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(54) **Plate freezer and method for operating a plate freezer**

(57) A plate freezer and a method for operating the plate freezer is disclosed. The plate freezer comprises a stack of freezer plates, each freezer plate having a first and a second surface, surrounding a hollow interior through which a coolant may be circulated, which freezer plates are movably mounted in a frame, wherein each freezer plate comprises at least a first actuator mounted in a first end of the freezer plate and at least a second actuator mounted in a second end of the freezer plate,

said actuators being mounted on the first surface of the freezer plate in a first end of the actuator and a second end of the actuator is intended for being brought into contact with to the second surface of an adjacent freezer plate. The actuators are preferably hydraulic actuators.

The overall height of a plate freezer having a certain capacity can be reduced, and the time needed for freezing the product is reduced.

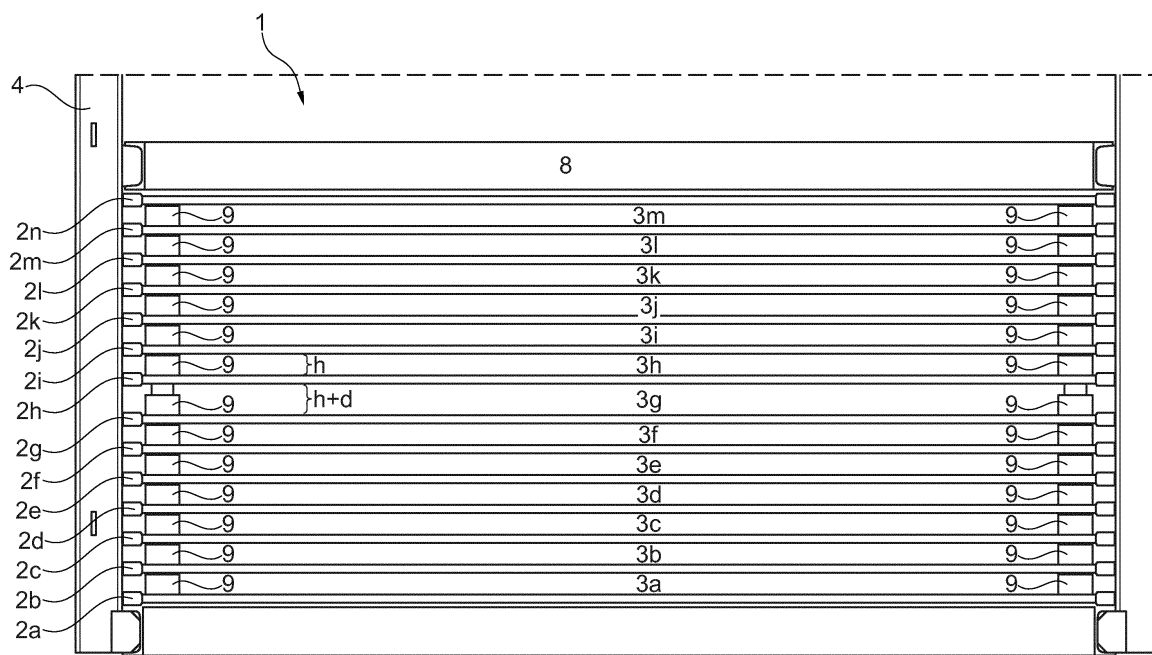


Fig. 5

Description

Field of the Invention

[0001] The present invention relates to a plate freezer comprising a stack of freezer plates, each freezer plate having a first and a second surface, surrounding a hollow interior through which a coolant may be circulated, which freezer plates are movably mounted in a frame.

[0002] In addition, the present invention relates to a method for operating a plate freezer comprising a stack of freezer plates.

Background of the Invention

[0003] In the processing of food there is often a freezer installation involved in that quite a number of food items are stored, transported and sold as frozen foods.

[0004] For example, on some fishing vessels, e.g. trawlers, the fish are frozen into blocks and are stored in freezers on the fishing vessel while at sea. Then, when the fishing vessel returns to a harbour, the frozen fish is delivered to a fishing processing plant on shore for further processing, e.g. after thawing.

[0005] Alternatively, a product to be frozen is packaged and the product in the package is frozen in a freezer.

[0006] Freezing is a very energy-intensive process requiring an effective cooling plant as well as efficient freezer means. The same considerations apply to other technical fields where it is desirable to utilise freezer installations.

[0007] In the art a number of freezer designs exist which are specifically designed to save energy in order to make the freezing process cheaper and potentially also faster. Horizontal plate freezers typically comprise a number of horizontal plates in a horizontal stack. The plates are constructed such that cooling medium may be guided through the plates. The plates are brought in close physical contact with the products to be frozen.

[0008] The cooling medium is usually supplied from a cooling media supply plant to the interior of the plates in the freezer via a pipe system.

[0009] After placement of products on the plates, the plates are pushed together in a vertical direction for slightly squeezing the product arranged between the plates in order to create a good thermal conductive contact between the products to be frozen and the freezing plates. Thus, the product to be frozen is brought into contact with two plates: The upper surface of the plate on which the product is placed and the lower surface of the plate above the product. Usually a hydraulic ram provides a pressure to the entire stack of plates, which ensures optimal contact between the product and the horizontal plates and thus optimizes the freezing process. In addition the blocks of frozen product are homogenous in shape.

[0010] The prior art horizontal plate freezers have different means for moving the plates vertically thereby creating larger openings between two adjacent plates in or-

der to be able to place the product to be frozen between adjacent plates and subsequently removing the product from the plates after freezing.

[0011] In DE4324192 is suggested a solution where air hoses or cushions are arranged between the ends of horizontal freezing plates. By injecting pressurized air into the hoses or cushions, the increased pressure will cause the freezing plates to be separated, and thereby allowing access to the freezing space between the freezing plates.

[0012] In some horizontal plate freezers the entire stack of plates are separated from each other when emptying the freezer. This results in interruption of the freezing process in products on all the plates, while the frozen product is removed from a single plate. This is inconvenient because the freezing capacity of the freezer is not utilised between the other plates when the frozen product is removed from a single plate. This further results in an overall increased consumption of time for freezing a certain product sufficiently and the full capacity of the horizontal plate freezer is not fully utilised. An example is disclosed in GB 395,962, where the freezing plates are arranged on chain driven spindles, such that all freezing spaces must be opened at the same time.

[0013] In other horizontal plate freezers the entire stack of plates is lifted into position in relation to the conveyor or other handling unit which is to receive the frozen product arranged between two plates. When the relevant plate in the horizontal freezer is empty, the position of the entire stack of plates is lifted or lowered and thereby adjusted in height in order to put another plate to be emptied in level with the conveyor or other handling unit etc. for each plate in the horizontal plate freezer. This procedure of adjusting the position is time-consuming. This construction also results in a relatively tall building height of the horizontal freezer.

