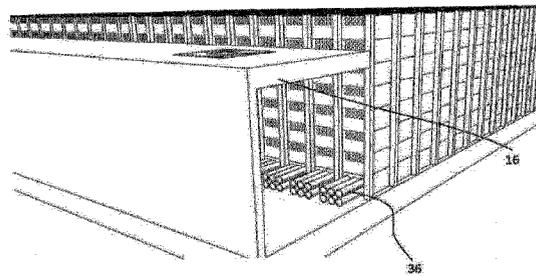




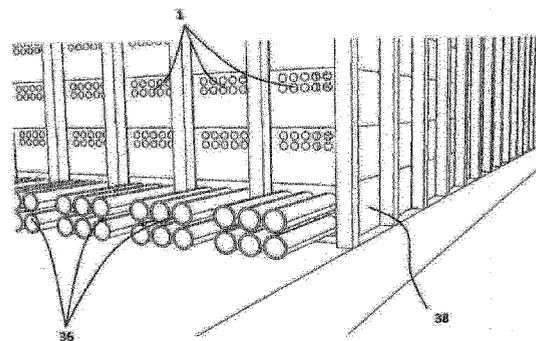
(86) **Date de dépôt PCT/PCT Filing Date:** 2016/06/03
 (87) **Date publication PCT/PCT Publication Date:** 2016/12/08
 (45) **Date de délivrance/Issue Date:** 2023/10/24
 (85) **Entrée phase nationale/National Entry:** 2017/12/01
 (86) **N° demande PCT/PCT Application No.:** EP 2016/062632
 (87) **N° publication PCT/PCT Publication No.:** 2016/193419
 (30) **Priorités/Priorities:** 2015/06/03 (GB1509661.3);
 2016/03/10 (GB1604096.6)

(51) **Cl.Int./Int.Cl. B65G 1/04** (2006.01),
F25D 13/00 (2006.01), **F25D 17/04** (2006.01),
F25D 17/08 (2006.01)
 (72) **Inventeurs/Inventors:**
 LINDBO, LARS SVERKER TURE, GB;
 FRYER, MARK, GB;
 BATES, MARTYN LEE, GB;
 FAUX, KEVIN, GB;
 STEINER, TIMOTHY DEIGHTON, GB;
 SHAIKH, SIDDIQUE, GB
 (73) **Propriétaire/Owner:**
 OCADO INNOVATION LIMITED, GB
 (74) **Agent:** NORTON ROSE FULBRIGHT CANADA
 LLP/S.E.N.C.R.L., S.R.L.

(54) **Titre : SYSTEME D'EMMAGASINAGE A TEMPERATURE CONTROLEE**
 (54) **Title: TEMPERATURE CONTROLLED STORAGE SYSTEM**



a



b

(57) **Abrégé/Abstract:**

The present invention relates to stacked, grid storage systems especially densely packed storage systems and methods of adjusting, regulating, controlling and maintaining the temperature of said storage systems.

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property
Organization
International Bureau(10) International Publication Number
WO 2016/193419 A1(43) International Publication Date
8 December 2016 (08.12.2016)

(51) International Patent Classification:

B65G 1/04 (2006.01) **F25D 13/06** (2006.01)
B65D 81/26 (2006.01)

(21) International Application Number:

PCT/EP2016/062632

(22) International Filing Date:

3 June 2016 (03.06.2016)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

1509661.3 3 June 2015 (03.06.2015) GB
1604096.6 10 March 2016 (10.03.2016) GB(71) Applicant: **OCADO INNOVATION LIMITED**
[GB/GB]; Ocado Innovation Limited, Titan Court, 3 Bishops Square, Hatfield Business Park, Hatfield, Herts AL10 9NE (GB).(72) Inventors: **LINDBO, Lars, Sverker, Ture**; Ocado Innovation Limited, Titan Court, 3 Bishops Square, Hatfield Business Park, Hatfield, Herts AL10 9NE (GB). **FRYER, Mark**; Ocado Innovation Limited, Titan Court, 3 Bishops Square, Hatfield Business Park, Hatfield, Herts AL10 9NE (GB). **BATES, Martyn, Lee**; Ocado Innovation Limited, Titan Court, 3 Bishops Square, Hatfield Business Park, Hatfield, Herts AL10 9NE (GB). **FAUX, Kevin**; Ocado Innovation Limited, Titan Court, 3 Bishops Square, Hatfield Business Park, Hatfield, Herts AL10 9NE (GB). **STEINER, Timothy, Deighton**; Ocado Innovation Limited, Titan Court, 3 Bishops Square, Hatfield Business Park, Hatfield,Herts AL10 9NE (GB). **SHAIKH, Siddique**; Ocado Innovation Limited, Titan Court, 3 Bishops Square, Hatfield Business Park, Hatfield, Herts AL10 9NE (GB).(74) Agent: **WOJCIK, Lucy**; Suite 31, West Devon Business Park Brook Lane, Tavistock Devon PL19 9DP (GB).

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— with international search report (Art. 21(3))

(54) Title: TEMPERATURE CONTROLLED STORAGE SYSTEM

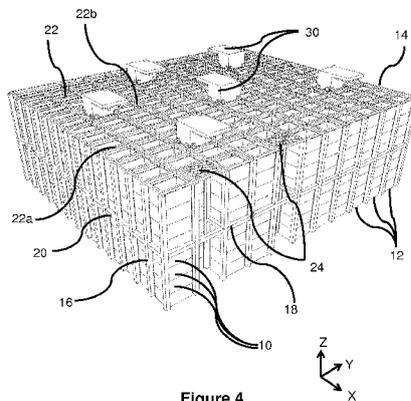


Figure 4

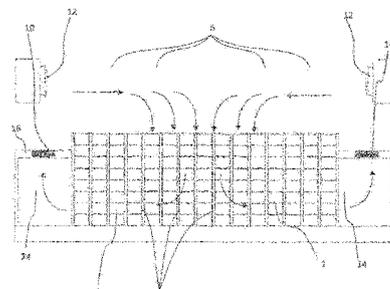


Figure 6a

(57) Abstract: The present invention relates to stacked, grid storage systems especially densely packed storage systems and methods of adjusting, regulating, controlling and maintaining the temperature of said storage systems.

TEMPERATURE CONTROLLED STORAGE SYSTEM

The present invention relates to stacked, grid storage systems especially densely packed storage systems and methods of adjusting, regulating, controlling and maintaining the temperature of said storage systems.

- 5 This application claims priority from UK Patent Application Nos. GB1509661.3 filed on 3rd June 2015 and GB1604096.6 filed on 10th March 2016.

10 Some commercial and industrial activities require systems that enable the storage and retrieval of a large number of different products. One known type of system for the storage and retrieval of items in multiple product lines involves arranging storage bins or containers in stacks on top of one another, the stacks being arranged in rows. The storage bins or containers are accessed from above, removing the need for aisles between the rows and allowing more containers to be stored in a given space.

15 Methods of handling containers stacked in rows have been well known for decades. In some such systems, for example as described in US 2,701,065, to Bertel comprise free-standing stacks of containers arranged in rows in order to reduce the storage volume associated with storing such containers but yet still providing access to a specific container if required. Access to a given container
20 is made possible by providing relatively complicated hoisting mechanisms which can be used to stack and remove given containers from stacks. The cost of such systems are, however, impractical in many situations and they have mainly been commercialised for the storage and handling of large shipping containers.

25 The concept of using freestanding stacks of containers and providing a mechanism to retrieve and store specific containers has been developed further, for example as described in EP 0 767 113 B to Cimcorp. '113 discloses a mechanism for removing a plurality of stacked containers, using a robotic load handler in the form of a rectangular tube which is lowered around the stack of containers, and which is configured to be able to grip a container at any level in
30 the stack. In this way, several containers can be lifted at once from a stack. The

movable tube can be used to move several containers from the top of one stack to the top of another stack, or to move containers from a stack to an external location and vice versa. Such systems can be particularly useful where all of the containers in a single stack contain the same product (known as a single-product stack).

In the system described in '113, the height of the tube has to be at least as high as the height of the largest stack of containers, so that the highest stack of containers can be extracted in a single operation. Accordingly, when used in an enclosed space such as a warehouse, the maximum height of the stacks is restricted by the need to accommodate the tube of the load handler.

EP 1037828 B1 (Autostore)

describes a system in which stacks of containers are arranged within a frame structure. A system of this type is illustrated schematically in Figures 1 to 4 of the accompanying drawings. Robotic load handling devices can be controllably moved around the stack on a system of tracks on the upper most surface of the stack.

It is a disadvantage of the prior art systems described above that the temperature within densely packed stacks is difficult to accurately regulate.

According to the invention there is provided an object handling system comprising two substantially perpendicular sets of rails forming a grid above a workspace, the workspace comprising a plurality of stacked containers, the handling system further comprising a plurality of robotic load handling devices operating on the grid above the workspace, the load handling devices comprising a body mounted on wheels, a first set of wheels being arranged to engage with at least two rails of the first set of rails, the second set of wheels being arranged to engage with at least two rails of the second set of rails, the first set of wheels being independently moveable and driveable with respect to the second set of wheels such that when in motion only one set of wheels is engaged with the grid at any one time thereby enabling movement of the load handling device along the rails to any point on the grid by driving only the set of wheels engaged with the rails, the system further comprising one or more heater and/or one or more chiller for

generating temperature controlled gas, one or more fan for circulating the temperature controlled gas through the storage system; and a plenum for receiving the temperature controlled gas.

5 In a preferred aspect the plenum has an opening adjacent a side of the grid of storage stacks.

In a preferred aspect in use the storage system generates a reservoir of temperature controlled gas in the storage system.

In a preferred aspect the reservoir of temperature controlled gas forms above the storage stacks.

10 In a preferred aspect the temperature controlled gas circulates around, under, over or through the storage container stacks.

In a preferred aspect the temperature of the storage system can be varied from -30°C to +30°C.

15 In a preferred aspect the temperature of the storage system can be controlled within a range of $\pm 2.5^{\circ}\text{C}$.

In a preferred aspect the temperature controlled gas is circulated through one or more apertures in the storage containers.

In a preferred aspect temperature controlled fluid is circulated through ducting.

20 In a preferred aspect the ducting runs through the walls and uprights and frame work structure of the grid.

In a preferred aspect the gas is air.

In a preferred aspect the gas is a coolant gas.

In a further aspect the invention relates to a storage container having one or more apertures in one or more sides.

25 In a preferred aspect the storage container further comprises ducting for receiving the temperature controlled fluid.

In this way, the present invention overcomes the problems of the prior art and provides a storage system capable of accurately maintaining and varying the temperature within a stacked grid storage system

5 The invention will now be described with reference to the accompanying diagrammatic drawings in which:

Figure 1: is a schematic perspective view of a frame structure for housing a plurality of stacks of bins in a known storage system;

Figure 2: is a schematic plan view of part of the frame structure of Figure 1;

10 Figures 3a and 3b: are schematic perspective views, from the rear and front respectively, of one form of robotic load handling device for use with the frame structure of Figures 1 and 2, and Figure 3c is a schematic perspective view of the known load handler device in use lifting a bin;

15 Figure 4: is a schematic perspective view of a known storage system comprising a plurality of load handler devices of the type shown in Figures 3a, 3b and 3c installed on the frame structure of Figures 1 and 2, together with a robotic service device;

Figures 5a and 5b: are schematic perspective views of two forms of container which form a major component of the storage system of the present invention;

20 Figure 6a: is a side elevation of one embodiment of the storage system according to the present invention comprising multiple stacks showing the air movement within said storage system.

Figure 6b: is a side elevation of a second embodiment of the storage system according to the present invention comprising multiple stacks and showing the air movement within said storage system.

25 Figure 7a: is a schematic perspective view of the storage system shown in Figure 6a showing the arrangement of the stacks in a grid the chiller units 12 and the fans 10.

Figure 7b: is a schematic perspective view of the storage system shown in Figure 6a showing the plenum.

Figure 8: is a side elevation of an alternative embodiment of the storage system showing the chillers 12 set back from the plenums 14.

- 5 Figure 9: is a side elevation of an alternative embodiment of the storage system showing the fans 10 located on a vertical side of the plenums 14.

