and may be easily implemented to facilitate handling, filling, and distribution and storage of gas cylinders, in particular, increasing safety and reducing manual interaction.

Technological Background

[0002] Depending on regional availability and prescribed or commonly acknowledged standards, a variety of transportation equipment is used for the transportation of various goods, such as wine racks, pellets, and medical boxes. The used transportation equipment is generally not equally compatible or interchangeable for different goods and in particular may not comply with cross-border standards or requirements. For example, across Europe, the Middle East, and Africa, different transportation equipment is used for the transportation of gas cylinders. By the same token, regional standards may be different, such that within Europe, for example, standards are not universally applicable, such that they may not be compatible with other countries within the same region, as is the case with e.g. RUK standards. This not only provides logistical problems, but also provides challenges with respect to the processing and handling of the respective goods.

[0003] In particular, the handling of gas cylinders may inflict safety issues as the handling of pressurized gas cylinders requires the following of strict protocols and may furthermore provide a health risk for a user required to manually handle the respective gas cylinder at a facility, as gas cylinders often comprise the respective gas as a pressure above 200 bar and furthermore comprise considerable weight. In addition, the transportation of gas cylinders requires specific safety measures in order to avoid any malfunctions or safety issues due to e.g. falling or tilting and considering the high pressure and potential volatility of the comprise gases. However, when transporting a plurality of gas cylinders to various countries, the on route transportation means may not be compatible with previously used transportation means, such that processing delays occur, manual handling is required, and safety issues are again inflicted.

[0004] Furthermore, common transportation means generally provide fixed arrangements, such that the respective transportation means may not be adjusted and is hence not adaptable to different needs or requirements, thereby providing an inefficient and potential insufficient transportation, potentially increasing the safety concerns with respect to the transportation of gas cylinders.

Summary of the invention

[0005] It is an object of the present invention to provide an improved transportation module and a modular transportation system as well as a method for transporting a plurality of gas cylinders that reduces the above problems.

[0006] In a first aspect, a transportation module is suggested for transporting a plurality of gas cylinders, which comprises a support for adjacently accommodating a plurality of gas cylinders in a first direction, and a first and second sidewall, which are arranged in parallel, wherein the support is arranged between the sidewalls and connected to the sidewalls. Furthermore, each of the sidewalls comprises a first and second surface on opposing sides in a second direction perpendicular to the first direction, wherein the first surface is configured to provide a stackable interface with the second surface of a second transportation module in the second direction.

[0007] Accordingly, the transportation module may be stacked with a second transportation module via the interface provided by the first surface and the second surface of each of the sidewalls. The stack ability of the transportation modules furthermore provides that the height of a stacking arrangement of a plurality of transportation modules may be easily adjusted by removing and/or adding a respective number of transportation modules. Hence, a modular setup to enable different transportation purposes is provided, e.g., depending on the required service, such as plant to plant or customer deliveries, wherein the transportation equipment may be adapted in size. The sidewalls preferably comprise a length and a longitudinal direction, which at least corresponds to a length of a respective gas cylinder in a longitudinal direction, such that, when the support accommodates a plurality of gas cylinders, none of the gas cylinders extend beyond the sidewalls in a longitudinal direction and are hence comprised within the transportation module.

[0008] While the first direction is defined by the arrangement of the gas cylinders on or in the support, the second direction is defined to be perpendicular to the first direction and corresponds to a stacking direction, in other words, a vertical orientation in a gravitational field.

[0009] The number of gas cylinders may be variable and dependent on the design of the support. For example, the support of the transportation module may accommodate five or six gas cylinders adjacently to each other, but may also be designed to only accommodate two to four gas cylinders having a respectively larger volume, or more than six gas cylinders having a respectively smaller volume. The gas cylinders may comprise standardized dimensions and hence preferably comprise a volume of up to 10 liters water capacity, preferably a pressurized and/or medical gas. Accordingly, the respective gas cylinders or tanks may be manually placed and removed from the support and at the same time may be carried by a person. Alternatively, the gas cylinders may

comprise a smaller or larger volume, e.g., about one liter or more than 10 liters.

[0010] By means of the stackable design, a plurality of transportation modules may be arranged in a stackable manner, thereby minimizing the required volume for the transportation while at the same time increasing the safety of the transportation. In addition, the loading and unloading of gas cylinders is facilitated by providing a plurality of gas cylinders in each module, such that in order to remove a plurality of gas cylinders, a respective transportation module may be removed. Furthermore, each transportation module may hence be provided as a stock keeping unit, also called SKU, comprising several gas cylinders and which may be processed in storage and transfer systems, preferably automated storage and transfer systems, to avoid a manual intervention. Hence, the transportation module may be implemented in a large variety of systems.

[0011] The arrangement of the accommodated gas cylinders may be varied according to the requirements. Accordingly, first direction may be perpendicular to a longitudinal axis of the plurality of gas cylinders. This at least has the advantage that the gas cylinders are accommodated side-by-side in an adjacent fashion, such that the length of the support delimited by the sidewalls may be minimized. While the number of gas cylinders may be increased with respect to an adjacent arrangement of the gas cylinders along a longitudinal axis of the gas cylinders. The orientation of the first direction perpendicular to a longitudinal axis of the plurality of gas cylinders is particularly advantageous for gas cylinders having a larger volume, e.g. five to ten liters water capacity.

[0012] Furthermore, the gas cylinders are preferably arranged in series, thereby forming a single row of gas cylinders on the support. However, in particular for small gas cylinders, e.g. having a volume smaller than five liters, the gas cylinders may also be arranged in multiple series, which are arranged in parallel with respect to the longitudinal axis of the gas cylinders. For example, two rows of gas cylinders may be accommodated by the support, wherein each row comprises the gas cylinders in the first direction and the rows are arranged in parallel to each other in a longitudinal direction of the gas cylinders, such that the rows are arranged side by side at respective longitudinal ends of the gas cylinders.

[0013] Alternatively, or in addition, the support may be configured to accommodate each of the plurality of gas cylinders such that the longitudinal axis of the plurality of gas cylinders is orientated in parallel to the support. In other words, the support may be configured to accommodate the gas cylinders in a lying fashion or in an essentially horizontal plane in a gravitational field. This at least has the advantage that, contrary to accommodating day gas cylinders in a standing fashion, a height of the transport module may be minimized, such that the transportation module may accommodate a diameter of the gas cylinders in the second direction. Furthermore, this has the advantage that the center of gravity of each of

the gas cylinders is in proximity to the support, such that a risk of tilting or falling of the gas cylinders is reduced.

[0014] The first direction may also be perpendicular to the first and second sidewall. This has the advantage that the gas cylinders may be easily accessed, for example, by providing openings between the sidewalls at the support. This is particularly advantageous, when having the first direction in an orientation perpendicular to the first and second sidewall and at the same time perpendicular to a longitudinal axis of the gas cylinders, such that the respective ends of the gas cylinders in a longitudinal direction extend into said openings between the sidewalls. Accordingly, access is provided to each of the gas cylinders, such that a removal or insertion of a respective gas cylinder does not require a removal or temporary modification of another gas cylinder.

[0015] In order to provide an improved interaction at the interface, the first surface preferably comprises one or more protrusions configured to be accommodated in corresponding one or more recesses on the second surface of a second transportation module. Preferably, the first surface comprises a portion that is complementary to the second surface.

[0016] For example, the one or more protrusions may comprise an edged or rectangular shape while the one or more recesses comprise a recess having a corresponding and complementary geometry, wherein the recess may either comprise dimensions to provide a press fit connection with a respective protrusion or may be dimensioned by providing a minimal tolerance range with respect to the dimensions of the protrusion. Accordingly, the one or more protrusions and one or more recesses together may prevent a sliding movement of the transportation module with respects to a second transportation module, which is connected via a respective interface, in a third direction perpendicular to the first and second direction. Alternatively, the protrusions may also comprise a rounded, domed, or wedge shape, or may be formed to provide a step that may be received by a correspondingly shaped recess on the second surface of a second transportation module.

[0017] Furthermore, the one or more protrusions may be formed as a continuous insert and the one or more recesses may be formed as a continuous sleeve. Preferably, the insert and sleeve are arranged in parallel to a direction corresponding to a longitudinal axis of a gas cylinder accommodated by the support, wherein the continuous insert is preferably wedge-shaped, pyramid-shaped, or comprises a rounded shape. The provision of a continuous insert and continuous sleeve has the advantage that the mounting and removal of a respective transportation module at the interface is facilitated, wherein the insert and sleeve may furthermore provide a guiding surface for a sliding movement of the respective transportation module.