[0014] The overall height of the horizontal freezer is important when the freezer is mounted e.g. on board a marine fishing vessel, in which the overall height of the freezer is determined by the height available in the vessel. Thus, when installing such horizontal freezers in a fishing vessel, the overall height of the freezer and thereby the fishing capacity is limited by the height available in the vessel.

[0015] In another known horizontal plate freezer, having a low overall total height, an alternative way is provided for lifting and lowering the horizontal plates when filling or emptying product from the freezer. The plate freezer comprises horizontally movable opening stations, which travel upwards /downwards at each of the ends of the stack of plates. The opening station comprises two arms, which are intended for moving the relevant freezer plates away from each other for providing access to the freezer station, i.e. the freezer space between the two adjacent plates, such as when filling and/or emptying the relevant station. After emptying, and optionally subsequent filling, of the freezer station, the opening station withdraws the arms and travels upwards or downwards

to the next freezer station to be emptied and/or filled etc.

[0016] This results in a reduced overall total height of the freezer, when compared to the above-mentioned alternative known horizontal freezers because the freezer plates only need to be lifted by a short distance corresponding to the space needed for filling or emptying a single freezer station. However, there is a significant load on each freezer plate, when they are lifted, in particular, when the freezer plates are loaded with products while lifted. This may further result in the freezer plates being bent during lifting, which causes stress in the freezer plate material, which in rare cases may cause formation of cracks in the plates, whereby coolant may escape from the interior of the plate, whereby repair and substitution of the freezer plate(s) are needed. This is highly inconvenient, in particular if the horizontal plate freezer is installed on a ship, such as a fishing vessel, which stays at sea for a certain period while catching and subsequently freezing the fish in blocks in the horizontal freezer, because the vessel needs to seek harbour for repair of the freezer.

Object of the Invention

[0017] It is an object of the present invention to provide horizontal plate freezers which reduce the overall total height of horizontal plate freezers even further.

[0018] It is also an object of the present invention to provide plate freezers with increased freezing capacity in a pre-defined space having a fixed total height.

[0019] In addition, it is an object of the present invention to provide plate freezers having a simple and reliable, yet robust and inexpensive construction of the system for lift-ing/lowering of the freezer plates.

[0020] Further, it is an object of the present invention to provide plate freezers, which are controlled in a simple and reliable way.

[0021] In addition, it is an object of the present invention to provide a method of operating a plate freezer, in an efficient and reliable way, and whereby fast freezing is obtained, which maintains the natural quality of the products.

[0022] In addition, when freezing products into blocks, the blocks obtained are homogenous in shape.

Description of the Invention

[0023] These objects are obtained by a plate freezer comprising a stack of freezer plates, each freezer plate having a first and a second surface, surrounding a hollow interior through which a coolant may be circulated, which freezer plates are movably mounted in a frame.

[0024] The plate freezer according to the present invention is special in that each freezer plate comprises at least a first and second actuator mounted in both ends of the freezer plate, said actuators being mounted on the first surface of the freezer plate in a first end of the actuator and a second end of the actuator is in contact with

or connected to the second surface of an adjacent freezer plate.

[0025] Plate freezer comprising a stack of freezer plates, each freezer plate having a first and a second surface, surrounding a hollow interior through which a coolant may be circulated, which freezer plates are movably mounted in a frame, wherein each freezer plate comprises at least a first and a second hydraulic actuator mounted in both ends of the freezer plate, said hydraulic actuators being mounted on the first surface of the freezer plate in a first end of the hydraulic actuator and a second end of the hydraulic actuator is in contact with or connected to the second surface of an adjacent freezer plate, such that an adjustable freezing space is defined between two adjacent freezer plates, and where said actuators are connected to a source of hydraulic fluid, controlled by a control unit.

[0026] When mounting small actuators between the freezer plates, these actuators can be used for lifting the plates mounted above the relevant freezer station when opening the relevant freezer station for filling and/or emptying said freezer station. A freezer station is defined as the freezer capacity area between two adjacent freezer plates also referred to as freezing space. During filling/emptying of a single freezer station, the remaining freezer stations are kept in their closed position, and thus maintain the optimal contact between the freezer plates and the product in these freezer stations and thus continue the freezing process while another freezer station is filled and/or emptied. This results in reduction of the overall time necessary for freezing the products in the freezer, leading to saving in energy used per kilo product to be frozen, and the overall capacity of the freezer is optimised. Further, the plate freezer has a simple construction, because the opening station can be avoided. In addition, the hydraulic ram, which provides pressure to the stack of plates, can be avoided. This further results in reduction of the overall height of a plate freezer having a certain number of freezer plates, i.e. having a certain freezing capacity. Alternatively, a plate freezer having an increased freezing capacity, i.e. having an increased number of freezer plates, may be installed in the same volume of space.

[0027] Preferably, the actuators are hydraulic actuators because they can be locked in a certain position, and thereby hold two adjacent freezer plates in a certain position in relation to each other. Because the hydraulic liquid, such as hydraulic oil, is incompressible, it is possible to lock the position of hydraulic actuators by blocking the flow of hydraulic liquid in the actuators. Thereby the minimal height of the actuators is locked in a very well-defined position and the small actuators mounted on the freezer plates can also act as adjustable spacers during the freezing process. In addition, the large hydraulic actuators of the hydraulic ram are able to provide the necessary pressure on the product between two adjacent plates during freezing, while the small actuators define the minimum distance between two adjacent freezer

plates. Thereby thermal transfer between the freezer plates and the product is optimized and the overall time needed for freezing the products is reduced and the frozen product obtains or maintains its optimal shape. In addition, hydraulic actuators are easy to control without needing to install sensors etc. for monitoring position etc. of the freezer plates. Sensors are often quite sensitive to low temperatures, and may thus cause the system to become sensitive. This is reduced or even avoided in the present invention simply because the need for sensors mounted in relation to the freezer is reduced significantly.

[0028] In one embodiment, the actuators are mounted in or near each corner of each of the freezer plates. Thereby load on each freezer plate is evenly distributed on the surface of the freezer plate, and it is possible to calibrate the position of the freezer plates by levelling it into horizontal position, which ensures uniformly formed blocks of frozen product, when the freezer is used for freezing blocks of product. Further it reduces any bending of the freezer plates to a minimum while they are loaded and thus reduces stress on the freezer plates.

[0029] Furthermore as the hydraulic actuators are mounted in the same positions on all freezing plates, force imparted for example when opening a station, will be transferred through the actuators (especially when they are locked), and not influence the freezing plates. Naturally the area where the actuators are arranged will be subjected to pressure, but the freezer plates can easily and cheaply be dimensioned for this, whereas bending or other induced stresses in the freezing plates stemming from movement of the freezing plates in other prior art systems, may put significant stress on the freezing plates.

[0030] A spacer is preferably mounted in each end of the upper and/or lower surface of the freezer plates. The spacer defines the minimum distance between two adjacent freezer plates. The spacers can be of different heights depending on the height of the blocks or packages of the product subjected to freezing in the plate freezer, and the minimum size can be varied by substituting the spacers with another set of spacers, defining a new minimum height. Thereby the lowermost position of the actuators does not necessarily need to define the minimum height between two adjacent freezer plates. Thereby the same type and size of actuators can be used for plate freezers in which a variety of different sizes of blocks/packages can be frozen.

