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(54) **Title:** DATA STORAGE SYSTEM

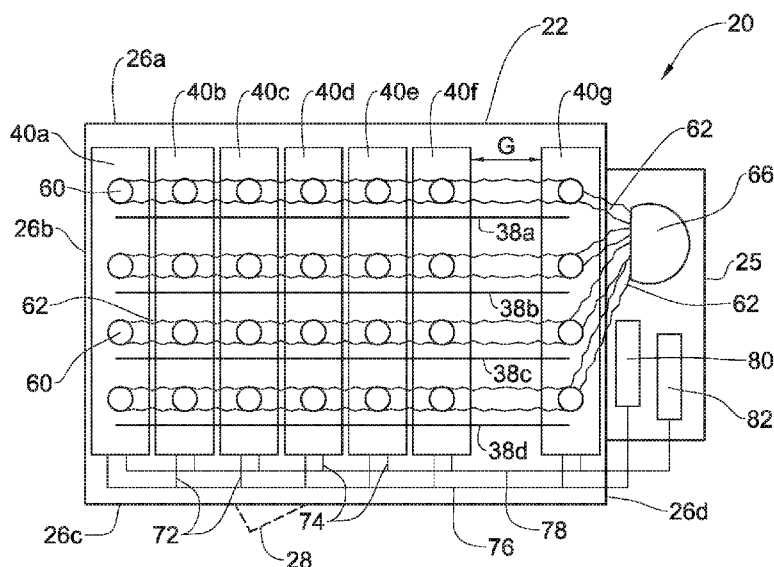


Fig. 1A

(57) **Abstract:** A data storage center comprising a plurality of cabinets configured with one or more racks. The racks are configured for accommodating one or more appliances. At least one of said cabinets is displaceable to facilitate access to the respective racks of said cabinet and to racks of a neighboring cabinet of said cabinets.

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## **DATA STORAGE SYSTEM**

### **TECHNOLOGICAL FIELD**

The present subject matter is concerned with a data storage system. More particularly, the disclosure is directed to a space saving data storage system.

### **BACKGROUND**

Storage data centers are facilities used to house computer storage systems and associated components such as data communications connections, power supplies and environmental controls, namely air conditioning, humidity control, fire/smoke detection and suppression systems, various security devices, shake detection and suppression, etc. Data centers are ever-growing and storage space is becoming a serious issue. There is thus a need for a new storage system and method.

### **GENERAL DESCRIPTION**

According to one aspect of the presently disclosed subject matter, there is provided a data storage center comprising a plurality of cabinets configured with one or more racks. The racks are configured for accommodating one or more appliances. At least one of said cabinets is displaceable to facilitate access to the respective racks of said cabinet and to racks of a neighboring cabinet of said cabinets.

The term *appliance/appliances* as used herein in the specification and claims denotes any form of data storage and communication equipment.

The arrangement is such that a duty service aisle extends neighboring a selected cabinet and is configured for servicing same, i.e. facilitating access to install/remove and service the data storage and communication appliances.

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According to a primary object of the present disclosure there is a data storage center with an improved volume/storage ratio, i.e. maximizing storage capacity within a given space by eliminating multiple aisles between cabinets, or substantially reducing the number of such aisles, thereby improving utilization of a given floor space.

A data storage center according to the present disclosure can be installed within any enclosure, i.e. any structure either stationary or mobile, e.g. mountable for locomoting.

The term *rack* as used hereinafter in the specification and claims denotes a shelf like compartment for supporting and electrically coupling data storage and communication appliances.

The term *data storage and communication appliances* as used hereinafter in the specification and claims denotes computer memory/storage systems, computer units, servers, communication modules, electric power units, etc.

The term *floating isle gap* as used hereinafter in the specification and claims denotes the maximal space between two neighboring cabinets, said space facilitating servicing the data storage center and communication appliances supported within said two neighboring cabinets. The floating isle gap can also extend between end cabinets within the enclosure, namely between a wall of the enclosure and a neighboring cabinet.

The term *environmental control* as used hereinafter in the specification and claims denotes at least a temperature controlling system. However, environmental control can include also humidity governing systems, air purifying systems, etc.

According to a particular example of the present disclosure there is provided a data storage center comprising a confined space accommodating a plurality of parallelly disposed cabinets and configured with an array of racks which in turn are configured for accommodating a plurality of data storage and communication appliances; at least some of the cabinets are displaceable within the confined space, with at least a floating isle gap between neighboring cabinets extending within the confined space; wherein one or more of the cabinets is associated with a data communications, electric power supply and environmental controls.

The arrangement is such that the utilization of a given floor space within a given confined space can be dramatically increased by minimizing isle space required

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between each two cabinets to a floating isle gap (a so-called duty isle gap, or s duty service isle). Accordingly, where the length and width of each cabinet are given, the parameter that can be altered is the redundant isle space between the cabinets, which can be eliminated and replaced by the floating isle gap which is exposed between two neighboring cabinets, or between an end cabinet and a neighboring wall, to facilitate access and service to the data storage and communication appliances mounted on the racks of the side of the duty cabinet/s facing the floating isle gap.

Thus, where an enclosure is fitted with a plurality of parallel disposed cabinets, each of particular height, width and length, the effective width ( $W_{Eff}$ ) of the cabinets is:

$$W_{Eff} = \sum_{i=1}^n W_i + W'$$

Where:

$W_i$  denotes the width of cabinet i;

$W'$  denotes the width of a floating isle gap, namely a maximal gap between two neighboring cabinets;

$n$  denotes the number of parallel disposed cabinets within the enclosure.