[0018] In addition, the continuous insert may comprise one or more further protrusions, which are disposed on the surface of the continuous insert to provide a stopper

or retaining element. Accordingly, the sleeve comprises corresponding one or more recesses to receive the one or more further protrusions. Hence, while the continuous insert and continuous sleeve provide a guiding surface and the transportation module may be slideably adjusted at the interface, the provision of further protrusions ensures that the transportation module is slideably fixed in the third direction, when the transportation module is seated at the designated location for transportation with respect to a second transportation module.

[0019] To accommodate the plurality of gas cylinders, the first and second sidewall preferably extend beyond the support in the second direction and are dimensioned such that a distance between the first surface and the second surface in the second direction comprises at least a height of a gas cylinder accommodated by the support in a radial direction.

[0020] The support may hence be arranged between the sidewalls in such a way that a diameter of and accommodated gas cylinder does not extend beyond the first surface, i.e. the support is arranged below the first surface, and wherein the second surface extends beyond the support, i.e. is arranged below the support. This has the advantage that the accommodated gas cylinders are fully comprised within the respective transportation module while at the same time a spacing is provided, e.g. with respect to a floor or bottom surface, to provide a base or support that is protected from any detrimental influences such as liquids or contaminations.

[0021] Preferably, the first and second sidewall are dimensioned such that an accommodated gas cylinder does not extend beyond a respective lower or bottom surface in the second direction. This has the advantage that, e.g. a bottom transportation module in a stack of transportation modules may serve as a base and the gas cylinders at least are not being brought in contact with any surface that potentially influences the arrangement or orientation of the plurality of gas cylinders.

[0022] The first surface may be engageable with the second surface of a second transportation module to form a positive locking, a non-positive locking, and/or an interference fit to slideably secure the transportation module with respect to the second transportation module in at least the first direction, preferably also in a third direction perpendicular to the first and second direction. For example, the first surface may comprise a geometry, which matches a geometry of the second surface of a respective second transportation module, such that upon assembly of said transportation modules the matching geometries engage each other, wherein said geometries are not releasably engaged in the first and third direction, but require a movement of at least one transportation module, in the second direction and the first or third direction. Alternatively, the engaging surfaces may be dimensioned to provide an interference fit or press fit engagement.

[0023] Furthermore, the geometry of the first surface and second surface of the first sidewall may be different

from the respective surfaces of the second sidewall, to ensure that a transportation module may only form an interface with a second transportation module in a pre-defined orientation. For example, the geometries of the first and second surface between the first and second sidewall may be asymmetric or mirror-symmetric.

[0024] To prevent further movement of the transportation module, at least one of the sidewalls may comprise at least one securing element, which is configured to slideably secure the transportation module with respect to a second transportation module in at least the second direction, preferably also in a third direction perpendicular to the first and second direction. The securing element preferably comprises a clamping device, a protruding element, and/or a press-fit element.

[0025] Accordingly, the securing element may, for example, comprise a clamping device, which is at least partially received by one of the sidewalls and is pivotable around an axis between a securing position, wherein the clamping device is configured to engage a geometry of an adjacent sidewall of a second transportation module to secure the transportation module with respect to a second transportation module in at least the second direction, and an open position, wherein the clamping device is configured to disengage a geometry of an adjacent sidewall of a second transportation module to allow that the first and second transportation modules may be moved with respect to each other in at least the second direction. To facilitate the engagement of the clamping device with the geometry of the second transportation module the clamping device may comprise a biasing member, e.g. resilient element such as a spring, which biases the clamping device in the securing position.

[0026] Alternatively, or in addition, the securing element may comprise a protruding element, which is preferably arranged on a first surface of a sidewall and is configured to engage a geometry in or on the lower surface of an adjacent sidewall of a second transportation module. For example, the protruding element may comprise a protrusion or hook, which engages a corresponding structure of the second transportation module, wherein the protruding element at least partially comprises a resilient portion. Accordingly, the protruding element may be deformed upon insertion and substantially attains its original shape and/or position in an inserted state, such that the protruding element secures the first transportation module to the second transportation module. For example, the protruding element may provide a notch effect, stress concentration, and/or edge pressure.

[0027] By the same token, the securing element may comprise a press-fit element, which is preferably arranged on a surface or within a cavity at an end of a sidewall in the second direction. For example, the lower surface of a sidewall of a first transportation module may be slideably received by an upper surface of an adjacent sidewall of a second transportation module, wherein the press-fit element may be arranged on either one or both of the surfaces. Preferably, the press-fit element com-

prises a deformable and resilient member, such that the press-fit element extends in the first direction upon compression, e.g. when the lower surface of a sidewall of the first transportation module is slideably received by the upper surface of the adjacent sidewall of the second transportation module. Accordingly, the press-fit element at least partially fills the cavity, thereby providing a frictional force impairing a relative movement of the first transportation module with respect to the second transportation module in at least the second direction.

[0028] The securing element may also be configured as a first and a second securing element, which are arranged such that the first securing element is engageable with the second securing element of a second transportation module to slideably secure the transportation module with respect to the second transportation module in at least the second direction.

[0029] For example, each sidewall may comprise a first and second securing element at an outer surface in the first direction or at an outer surface in a third direction perpendicular to the first and second direction. Accordingly, each sidewall may comprise a hook and/or detent, e.g. disposed above each other in a second direction, which may engage a corresponding key and/or slot, respectively, of a corresponding second transportation module, to thereby securely attach the transportation modules with respect to each other in the second direction. Preferably, the securing elements also slideably secure the transportation module with respect to the second transportation module in the third direction. The securing elements may also be provided as clamping elements, latches, and/or locks.

[0030] Furthermore, a plurality of securing elements may be provided, either as a single securing element and/or as a first and second securing element. Accordingly, the first and second securing elements may be provided as an alternative or additional to the securing element.

[0031] To fix the plurality of accommodated gas cylinders to the support, the transportation module may further comprise a retaining element arranged between, perpendicular to, and at at least one end face in a longitudinal direction of the sidewalls, which is configured to retain a plurality of gas cylinders accommodated by the support in a third direction perpendicular to the first and second direction. Preferably, the retaining element is mechanically connected to the sidewalls and the support, wherein the retaining element may comprise a third sidewall, a rod and/or roll-up door.

[0032] For example, the end face may correspond to an outer surface in a third direction perpendicular to the first and second direction, as described in the above, or may be provided in a corresponding region at an outer surface in the first direction. At least one retaining element may be configured as a third sidewall, which is arranged between and is perpendicular to the first and second sidewall. The provision of a third sidewall at least has the advantage that a further structural stability is pro-

vided for the transportation module while at the same time, the third sidewall may prevent a sliding movement of accommodated gas cylinders in a longitudinal direction beyond the third sidewall. Accordingly, the third sidewall not only provides mechanical and structural stability, but also provides a retaining element for the plurality of gas cylinders to be accommodated by the support.

[0033] In addition, or alternatively, a retaining element may be provided, either at the same end face or at an opposing end face, as a fixing rod or bar, which securely fixes the plurality of gas cylinders to be accommodated in the transportation module. By the same token, an end wall, preferably a rollable wall may be provided, which closes an open end of the transportation module at the respective end face.

[0034] Furthermore, the support preferably defines a plane, which is tilted with respect to the first and/or second surface, preferably with an angle between 1 and 25 degrees, more preferably between 5 and 10 degrees. The tilting of the support facilitates a fixation of the respective gas cylinders in at least the second direction. Furthermore, the tilting may provide that handling of the respective transportation module is facilitated by providing an additional spacing of the plurality of accommodated gas cylinders with respect to one of the surfaces. In addition, the removal and insertion of a respective gas cylinder is likewise facilitated since a larger area of a respective gas cylinder may be accessed.

[0035] To fix the plurality of gas cylinders in the support, the support may also comprise a plurality of apertures sized to accommodate each of the plurality of gas cylinders and to retain the gas cylinders in a second direction, wherein the support preferably comprises a plurality of rods that are spaced apart to define the plurality of apertures. Preferably, the support accommodates a circumferential surface of the gas cylinder to be accommodated.

[0036] For example, the support may be provided by a bar or third sidewall perpendicular to the first and second sidewall and arranged at an end face or outer surface of the first and second sidewall in a third direction perpendicular to the first and second direction, wherein a plurality of rods extend from the bar or third sidewall in said third direction from one end to the opposing end of the first and second sidewalls in a longitudinal direction. Hence, for each gas cylinder two corresponding rods are provided, wherein the rods arranged between two of the accommodated gas cylinders may be shared by the respective gas cylinders. The spacing between each of the two rods furthermore provides that a circumference of a respective gas cylinder is accommodated, i.e. extends beyond the support, wherein the spacing is limited by the diameter of the respective gas cylinders in order to accommodate a gas cylinder yet prevent the respective gas cylinder from falling through the respective aperture.

[0037] Furthermore, the rods may be provided as a single or a plurality of continuous rods, which are bent at the opposing and of the sidewalls in a longitudinal direction to accommodate a respective end of a respective

gas cylinder, thereby simultaneously fixing the gas cylinder with respect to the third direction.