Figure 10: is a plan view of the storage system shown in Figure 6a

- Figure 11: is a plan view of an alternative embodiment of the storage system in which the stacks are of different widths showing how the plenum follows the edge
10 of the grid storage system.

Figure 12: is a side elevation of another embodiment of the storage system in which a number of empty rows 24 are located within the grid of stacks.

- Figure 13: is a side elevation of another embodiment of the storage system in which the stacks are raised above the floor showing air being drawn through the
15 system and into the vacant space under the stacks.

Figure 14: a side elevation of another embodiment of the storage system on a mezzanine floor above ground level 32 showing the movement of air through vertical ducting 30 and horizontal ducting 28.

- Figure 15a and 15b: are schematic perspective views of another embodiment of
20 the storage system in which storage containers having additional and larger apertures 34 are used on the bottom level of each stack to allow greater air flow.

Figure 16a, 16b: are schematic perspective views of another embodiment of the storage system in which ducting 36 runs through the storage containers to increase air flow.

- 25 Figures 17a and 17b: are schematic perspective views of another embodiment of the storage system in which tubes 40 are provided in the walls of the grid to assist air circulation between the storage stacks.

As used herein the term plenum is a space or chamber for receiving heated or cooled air.

As shown in Figures 1 and 2, stackable containers, known as bins 10, are stacked on top of one another to form stacks 12. The stacks 12 are arranged in a grid frame structure 14 in a warehousing or manufacturing environment. Figure 1 is a schematic perspective view of the frame structure 14, and Figure 2 is a top-down view showing a single stack 12 of bins 10 arranged within the frame structure 14. Each bin 10 typically holds a plurality of product items (not shown), and the product items within a bin 10 may be identical, or may be of different product types depending on the application.

The frame structure 14 comprises a plurality of upright members 16 that support horizontal members 18, 20. A first set of parallel horizontal members 18 is arranged perpendicularly to a second set of parallel horizontal members 20 to form a plurality of horizontal grid structures supported by the upright members 16. The members 16, 18, 20 are typically manufactured from metal. The bins 10 are stacked between the members 16, 18, 20 of the frame structure 14, so that the frame structure 14 guards against horizontal movement of the stacks 12 of bins 10, and guides vertical movement of the bins 10.

The top level of the frame structure 14 includes rails 22 arranged in a grid pattern across the top of the stacks 12. Referring additionally to Figures 3 and 4, the rails 22 support a plurality of robotic load handling devices 30. A first set 22a of parallel rails 22 guide movement of the load handling devices 30 in a first direction (X) across the top of the frame structure 14, and a second set 22b of parallel rails 22, arranged perpendicular to the first set 22a, guide movement of the load handling devices 30 in a second direction (Y), perpendicular to the first direction. In this way, the rails 22 allow movement of the load handling devices 30 in two dimensions in the X-Y plane, so that a load handling device can be moved into position above any of the stacks 12.

Each load handling device 30 comprises a vehicle 32 which is arranged to travel in the X and Y directions on the rails 22 of the frame structure 14, above the stacks 12. A first set of wheels 34, consisting of a pair of wheels 34 on the front of

the vehicle 32 and a pair of wheels 34 on the back of the vehicle 32, are arranged to engage with two adjacent rails of the first set 22a of rails 22. Similarly, a second set of wheels 36, consisting of a pair of wheels 36 on each side of the vehicle 32, are arranged to engage with two adjacent rails of the second set 22b
5 of rails 22. Each set of wheels 34, 36 can be lifted and lowered, so that either the first set of wheels 34 or the second set of wheels 36 is engaged with the respective set of rails 22a, 22b at any one time.

When the first set of wheels 34 is engaged with the first set of rails 22a and the second set of wheels 36 are lifted clear from the rails 22, the wheels 34 can be
10 driven, by way of a 20 drive mechanism (not shown) housed in the vehicle 32, to move the load handling device 30 in the X direction. To move the load handling device 30 in the Y direction, the first set of wheels 34 are lifted clear of the rails 22, and the second set of wheels 36 are lowered into engagement with the second set of rails 22a. The drive mechanism can then be used to drive the
15 second set of wheels 36 to achieve movement in the Y direction.

In this way, one or more robotic load handling devices 30 can move around the top surface of the stacks 12 on the frame structure 14 under the control of a central picking system (not shown). Each robotic load handling device 30 is provided with means for lifting out one or more bins or containers from the stack
20 to access the required products. In this way, multiple products can be accessed from multiple locations in the grid and stacks at any one time.

It will be noted from the description above and with reference to the drawings, that the portion of the load handling device 30 carried by the wheels covers one grid spacing of the grid system above the stack.

25 Figure 4 shows a typical storage system as described above, the system having a plurality of load handling devices 30 active on the stacks 12.

With reference to Figure 5 the storage system of the present invention comprises a series of storage bins or containers 1 stacked one on top of another to form a storage stack 12.

As shown in Figure 5 each storage container may have one or more aperture 50 in one or more side to allow air to circulate freely through the storage container. This container can vary in shape and size.

5 The apertures are shaped and sized such that they do not undermine the strength or structural integrity of the storage container. Preferably between 5 % and 20 % of the surface area of the side of the storage container should be open in the form of apertures to allow air flow through the container. Apertures may be provided in 2,3,4,5 or 6 sides of the container.

10 As shown in Figure 6a a plurality of stacks are arranged in a grid frame structure 8 to form a high density grid storage system.

One or more chiller units 12 are located above the storage stacks and form a reservoir 6 of cooled air above the storage stacks. As shown by the arrows in Figures 6a and 6b the cooled air moves between, around and through the storage stacks and enters a plenum 14.

15 The plenum 14 comprises a channel of height 20 and width 22. The width 22 of the plenum 14 can vary from 1 m to 4 m. The height of the plenum 20 can vary from the same height as the storage system to 2 m below the top of the storage system.

20 The plenum is sealed on three sides. The plenum has an opening adjacent the storage stacks.

As shown in Figures 7a and 7b the plenum 14 is located along one or more side of the grid of stacks.

One or more fans 10 are located either on the top of the plenum 14 as shown in Figure 6 or on the vertical face of the plenum as shown in Figure 9.

25 The one or more fans 10 helps to circulate the cooled air from the reservoir 6 through around, and between the storage stacks to the plenum 14

As the cooled air circulates through the storage system it adjusts the temperature of the storage stacks and their contents.

The chiller units 12 units can be located either directly above the plenums as shown in Figure 6 or they can be set back as shown in Figure 8. The key requirement is that a reservoir of cooled air 6 is created above the storage system.

- 5 The number, size and location of chiller units will vary depending on the size of the storage system.

The width of the storage system 18 can vary from 15 m to 80 m, however, it will be appreciated that any width of storage system may be envisaged with suitable adjustments to the equipment required.

- 10 The length 21 of the storage system has no upper limit. Multiple plenums, fans, and chillers can be positioned periodically along the entire length of the storage system to achieve the desired level of temperature control.

The height 25 of the system can be up to 7.8 m high.

- 15 The power and number of fans 10 depends on the size of the system with diameter of the fans varying from 0.5 m to 2.5 m.

In an alternative embodiment the chillers 12 may be replaced with heaters which form a reservoir 6 of heated air.

In an alternative embodiment the chiller units may be supplemented by heater units. The reservoir 6 is then one of temperature controlled air.

- 20 In an alternative embodiment the reservoir 6 may be formed under the storage stacks.

In an alternative embodiment a gas other than air e.g. a coolant may be circulated in the storage system to better assist temperature regulation.

- 25 In an alternative embodiment the chillers 12 may be replaced with heaters which form a reservoir of heated air above the storage stacks.

The temperature of the storage system can be controlled within a range of $\pm 2.5^{\circ}\text{C}$.

The temperature within the storage system can be varied from -30°C to $+30^{\circ}\text{C}$.

Referring to Figure 11 which is a plan view of an alternative embodiment of a storage system of the present invention in which the stacks within the grid storage system are of different widths. The plenum follows the edge of the storage system grid even as the width of the grid changes.

The plenum does not need to provide a uniform, continuous straight channel to be effective.

Figure 12 shows an alternative arrangement in which one or more rows 24 are omitted within the grid of stacks. These empty rows 24 allow some of the cold reservoir air to fall through the storage system and thus promote additional air flow through the stacks of containers. The width of empty rows can vary from 0.5 m wide to 2 m wide. Optionally the empty rows can be partially filled with empty or filled storage containers.

Figure 13 shows the system raised above the floor 30. In this embodiment air is circulated around, though between and under the stacks to regulate their temperature.

Figure 14 shows a storage system on a mezzanine floor raised above ground level 32. Air travels from the reservoir though the stacks to vertical 30 and horizontal 28 ducting located in the mezzanine floor. The ducting channels air under the stacks and towards the plenum.

Figure 15 shows the use of storage containers of a different design on the bottom level of each stack. The containers have additional and larger apertures 34 in them to allow greater air flow but still have sufficient strength to be able to support storage containers stacked on top of them.

With reference to Figure 16 in an alternative embodiment the storage containers on the bottom level of one or more stack comprise ducting 36 running through the container to further aid the circulation of temperature controlled gas from reservoir 6 or temperature controlled fluids from elsewhere.

With reference to Figure 17 in an alternative arrangement, tubes 40 are provided in the walls 8 of the grid to further aid the circulation of temperature controlled gas from reservoir 6 or temperature controlled fluids from elsewhere to reduce the temperature variation throughout the storage stacks. The tubes 40 can be used to
5 either draw or force fluids through the storage system.

Moreover, the temperature controlled air may be further directed and circulated through ducting or holes and cavities within the uprights and framework 14 structure of the storage system.

It will be appreciated that the foregoing embodiments are described in terms of a
10 temperature control system for a storage system such as that used as part of an online retail operation. However, it will be appreciated that a similar form of temperature control system may be used in a similar structure of storage system used for other applications. For example, use of such storage systems has been envisaged for a mechanized greenhouse wherein the containers 10 contain
15 plants or other living organisms growing under controlled conditioned. In such systems, control of temperature may be critical but additionally humidity, air flow and other environmental variables may require control. It will be appreciated that use of the temperature controlling system hereinbefore describe may advantageously assist in the control of humidity, air flow and the like.

20 It has been shown that the growth of plants and other living organisms has been greatly affected by air flow across said plants or organisms. Accordingly, the use of a temperature control system based on air flow may be advantageous in such applications.

Many variations and modifications not explicitly described above are also
25 possible without departing from the scope of the invention as defined in the appended claims.

CLAIMS

1. An storage system comprising:

a plurality of upright members;

two substantially perpendicular sets of rails supported by the plurality of upright members and forming a grid above a workspace, the workspace comprising a plurality of stacked containers, each stack of containers in the workspace corresponding to an opening in the grid;

a plurality of robotic load handling devices operating on the grid above the workspace, the load handling devices comprising a body mounted on wheels, a first set of wheels being arranged to engage with at least two rails of the first set of rails, a second set of wheels being arranged to engage with at least two rails of the second set of rails, the first or second set of wheels being independently moveable and driveable with respect to the other of the first or second set of wheels such that when in motion only one set of wheels is engaged with the grid at any one time thereby enabling movement of the load handling device along the rails to any point on the grid by driving only the set of wheels engaged with the rails, the load handling device being configured to access one or more stacked containers through a corresponding opening in the grid,

at least one heater and/or at least one chiller located above the workspace for generating a reservoir of temperature controlled gas above the workspace;

a plenum comprising an opening adjacent a side of the stacked containers for receiving the temperature controlled gas, at least one fan being adapted to circulate temperature controlled gas through the stacked containers to the plenum; and

a plurality of ducts formed as tubes extending between two or more of the plurality of upright members, the tubes being configured to reduce temperature variation throughout the stacks of containers in the workspace by drawing or forcing the temperature controlled gas or temperature controlled fluids through the storage system.

