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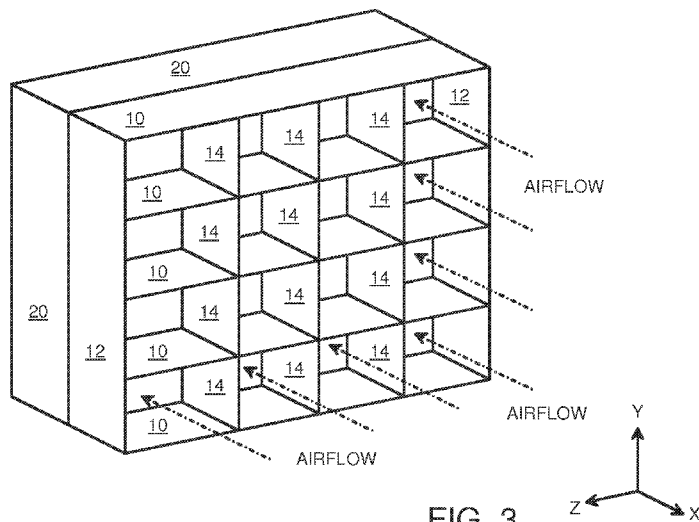


FIG. 3

(57) Abstract: An electronics chassis has many removable boards (50) on sleds (30) that are interconnected by a honeycomb interconnect structure. Interconnect boards (10, 12) in Y-planes and Z-planes are orthogonal to each other and form cells. Cooling air flows through the cells in an X direction, parallel to surfaces of the interconnect boards. The removable boards have connectors (40, 42, 44) that mate with an edge of Z-divider interconnect boards (14). Fans blow air through the cells in the honeycomb structure unimpeded since no boards are perpendicular to the airflow. Notches in the rear of the Z-divider boards provide airflow equalization allowing closer spacing of fans to the honeycomb structure. A sled carrier honeycomb structure (16, 18, 19) is placed in front of the honeycomb interconnect structure to guide sleds into position. Sled carrier dividers (16) are offset from the Z-divider boards to allow removable boards to align with Z-divider boards in the Zplanes, parallel to airflow.



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ELECTRONIC INTERCONNECT METHOD AND APPARATUS

FIELD OF THE INVENTION

[0001] This invention relates to methods and apparatus for electronic interconnect, and more particularly to electronic chassis with interconnect boards.

BACKGROUND OF THE INVENTION

[0002] Many larger electronic systems are contained in one or more cabinets or chassis that allow removal of racks, drawers, or boards. Boards may need to be added or removed while the system is still operating for repair or expansion purposes. In older systems, boards were interconnected by many cables, often creating a confusing nest of cabling.

[0003] More recently, a larger board known as a backplane is provided with connector sockets that receive the edges of boards. A midplane is a variation of a backplane that is not located in the back of the chassis, but is located in the middle of the chassis. Connector sockets may be mounted to both sides of a midplane board, allowing boards to be inserted on both surfaces of the midplane.

[0004] Boards are inserted perpendicularly to the main surfaces of backplanes and midplanes. Cooling airflow is often directed between the removable boards. Since the backplane or midplane is orthogonal to the removable boards, backplanes and midplanes often act as a wall to block the airflow and to restrict the airflow to a single vertical direction. Holes or notches may be added to the backplane or midplane to allow for some air to flow through, but this may waste valuable component space. Cascading several boards together may require a higher or cooler airflow.

[0005] A variety of other configurations have been attempted, such as co-planar backplanes that are mated through a connector, and orthogonal backplanes that mate through specialized connectors. Although co-planar backplanes are parallel to each other, they only span one dimension each and are rarely used. Orthogonal backplanes often require staggering boards and other specialized connectors. The density of the removable boards is often less than desired.

[0006] What is desired is an improved high-density interconnect.