[0031] In a preferred embodiment, the plate freezer according to the present invention is a plate freezer with horizontally mounted freezer plates.

[0032] The objects of the present invention and the effects mentioned above are also obtained by a method for operating a plate freezer as described above.

[0033] The method for operating a plate freezer comprising a stack of freezer plates, which freezer plates are movably mounted in a frame, wherein each freezer plate comprises at least a first and a second hydraulic actuator

mounted in each end of the freezer plate, said hydraulic actuators being mounted on the first surface of the freezer plate in a first end of the actuator, and a second end of the actuator is intended for being brought into contact with the second surface of an adjacent freezer plate, which method comprises

- activating the hydraulic actuators mounted on one or more freezer plates in order to open the freezing space between two adjacent freezer plates;
- if necessary emptying or filling said freezing space with material to be frozen;
- operating the hydraulic actuators, thereby moving two adjacent plates in relation to each other by controlling the flow of a hydraulic fluid to and from each of the hydraulic actuators allowing the adjacent freezer plates in one freezing space to come into contact with the material to be frozen;
- maintaining a hydraulic pressure in the hydraulic actuators, which pressure assures that the freezing plates in a first freezing space are in contact with the material to be frozen, and when actuators in an adjacent freezing space are activated, the forces from the actuators in the adjacent freezing space are transferred by means of the pressurized actuators in said first freezing space.

[0034] Thus, increasing the distance between the first surface of one freezer plate and the second surface of an adjacent plate is performed by activating a flow of hydraulic liquid to each of the actuators mounted on the first freezer plate. Then subsequently decreasing the distance between the first surface of one freezer plate and the second surface of an adjacent plate is performed by withdrawing hydraulic liquid from each of the actuators mounted on the first freezer plate.

[0035] Preferably, the method includes blocking the flow of hydraulic fluid to and from all actuators between two adjacent freezer plates whereby the height of the hydraulic actuators is locked in relation to each other and thus also provides an adjustable spacer between two adjacent freezer plates.

[0036] Hereby it is obtained that a single freezer station between two adjacent plates can be opened and emptied and/or filled with product, while the other freezer stations are closed in their freezing position, whereby the overall height of the plate freezer can be reduced, or a plate freezer having more freezer plates can be obtained, and thus increased capacity can be installed in the same volume of space. In addition, when the hydraulic actuators are locked by blocking the flow of hydraulic liquid as described above, the distance between two adjacent plates are very well-defined, as also discussed above, and the actuator can act as an adjustable spacer between two adjacent freezer plates. Thus, the hydraulic actuators of the hydraulic ram are able to provide the necessary pressure on the product between two adjacent plates during freezing, while the small actuators on each plate also

act as an adjustable spacer whereby thermal transfer between the freezer plates and the product is optimized, and the overall time needed for freezing the products is reduced, and the frozen product obtains or maintains its optimal shape.

[0037] As the actuators are subjected to a certain minimum pressure, by maintaining the pressure in the hydraulic actuators, any force stemming from manipulating other freezing plates, is transferred through the levels by the actuators (and not the freezing plates). The freezing plates are subjected to compression in the areas where the actuators are mounted, and may advantageously (if necessary) be provided with solid compression zones, such that any damage to the freezing plates is avoided.

[0038] The method may further comprise a step of adjusting the height of the actuators mounted between two adjacent freezing plates slightly by a distance Δ , such as 0.5-10 mm, or preferably 0.5-5 mm for compensating for the expansion of the product during freezing, preferably after initiation of the freezing process. Hereby, a certain pressure between the freezer plates and the product is maintained, and the overall time needed for freezing the products is reduced.

[0039] The relative position between the two adjacent freezer plates is preferably adjusted by applying a minor pressure increase in the actuators on a plate, whereby the height of the freezer station between two adjacent plates is increased by Δ . Δ is e.g. 0.5-10 mm, or preferably 0.5-5 mm.

[0040] The method may further comprise calibrating the overall height of each of the actuators mounted on a freezing plate in relation to the other actuators prior to locking the position of the freezer plate in relation to the adjacent freezer plate.

[0041] This levels the position of the freezer plates in horizontal position and ensures uniformly formed blocks of frozen product when the freezer is used for freezing blocks of product. Further it reduces any bending of the freezer plates to a minimum while they are loaded and thus reduces stress on the freezer plates and thereby reduces the risk of formation of cracks in the freezer plates and subsequently the need for repair. Although the present invention is described and preferably used in plate freezers having horizontally mounted freezer plates, the present invention may also be applicable in freezers with vertically mounted freezer plates.

Description of the Drawing

[0042] The present invention will be described with reference to the drawings, in which

Fig. 1 shows a known horizontal plate freezer provided by Dybvad Staal-industri A/S (DSI), without its cover,

Fig. 2 shows an isometric view of a plate freezer according to the present invention, without its cover,

Fig. 3 shows an isometric view of a plate freezer

according to the present invention, in which some of the upper plates are not shown,

Fig. 4 shows a front view of a plate freezer according to the invention, where all freezer stations are in their closed position, and

Fig. 5 shows a front view of a plate freezer according to the invention, where one freezer station is in an open position, e.g. during filling and/or emptying thereof.

Detailed Description of the Invention

[0043] Fig. 1 shows a prior art horizontal plate freezer 1. Prior art plate freezers, e.g. of the type used in the food industry, comprises a row or stack of flat juxtaposed cooling units 2, freezer plates 2a-2q. The freezer plates 1 are held in position by a frame 4. Between two adjacent freezer plates 1 there are openings 3a-3p, also called freezing stations, or spaces where products can be arranged and subsequently frozen.

[0044] The products are preferably food products, e.g. fish, meat, fruit or vegetables, which can be frozen either in blocks for subsequent further thawing and/or processing in the industry, or the products can be frozen after being wrapped in packages which are then ready for sale.

[0045] Coolant is circulating through the interior of the freezer plates 1 and is supplied from a cooling plant (not shown) via hose connections (not shown) to each of the freezer plates 1 and returns to the cooling plant via additional hose connections (not shown). When the spaces 3 between the freezer plates 2 are filled with products to be frozen, a large actuator 5 in each corner of the stack of freezer plates 2 is activated to pull a ram downwards for providing a certain pressure on the stack of freezer plates while freezing the products arranged on each freezer plate 2a-2p. Thereby the product is squeezed slightly between two adjacent freezer plates 2a-2q, whereby the product is in contact with the freezer plates on two sides, i.e. on the upper and the lower surfaces of the product. Thereby a quick and even freezing process is obtained. In addition, the expansion of the frozen products is controlled, because of the slight pressure added to the stack of plates ensures frozen blocks of product, which are homogenous in shape. Thus, such blocks are easily stacked after freezing. When the products are packaged prior to freezing, there is less risk that the frozen product alters the shape of the package, when the stack of plates is squeezed slightly.