Any one or more of the following features, design and configurations can be associated with a data storage center according to the present disclosure, separately or in combinations thereof:

- The cabinets can be configured for displacement within the enclosure either manually or motorized;
- The cabinets can be displaceable over parallelly disposed rails within the enclosure; the cabinets can be displaceable parallel to one another;
- The cabinets can be configured with a dampening system for reducing shocks imparted to the cabinets upon collision with neighboring cabinets and/or shakes;
- The dampening system can be associated with the cabinets and or with a rail/track system supporting the cabinets;
- The environmental controls can be configured with a temperature controlling system (in particular a cooling system);
- The environmental controls can be configured with a humidity control system;

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- The environmental controls can be configured with an air filtration system;
- Each of the cabinets is articulated with an environmental controls, wherein climate controlling fluid flow can take place through a conduit associated with a respective cabinet;
- The enclosure can be configured with additional environmental controls, irrespective of those articulated with the cabinets;
- The climate controlling fluid flow conduit can be fixedly articulated with a cabinet and thus be configured for displacing along with the respective cabinet;
- The climate controlling fluid flow conduit can be a stationary flow port extending from the enclosure and configured for engaging with a respective pickup flow port of a respective cabinet;
- The climate controlling unit associated with each cabinet can be independent or part of a central system;
- The stationary flow port can be configured for shut off at the event that a cabinet is disengaged therefrom;
- Each cabinet can be configured with one or more climate control systems, depending on the amount of heat generated by the data storage and communication appliances mounted on a respective cabinet;
- The storage data center can be configured with a plurality of climate controlling sensors associated with the enclosure and/or with one or more of the cabinets, so as to monitor environmental parameters such as temperature, humidity, purity of the air, etc.;
- The storage data center can be configured with fire/smoke detectors and with a fire suppression arrangement;
- The cabinets can be configured with an anti-static arrangement;
- The storage data center can be configured with an air filtering/purifying system;
- The enclosure can be configured with one or more floating isle gaps along the length of the enclosure;

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- The floating isle gap has a width being substantially similar to the width of a rack of a cabinet. Accordingly, where a cabinet is a two sided cabinet (i.e. comprising storage racks at both sides thereof) the width of the gap corresponds substantially with half the width of the respective cabinet. Where the rack extends substantially the width of the cabinet, the width of the gap corresponds substantially with the width of the respective cabinet;
- Where the rack extends substantially along the width of the cabinet, the data storage and communication appliances can be accessed from one side or from both sides of the cabinet;
- Electric supply to the data storage and communication appliances can be through fixed wiring/cabling coupled to the cabinets, contactors, current collector, and the like;
- Data communications of the data storage and communication appliances can be facilitated through fixed wiring articulated with each cabinet;
- Data communications of the data storage and communication appliances can be facilitated through contactors [data port collectors];
- Data communications of the data storage and communication appliances can be facilitated through wireless communication;
- For practical reasons, the arrangement can be such that more than one floating isle gap is provided for a given number of cabinets, e.g. in case of large enclosures, and the like;
- A cabinet may be segmented about its length, where segments of a cabinet can be locomoted jointly, as an integral unit, or each segment individually;
- Some of the cabinets can be segmented and configured for displacing in a so-called side-to-side relation, i.e. along the length of the cabinet;
- The cabinets can be locomoted over a trail/rack system articulated to the floor and/or suspended from the ceiling of the enclosure;
- The racks can be configured with snap coupling ports for fast coupling/detaching of the data storage and communication appliances.

## BRIEF DESCRIPTION OF THE DRAWINGS

In order to better understand the subject matter that is disclosed herein and to exemplify how it may be carried out in practice, embodiments will now be described, by way of non-limiting examples only, with reference to the accompanying drawings, in which:

**Fig. 1A** is a schematic top view of a data storage center according to an example of the present disclosure;

**Fig. 1B** is a schematic side view of the data storage center of **Fig. 1A**;

**Fig. 1C** is a schematic top view of the storage data center of **Fig. 1A**, some cabinets of which are displaced;

**Fig. 2** is a schematic side view of a storage data center according to another example of the present disclosure; and

**Fig. 3** is a schematic top view of a storage data center according to yet another example of the present disclosure; and

**Fig. 4** is perspective representation of a storage data center according to the present disclosure.

## DETAILED DESCRIPTION OF EMBODIMENTS

Attention is directed first to Figs. 1A to 1C of the drawings, directed to a data storage system generally designated **20**, according to a first example of the disclosure.

The data storage system **20** comprises an enclosure **22** which in the present example is a structure comprising a confined space in the form of a storage hall **24** and a support section **25** articulated thereto. The storage hall **24** is configured with four side walls **26a** to **26d**, a door **28** formed in side wall **26c**, a ceiling **32** (Fig. 1B) and a solid floor **34**.

It is appreciated that the present disclosure is a mere example and that the data storage system can in fact be assembled at any suitable location e.g. a confined space or a space within a larger space.

The floor **34** is fitted with four parallelly extending rails **38a** to **38d**, fixedly articulated thereto. At the event that the data storage system is configured for bearing heavy loads, the floor has to be reinforced, as known in the art.

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It is further appreciated that whilst in the particular example the cabinets are displaceable over rails, other locomotive configurations can be facilitated, such as wheels, grooves, magnetic rails, suspension rails and the like.