[0038] Alternatively, the fixation of the plurality of gas cylinders may be provided by a support having an essential continuous surface with plurality of apertures. By the same token, a support may be provided, comprising a plurality of stopping elements or protrusions disposed to accommodate a specific dimension of gas cylinder.

[0039] To improve the handling of a respective transportation module, the sidewalls preferably each comprise at least one gripping part, wherein the gripping part is preferably configured for an automated robotic system. The gripping part may hence be formed e.g. as a latch, handlebar, and/or recess to facilitate the transportation of the respective transportation module. Furthermore, the gripping part may comprise mechanical elements such as clamps or hooks, which are engageable with robotic systems to provide e.g. an automatic storage and/or transfer system. Such automatic handling may be furthermore facilitated by providing e.g. a scannable element, such as a barcode representing specific information with regard to the respective transportation module. Accordingly, the transportation module may be handled as a SKU, wherein the handling is facilitated by the respective gripping parts. Hence, the efficiency of a supply chain for the filling and distribution of gas cylinders is increased.

[0040] For further transportation of the respective gas cylinders, the support may be configured to accommodate at least one carrying device for at least one gas cylinder, preferably two or four gas cylinders, wherein the carrying device preferably comprises a gripping part.

[0041] For example, the carrying device may be configured as an essentially rectangular shape, having at least one recess, which is dimensioned to accommodate a diameter of a respective gas cylinder, wherein a height of the recess ensures that a gas cylinder accommodated in the recess is prevented from tilting, e.g. having a height between one tenth and one third of the gas cylinder. The carrying device preferably comprises two or four recesses to accommodate a corresponding number of gas cylinders.

[0042] Preferably, the carrying device is furthermore configured to carry gas cylinders between one and five liters water capacity, such that the carrying device and the accommodated gas cylinders may be carried by one person. The gripping parts may be provided by a handle or handlebar, which is pivotably secured to the carrying device at to pivot points at opposing sides of the carrying device. Furthermore, the handle or handlebar may be sized in such a way that at least one carrying device may be accommodated by the support, when the handlebar of said carrying device is orientated in a longitudinal direction of the first and second sidewalls. Hence, a transportation module accommodating at least one carrying device may also be used as a separate SKU.

[0043] The provision of at least one carrying device furthermore has the advantage that a direct delivery to

end customers may be provided, enabling the customers to remove a respective gas cylinder and accommodate the gas cylinder. In a carrying device, such that the respective gas cylinder may be transported to the required location for further use. In other words, internal transportations within a facility are facilitated.

[0044] According to a further aspect of the invention, a transportation system for transporting a plurality of gas cylinders is suggested, comprising a base part, a top part, and a plurality of transportation modules as described in the above. The base part is fixed to one of the transportation modules, preferably a bottom one of the transportation modules, and the top part is connected to a top one of the transportation modules, wherein the plurality of transportation modules are stackably arranged on each other in the second direction via a respective interface.

[0045] While the base part may be formed by a respective bottom or lower transportation module in the arrangement of transportation modules, the base part is preferably configured to be compatible with internal transportation means at the facility, existing supply chain means, and/or automated storage and transfer systems. For example, the base part may comprise one or more openings that may be engaged by e.g. forklifts and robotic systems while at the same time being configured to provide further structural stability, e.g. by cross bars and/or a plurality of layers. For example, the base part may have a configuration essentially corresponding to existing pallet structures, e.g. across Europe or the RUK. Accordingly, the base part may be adapted to local and/or international requirements, thereby increasing the compatibility with existing and future solutions.

[0046] Preferably, the base part and top part comprise a surface complementary to a respective surface of the transportation module. Accordingly, the base part and top part may be easily integrated in a modular transportation system and the structural stability is furthermore improved. Furthermore, the base part may comprise a fixation element configured as a second securing element that corresponds to a first securing element arranged on a bottom transportation module, such that the fixation of the base part to the arrangement of transportation modules is facilitated.

[0047] To enable handling and internal transportation at a delivery endpoint, e.g. a facility, the top part may be configured to accommodate at least one carrying device for at least one gas cylinder, preferably two or four gas cylinders, wherein the carrying device preferably comprises a gripping part. As described in the above, such carrying device provides that's a person or customer may carry a plurality of gas cylinders within a facility to a required location. Furthermore, the top part may hence be configured depending on the requirements of the respective endpoint, such that the top part may be configured as a modular top part either comprising at least one carrying device or being configured to carry a plurality of gas cylinders, thereby corresponding to the transportation

module.

[0048] According to a further aspect of the invention, a method for providing a transportation module system for a plurality of gas cylinders is suggested, comprising the steps of providing a base part, arranging an assembly of a plurality of transportation modules as described in the above on the base part, and arranging a top part on the assembly of a plurality of transportation modules. Furthermore, the plurality of transportation modules are arranged in the assembly in a stackable manner in the second direction via a respective interface. The method is preferably provided by an automated robotic system, e.g. an automated storage and transfer system.

[0049] In order to adjust the modular transportation system, the method may further comprise the steps of removing the top part, removing one or more transportation modules from and/or adding one or more transportation modules to the assembly in a stackable manner in the second direction via a respective interface, and arranging the top part to the assembly. Accordingly, a simple and reliable method is provided by the modular system.

[0050] By providing a plurality of stackable transportation modules, the transportation modules may be easily arranged as a modular transportation system, wherein a height of the transportation system is adjustable by the number of transportation modules depending on the requirements and needs at an endpoint or facility. In particular, by providing corresponding gripping parts, the method may be automated by a robotic system, such that a supply chain of filling and distributing of a plurality of gas cylinders is facilitated. Accordingly, the processing speed of SKUs and the corresponding assembly of said SKUs is accelerated and facilitated while at the same time a manual intervention may be avoided, thereby increasing the safety and accuracy of the processing.

Brief description of the drawings

[0051] The present disclosure will be more readily appreciated by reference to the following detailed description when being considered in connection with the accompanying drawings in which:

Figure 1A is a schematic top view of a transportation module accommodating a plurality of gas cylinders;

Figure 1B is a schematic side view of the embodiment according to Figure 1 seen from a longitudinal direction of the respective gas cylinders;

Figure 2 is a schematic side view of a transportation module accommodating a plurality of gas cylinders seen from the first direction and having a tilted support;

Figure 3 is a schematic top view of a transportation module accommodating a plurality of gas cylinders

according to another embodiment;

Figure 4 is a schematic side view of a transportation module accommodating a plurality of gas cylinders seen from a sidewall from the first direction;

Figure 5A to 5C schematically depict various embodiments of the first and second sidewalls as seen from the third direction;

Figure 6 is a schematic perspective view of a carrying device accommodating a gas cylinder;

Figure 7 is a schematic view of a modular transportation system seen from the third direction;

Figure 8A and 8B are schematic cross-sectional views of the first and second sidewalls with a clamping device as seen from the third direction;

Figure 9A to 9C are schematic cross-sectional views of the first and second sidewalls with a protruding element as seen from the third direction, and

Figure 10 are schematic cross-sectional views of the first and second sidewalls with a press-fit element as seen from the third direction.

Detailed description of preferred embodiments

[0052] In the following, the invention will be explained in more detail with reference to the accompanying figures. In the Figures, like elements are denoted by identical reference numerals and repeated description thereof may be omitted in order to avoid redundancies.

[0053] In Figure 1 a transportation module 1 is schematically depicted from a top view accommodating a plurality of gas cylinders 2. The gas cylinders 2 are arranged adjacently to each other and are supported by a support 3. The support 3 is arranged between a first sidewall 10 and a second sidewall 12 and is connected to and held by said sidewalls 10, 12. Accordingly, the plurality of gas cylinders 2 are arranged adjacently to each other in a first direction R1, which according to the embodiment is orientated in a direction perpendicular to the first sidewall 10 and the second sidewall 12. Furthermore, the plurality of gas cylinders 2 are arranged such that a longitudinal axis of the respective gas cylinders 2 is orientated in parallel to both the first sidewall 10 and the second sidewall 12.

[0054] The first sidewall 10 and the second sidewall 12 each comprise a first surface 100 and a second surface (not shown). The first surface 100 of each of the first sidewall 10 and second sidewall 12 is configured to provide a stackable interface with a second surface of a second transportation module (not shown). Accordingly, the first surface 100 comprises a plurality of protrusions 110, which are spaced apart from each other, such that upon

assembly, i.e. stacking, of the transportation module 1 with a second transportation module, said protrusions 110 engage corresponding recesses (not shown). Accordingly, the protrusions 110 provide that the transportation module 1 is slideably fixed in a direction corresponding to a longitudinal axis of each of the sidewalls 10, 12.