[0046] An opening station is provided at each end of the stack of freezer plates 2. The plate freezer comprises horizontally movable opening stations 7 which travel upwards/downwards at each of the ends of the stack of freezer plates 2. The opening station 7 comprises two arms (not shown), which are intended for moving two adjacent freezer plates 2 away from each other for providing access to the freezer station 3, i.e. the freezer space 3 between the two adjacent freezer plates 2, such as when filling and/or emptying the relevant freezer sta-

tion 3. After emptying, and optionally subsequent filling, of the freezer station 3, the opening station withdraws the arms and travels upwards or downwards to the next freezer station 3 to be emptied and/or filled etc.

[0047] Figs. 2-5 shows a plate freezer according to the present invention which provides an alternative way of maintaining the pressure on the product arranged in the freezer stations, and for opening and closing each of the freezer stations. The plate freezer according to the invention also comprises a stack of freezer plates 2a-2n mounted in a frame 4 and a hydraulic ram (not shown in figs. 2-5) similar to the hydraulic ram shown in fig. 1. The large actuator 5 in each corner of the stack of freezer plates 2 is activated to pull the ram downwards for providing a certain pressure on the stack of freezer plates while freezing the products arranged on each freezer plate 2a-2p. The freezer plates 2a-2n are preferably rectangular in shape, although other freezer plates in other shapes may be provided.

[0048] The stack of freezer plates 2a-2n thus comprises a number of freezing stations 3a-3m between two adjacent freezer plates 2a-2n.

[0049] A spacer (not shown) is arranged at each end of each of the freezer plates 2a-2n. The spacer defines the minimum height between two adjacent freezer plates 2. The spacer may be mounted near the end of the upper surface 2' of the freezer plate and/or near the end of the lower surface 2" of the freezer plate 2.

[0050] One or more actuators 9 are arranged at each end of the upper surface 2' of each freezer plate 2a-2m except on the uppermost freezer plate 2n.

[0051] Each actuator 9 is connected to a controller (not shown) in order to be able to move each of the freezer plates 2 in relation to an adjacent freezer plate 2. The controller may be manually controlled, e.g. by input via pushbuttons, or the controller may provide automatic control of the plate freezer 1 and the freezing process. The actuators 9 are preferably connected to a manifold with the necessary number of valves for applying and/or withdrawing hydraulic liquid to and/or from the hydraulic actuators.

[0052] The actuators 9 are preferably hydraulic actuators, in which the overall height of the actuator is adjusted up and/or down by means of varying the position of a piston in the actuator. The hydraulic actuators are preferably single acting actuators, although double-acting actuators may also be used. The piston is arranged in a cylinder and the hydraulic actuators 9 comprise means for supplying/withdrawing a hydraulic liquid, such as an oil to/from the chamber on the first side of the piston in the actuator 9, whereby the overall height of the actuator is adjusted accordingly by lifting or lowering the piston in the actuator 9. If double-acting hydraulic actuators are used, hydraulic actuators 9 also comprise means for supplying/withdrawing a hydraulic liquid, such as an oil to/from the chamber on the second side of the piston in the actuator 9, depending on whether the actuators need to increase or decrease the overall height. (These means

are similar to conventional hydraulic actuators). Thereby the distance between two adjacent freezer plates 2 may be changed or adjusted, and the actuator can act as an adjustable spacer between two adjacent freezer plates 2.

[0053] The actuators 9 are preferably hydraulic actuators because they can operate at the temperatures at which the freezer operates, and because they are easily controlled. For example, hydraulic actuators can be locked in a certain position, simply by blocking the flow of hydraulic liquid to and from at least that side of the piston which lifts the piston in the actuator 9 and thus results in the overall minimum height of the actuators 9 being adjustable between the minimum and maximum position of the actuators 9. In addition, hydraulic actuators are preferred because they require less additional equipment, such as sensors for determining the state of freezing, e.g. the temperature of the product or the distance between two adjacent freezer plates 2a-2n in a certain freezing station 3a-3m in the freezer stack.

[0054] As shown in fig. 3, four actuators 9 are mounted on the first surface 2', i.e. the upper surface 2', of each freezer plate 2a-2m in the stack, one in each corner region of the freezer plate 2.

[0055] The plate freezer is preferably operated as indicated below.

[0056] Fig. 4 shows an empty plate freezer 1 in which the distance between two adjacent plates correspond to the height h of the actuators in their relaxed position.

[0057] When the plate freezer 1 is loaded and or unloaded with product, a freezer station, e.g. 3g, is opened (see fig. 5) by activating the actuators 9 arranged on the first/upper surface 2' of the lowermost freezer plate 2g in the relevant freezer station 3g, which lifts the freezer plate 2h and the entire stack of freezer plates 2i-2n above. The plate 2g is lifted by a certain distance, d, which is sufficient for emptying and/or placing product on top surface 2' of the freezer plate 2g. The distance d needed for filling or emptying a freezer station 3a-3m in the plate freezer stack is e.g. 15-75 mm or preferably 20-50 mm, or more preferred 25-40 mm. Then the upper plate 2h in the freezing station 3g is lowered by relaxing the pressure in each of the actuators 9, preferably the distance d, by reducing the pressure in each of the actuators 9 on the freezer plate 2g, whereby the lower surface 2" of the freezer plate 2h comes into contact with the upper surface of product on the first freezer plate 2g and slightly presses the product between the adjacent freezer plates 2g, 2h. This ensures optimal thermal contact between the product and the freezer plates 2g, 2h and thereby reduces the overall time necessary for freezing the product.

[0058] Then the filling step may be repeated for one or more other freezing station 3a-3m in the stack by activating the actuators 9 arranged between the two relevant freezer plates 2 between which the product is to be placed.

[0059] When all freezer stations 3a-3m are filled, the large actuator 5 in each corner of the stack of freezer plates 2 is activated to pull the ram downwards for pro-

viding a certain pressure on the stack of freezer plates while freezing the products arranged on each freezer plate 2a-2p.

[0060] During freezing, the product expands. Therefore, the position of the freezer plates 2a-2n, e. are adjusted slightly in relation to their adjacent freezer plates 2, preferably by a distance Δ corresponding to the expansion of the product during freezing. Thus the actuators 9 serve as adjustable spacers between the freezer plates 2a-2n.

[0061] The relative position between the two adjacent freezer plates 2g, 2h is adjusted by applying a minor pressure increase in the actuators 9 on plate 2g, whereby the height of the freezer station 3g between the plates 2g, 2h is increased slightly by Δ . Thus a predefined height is obtained when the actuators 9 are locked, e.g. when the second end of the actuators touches the second/lower surface 2" of the adjacent upper freezer plate 2, e.g. if the product is already expanding during freezing.