According to the particularly illustrated example, data storage system **20** comprises seven cabinets designated **40a** to **40g**, wherein end cabinets **40a** and **40g** are stationary cabinets and cabinets **40b** to **40f** are displaceable and are articulated to the rails **38a** to **38d** and configured for smooth siding there over, in a parallel relationship. However, according to the disclosure all or some of the cabinets are displaceable, wherein displacement of the cabinets can be facilitated manually, i.e. pushing/pulling, or by mechanical gearing e.g. deploying a manipulating system such as chain and gear train with the aid of a rotatable manipulator **39** (Fig. 4), and optionally by an electric motor (not shown).

Noting the sensitive nature of the gear mounted on the racks, it is noted that the locomotive system can be configured with a shock observing system for dampening and suppressing possible impact of the cabinets against each other upon displacement thereof.

Each of the cabinets **40a** to **40g** is configured with a plurality of racks represented in Fig. 1B by dashed lines designated **42** though better appreciated in Fig. 4. Each of the racks **42** is configured for accommodating a variety of data storage and communication appliances, such as computer memory/storage systems, computer units, servers, communication modules, electric power units, schematically illustrated and collectively referred to hereinafter as DSAC and designated **50** (Fig. 4). The racks **42** are configured with a plurality of data ports and power sockets for articulation to the DSACs and preferably, such ports and sockets are quick-release type couplings. The racks **42** can be modular (as far as height, couplings, sockets etc.), i.e. can be easily modified in size so as to accommodate different DSACs.

The data ports and power sockets of each of the cabinets **40a** to **40g** extend to a communications port **72** and power port **74**, which ports are in communication with a main communications line (dash-dotted line **76** in Fig. 1A) and a main power line **78** (dashed line **78** in Fig. 1A), which respectively extend into the support section **25** to a central communication facility **80** and a central power backup **82**.



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It is appreciated that data communication to/from the DSACs, and power supply to the DSACs can be facilitated by flexible cabling. Alternatively, data contactors and/or power contactors can be used, so as to facilitate data and power transfer to the cabinets, however without interfering with their mobility within the enclosure and without there occurring any momentarily discontinuities of data communication or power supply.

Noting the nature of the DSCAs, namely electric components emitting considerable heat and requiring cooling system for maintain their proper operation, the cabinets **40a** to **40g** are configured with an environmental control system comprising at least a cooling and or heat evacuating system. In the example of Figs. 1A to 1C, the environmental control system associated with each of the cabinets **40a** to **40g** is a flexible fluid conduit **60** (e.g. bellows type conduit etc.) branching from supply lines **62** and which extend to a central air cooling unit **66** disposed at the support section **25**. The flexible piping **62** renders the displaceable cabinets with controlled climate in spite their displacement. It is noted that the support section **25** can be disposed at any location in the vicinity of the data storage system.

It is appreciated that according to other configurations (not illustrated) the environmental control system can comprise in addition to cooling units, or instead, heat extractors, heat changers, other types of heat control units such as thermoelectric (peltier) units, etc., and combinations thereof,

Furthermore, it is appreciated that additional one or more environmental controls can be associated with each of the cabinets, such as temperature and humidity controls, etc. Also, air treating units such as drying units, purifying/filtering units, etc. can be installed. In addition, the enclosure or each cabinet can be fitted with a variety of sensors of sensing and controlling the environmental parameters, and additional parameters such as quake sensors, smoke/fire detectors and suppressors **69a** and **69b** (Fig. 4).

In Figs. 1A and 1B, the cabinets are disposed as follows: end cabinets **40a** and **40g** are stationary and are thus disposed in proximity to the respective side walls **26b** and **26d**. Cabinets **40b** to **40f** are all disposed to the left, in close proximity to cabinet

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**40a** and in close proximity to one another, thereby giving rise to a floating isle gap **G** extending between cabinet **40f** and cabinet **40g**.

Turning now to Fig. 1C, the cabinets **40d** to **40f** are displaced all the way to the left, in close proximity to cabinet **40g** and in close proximity to one another, thereby giving rise to a floating isle gap **G**, now extending between cabinet **40c** and cabinet **40d**.

The arrangement is such that the utilization of a given floor space within the given enclosure **22** is substantially increased by avoiding redundant isle space between each two neighboring cabinets, and instead a floating isle gap **G** is configured. Accordingly, where the length **L** (Fig. 1C) and width **W<sub>i</sub>** of each cabinet **40a** to **40g** are given, the parameter that can be altered is the redundant isle space between the cabinets, now eliminated and replaced by the floating isle gap **G** which is exposed between any two neighboring cabinets, or between an end cabinet and a neighboring side wall, to facilitate access and service to the DSCAs mounted on the racks **42** of the side of the duty cabinet facing the floating isle gap.

Thus, where an enclosure **22** is fitted with a plurality of parallel disposed cabinets, each of particular height, width and length, the effective width (**W<sub>Eff</sub>**) of the cabinets is:

$$W_{Eff} = \sum_{i=1}^n W_i + W'$$

Where:

**W<sub>i</sub>** denotes the width of cabinet *i*;

**W'** denotes the width of a floating isle gap, namely a maximal gap between two neighboring cabinets;

**n** denotes the number of parallel disposed cabinets within the enclosure.

The width of the enclosure **22** is substantially equal to the effective width **W<sub>Eff</sub>**.