BRIEF DESCRIPTION OF THE DRAWINGS

- [0007] Figures 1A-E show construction of a honeycomb structure that replaces a backplane for interconnect.
- [0008] Figure 2 shows a bank of fans that pulls air through the honeycomb interconnect structure.
- [0009] Figure 3 shows the honeycomb interconnect structure with a fan bank creating an airflow through the cells of the honeycomb structure.
- [0010] Figure 4 shows the honeycomb interconnect structure with sled carriers to guide removable boards.
- [0011] Figure 5 shows a removable board being inserted into the sled guides to mate with an exposed edge of the z-divider boards.
- [0012] Figure 6 shows several sleds of removable boards that have been inserted into the honeycomb interconnect structure.
- [0013] Figure 7 is a side view highlighting insertion of removable boards on sleds into the z-divider boards.
- [0014] Figure 8 is a top view of removable boards being inserted into the honeycomb interconnect structure.
- [0015] Figure 9 shows an air flow plenum in the z-divider board.
- [0016] Figure 10 shows a dual-sided z-divider board.
- [0017] Figure 11 shows a small board connected to the rear of a z-divider board.

DETAILED DESCRIPTION

[0018] The present invention relates to an improvement in electronic system interconnect. The following description is presented to enable one of ordinary skill in the art to make and use the invention as provided in the context of a particular application and its requirements. Various modifications to the preferred embodiment will be apparent to those with skill in the art, and the general principles defined herein may be applied to other embodiments. Therefore, the present invention is not intended to be limited to the particular embodiments shown and described, but is to be accorded the widest scope consistent with the principles and novel features herein disclosed.

[0019] The inventor has realized that a backplane may act as a wall to block airflow between removable boards inserted into the backplane. The inventor realizes that a flat planar backplane may be replaced by a honeycomb-like (or grid-like) structure. In some exemplary embodiments each cell of the honeycomb structure can receive one removable board. The walls of the honeycomb structure are interconnect boards. The removable board is inserted parallel to two of the walls of a honeycomb cell. Air may flow parallel to both the removable board and to the cell walls of the honeycomb structure. Thus the airflow-blocking backplane has been opened up by the cells of the honeycomb structure, allowing air to pass through and cool both the removable boards and the interconnect boards.

[0020] Figures 1A-E show construction of a honeycomb structure that replaces a backplane for interconnect. In Fig. 1A, y-plane board 10 forms the floor of the structure and is in the y-plane (that is, a y-plane board 10 has a normal that is parallel to the y-axis). Z-plane board 12 forms the right edge of the structure and is in the z-plane (that is, a Z-plane board 12 has a normal that is parallel to the z-axis). Z-divider boards 14 are in other z-planes that are parallel to z-plane board 12 (and, consistent with the naming convention used herein, Z-divider boards 14 have a normal that is parallel to the z-axis). Z-planes have normal vectors that are parallel to the z-axis. Z-divider boards 14 are inserted into connector sockets on y-plane board 10 or are otherwise mounted to y-plane board 10.

[0021] In Fig. 1B, a second y-plane board 10 has been attached to the tops of the first row of z-divider boards 14 and to z-plane board 12. Edge connectors, sockets, or other standard connectors may be used. A second row of z-divider boards 14 is then inserted into sockets on the top of second y-plane board 10.

[0022] In Fig. 1C, a third y-plane board 10 has been attached to the tops of the second row of z-divider boards 14 and to z-plane board 12. A third row of z-divider boards 14 is then inserted into sockets on the top of third y-plane board 10.

[0023] In Fig. 1D, a fourth y-plane board 10 has been attached to the tops of the third row of z-divider boards 14 and to z-plane board 12. A fourth row of z-divider boards 14 is then inserted into sockets or other connectors on the top of fourth y-plane board 10.

[0024] In Fig. 1E, a fifth y-plane board 10 has been attached to the tops of the fourth row of z-divider boards 14 and to z-plane board 12. A second z-plane board 12 is

attached to the left edges of all five y-plane boards 10.

[0025] A total of 16 honeycomb cells are formed by the structure in Fig. 1E. Each cell has two edges, a top and a bottom, formed from parts of two y-plane board 10. Each cell has two sides, formed by two z-divider boards 14, or by one z-divider boards 14 and one z-plane board 12.

[0026] Y-plane boards 10, z-plane boards 12, and z-divider boards 14 are adapted to be interconnected to other boards and may include one or more interconnect devices formed on them, such as by metal wiring traces on a printed-circuit board (PCB), sockets, adapters, plugs, and the like. Edge connectors or sockets allow interconnect between boards where y-plane boards 10, z-plane boards 12, and z-divider boards 14 intersect.

[0027] As is shown later in Figs. 5-6, one removable board (removable board 30) may be mated with various parts of the 16 cells of Fig. 1E. The removable board 30 is in the z-plane and parallel to z-divider boards 14 and z-plane board 12.