[0055] Figure 1B schematically depicts the embodiment according to Figure 1A from a side view seen from a longitudinal direction of the respective gas cylinders 2, wherein the plurality of gas cylinders 2 are adjacently arranged in the first direction R1, e.g., in an essentially horizontal orientation. As indicated in Figure 1B, the plurality of protrusions 110 at the first surface 100 are configured to have a wedge shape or pyramid shape, wherein the plurality of recesses 130 at the second surface 120 comprise a corresponding shape. Accordingly, the first sidewall 10 and a second sidewall 12 provide first and second surfaces 110, 120 that match in geometry, such that the transportation module 1 is stackable in a second direction perpendicular to the first direction R1, e.g., in a vertical orientation.

[0056] In addition, the support 3 is arranged between the first sidewall 10 and the second sidewall 12, such that the first sidewall 10 and the second sidewall 12 extend beyond the gas cylinders 2 in a radial direction, which corresponds to the second direction R2 according to Figure 1B. Accordingly, the gas cylinders 2 are fully comprised within the transportation module 1.

[0057] A transportation module 1 accommodating a plurality of gas cylinders 2 and having a tilted support 3 is schematically depicted in Figure 2 from a side view and seen from the first direction. Accordingly, although the gas cylinders 2 are accommodated in the support 3 in a parallel manner, a plane defined by the support 3 is tilted with respect to both the second surface 120 and the first surface 100, schematically depicted by an angle of about 15°. The provided tilting of the gas cylinders 2 ensures that the gas cylinders 2 are held or securely fixed in a second direction R2, e.g. a vertical direction in a gravitational field. Furthermore, it is shown that the gas cylinders 2 are accommodated by the support 3 in such a way that a circumference of the gas cylinders 2 extends beyond the support 3. However, although the gas cylinders 2 extend beyond the first surface 100 and the second direction R2, the gas cylinders 2 do not extend beyond the second surface 120 at a respective lower longitudinal endpoint of the gas cylinders 2.

[0058] Furthermore, to secure the transportation module 1 in at least a second direction R2, the sidewall comprises a first securing element 150 and a second securing element 160, which are arranged at an end face of the sidewall in a longitudinal direction of the sidewall, wherein the first securing element 150 is disposed below the second securing element 160, such that the first securing element 150 of the transportation module 1 may engage the second securing element 160 of a second transportation module (not shown). Accordingly, the first securing

element 150 and the second securing element 160 are also configured to prevent a slidable movement of the transportation module 1 in a third direction R3, which is perpendicular to the first direction (not shown) and the second direction R2.

[0059] According to another embodiment, the support may be provided by a plurality of rods 32, as schematically depicted in Figure 3 in a top view. The rods 32 extend from a third sidewall 14 arranged at an end surface of the first sidewall 10 and the second sidewall 12 in a longitudinal direction of the sidewalls 10, 12, and comprising an orientation corresponding to the first direction R1. Each pair of rods 32 defines an aperture 30 there between to accommodate a part of the circumference of a respective gas cylinder 2, such that the gas cylinders 2 are held by the rods 32. Furthermore, the third sidewall 14 is configured to prevent a sliding movement of an end of the gas cylinders 2 in a longitudinal direction beyond the third sidewall 14. In order to prevent a sliding movement of the gas cylinders 2 in a longitudinal direction extending from the opposing end of the gas cylinders 2, a retaining element 4 is provided at the opposing end, which is arranged between the first sidewall 10 and the second sidewall 12 in the first direction R1.

[0060] To facilitate the handling of the transportation module 1, the first sidewall 10 and the second sidewall 12 comprise a plurality of gripping parts 5 arranged at an outer surface in the first direction R1. Said gripping parts 5 may be configured to both allow a manual handling as well as a handling by an automated robotic system.

[0061] The gripping parts 5 are shown in more detail in Figure 4, in a schematic side view of the transportation module 1 seen from a sidewall 10, 12 from the first direction R1. Accordingly, the gripping parts 5 may comprise a mechanical element 50, which may be engaged by an automated robotic system, such that the transportation module 1 may be slideably moved and/or lifted. In addition, the gripping part 5 comprises a recess, such that a manual handling of the transportation module 1 is also enabled.

[0062] As the transportation module 1 may be configured as a SKU, the transportation module 1 also comprises a scannable element 6, e.g. a barcode, which may be manually scanned by a user, but may also be automatically detectable by an automated robotic system to identify the SKU and the corresponding plurality of gas cylinders 2.

[0063] In Figure 5A to 5C various embodiments of the first and second sidewalls are depicted as seen from the third direction R3. Accordingly, Figure 5A, shows a sidewall having a first surface 100 and second surface 120, which are configured as a continuous wedge shape, thereby providing a guiding surface while at the same time biasing the transportation module 1 in the first direction R1, when assembling or stacking the transportation module 1 on a second transportation module.

[0064] By the same token, the first surface 100 and the second surface 120 according to the embodiment of fig-

ure 5B comprise a step, forming a similar guiding and biasing surface, as described for the embodiment of Figure 5A. Accordingly, the configuration of the first surface 100 and a second surface 120 as a step also ensures that the transportation module 1 is slideably fixed in the first direction R1.

[0065] In the embodiment according to Figure 5C, the first surface 100 is surrounded or dome-shaped in a continuous fashion in a longitudinal direction of the sidewall. The second surface 120 comprises a corresponding or matching geometry, i.e. having a recess, which is rounded or dome-shaped, thereby providing a cavity to receive the first surface 100. Accordingly, the first surface 100 of the transportation module 1 may only be coupled to a second surface of a second transportation module in a sliding direction. This has the advantage that the transportation module 1 is not only securely fixed in the first direction R1, but also in the second direction R2, i.e. in the vertical orientation in a gravitational field.

[0066] Figure 6 schematically shows an embodiment of a caring device 20 in a perspective view. The caring device 20 is configured as an essentially rectangular shape, having a plurality of apertures 24 to accommodate a corresponding number of gas cylinders 2. A height of the aperture 24 is thereby configured to prevent a tilting of an accommodated gas cylinder 2. Furthermore, in order to facilitate the transportation and carrying of the carrying device 20, and a caring device 20 comprises a gripping part 22, which is arranged at opposing sides of the caring device 20 in a pivotable manner around a pivot 26. Accordingly, the gripping part 22 may be turned or folded in a circular fashion around the carrying device 20. To further facilitate the transportation of the plurality of gas cylinders 2, the gripping part 22 furthermore comprises a length that extends beyond the length of the gas cylinder 2 in a longitudinal direction.

[0067] A modular transportation system 200 comprising a plurality of transportation modules 1 is schematically depicted in Figure 7 seen from the third direction R3. According to the embodiment, four transportation modules 1 are arranged in a stackable matter in the second direction R2 via a respective interface 140 provided by the first surface 100 and the second surface 120. The first surface 100 and the second surface 120 comprise a wedge or pyramid shape, resembling the configuration according to the embodiment of Figure 1B, wherein the first surface 100 and the second surface 120 are configured as continuous inserts and sleeves, respectively.

[0068] Furthermore, a base part 220 is provided at the bottom of the modular transportation system 200, wherein sidewalls of the base part 220 comprise a top surface corresponding to the second surface 120 of the bottom or lower transportation module 1. Accordingly, the transportation modules 1 are slideably fixed with respect to the base part 220 in the first direction R1.

[0069] In addition, the base part 220 is fixed to the bottom or lower transportation module 1 by means of a base part fixation 222. According to the embodiment, the base

part fixation 222 corresponds to the first second securing element 150, 160, described in the above, wherein the base part 222 comprises a second securing element that is engaged by the first securing element of the bottom or lower transportation module 1. Accordingly, the base part fixation 222 ensures that the bottom or lower transportation module 1 is securely fixed to the base part 220 in the second direction R2.

[0070] Also provided is a top part 240, wherein sidewalls of the top part 240 comprise a bottom surface corresponding to the first surface 100 of the top or upper transportation module 1. Accordingly, the transportation modules 1 are slideably fixed with respect to the top part 240 in the first direction R1. The top part 240 furthermore comprises several carrying devices 20, which may be removed by a user or customer at a facility to enable an internal transportation of one or more gas cylinders 2 in the facility towards a required location.

[0071] In order to move the transportation system 200, the base part 220 furthermore comprises a plurality of openings 224, which may be engaged by a corresponding transportation means, e.g. a forklift or an automated robotic system.

[0072] In addition, a retaining element may be provided at an end face of the sidewalls 10, 12, e.g. a rolling door or wall (not shown), which securely fixes the base part 220, the plurality of transportation modules 1, and the top part 240 in a third direction R3.