It is appreciated that according to the present example five isles have been eliminated (assuming the tow end cabinets **40a** and **40g** are stationary and are accessible from their inside face), and however designating a single floating isle gap **G**. It should be noted that in large facilities it may be required that additional floating isle gap be allocated, so as to enable two or more simultaneously operative gaps between cabinets within an enclosure.

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Turning now to Fig. 2 of the drawing, there is schematically illustrated a data storage system generally designated **120**, according to a second example of the disclosure.

The enclosure **122** accommodates **n** cabinets (four in the schematic example; designated **140a** to **140d**) slidable over support rails (not shown). It is appreciated that the principal of a floating isle gap **G** is maintained, whereby the servicing isle now extending between cabinets **140c** and **140d** can extend between any of the cabinets or between one of the end cabinets (**140a** or **140d**) and a respective side wall.

However, in the present example the cabinets are displaceable over a 'floating floor' **134** and wherein a controlled air duct **162** is disposed under said floor **134**, extending from a central air treating and cooling unit **166** towards a plurality of ports **163a** to **163e**, each extending in register with a potential address (location) of a cabinet. The arrangement is such that each port is configured with a selectively sealable gate **165**. In the illustrated position ports **163a** to **163c** and port **163e** extend opposite and in register with corresponding inlet openings of the respective cabinets **140a** to **140c** and **140d**, whilst gate **165** of unoccupied port **163d** is shut, namely at the location of the floating isle gap **G**. it is appreciated that according to another configuration, the unoccupied port **163d** can remain open and thus contribute to controlling temperature within the enclosure.

In addition to the above, all communications between the central communication facility **180** and the cabinets **163a** to **163e** (namely with the DSCAs mounted over the racks in the cabinets), as well as connectivity with the central power and backup unit **182** takes place by contactors **193** engaged with communication and power lines schematically represented by line **195**.

The schematic representation of Fig. 3 illustrates yet another example of a data storage system generally designated **220** wherein an enclosure **222** is configured with six cabinets **240a** to **240f**, of which endmost cabinets **240a** and **240f** are stationary and extend in proximity to side walls of the enclosure. Cabinets **240b** to **240e** are displaceable along parallel rails **238** following the principal disclosed hereinabove, namely floating isle gap **G** is maintained, whereby the servicing isle now extending

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between cabinets **240d** and **240e**, though it can extend between any two cabinets or between one of the end cabinets and a respective side wall.

However, in the present example, cabinets **240c** and **240d** are segmented, namely each composed of two sub compartments **A** and **B** and are each positioned, at the currently illustrated position, over transverse paired rails **237a** to **237d**. This arrangement renders displacing segments **A** or **B** of a respective cabinet along the transverse rails **237a** to **237d**, thus facilitating servicing access to intermediate portions of the respective cabinets **240c** and **240d**. Apart from that it is appreciated that each of the cabinets is configured with the same features as discussed hereinabove, namely temperature and environmental control, communications coupling and power supply, etc.

**CLAIMS:**

1. A data storage center comprising a plurality of cabinets configured with one or more racks, said racks being configured for accommodating one or more appliances;  
wherein at least one of said cabinets is displaceable to facilitate access to the respective racks of said cabinet and to racks of a neighboring cabinet of said cabinets.
2. A data storage center according to Claim 1, further comprising an enclosure defining a confined space in which said cabinets are disposed.
3. A data storage center according to Claim 2, wherein at least one of said cabinets is displaceable within said confined space so that a floating isle gap between each two neighboring cabinets is formed within the confined space.
4. A data storage center according to Claim 3, wherein said cabinets are parallel with respect to each other and each having a width  $W_i$ , said floating isle gap having a width  $W'$ , and wherein an effective width ( $W_{Eff}$ ) of the cabinets is:  $W_{Eff} = \sum_1^n W_i + W'$ , where  $n$  is a number of said cabinets and  $i$  is a number of a particular cabinet and having a value of 1 to  $n$ .
5. A data storage center according to Claim 4, wherein a width of said confined space is substantially equal to  $W_{Eff}$ .
6. A data storage center according to Claim 4 or 5, wherein the width  $W_i$  is identical in all the cabinets and is substantially equal to width  $W'$ .
7. A data storage center according to any one of Claims 4 to 6, wherein the width  $W'$  is substantially equal to a width of the racks of said cabinets.

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8. A data storage center according to any one of the preceding claims, wherein the displacement at least one of said cabinets is manual or motorized.
9. A data storage center according to any one of the preceding claims, wherein the at least one cabinet is displaceable over parallelly disposed rails.
10. A data storage center according to any one of the preceding claims, further comprising environmental controls associated with at least one of said cabinets for providing environmental control to the appliances thereof.
11. A data storage center according to Claim 10, wherein environmental controls comprise at least one of: a temperature controlling system, a humidity control system, and an air filtration system.
12. A data storage center according to Claim 10 or 11, wherein said association with at least one of said cabinets is provided by a climate controlling fluid flow conduit articulated thereto.
13. A data storage center according to Claim 12, when dependent on Claim 2, wherein the climate controlling fluid flow conduit is a stationary flow port extending from the enclosure and configured for engaging with a respective pickup flow port of a respective cabinet of said cabinets.
14. A data storage center according to Claim 12, wherein said climate controlling fluid flow conduit is displaceable with its respective cabinet.
15. A data storage center according to any one of the preceding claims, when dependent on Claim 2, further comprising a plurality of climate controlling sensors associated with the enclosure or with one or more of the cabinets, so as to monitor environmental parameters such as temperature, humidity, and purity of air.