[0062] Then, the position of the actuators 9 is locked by blocking the flow of hydraulic liquid to and from the piston chamber(s) whereby the minimum height of the actuators 9 are locked. If necessary, the pressure on the large actuator 5 in each corner of the stack of freezer plates 2, which provides the ram 8 pressure on the stack of plates, is decreased slightly during adjusting of the small actuators 9 on the freezer plates 2, if the adjustment of the actuators 9 results in change of position of the freezer plates 2 in the stack. When the adjustment is completed, the pressure on the large actuators 5 of the hydraulic ram 8 may be reapplied for continued freezing and pressure on the product.

[0063] The adjustment for expansion of the product may be performed simultaneously for all freezer plates 2 in the stack, after all freezer stations 3a-3m have been filled with product if the plate freezer is filled and subsequently emptied in a batchwise manner. Alternatively, if the freezer stations 3 in the plate freezer 1 are filled and subsequently emptied on a continuous basis, this adjustment of distance between two adjacent plates may be also be performed on a continuous basis. Thus adjustment of the height of the actuators is performed for each single freezer station 3a-3m at a certain interval of time after the relevant freezer station 3a-3m has been filled.

[0064] This adjustment of the distance between two subsequent freezer plates with the hydraulic actuators 9 ensures an even pressure on the products in the freezer 1 during the entire freezing process while the hydraulic ram 8 provides and maintains sufficient pressure on the entire stack of the freezer plates, e.g. 2g-2h, so that the product maintains its optimal shape, such as block shape, during freezing, and so that the pressure provided during the freezing process ensures optimal transfer of heat from the product to the cooling medium inside the freezer plates 2 thereby optimizing the freezing process.

[0065] When one of the freezer stations, e.g. 3g, is to be emptied, the pressure on the hydraulic actuators 5 for the ram 8 is relieved, and relevant actuators 9 are acti-

vated and lift the uppermost freezer plate 3h by a distance d as described above, while the remaining freezer stations are kept in their relative position for continuing the freezing process. This ensures continued freezing of the products in all other freezer stations 3a-3f, 3h-3m than the one which is emptied and/or filled. Thereby it is possible to reduce the overall time needed for freezing the products in the entire freezer, because one of the first freezer stations 3a-3m, e.g. 3a, which was previously filled, can be emptied and optionally subsequently refilled while the other freezer stations 3a-3m continue and eventually finish freezing of the products in the relevant freezer station.

[0066] Prior to locking the position of the freezer plates 2a-2n in relation to their adjacent freezer plates, the actuators may be calibrated by calibrating the overall height of each of the actuators mounted on a freezer plate, e.g. 3g, in relation to each other. This levels the position of the freezer plates 2 in horizontal position and ensures uniformly formed blocks of frozen product, when the freezer is used for freezing blocks of product. Further it reduces any bending of the freezer plates 2 to a minimum while they are loaded and thus reduces stress on the freezer plates.

[0067] The freezer plates are shown as rectangular plates, although other shapes, e.g. square, are possible. The shape may thus depend on the space available for installing the freezer.

[0068] The number of freezer plates in a plate freezer according to the invention described in the text above and shown in the figures is only examples. Thus a plate freezer according to the present invention may comprise a higher as well as a lower number of freezer plates.

Claims

1. Plate freezer comprising a stack of freezer plates, each freezer plate having a first and a second surface, surrounding a hollow interior through which a coolant may be circulated, which freezer plates are movably mounted in a frame, wherein each freezer plate comprises at least a first and a second hydraulic actuator mounted in both ends of the freezer plate, said hydraulic actuators being mounted on the first surface of the freezer plate in a first end of the hydraulic actuator and a second end of the hydraulic actuator is in contact with or connected to the second surface of an adjacent freezer plate, such that an adjustable freezing space is defined between two adjacent freezer plates, and where said actuators are connected to a source of hydraulic fluid, controlled by a control unit.
2. Plate freezer according to claim 1, wherein the actuators are mounted in or near each corner of each of the freezer plates.

3. Plate freezer according to any of the claims 1-2, wherein a spacer is mounted in each end of the upper and/or lower surface of the freezer plates.
4. Plate freezer according to any of the claims 1-3, wherein the freezer plates are mounted horizontally. 5
5. Method for operating a plate freezer comprising a stack of freezer plates, which freezer plates are movably mounted in a frame, wherein each freezer plate comprises at least a first and a second hydraulic actuator mounted in each end of the freezer plate, said hydraulic actuators being mounted on the first surface of the freezer plate in a first end of the actuator, and a second end of the actuator is intended for being brought into contact with the second surface of an adjacent freezer plate, which method comprises 10
 - activating the hydraulic actuators mounted on one or more freezer plates in order to open the freezing space between two adjacent freezer plates; 20
 - if necessary emptying or filling said freezing space with material to be frozen; 25
 - operating the hydraulic actuators, thereby moving two adjacent plates in relation to each other by controlling the flow of a hydraulic fluid to and from each of the hydraulic actuators allowing the adjacent freezer plates in one freezing space to come into contact with the material to be frozen; 30
 - maintaining a hydraulic pressure in the hydraulic actuators, which pressure assures that the freezing plates in a first freezing space are in contact with the material to be frozen, and when actuators in an adjacent freezing space are activated, the forces from the actuators in the adjacent freezing space are transferred by means of the pressurized actuators in said first freezing space. 35 40
6. Method according to claim 5 wherein after initiation of the freezing process, the height of the actuators mounted between two adjacent freezing plates is adjusted slightly by a distance Δ , such as 0.5-10 mm, or preferably 0.5-5 mm, for compensating for the expansion of the product during freezing. 45
7. Method according to claim 5 or 6 wherein blocking the flow of hydraulic fluid to and from all actuators between two adjacent freezer plates locks said actuators and thus defines a minimum distance between two adjacent freezer plates during the freezing process. 50 55
8. Method according to any of the claims 5-7, further comprising calibrating the overall height of each of

the actuators mounted on a freezing plate in relation to the other actuators prior to locking the position of the freezer plate in relation to the adjacent freezer plate.