[0073] Figure 8A and 8B are schematic cross-sectional views of the first and second sidewalls with a clamping device 170 as seen from the third direction R3. Accordingly, the clamping device 170 is at least partially received in a cavity 174 of a sidewall. The clamping device 170 is pivotable around an axis or pivot point 176 between a securing position as depicted in Figure 8A, wherein the upper part of the clamping device 179 is configured to engage a geometry of an adjacent sidewall of a second transportation module to secure the transportation module with respect to a second transportation module in at least the second direction, and an open position as depicted in Figure 8B, wherein the clamping device 176 is configured to disengage a geometry of an adjacent sidewall of a second transportation module to allow that the first and second transportation modules may be moved with respect to each other in at least the second direction.

[0074] To facilitate the engagement of the clamping device 176 with the geometry of the second transportation module the clamping device 176 comprises a biasing member 172, depicted in Figure 8A and 8B as a coiled spring, which biases the clamping device 170 in the securing position. Accordingly, a movement in the second direction R2 (not shown) is essentially prevented in the secured position of the clamping device 170.

[0075] By pressing the lower part of the clamping device 178 in a first pushing direction P1 (Figure 8B), the biasing force exerted by the biasing member 172 is overcome, thereby causing the clamping device 170 to pivot

around the pivot point 176, such that the upper part of the clamping device 179 is brought into the open position and disengages the geometry of the second transportation module. Accordingly, the first and second transportation module may be moved relatively to each other in the second direction (not shown).

[0076] Alternative embodiments of the securing element are depicted in Figures 9A to 9C, which schematically depict the first and second sidewalls with a protruding element as seen from the third direction. Accordingly, a protruding element 180 is shown in Figure 9A, which is arranged on a first surface 100 of a sidewall and is configured to engage a geometry in the lower or second surface 120 of an adjacent sidewall of a second transportation module. The protruding element 180 comprises a protrusion hook-shape at the upper part of the protruding element 189, which is received by a cavity 184 of the second transportation module and engages a corresponding structure of the second transportation module. The protruding element is at least partially a resilient, such that the insertion of the protruding element 180 into the cavity 184 is facilitated yet substantially attains its original shape and/or position in the inserted state, such that the protruding element 180 secures the first transportation module to the second transportation module in at least the second direction (not shown), e.g. by providing a notch effect, stress concentration, and/or edge pressure.

[0077] In a further alternative embodiment of the securing element as depicted in Figure 9B, the protruding element 180 comprises an extended resilient portion, which is connected to an inner surface of the first surface 100 and is accordingly received in a cavity of said first surface 100. Accordingly, the insertion of the protruding element 180 into the cavity 184 is further facilitated while at the same time a biasing force is exerted by the extended resilient portion, thereby biasing the protruding element 180 into the securing position in an inserted state.

[0078] By the same token, protruding element 180 may comprise, alternatively or in addition to the extended resilient member depicted in Figure 9B, a biasing member 182, as depicted in Figure 9C. For example, the biasing member 182 may be formed as a leaf spring, which is arranged on the first surface 100 and further biases the protruding element 180 into the securing position.

[0079] As can be seen in Figures 9A to 9C, the cavity 184 preferably comprises an opening or through-hole in a lateral direction, i.e. in the second direction (not shown), such that the upper part of the protruding element 189 may be displaced. Accordingly, the through-hole may provide that the protruding element 180 may be biased into an opening position, such that the first and second transportation module may be moved relative to each other in at least the second direction.

[0080] In addition, the through-hole may be provided at the surface of the transportation module facing the plurality of gas cylinders, i.e. facing the support (not shown) or on the surface facing away from the support,

i.e. the outer side.

[0081] Furthermore, the securing element may comprise a press-fit element 190 as shown in Figures 10A and 10C. Accordingly, the press-fit element 190 is arranged both on second surface 120 and within a cavity 194 of the first surface 100 at ends of the respective sidewall in the second direction. Accordingly, as depicted in Figure 10A, the lower surface of a sidewall of a first transportation module may be slideably received by an upper surface of an adjacent sidewall of a second transportation module. The press-fit element 190 is formed as a deformable member made and hence comprises a resilient member 199, such that said resilient member may form a semi-circular structure in the state, wherein the lower surface of a sidewall of a first transportation module is not received by an upper surface of an adjacent sidewall of a second transportation module (Figure 10A). Instead of such semi-circular shape other geometrical shapes may be provided, e.g. an ellipsoid or essentially rectangular structure.

[0082] When the lower surface of the sidewall of the first transportation module is slideably received by the upper surface of the adjacent sidewall of the second transportation module (Figure 10B) by insertion in the second pushing direction P2, the resilient member 199 of the press-fit element 190 extends in the first direction (not shown) due to compressive forces. Accordingly, the press-fit element 190 at least partially fills the cavity 194, thereby providing a frictional force impairing a relative movement of the first transportation module with respect to the second transportation module in at least the second direction (not shown). It may be provided that said extension in the first direction depends on the weight of the second transportation, such that the frictional force is increased when a second transportation module placed on top of the first transportation module is loaded with gas cylinders.

[0083] Although the embodiment according to Figure 10 depicts the first surface 100 as the receiving end of the sidewall, the configuration may also be inverted, such that the first surface 100 is received by the second surface 120, depending on the desired shape of the transportation module.

[0084] The embodiments shown in Figures 8 to 10 hence provide securing elements, which either on itself or combined as a plurality of spaced apart securing elements secure the first and second transportation module in at least the second direction. Furthermore, such securing elements may be provided, alternatively or in addition, as a first securing element 150 and second element 160, e.g. as depicted in Figure 2. Accordingly, the clamping device 170, the protruding element 180, and/or the press-fit element 190 may be added to or replaced by the first and second securing element 150, 160 and vice versa. The arrangement of said securing elements may hence also be varied, such that they may be arranged on e.g. ends of the respective sidewall, asymmetrically, or evenly distributed in the third direction.

[0085] It will be obvious for a person skilled in the art that these embodiments and items only depict examples of a plurality of possibilities. Hence, the embodiments shown here should not be understood to form a limitation of these features and configurations. Any possible combination and configuration of the described features can be chosen according to the scope of the invention.

List of reference numerals

[0086]

1	Transportation module
10	First sidewall
12	Second sidewall
14	Third sidewall
100	First surface
110	Protrusion
120	Second surface
130	Recess
140	Interface
150	First securing element
160	Second securing element
170	Clamping device
172	Biasing member
174	Cavity
176	Pivot point
178	Lower part of clamping device
179	Upper part of clamping device
180	Protruding element
182	Biasing member
184	Cavity
189	Upper part of protruding element
190	Press-fit element
194	Cavity
199	Resilient member
2	Gas cylinder
20	Carrying device
22	Gripping part
24	Aperture
26	Pivot
200	Transportation system
220	Base part
222	Base part fixation
224	Opening
240	Top part
3	Support
30	Aperture
32	Rod
4	Retaining element
5	Gripping part
50	Mechanical element
6	Scannable element
P1	First pushing direction
P2	Second pushing direction
R1	First direction
R2	Second direction
R3	Third direction

Claims

1. Transportation module (1) for transporting a plurality of gas cylinders (2), comprising:

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- a support (3) for adjacently accommodating a plurality of gas cylinders (2) in a first direction (R1); and

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- a first (10) and second sidewall (12), which are arranged in parallel, wherein the support (3) is arranged between the sidewalls (10, 12) and connected to the sidewalls (10, 12),

characterized in that

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each of the sidewalls (10, 12) comprises a first (100) and second surface (120) on opposing sides in a second direction (R2) perpendicular to the first direction (R1), wherein the first surface (100) is configured to provide a stackable interface (140) with the second surface (120) of a second transportation module (1) in the second direction (R2).

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2. Transportation module (1) according to claim 1, **characterized in that** the first direction (R1) is perpendicular to a longitudinal axis of the plurality of gas cylinders (2) and/or wherein the support (3) is configured to accommodate each of the plurality of gas cylinders (2) such that the longitudinal axis of the plurality of gas cylinders (2) is orientated in parallel to the support (3), wherein preferably the first direction (R1) is perpendicular to the first (10) and second sidewall (12).

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3. Transportation module (1) according to claim 2, **characterized in that** the first surface (100) comprises one or more protrusions (110) configured to be accommodated in corresponding one or more recesses (130) on the second surface (120) of a second transportation module (1), wherein the first surface (100) preferably comprises a portion that is complementary to the second surface (120).

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4. Transportation module (1) according to claim 3, **characterized in that** the one or more protrusions (110) are formed as a continuous insert and the one or more recesses (130) are formed as a continuous sleeve, which are preferably arranged in parallel to a direction corresponding to a longitudinal axis of a gas cylinder (2) accommodated by the support (3), wherein the continuous insert is preferably wedge-shaped, pyramid-shaped, or comprises a rounded shape.

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5. Transportation module (1) according to any of the claims 2 to 4, **characterized in that** the first (10) and second sidewall (12) extend beyond the support (3) in the second direction (R2) and are dimensioned such that a distance between the first surface (100)

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and the second surface (120) in the second direction (R2) comprises at least a height of a gas cylinder (2) accommodated by the support (3) in a radial direction, wherein the first (10) and second sidewall (12) are preferably dimensioned such that an accommodated gas cylinder (3) does not extend beyond a respective lower or bottom surface in the second direction (R2).