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**16.** A data storage center according to any one of the preceding claims, further comprising data communications associated with said cabinets for providing data communication to the appliances of the cabinet.

**17.** A data storage center according to Claim 16, wherein the data communications is facilitated through fixed wiring articulated with said cabinets or through wireless communication.

**18.** A data storage center according to any one of the preceding claims, wherein at least part of the cabinets is segmented and configured for displacing in a side-to-side relation along the length of the cabinet.

**19.** A data storage center according to any one of the preceding claims, when dependent on Claim 2, wherein the cabinets are displaceable over a rail system articulated to a floor or suspended from a ceiling of the enclosure.

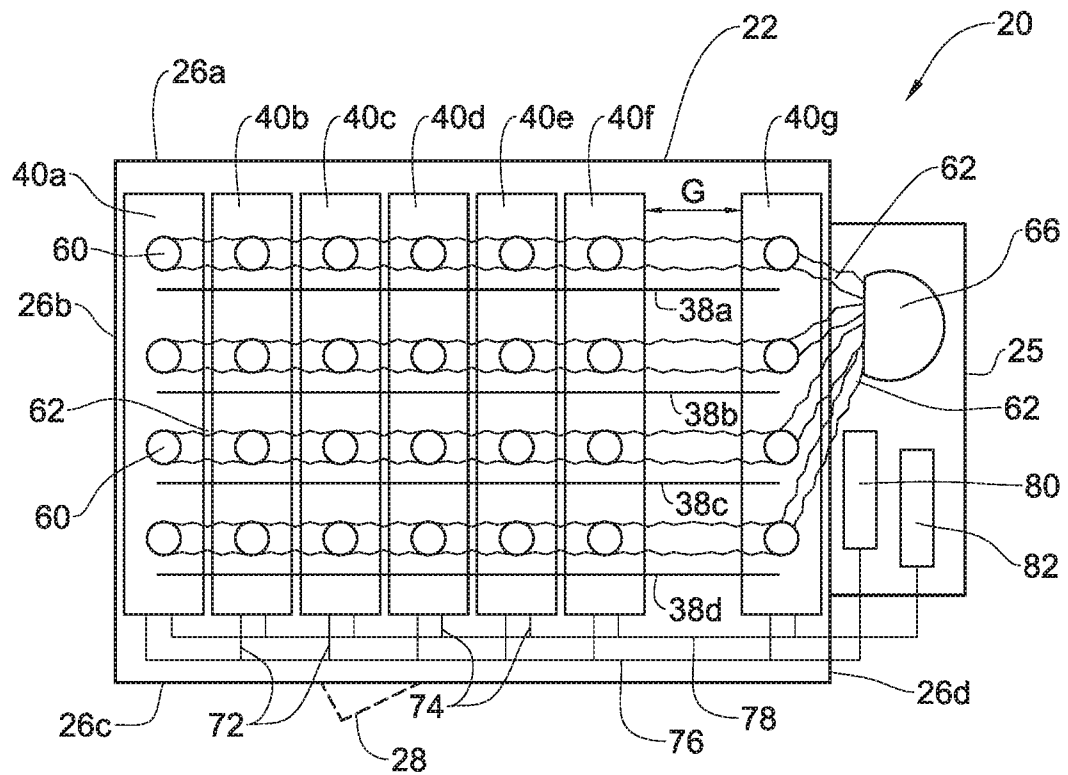


Fig. 1A

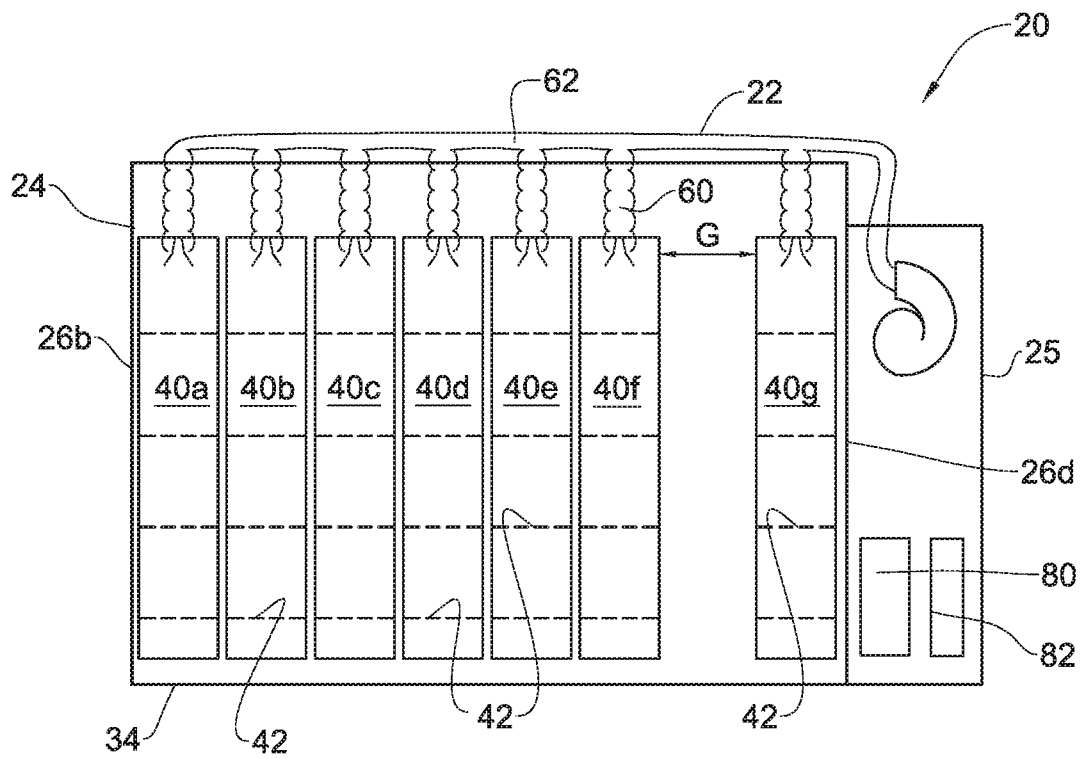


Fig. 1B



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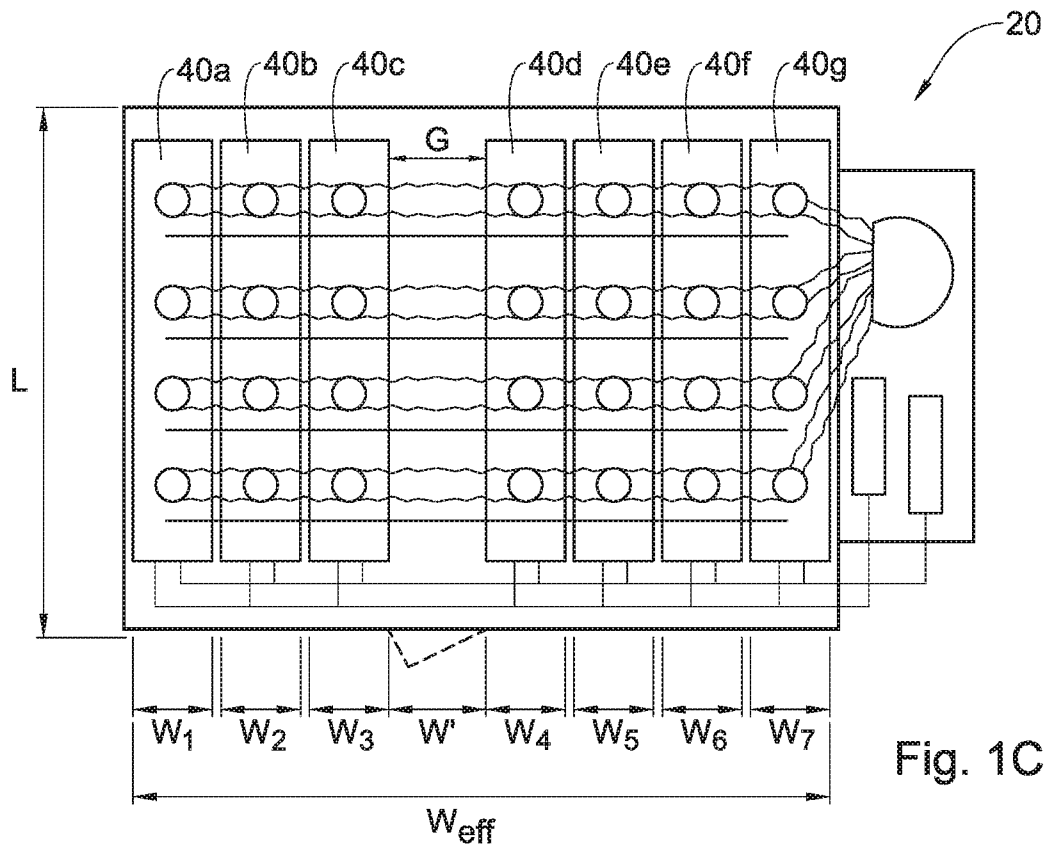