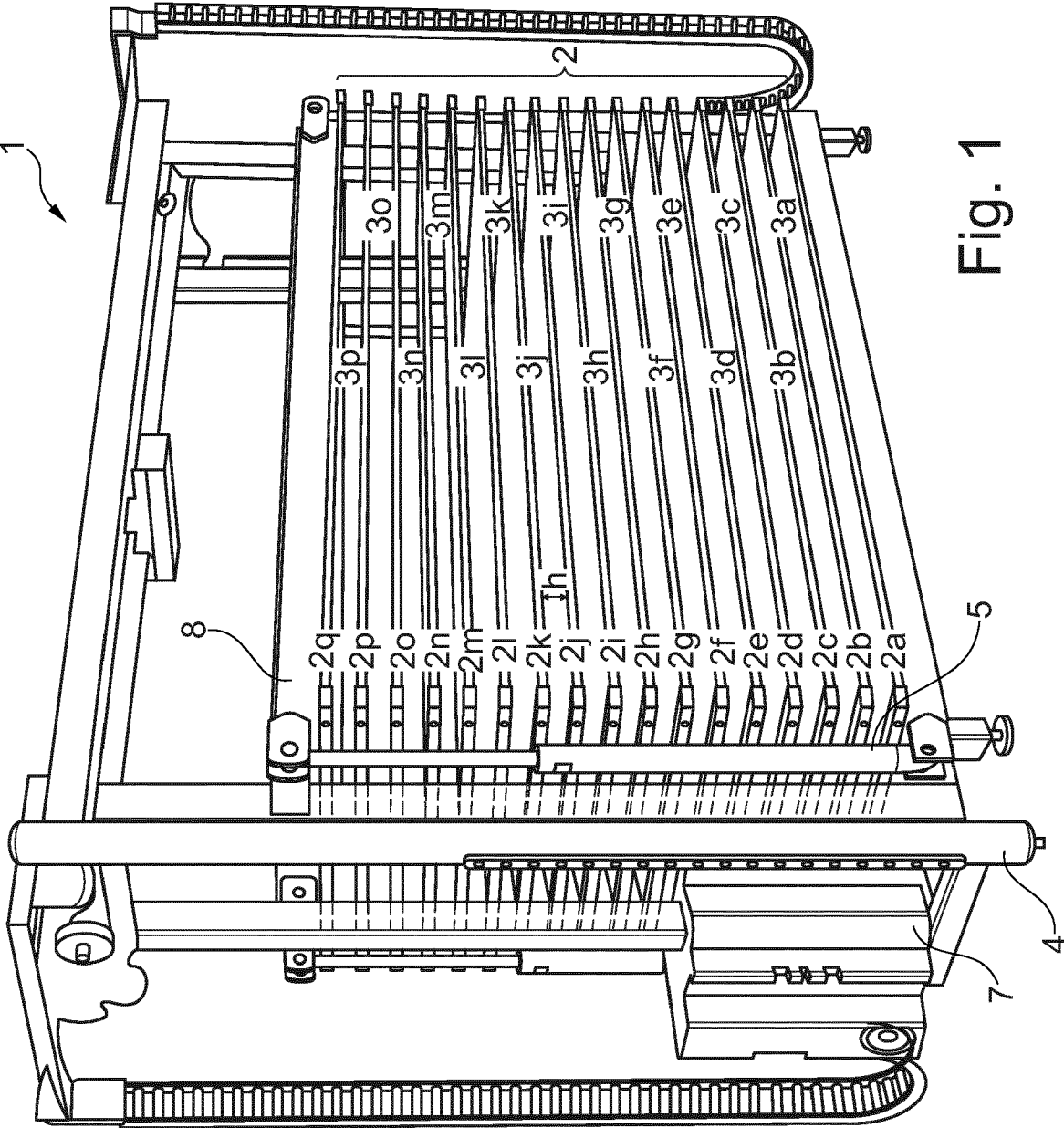


Fig. 1

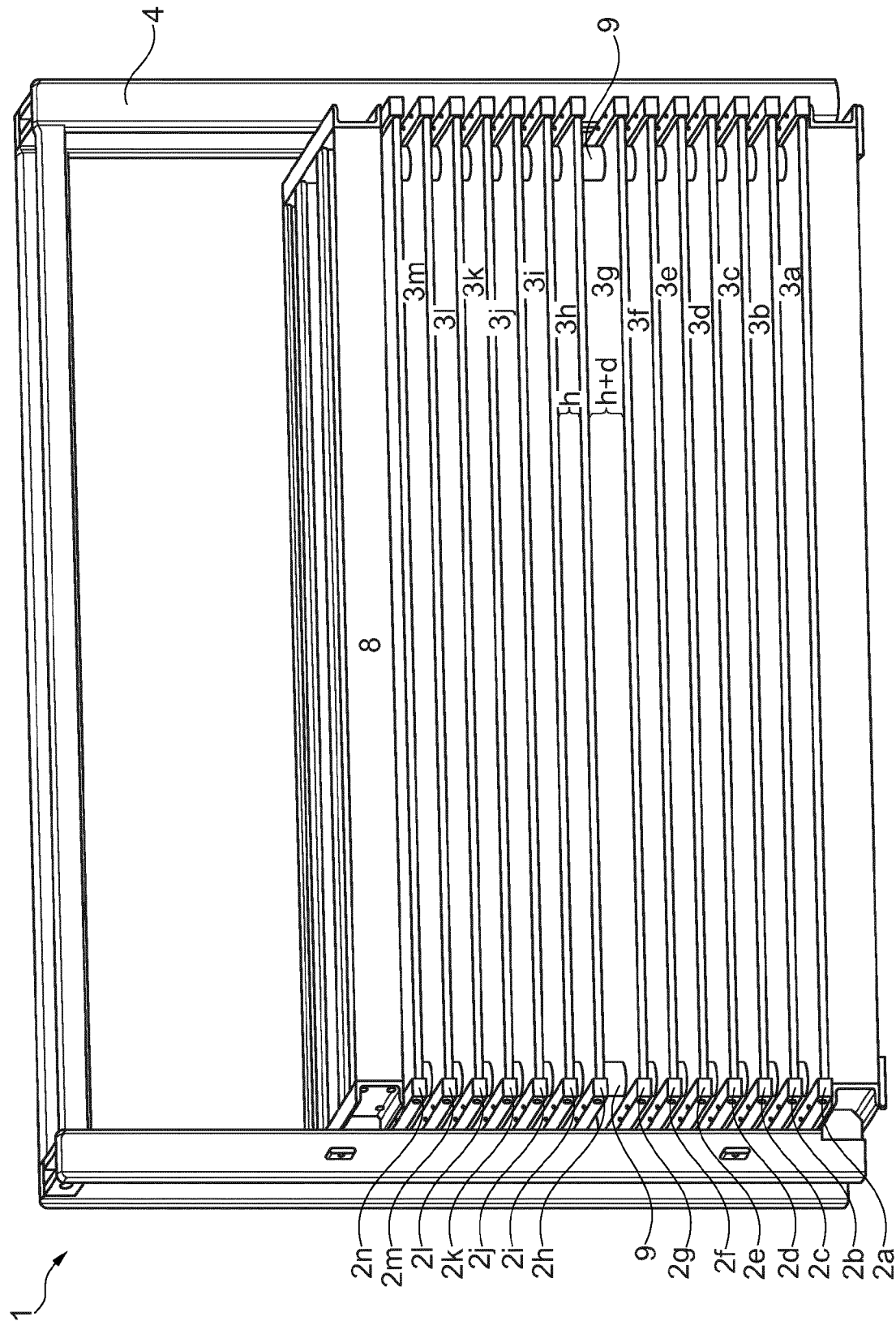


Fig. 2

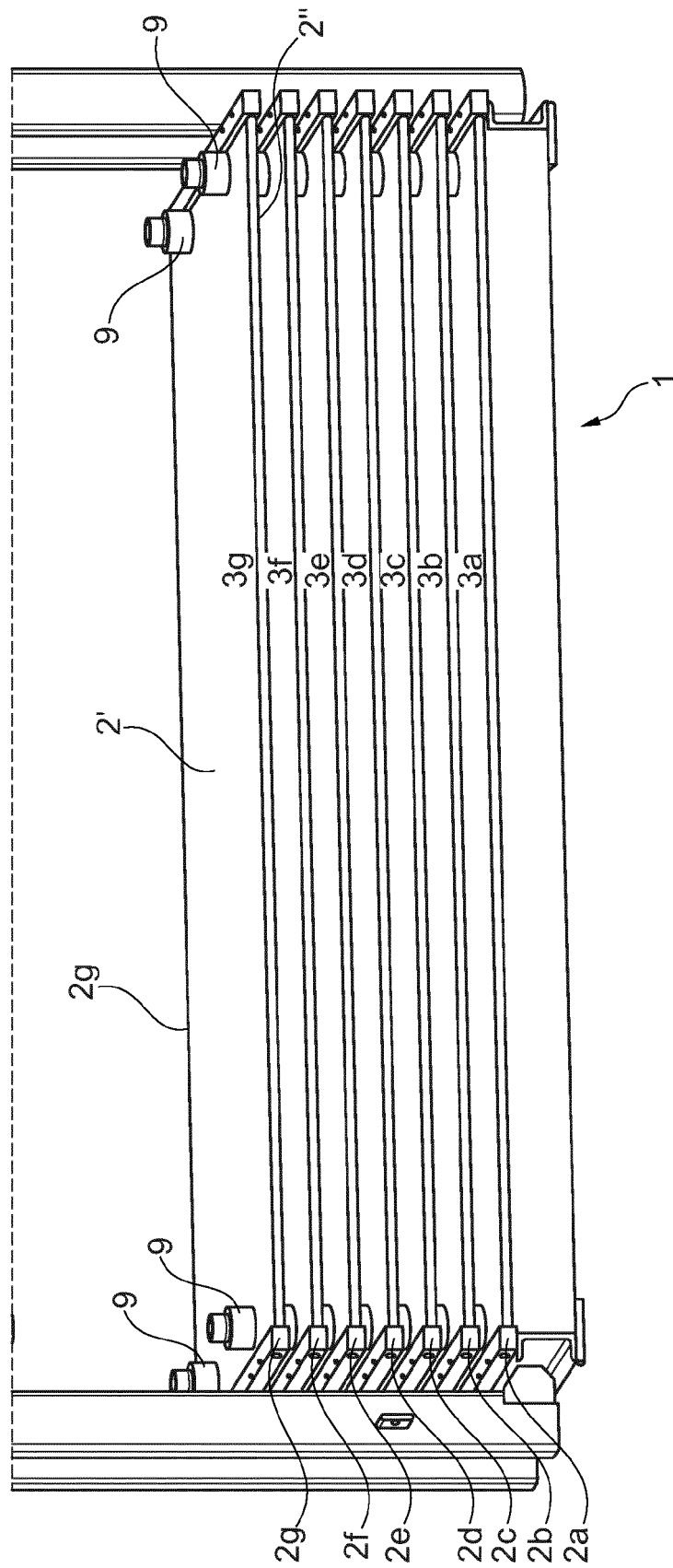


Fig. 3

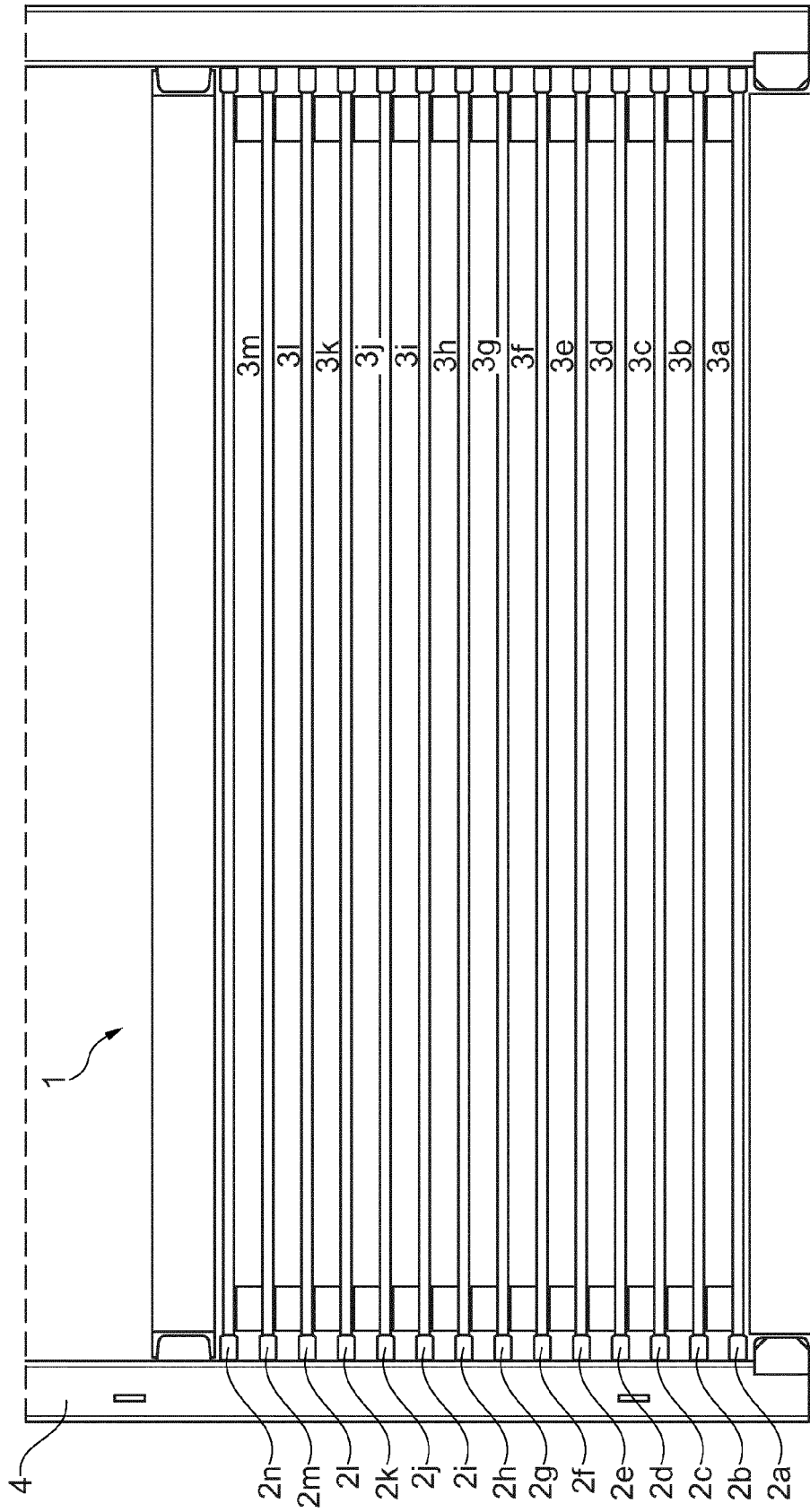


Fig. 4

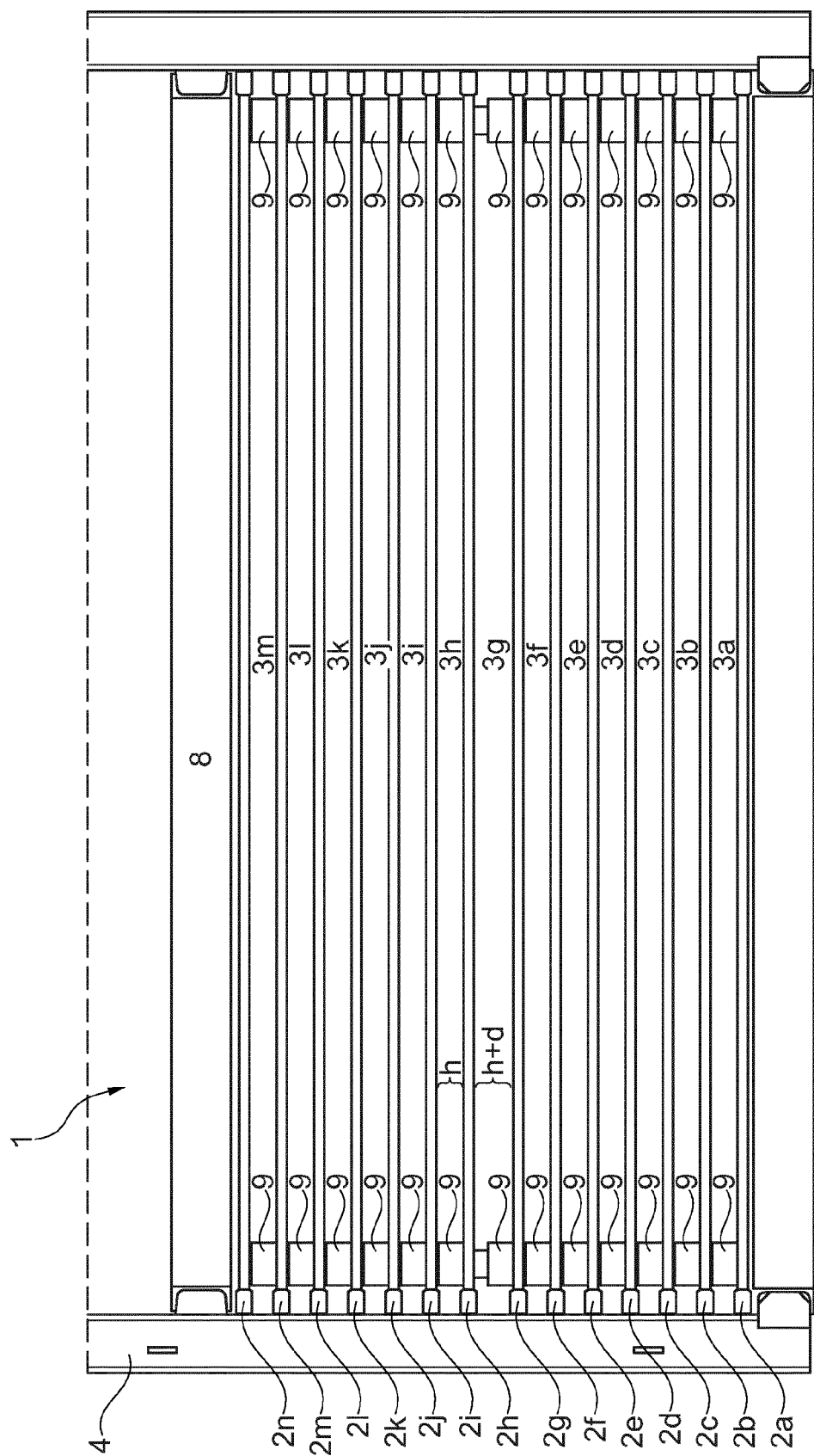


Fig. 5



EUROPEAN SEARCH REPORT

Application Number
EP 15 15 3146

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y	US 4 558 572 A (AOKI SHIGETADA [JP] ET AL) 17 December 1985 (1985-12-17) * the whole document *	1-5,7 6,8	INV. F25D31/00
A	-----		
Y	DE 43 24 192 A1 (KUEHLAUTOMAT BERLIN GMBH KAB [DE]) 19 January 1995 (1995-01-19) * figures 1,2 *	1-5,7	
A	-----		
A	GB 2 120 766 A (JACKSTONE FROSTER LTD) 7 December 1983 (1983-12-07) * the whole document *	1,5	
A	-----		TECHNICAL FIELDS SEARCHED (IPC) F25D