6. Transportation module (1) according to any of the claims 2 to 5, **characterized in that** the first surface (100) is engageable with the second surface (120) of a second transportation module (1) to form a positive locking, a non-positive locking, and/or an interference fit to slideably secure the transportation module (1) with respect to the second transportation module (1) in at least the first direction (R1), preferably also in a third direction (R3) perpendicular to the first (R1) and second direction (R2).
7. Transportation module (1) according to any of the preceding claims, **characterized in that** at least one of the sidewalls (10, 12) comprises at least one securing element (150, 160, 170, 180, 190), which is configured to slideably secure the transportation module (1) with respect to a second transportation module (1) in at least the second direction (R2), preferably also in a third direction (R3) perpendicular to the first (R1) and second direction (R2), wherein the securing element preferably comprises a clamping device (170), a protruding element (180), and/or a press-fit element (190).
8. Transportation module (1) according to claim 7, **characterized in that** the securing element comprises a first (150) and second securing element (160), which are arranged such that the first securing element (150) is engageable with the second securing element (160) of a second transportation module (1).
9. Transportation module (1) according to any of the preceding claims, **characterized in that**
 - the transportation module (1) further comprises a retaining element (4) arranged between, perpendicular to, and at at least one end face in a longitudinal direction of the sidewalls (10, 12), which is configured to retain a plurality of gas cylinders (2) accommodated by the support (3) in a third direction (R3) perpendicular to the first (R1) and second direction (R2), wherein the retaining element (4) is preferably mechanically connected to the sidewalls (10, 12) and the support (3), the retaining element (4) preferably comprising a third sidewall, a rod and/or roll-up door; and/or
 - the support (3) defines a plane, which is tilted

with respect to the first (100) and/or second surface (120), preferably with an angle between 1 and 25 degrees, more preferably between 5 and 10 degrees.

10. Transportation module (1) according to any of the preceding claims, **characterized in that** the support (3) comprises a plurality of apertures (30) sized to accommodate each of the plurality of gas cylinders (2) and to retain the gas cylinders (2) in a second direction (R2), wherein the support (3) preferably comprises a plurality of rods (32) that are spaced apart to define the plurality of apertures (30), wherein the support preferably accommodates a circumferential surface of the gas cylinder (2) to be accommodated.
11. Transportation module (1) according to any of the preceding claims, **characterized in that** the sidewalls (10, 12) each comprise at least one gripping part (5), wherein the gripping part (5) is preferably configured for an automated robotic system, and/or wherein the support (3) is configured to accommodate at least one carrying device (20) for at least one gas cylinder (2), preferably two or four gas cylinders (2), wherein the carrying device (20) preferably comprises a gripping part (22).
12. Transportation system (200) for transporting a plurality of gas cylinders (2), comprising:
 - a base part (220);
 - a top part (240); and
 - a plurality of transportation modules (1) according to any of the claims 1 to 11,

wherein the base part (220) is fixed to one of the transportation modules (1), preferably a bottom one of the transportation modules (1), and wherein the top part (240) is connected to a top one of the transportation modules (1), the base part (220) and top part (240) preferably comprising a surface complementary to a respective surface (100, 120) of the transportation module (1),

characterized in that

the plurality of transportation modules (1) are stackably arranged on each other in the second direction (R2) via a respective interface (140).

13. Transportation system (200) according to claim 12, **characterized in that** the top part (240) is configured to accommodate at least one carrying device (20) for at least one gas cylinder (2), preferably two or four gas cylinders (2), wherein the carrying device (20) preferably comprises a gripping part (22).
14. Method for providing a modular transportation system (200) for a plurality of gas cylinders (2), prefer-

ably by an automated robotic system, comprising the steps of:

- providing a base part (220);
- arranging an assembly of a plurality of transportation modules (1) according to any of the claims 1 to 11 on the base part (220); and
- arranging a top part (240) on the assembly of a plurality of transportation modules (1),

characterized in that

the plurality of transportation modules (1) are arranged in the assembly in a stackable manner in the second direction (R2) via a respective interface (140).

- 15. Method for providing a modular transportation system (200) according to claim 14,**
characterized by further comprising the steps of:

- removing the top part (240);
- removing one or more transportation modules (1) from and/or adding one or more transportation modules (1) to the assembly in a stackable manner in the second direction (R2) via a respective interface (140); and
- arranging the top part (240) to the assembly.