2. A storage system as claimed in claim 1 wherein the temperature controlled gas circulates around, under, over or through the storage container stacks.
3. A storage system as claimed in claim 1 or 2 wherein temperature of the storage system can be varied from -30°C to +30°C.
4. A storage system as claimed in any one of claims 1 to 3 wherein the temperature of the storage system can be controlled within a range of $\pm 2.5^{\circ}\text{C}$.
5. A storage system as claimed in any one of claims 1 to 4 wherein temperature controlled gas is circulated through one or more apertures in the storage containers.
6. A storage system as claimed in any one of claims 1 to 5 wherein the gas is air.
7. A storage system as claimed in any one of claims 1 to 5 wherein the gas is a coolant gas.
8. A storage system according to any one of claims 1 to 7 in which the storage system is used for the growing of plants or other living organisms and the container comprises plants or other living organisms.
9. A storage system according to claim 8 in which the humidity and/or airflow throughout the storage system is controlled via the circulation of temperature controlled air throughout the storage system.
10. A storage system comprising two substantially perpendicular sets of rails forming a grid above a workspace, the workspace being located on a mezzanine floor and comprising a plurality of stacked containers, the storage system further comprising a plurality of robotic load handling devices operating on the grid above the workspace, the load handling devices comprising a body mounted on wheels, a first set of wheels being arranged to engage with at least two rails of the first set of rails, the second set of wheels being arranged to engage with at least two rails of the second set of rails, the first set of wheels being independently moveable and driveable with respect to the second set of wheels such that when in motion only one set of wheels is engaged with the grid at any one time thereby enabling movement of the load handling device along

the rails to any point on the grid by driving only the set of wheels engaged with the rails, the system further comprising one or more heater and/or one or more chiller for generating temperature controlled gas; one or more fan for circulating the temperature controlled gas through the storage system; a plenum for receiving the temperature controlled gas; and, a duct arrangement comprising one or more substantially vertical ducts extending from the workspace through the mezzanine floor and a substantially horizontal duct located beneath the mezzanine floor and connected to the one or more substantially vertical ducts for channelling the temperature controlled gas under the workspace towards the plenum.

11. A storage system as claimed in claim 10 which in use generates a reservoir of temperature controlled gas in the storage system.

12. A storage system as claimed in claim 11 wherein the reservoir of temperature controlled gas forms above the storage stacks.

13. A storage system as claimed in claim 11 or claim 12 wherein the temperature controlled gas circulates around, under, over or through the storage container stacks.

14. A storage system as claimed in any one of claims 10 to 13 wherein the temperature of the storage system can be varied from -300C to +300C.

15. A storage system as claimed in any one of claims 10 to 14 wherein the temperature of the storage system can be controlled within a range of $\pm 2.50\text{C}$.

16. A storage system as claimed in any one of claims 10 to 15 wherein temperature controlled gas is circulated through one or more apertures in the storage containers.

17. A storage system as claimed in any one of claims 10 to 16 wherein the ducting runs through the walls of the grid.

18. A storage system as claimed in any one of claims 10 to 17 wherein the gas is air or a coolant gas.

19. A storage system according to any one of claims 10 to 18 in which the system is used for the growing of plants or other living organisms.

20. A storage system according to any one of claims 10 to 19 in which the humidity and/or airflow throughout the system is controlled via the circulation of temperature controlled air throughout the system.