A	DE 44 11 484 A1 (KUEHLAUTOMAT BERLIN GMBH KAB [DE]) 5 October 1995 (1995-10-05) * the whole document *	1,5	
A	-----		
A	DE 44 12 465 A1 (KUEHLAUTOMAT BERLIN GMBH KAB [DE]) 12 October 1995 (1995-10-12) * the whole document *	1,5	
A	-----		
A	US 4 180 987 A (MCLAUGHLIN THOMAS P [US]) 1 January 1980 (1980-01-01) * the whole document *	1	
A	-----		
A	GB 2 186 674 A (APV HALL LIMITED APV HALL LIMITED [GB]) 19 August 1987 (1987-08-19) * the whole document *	1	

The present search report has been drawn up for all claims			

1

EPO FORM 1503 03.82 (P04C01)

Place of search

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Date of completion of the search

18 June 2015

Examiner

de Graaf, Jan Douwe

CATEGORY OF CITED DOCUMENTS

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ON EUROPEAN PATENT APPLICATION NO.**

EP 15 15 3146

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18-06-2015

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 4558572 A	17-12-1985	DK 219584 A	05-11-1984
		JP H0345309 B2	10-07-1991
		JP S59202378 A	16-11-1984
		NO 841775 A	05-11-1984
		SE 457910 B	06-02-1989
		US 4558572 A	17-12-1985
DE 4324192 A1	19-01-1995	NONE	
GB 2120766 A	07-12-1983	NONE	
DE 4411484 A1	05-10-1995	NONE	
DE 4412465 A1	12-10-1995	NONE	
US 4180987 A	01-01-1980	DE 2838170 A1	15-03-1979
		DE 7826004 U1	14-12-1978
		GB 1581973 A	31-12-1980
		JP S5447146 A	13-04-1979
		JP S5810666 B2	26-02-1983
		US 4180987 A	01-01-1980
GB 2186674 A	19-08-1987	NONE	

EPO FORM P4459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- DE 4324192 [0011]
- GB 395962 A [0012]