Fig. 1C

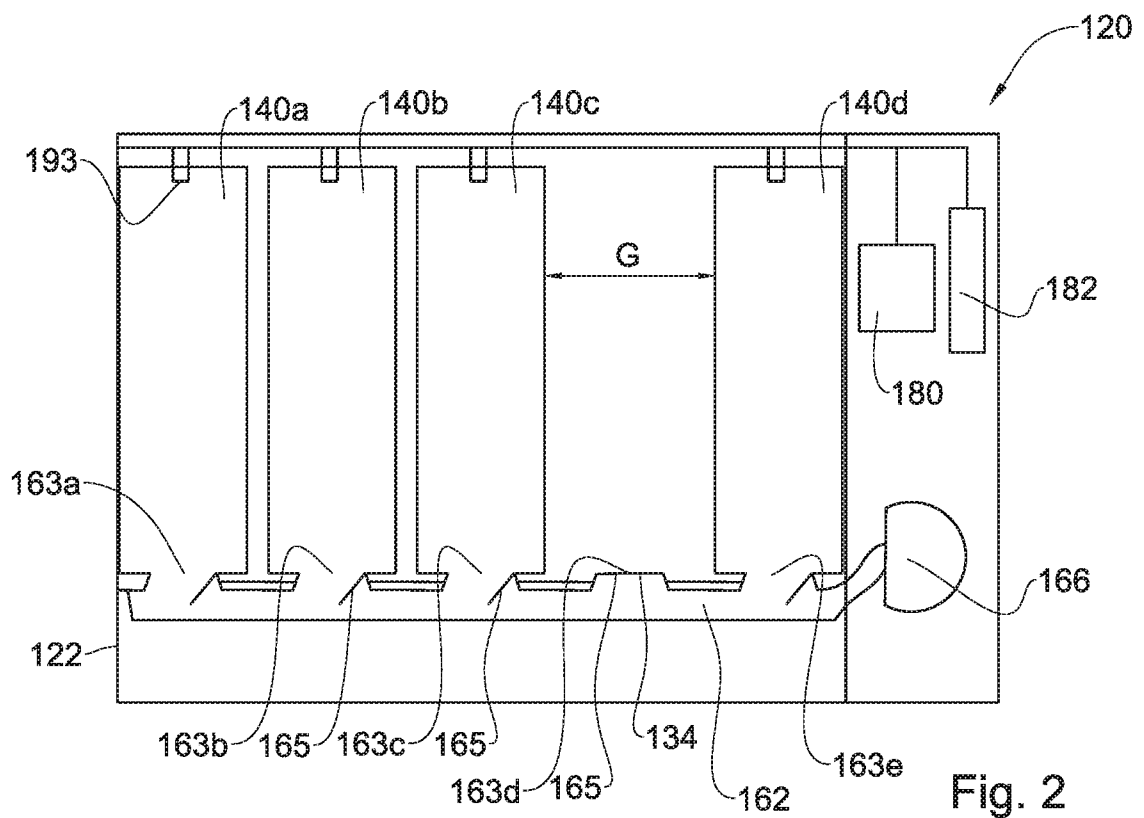


Fig. 2