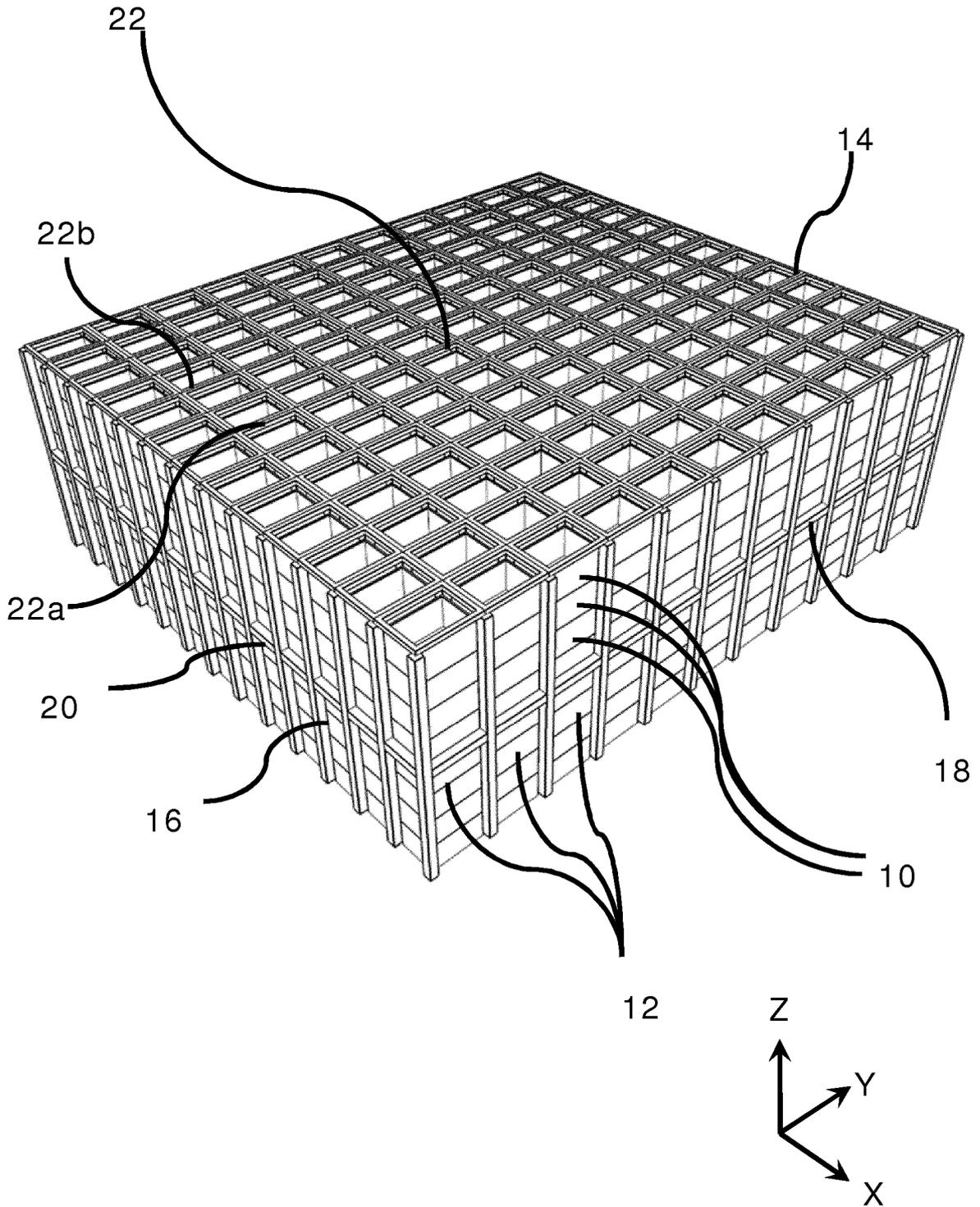


Figure 1

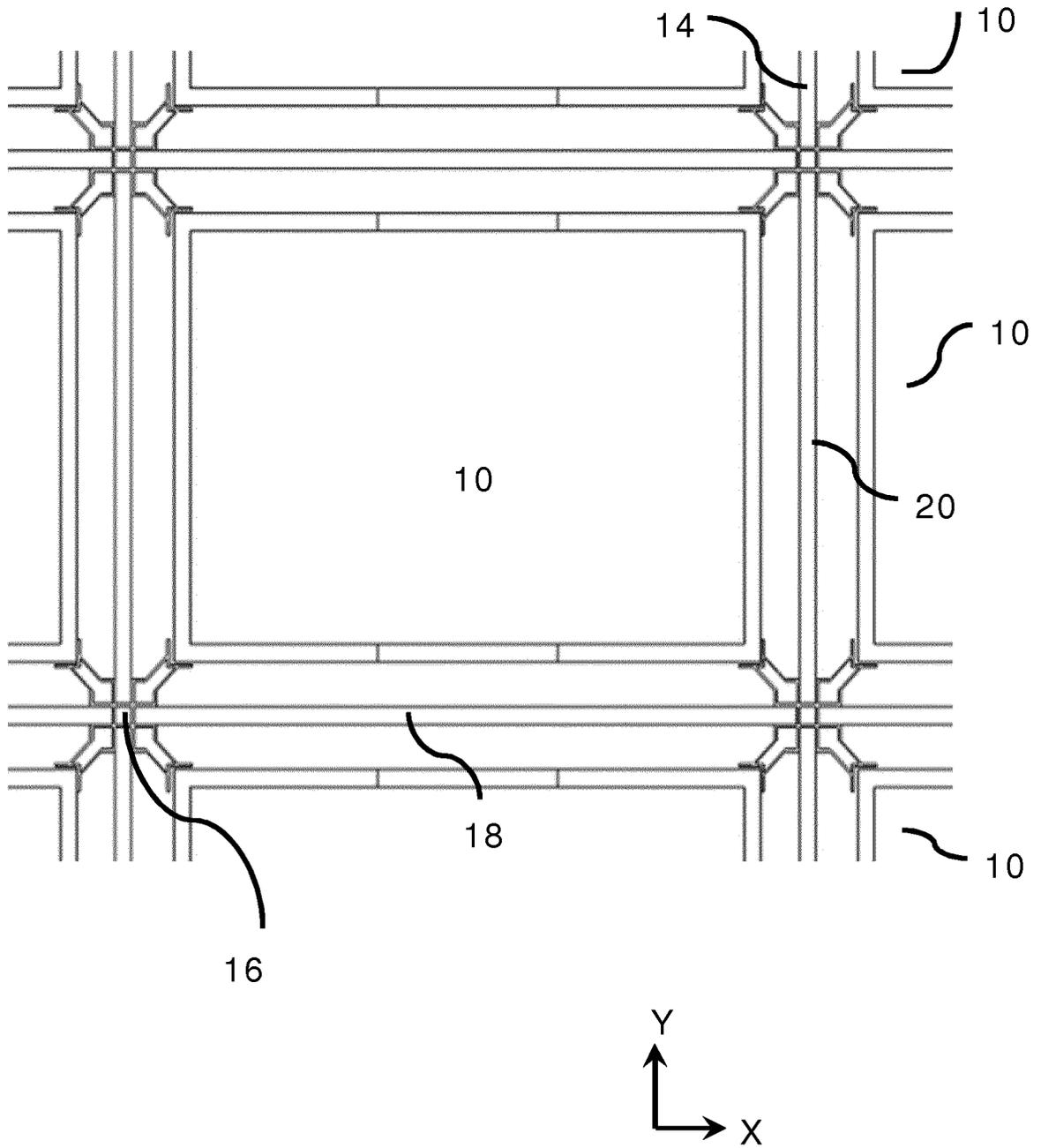


Figure 2

3/15

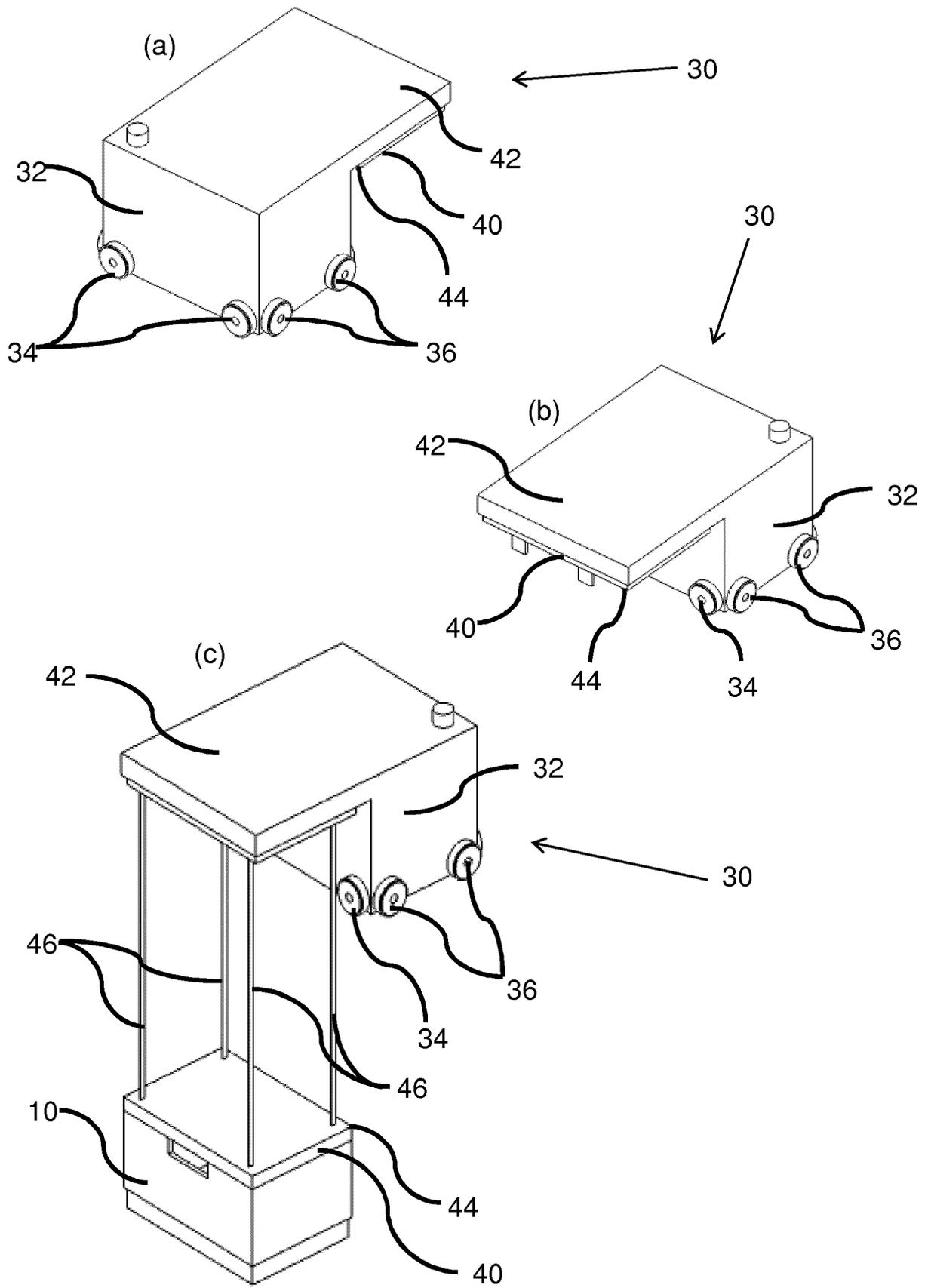


Figure 3

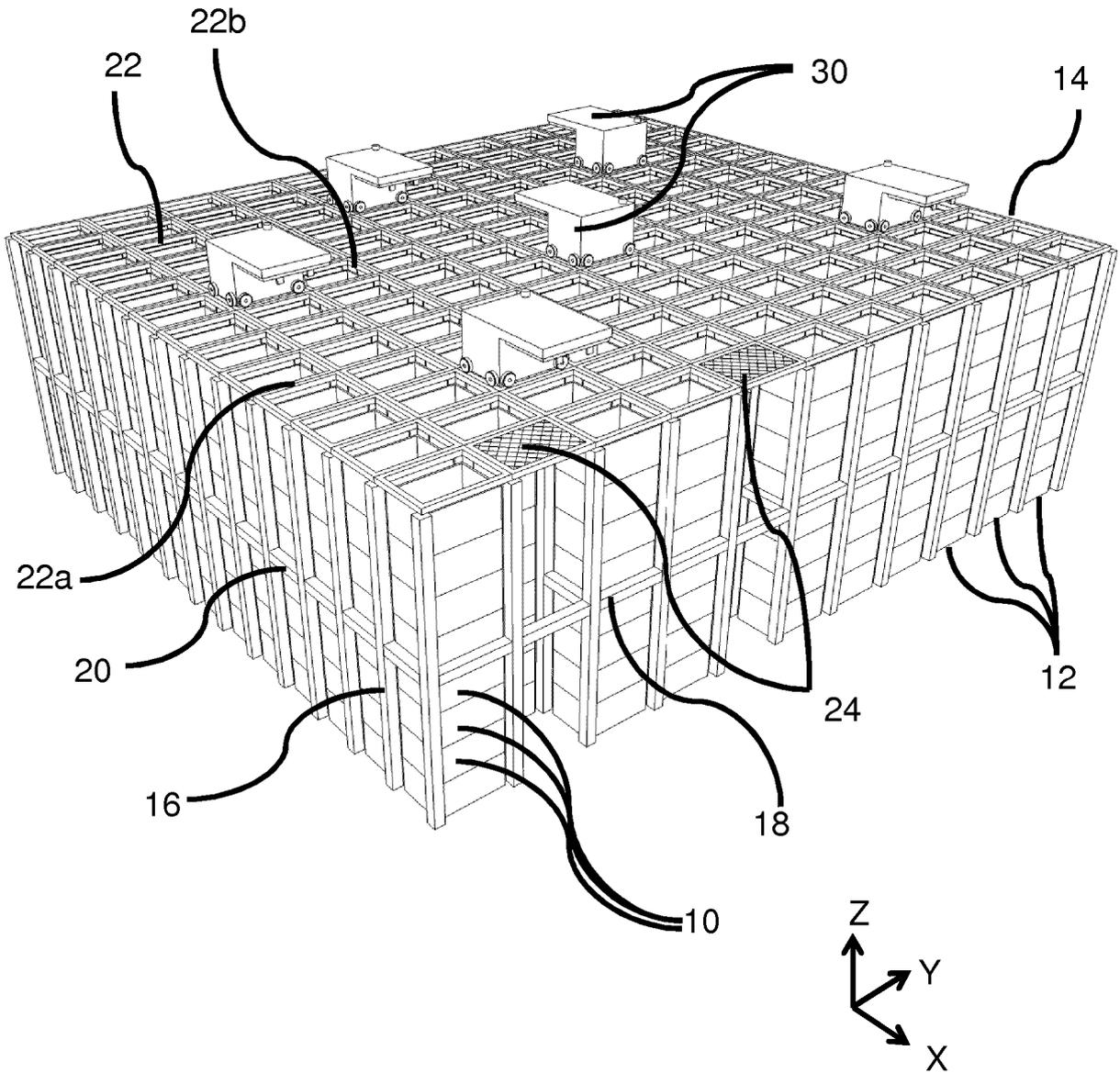


Figure 4

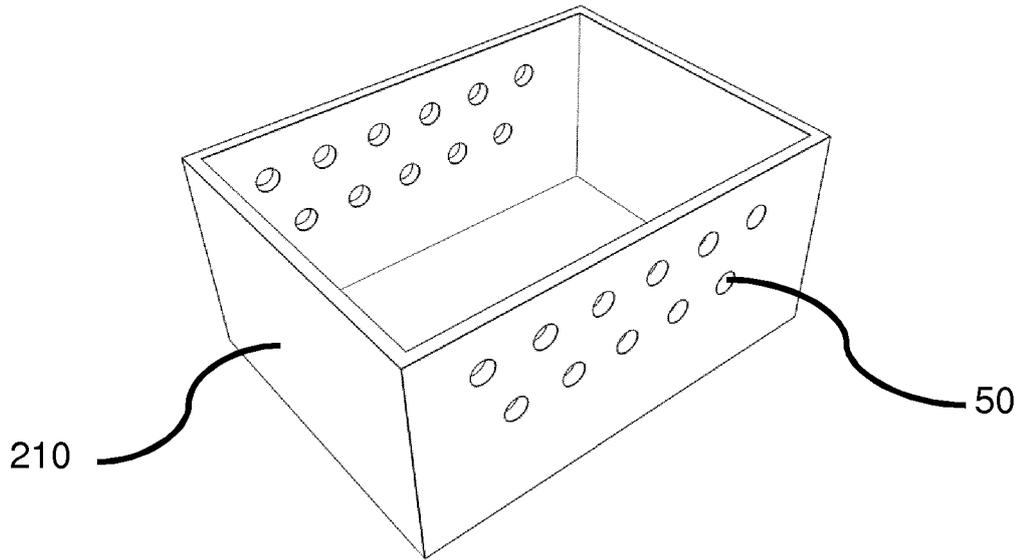


Figure 5a