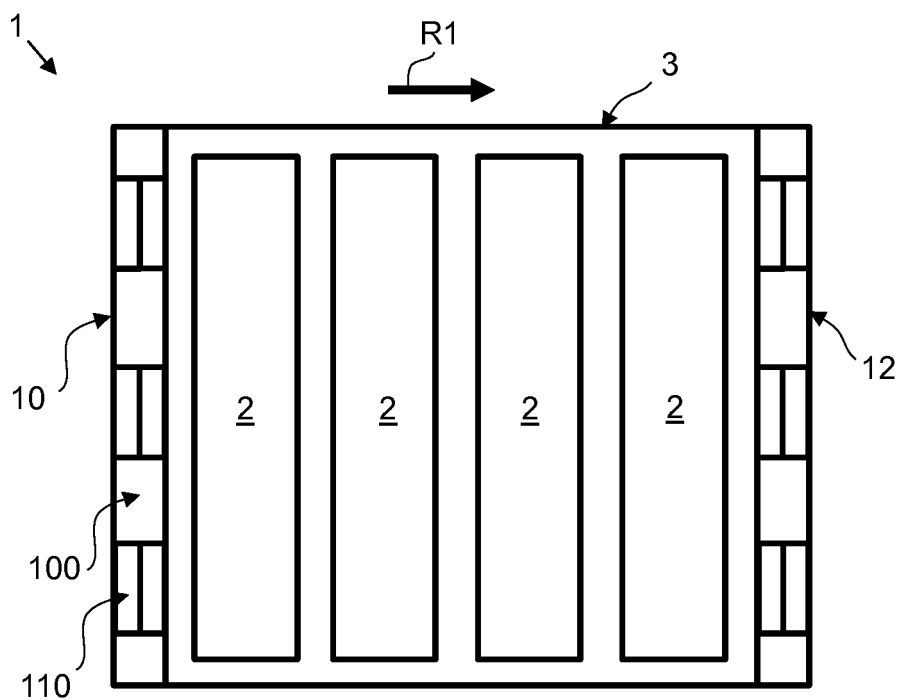


Fig. 1A

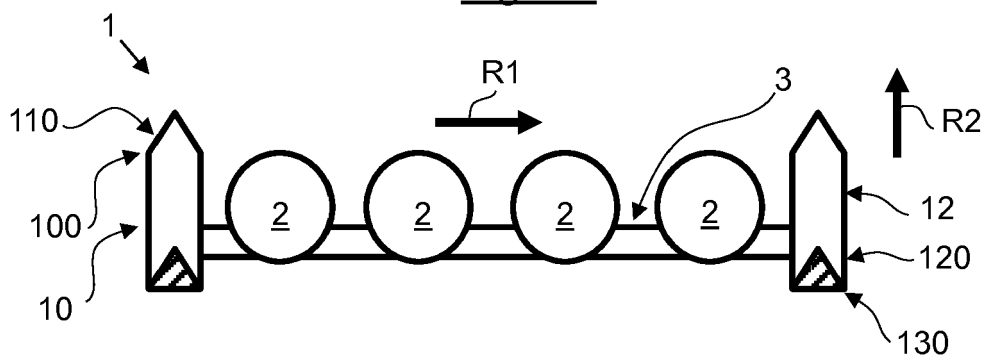


Fig. 1B

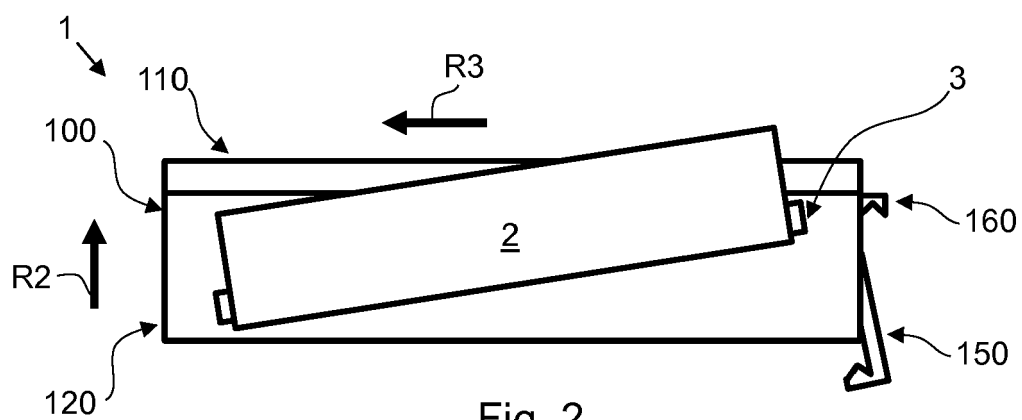


Fig. 2

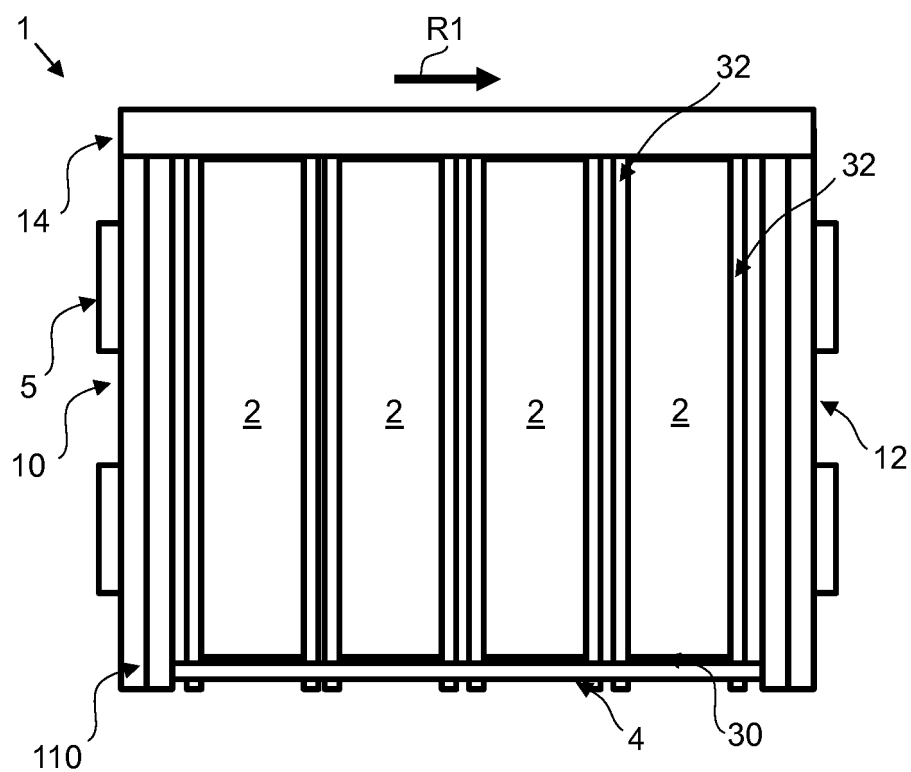


Fig. 3

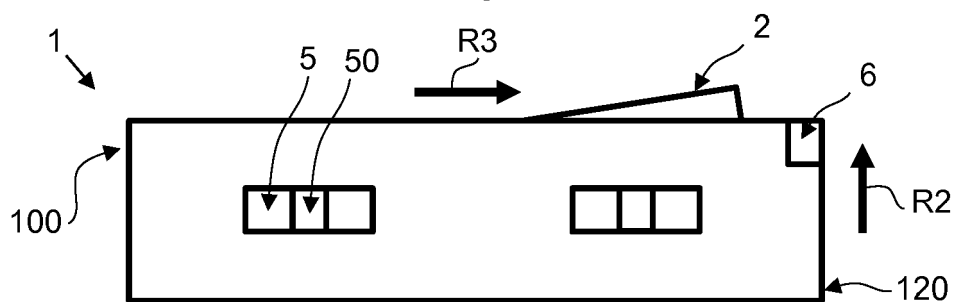


Fig. 4

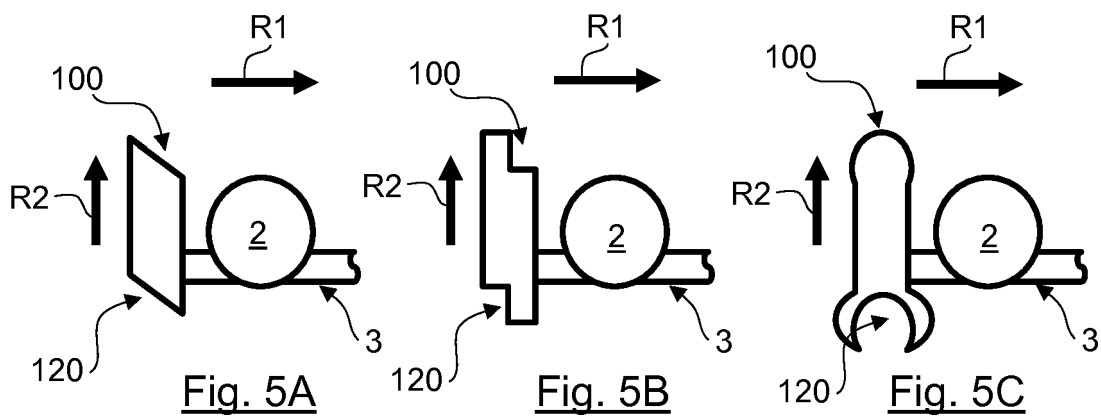


Fig. 5A

Fig. 5B

Fig. 5C

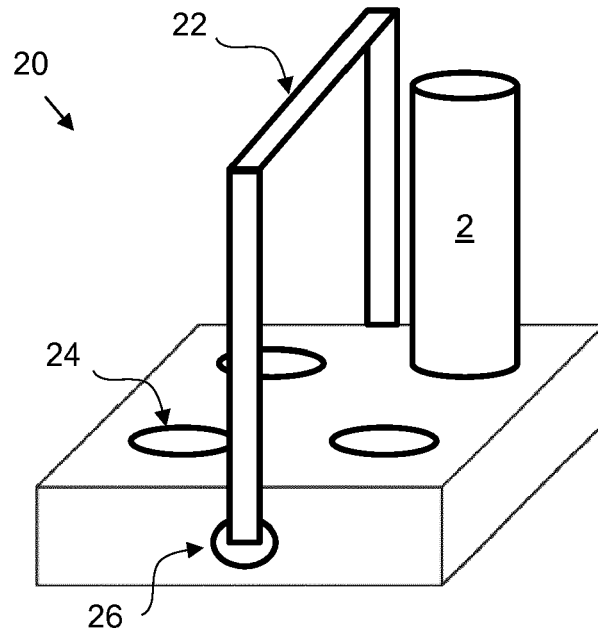


Fig. 6

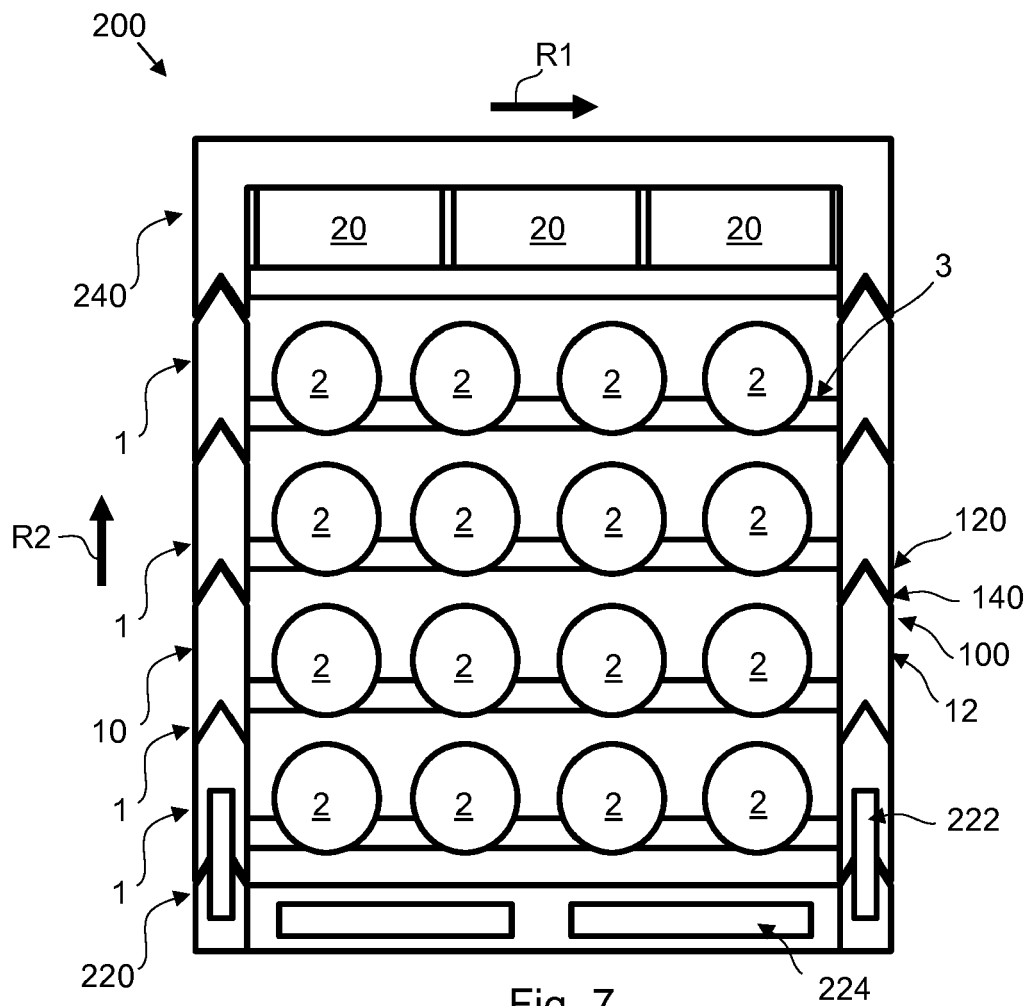


Fig. 7

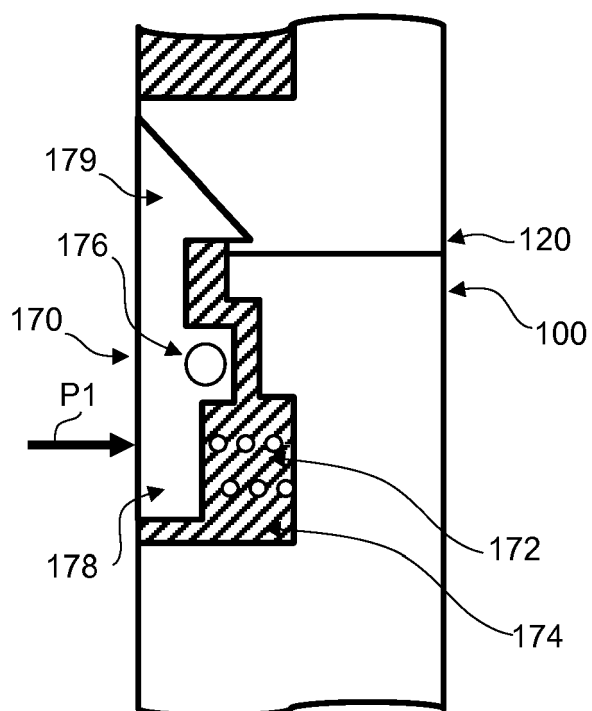


Fig. 8A

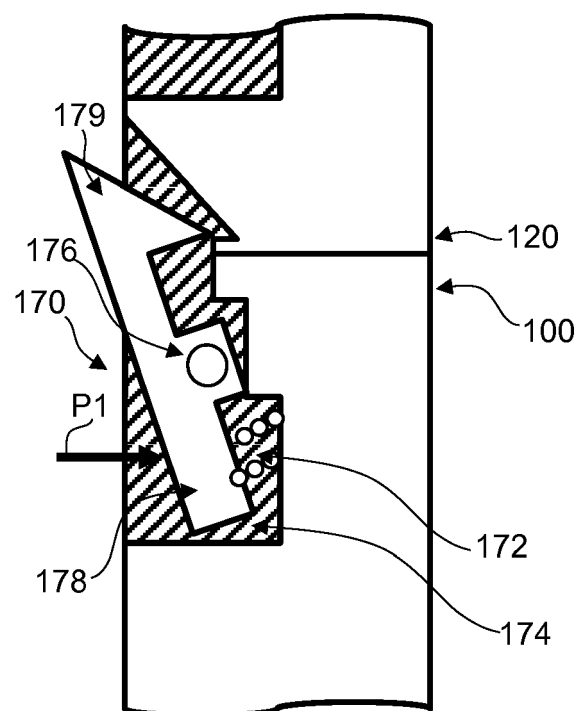


Fig. 8B