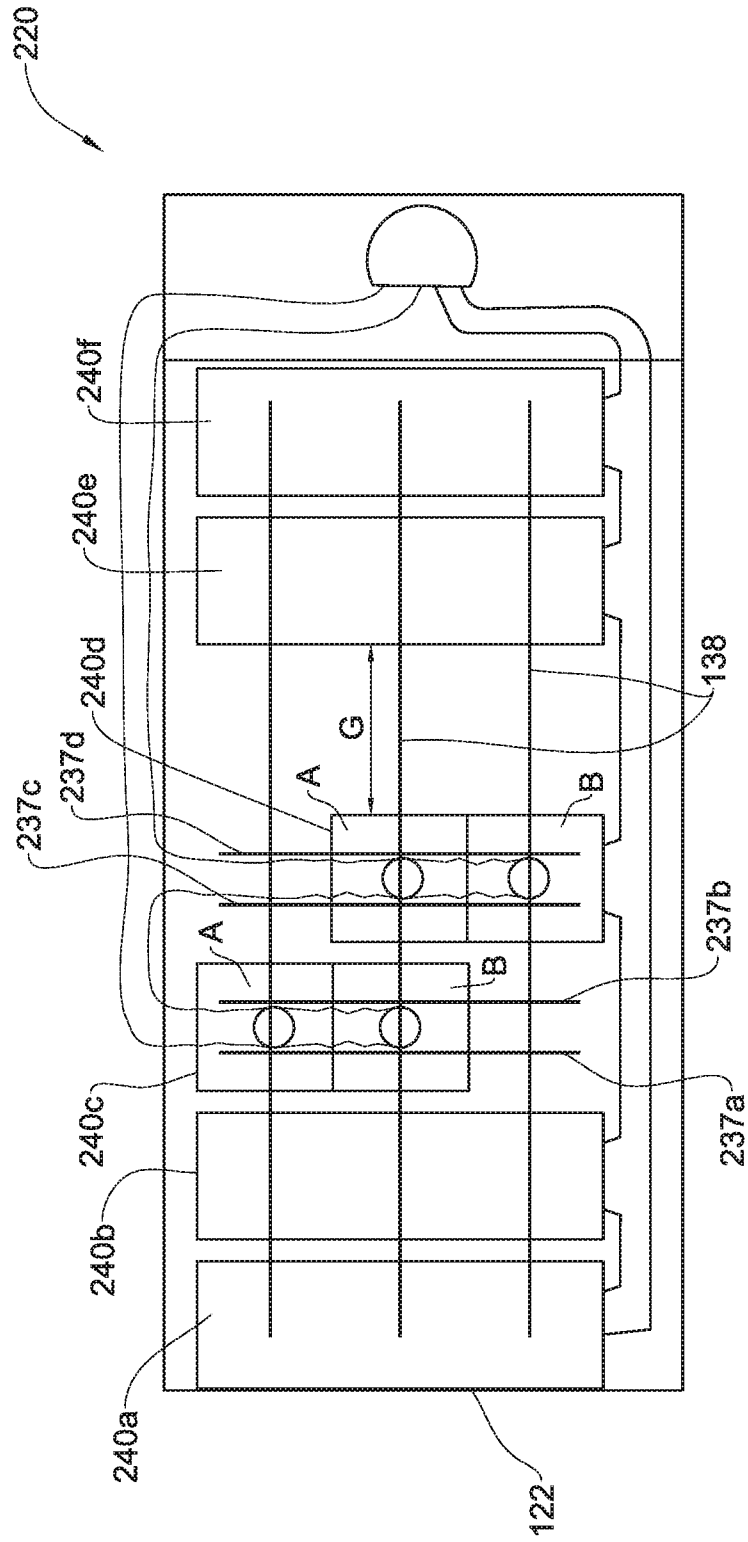
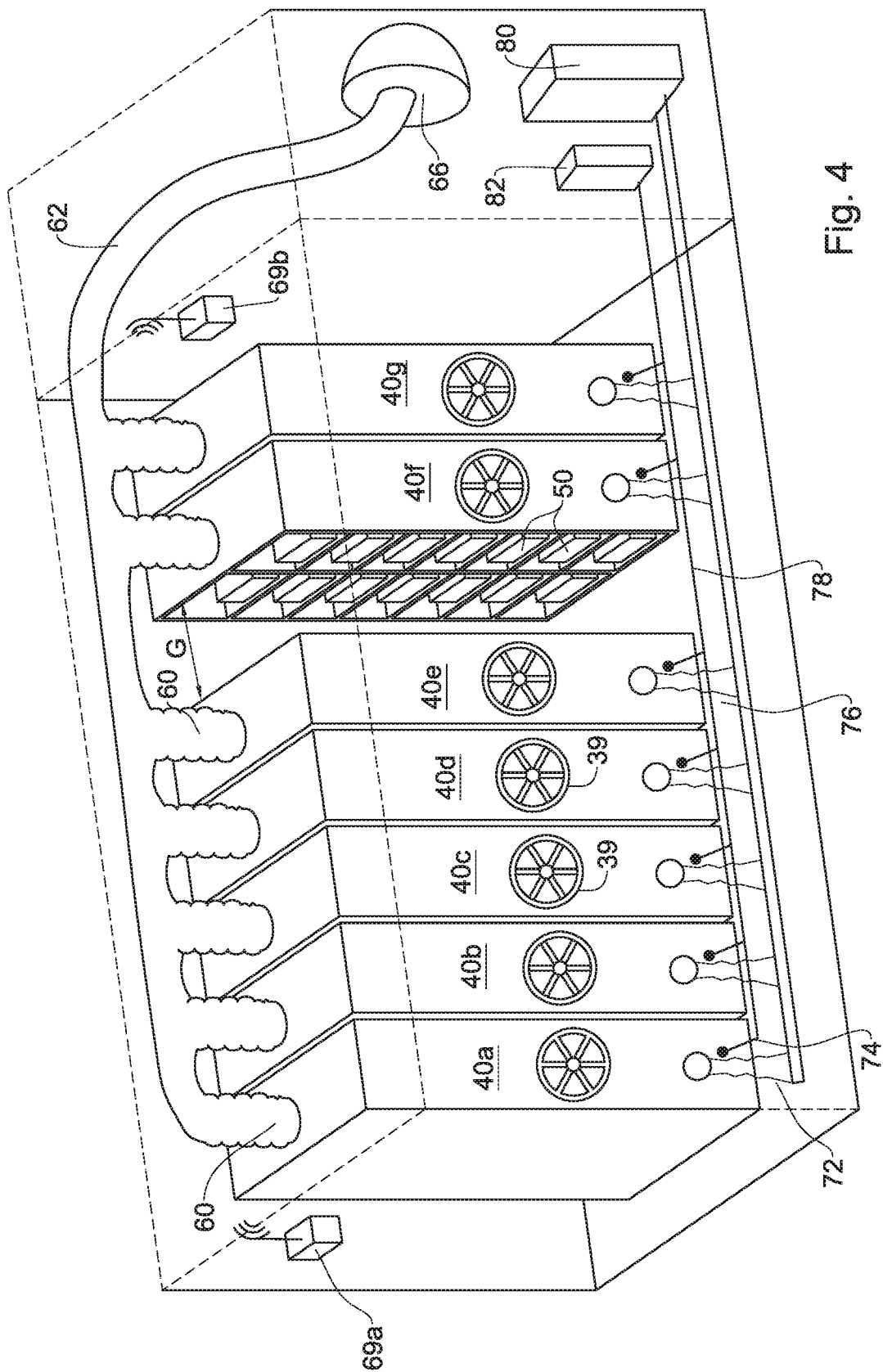