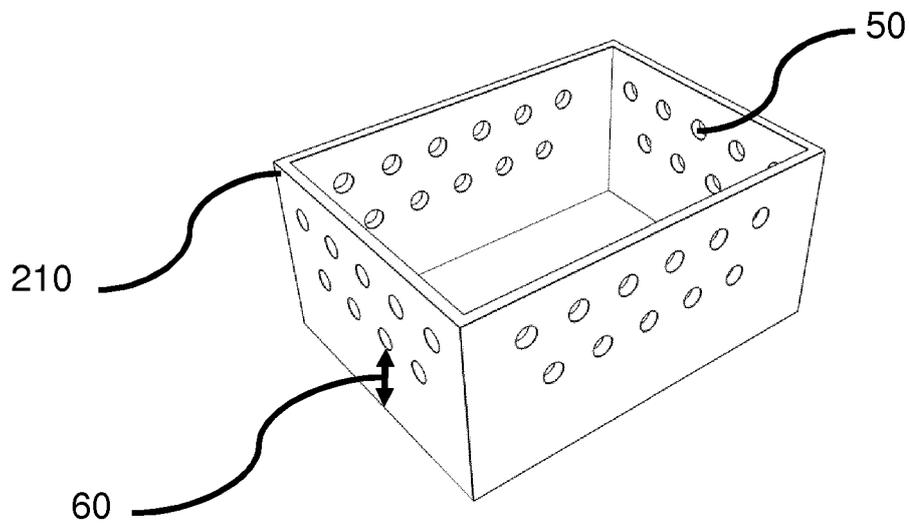


Figure 5b

6/15

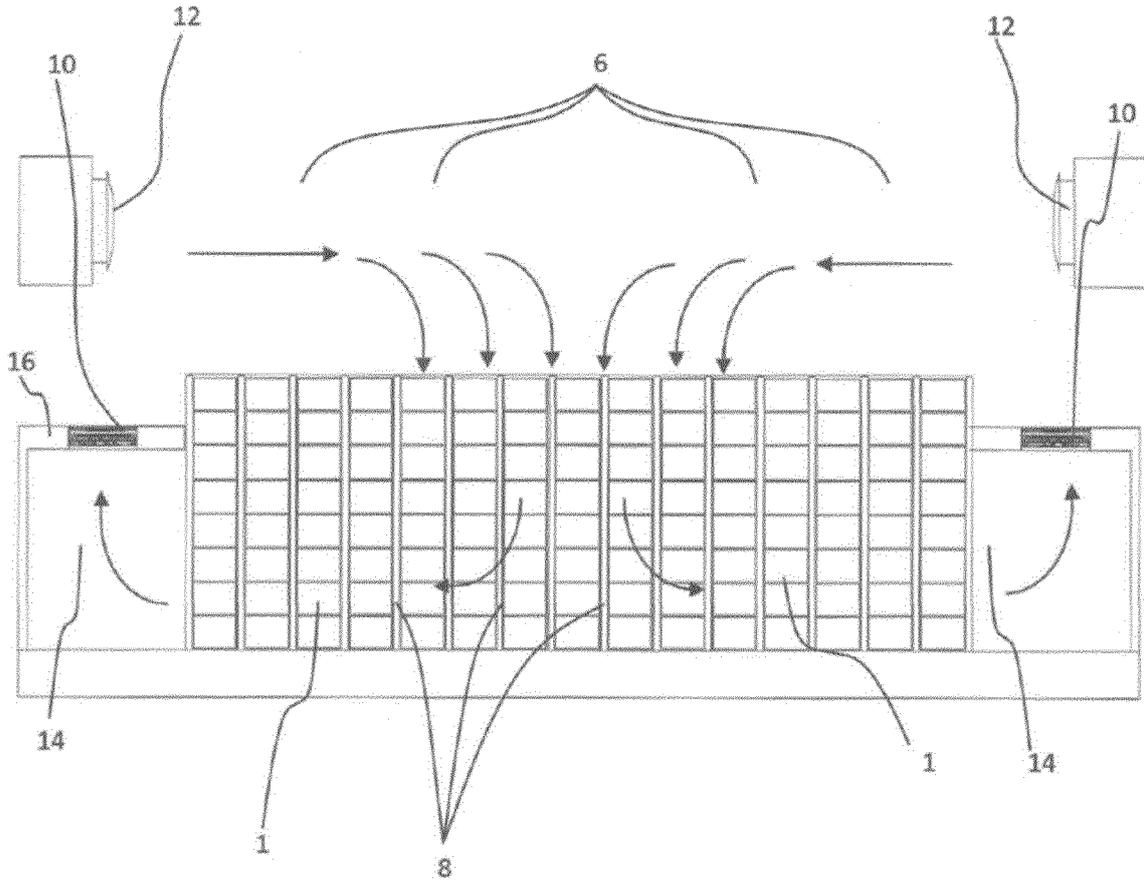


Figure 6a

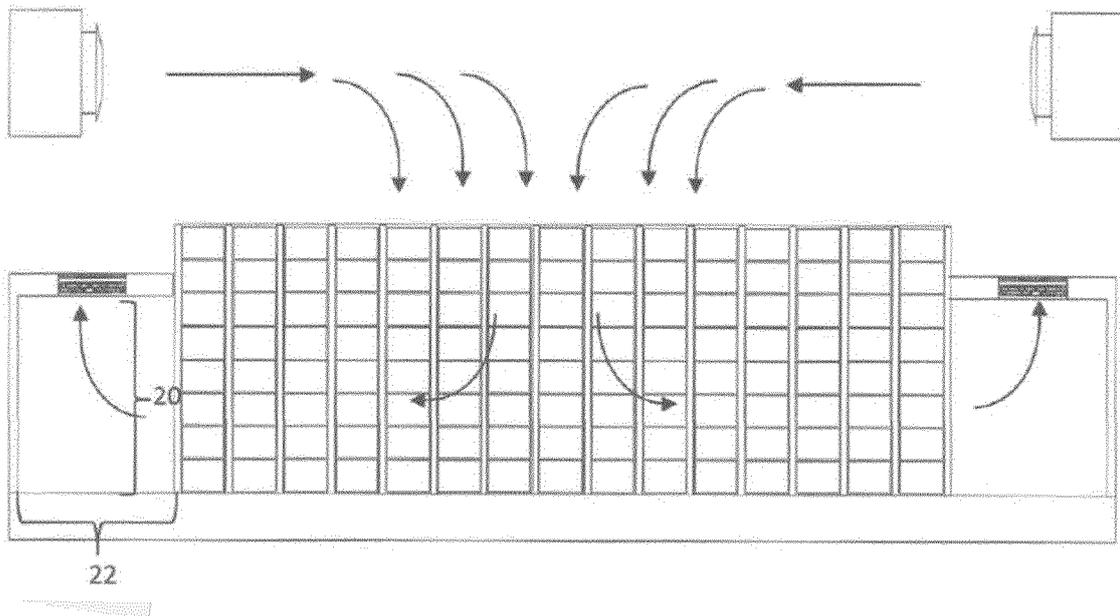


Figure 6b

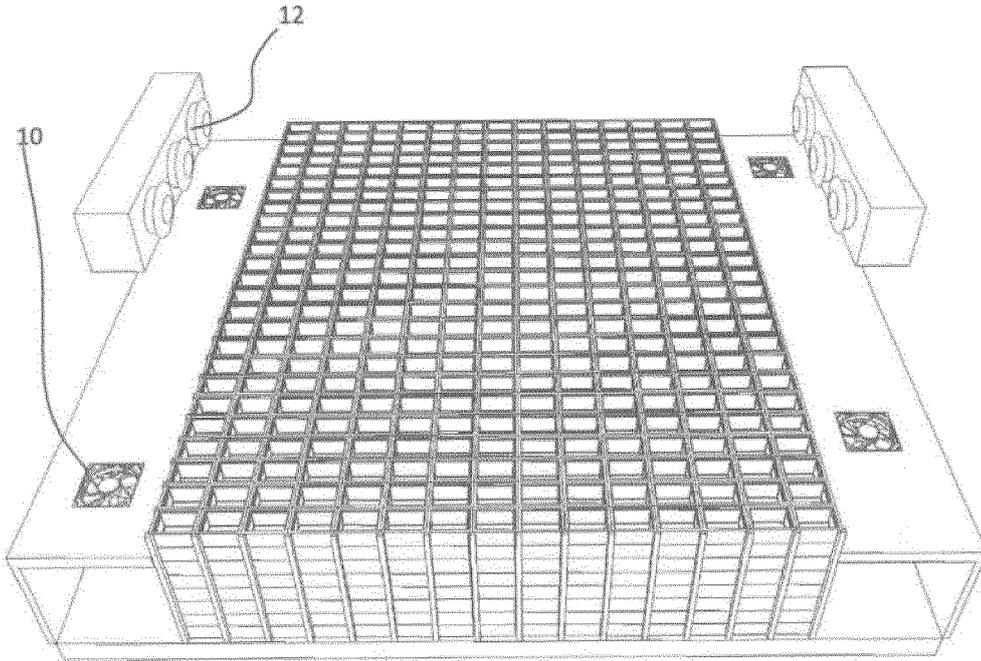


Figure 7a

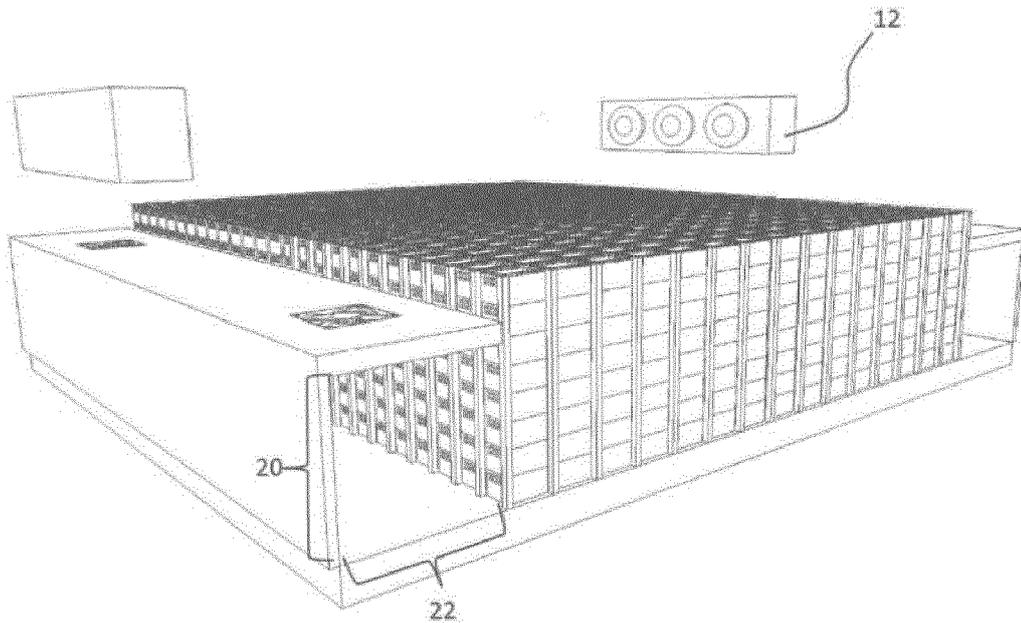


Figure 7b