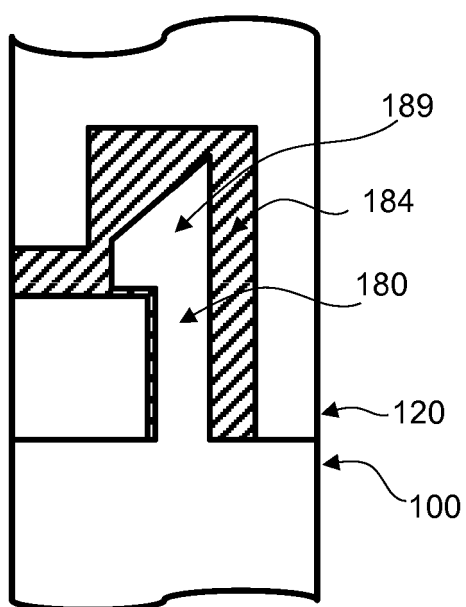


Fig. 9A

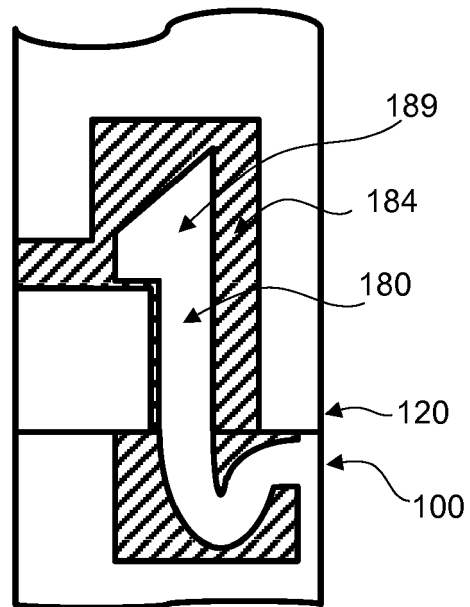


Fig. 9B

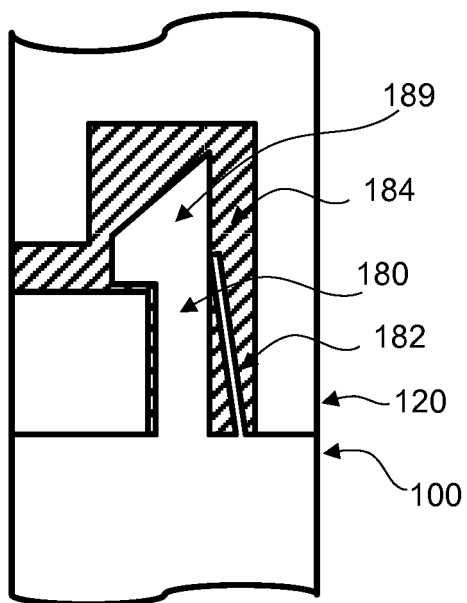


Fig. 9C

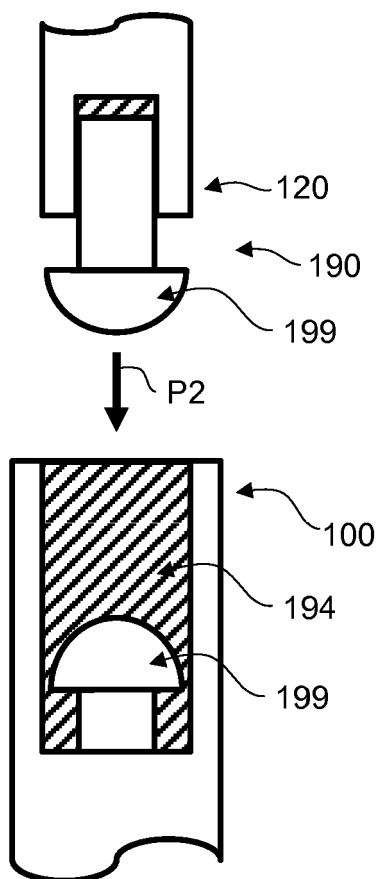


Fig. 10A

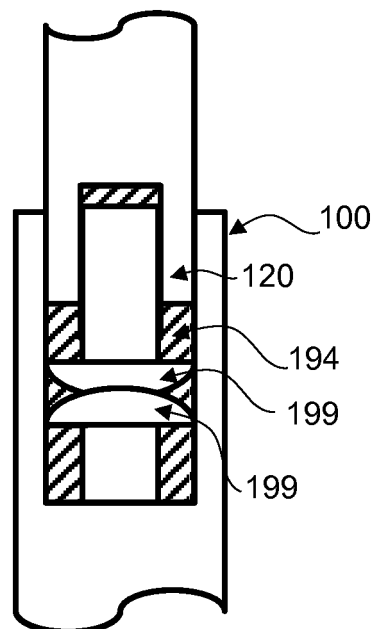


Fig. 10B



EUROPEAN SEARCH REPORT

 Application Number
EP 18 02 0166

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			F17C
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 27 September 2018	Examiner Papagiannis, Michail
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82