Fig. 3



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# INTERNATIONAL SEARCH REPORT

International application No.

PCT/IL2015/050950

<b>A. CLASSIFICATION OF SUBJECT MATTER</b> IPC (2015.01) A47B 53/02, H05K 7/20  According to International Patent Classification (IPC) or to both national classification and IPC		
<b>B. FIELDS SEARCHED</b>  Minimum documentation searched (classification system followed by classification symbols) IPC (2015.01) A47B 53/02, H05K 7/20  Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched  Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) Databases consulted: THOMSON INNOVATION, Esp@cenet, Google Patents Search terms used: cabinet, racks, slide, float, roll, rail, wheel, aisle, width, servers, environment, temperature, humidity, control		
<b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6845721 B1 Doucet et al. 25 Jan 2005 (2005/01/25) The whole document	1-9,18,19
Y	The whole document	10-17
Y	EP 2101017 A2 ADVANCED SHIELDING TECHNOLOGIES EUROPE S.L. 16 Sep 2009 (2009/09/16) The whole document	10-17
A	JP H11225835 A TANIGAWA BUNJI; KIRA RYOKICHI 24 Aug 1999 (1999/08/24) The whole document	1-19
<input type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> See patent family annex.		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search 08 Dec 2015		Date of mailing of the international search report 14 Dec 2015
Name and mailing address of the ISA: Israel Patent Office Technology Park, Bldg.5, Malcha, Jerusalem, 9695101, Israel Facsimile No. 972-2-5651616		Authorized officer GORBUNOVA Yelena  Telephone No. 972-2-5651669

International application No.  
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