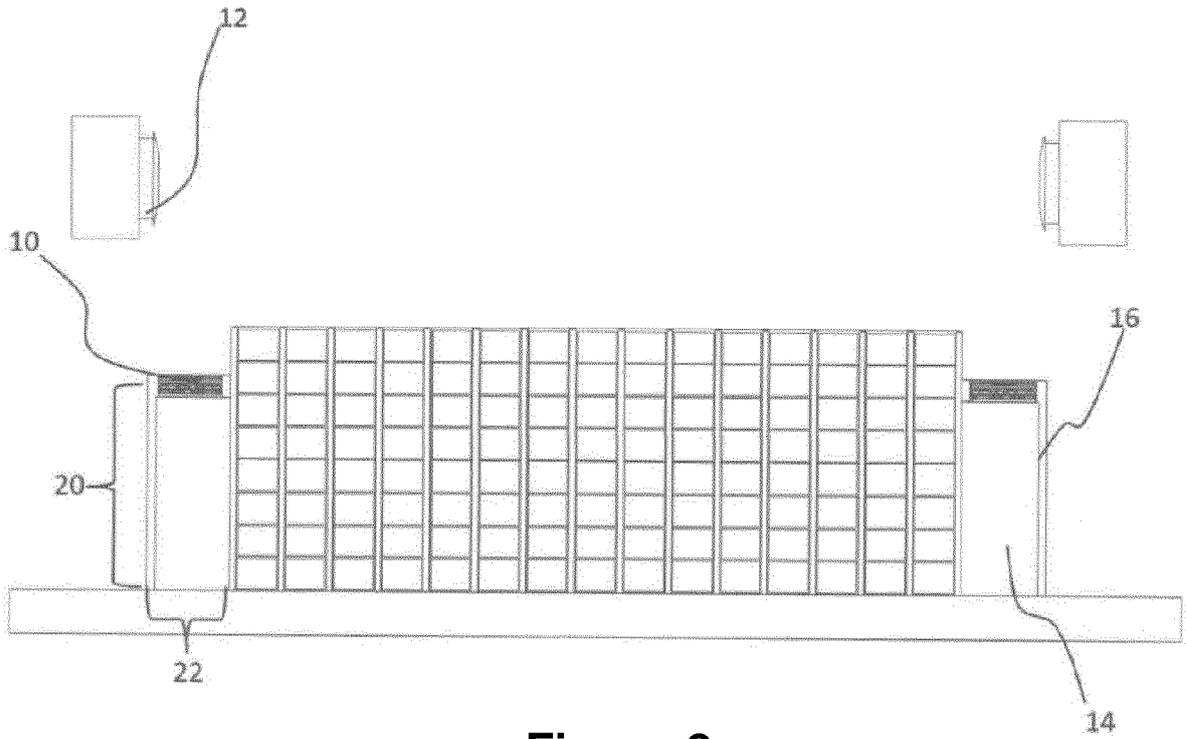


Figure 8

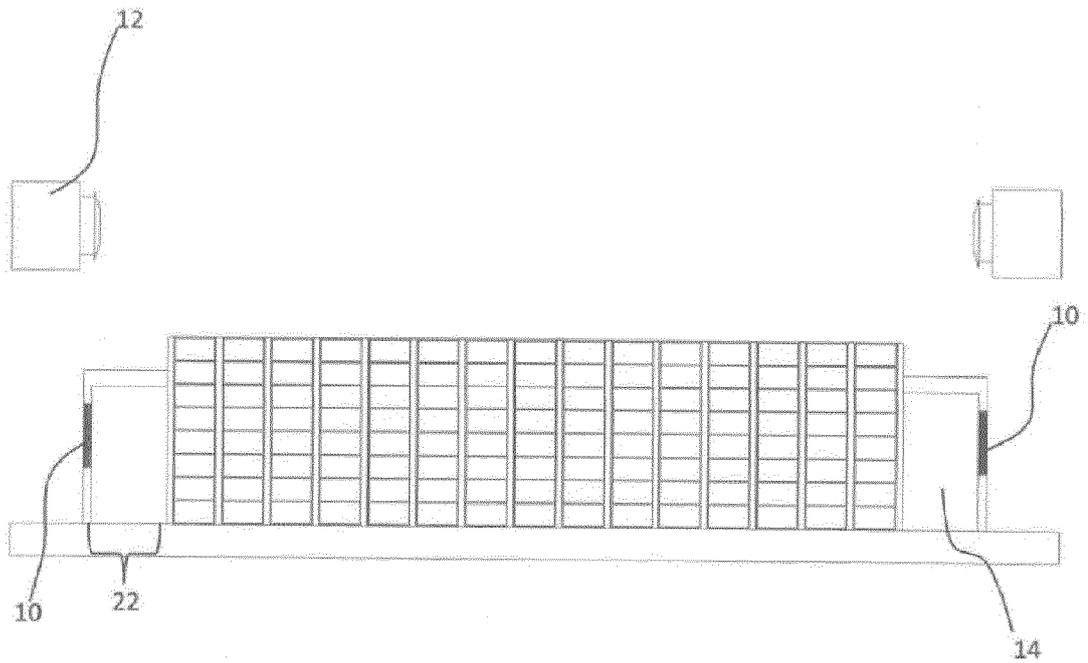


Figure 9

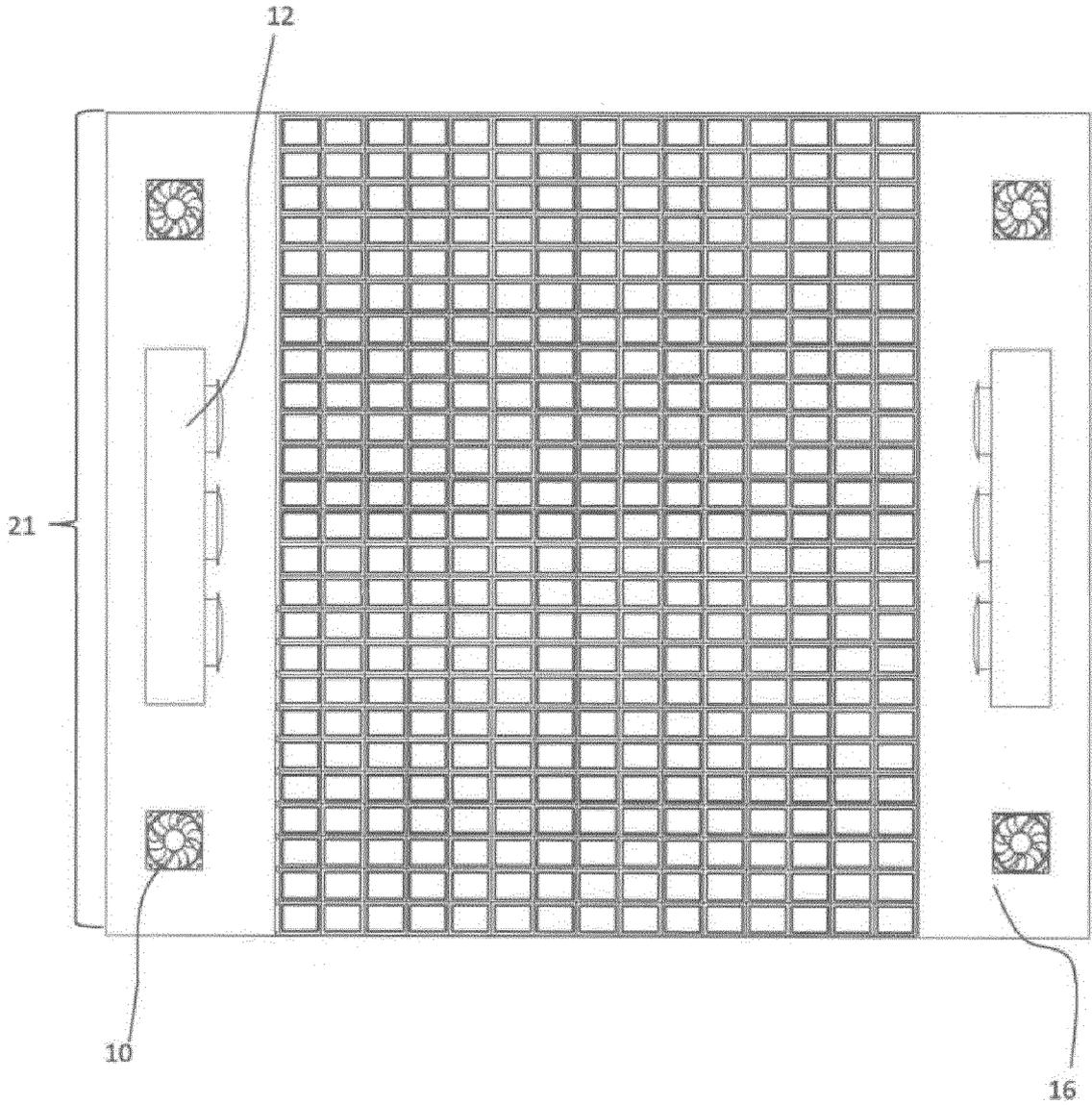


Figure 10

10/15

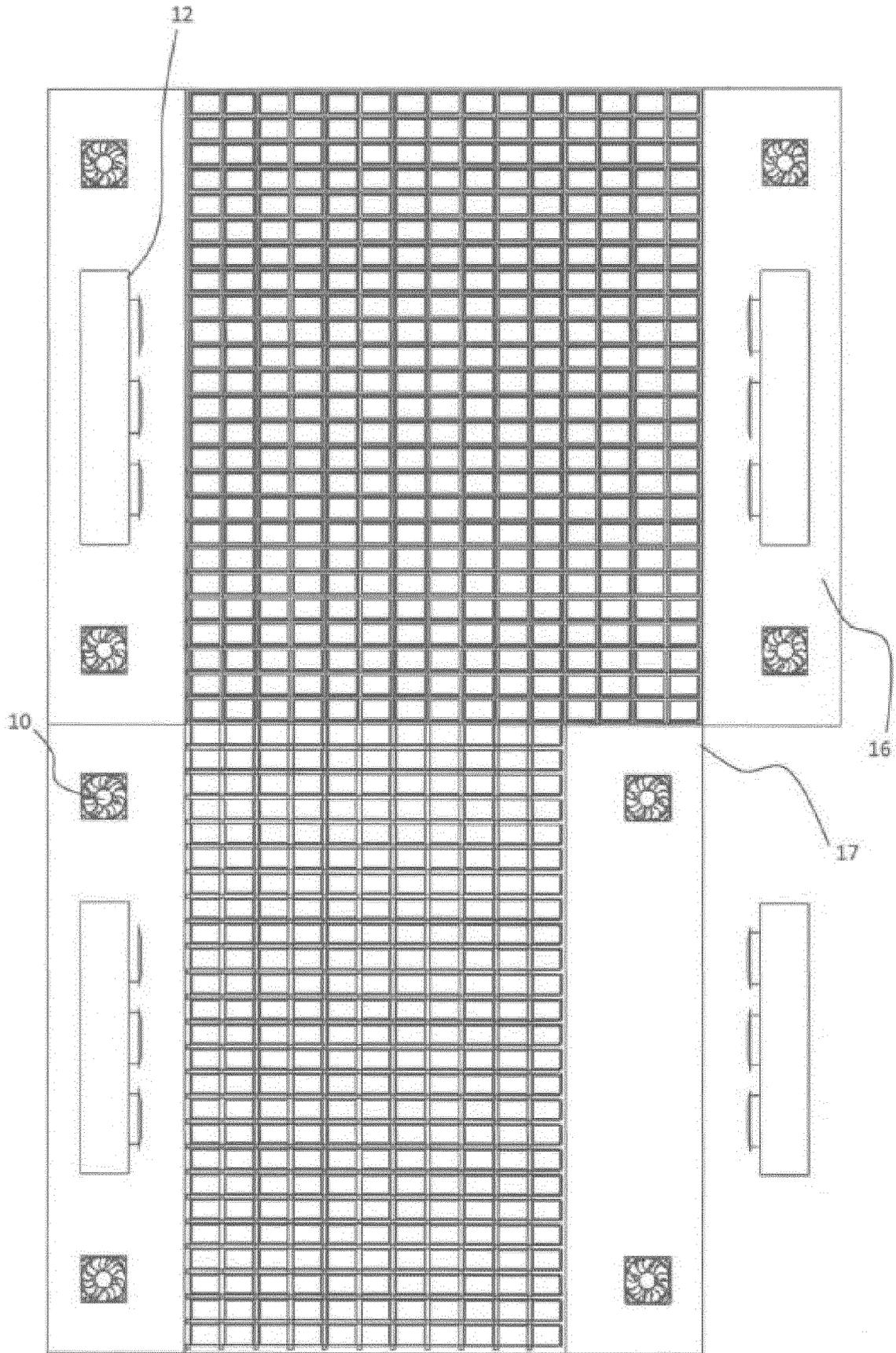


Figure 11

11/15

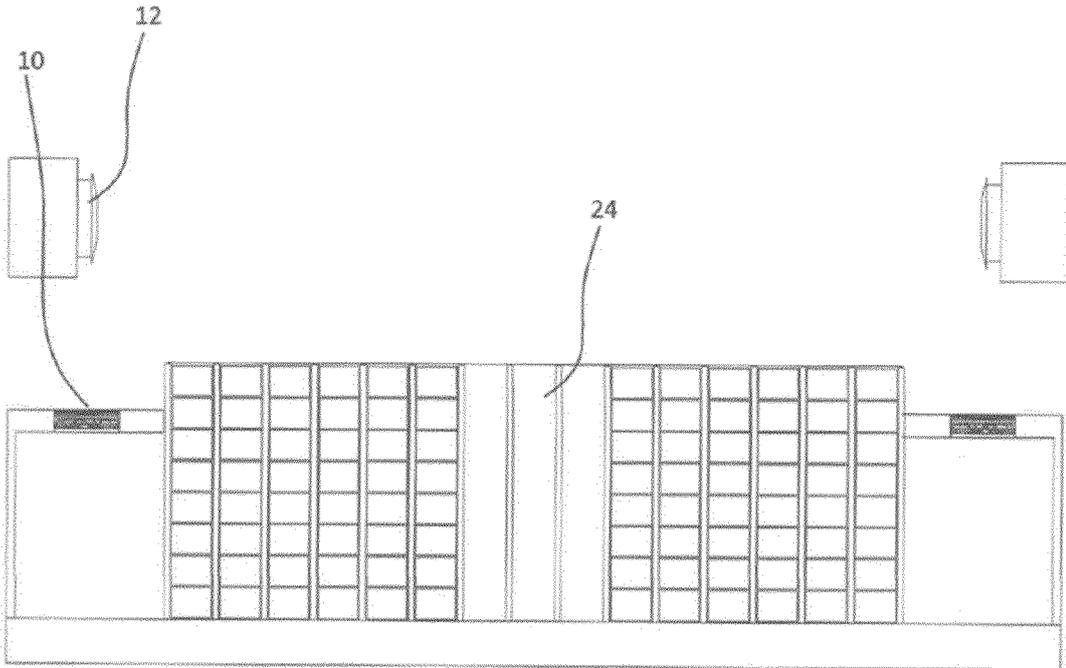


Figure 12

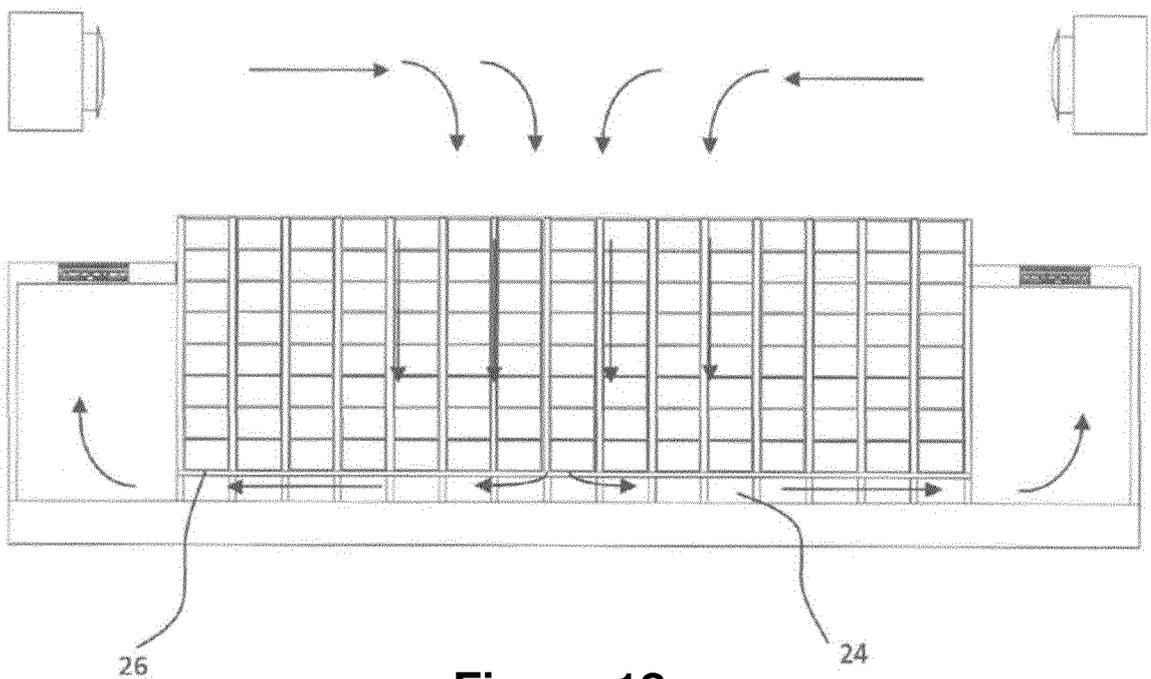


Figure 13

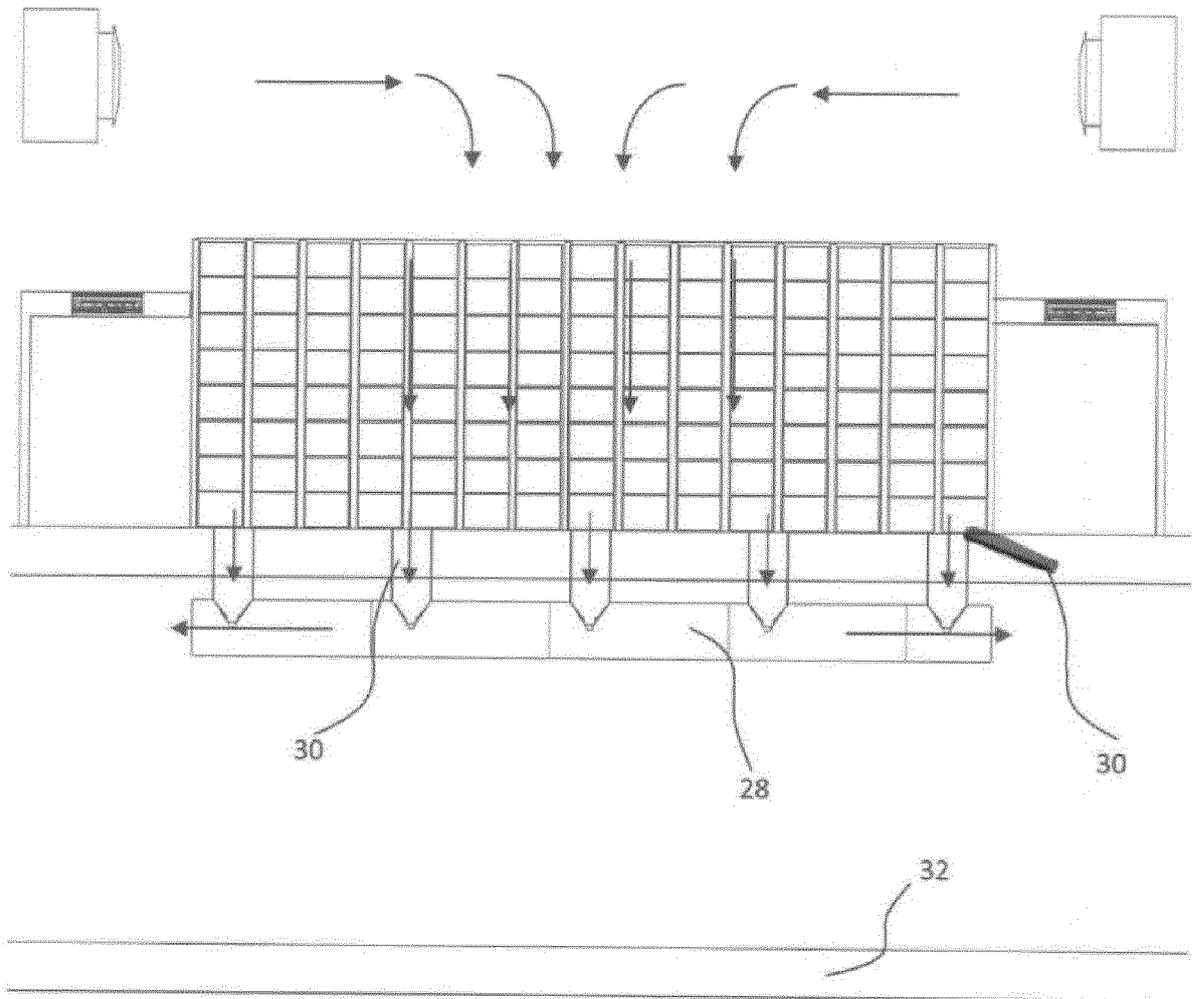


Figure 14

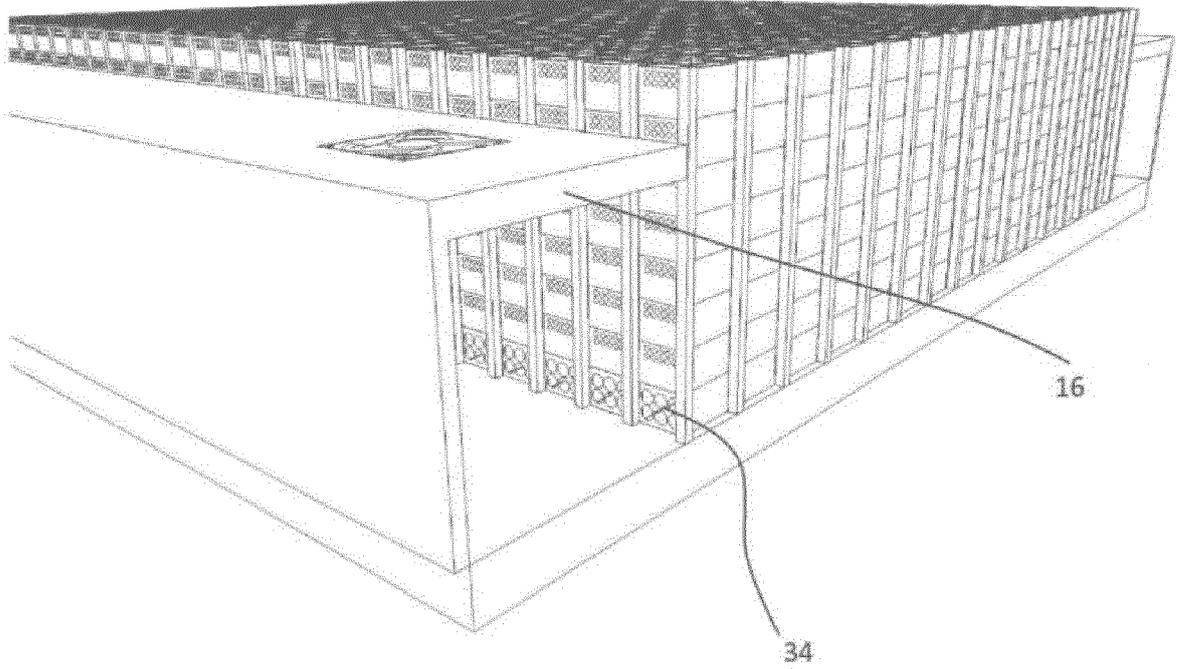


Figure 15a

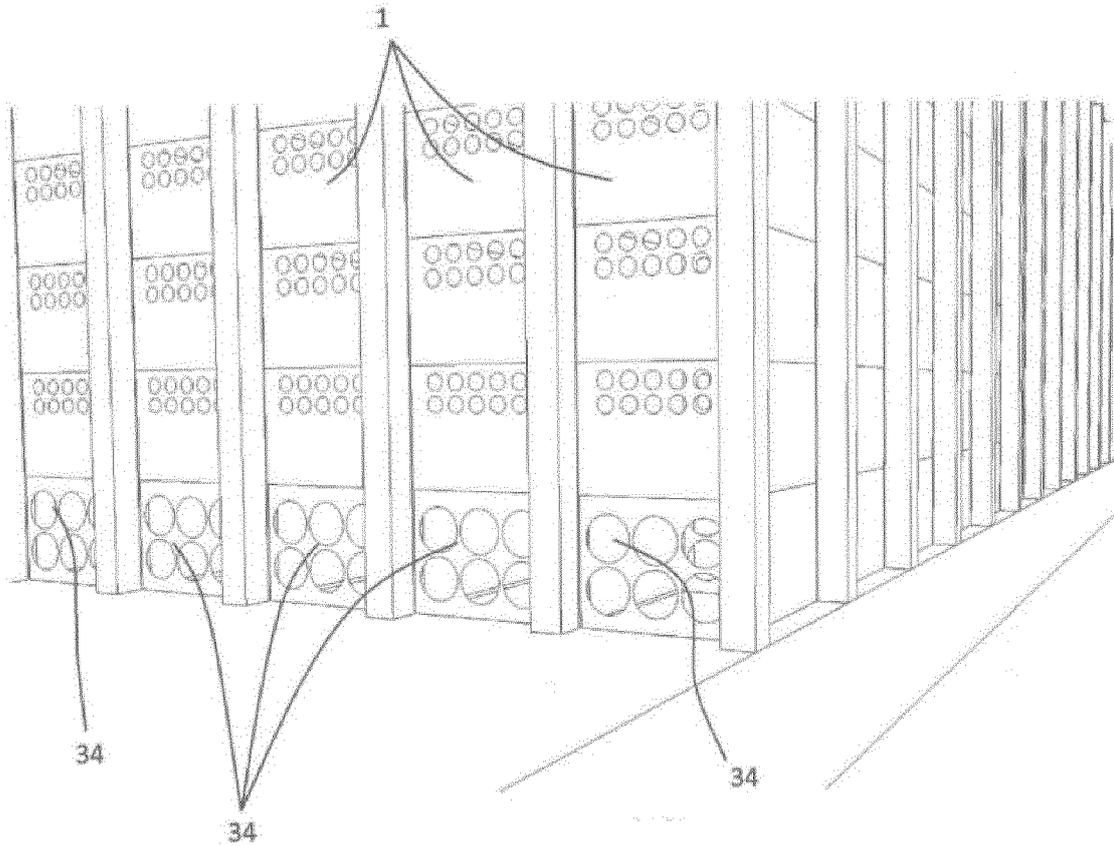


Figure 15b

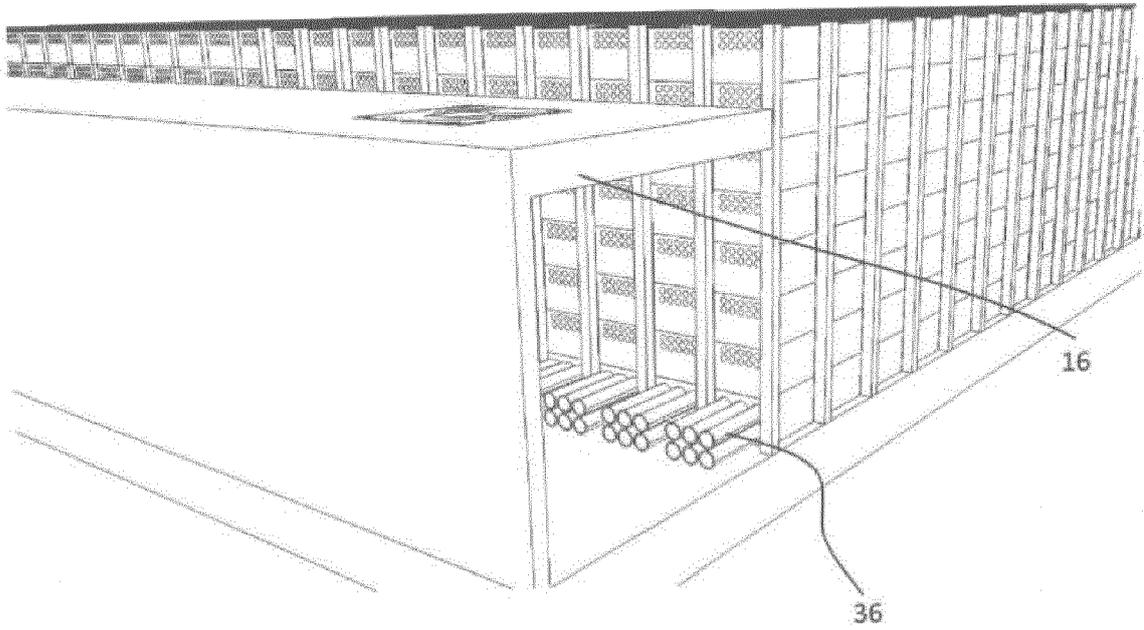


Figure 16a

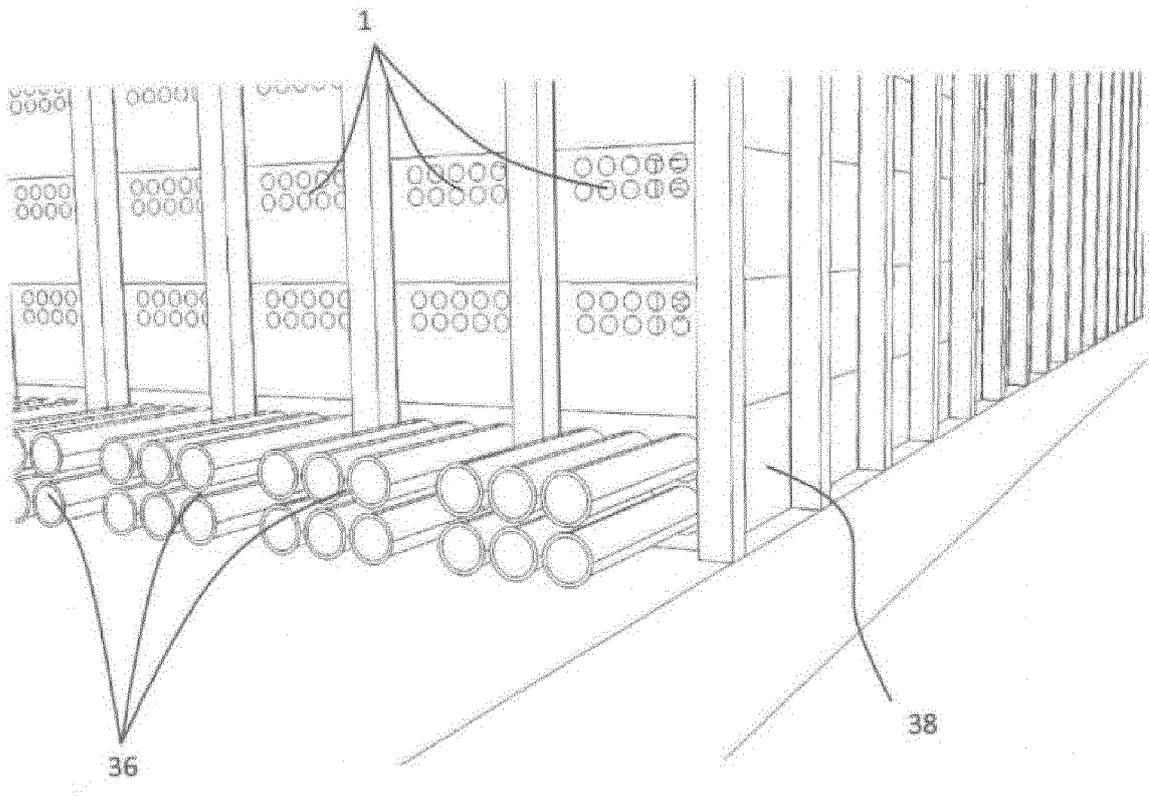


Figure 16b

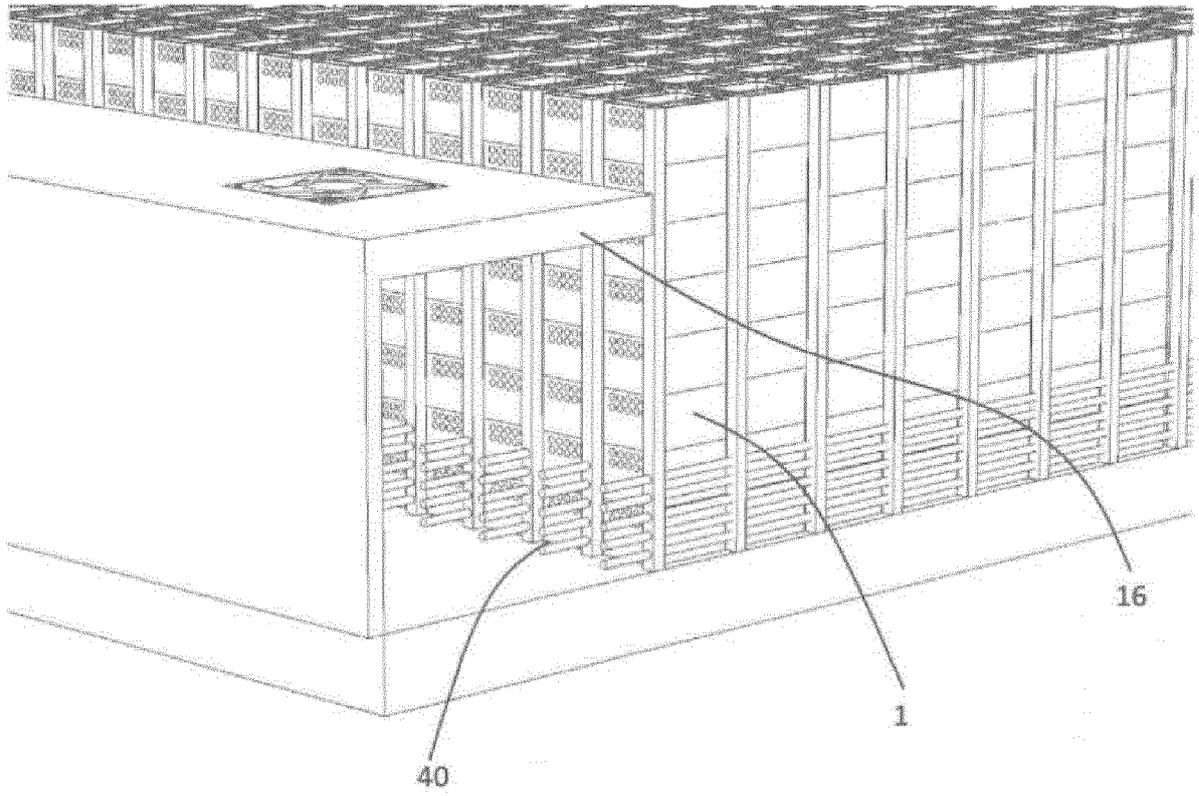


Figure 17a

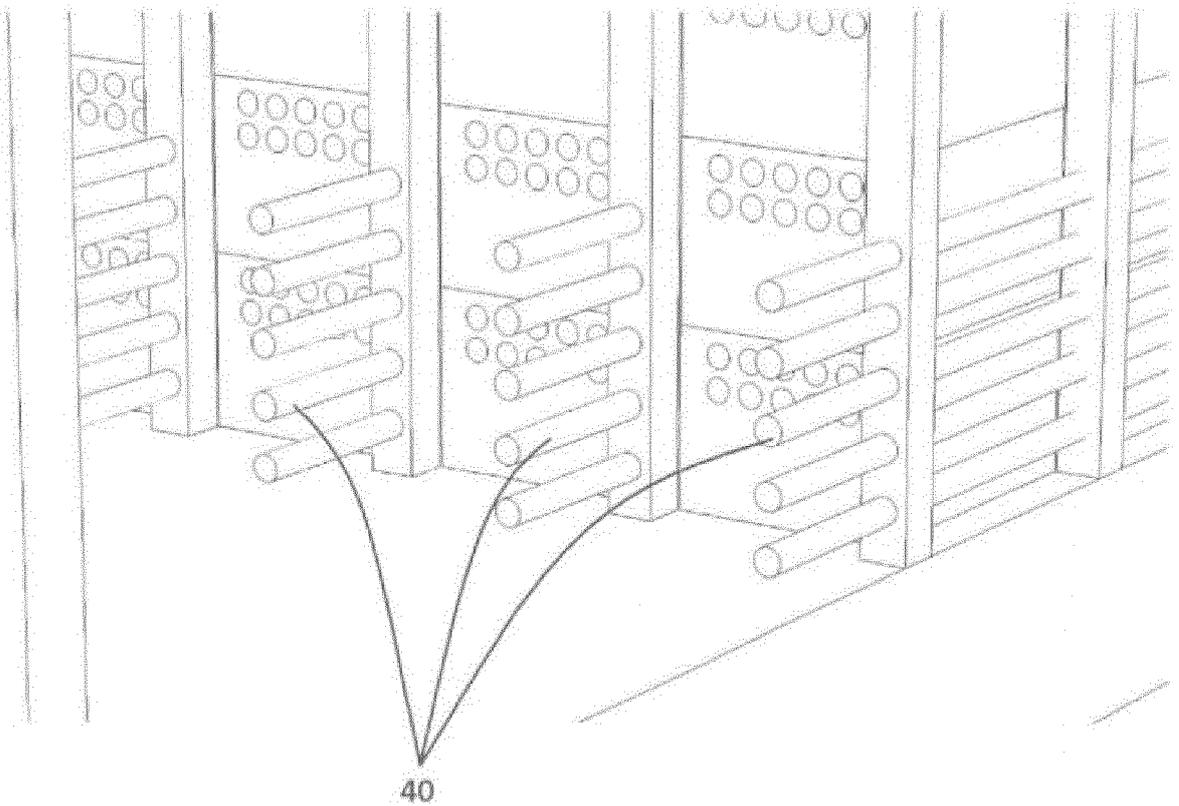
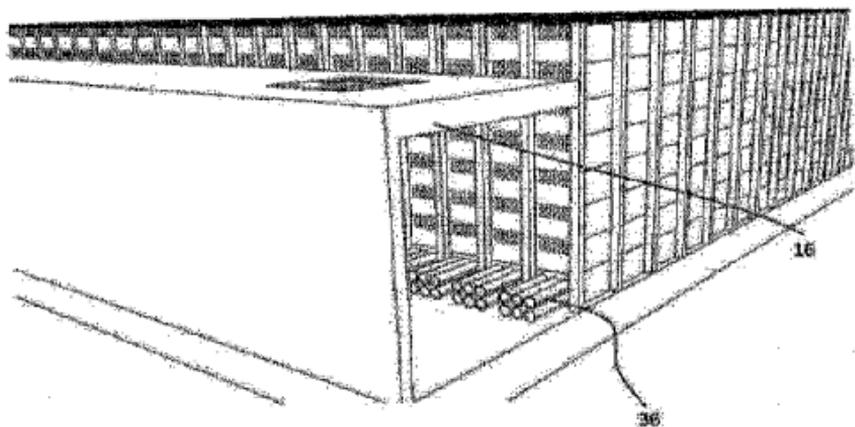
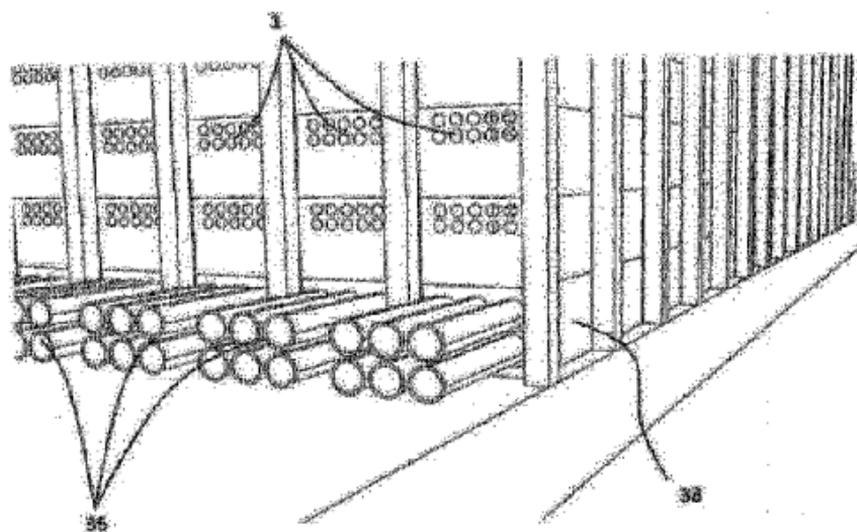


Figure 17b



a



b