[0028] Figure 2 shows a bank of fans that pulls air through the honeycomb interconnect structure. Fan bank 20 has several fans 22 that pull air from their fronts and expels the air behind fan bank 20. The air flow is in the x direction, according to the x,y,z reference used in the drawings. Fans 22 may be mounted to fan trays or racks that are removable, such as for servicing, upgrading or replacement of faulty fans 22, or other boards 10, 12, 14 or 30 .

[0029] Figure 3 shows the honeycomb interconnect structure with a fan bank creating an airflow through the cells of the honeycomb structure. Fan bank 20 is attached to one x-plane (e.g., the rear) of honeycomb interconnect structure 100 also shown in Fig. 1E. Fan bank 20 moves air through the cells of the honeycomb interconnect structure.

[0030] Air flows in the negative x direction in the exemplary embodiment, parallel to the surfaces of the removable boards (not shown), z-divider boards 14, and z-plane board 12. This minus x-direction airflow is also parallel to the surfaces of y-plane boards 10.

[0031] Y-plane boards 10 are in the exemplary embodiments orthogonal to z-plane boards 12 and z-divider boards 14 but substantially parallel to the airflow and the direction of removal of the removable boards. Z-plane boards 12 and z-divider boards 14 are orthogonal to y-plane board 10 but parallel to the airflow and the direction of removal

of the removable boards. Since none of y-plane boards 10, z-plane boards 12, or z-divider boards 14 are perpendicular to the airflow direction (none are orthogonal), the airflow from fan bank 20 is not substantially impeded. There is no wall, such as a flat backplane board, to block the airflow.

[0032] Figure 4 shows the honeycomb interconnect structure with sled carriers to guide removable boards. While the removable boards could be inserted into each cell of the honeycomb, an extension of the honeycomb interconnect is used to guide and receive the removable boards.

[0033] An extension of the honeycomb interconnect structure of y-plane boards 10, z-plane boards 12, and z-divider boards 14 is provided by sled carrier walls 18, sled carrier dividers 16, and sled carrier floors 19. Sled carrier walls 18, sled carrier dividers 16, and sled carrier floors 19 may be formed in the same basic manner as described for y-plane boards 10, z-plane boards 12, and z-divider boards 14 as shown in Figs. 1A-E and is placed in front of the honeycomb interconnect structure of y-plane boards 10, z-plane boards 12, and z-divider boards 14. Alternative arrangements and embodiments of sleds 16, 18 and 19 may also be provided. Sleds 16, 18 and 19 may provide mere structural support or may be electrically connected to portions of boards, 10 or 12.

[0034] However, sled carrier dividers 16 are offset from the positions of z-divider boards 14. This offset allows the front edges of z-divider boards 14 to be exposed between or next to sled carrier dividers 16. A removable board (not shown) is connected to this exposed edge of z-divider board 14.

[0035] Sled guides 24 are formed on the top surfaces of sled carrier floors 19. Each sled guide 24 can be a groove or other positioning aid that accepts an edge of a removable board, or a sled that holds the removable board, and guides the removable board into position with the exposed edge of z-divider board 14 to allow for the connectors to mate during insertion. Other sled guides 24 may be formed on the bottoms of sled carrier floors 19 and on the bottom of the top sled carrier wall 18, but these are not visible in the perspective view of Fig. 4.

[0036] Figure 5 shows a removable board being inserted into the sled guides to mate with an exposed edge of the z-divider boards. Sled 30 holds a removable board, such as a circuit board with integrated circuits (IC's) and other electronic components. Each

removable board may be a computer processor board, a communication board, a storage card, a network card, etc. in a larger system.

[0037] Sled 30 has edges 26 that fit into sled guides 24 on sled carrier floors 19. The direction of insertion of sled 30 is in the negative x direction. This is the same direction as the airflow direction.

[0038] In Figure 6, several sleds of removable boards have been inserted into the honeycomb interconnect structure. Edges 26 of sleds 30 are guided by sled guides 24 as they are pushed in the $-x$ direction. Sled guides 24 align a connector at the far edge of the removable board mounted on sled 30 with a mating connector on the exposed edge of z-divider board 14. A final firm pressure is applied to lock the connectors together, bringing the removable board on sled 30 in electrical contact with z-divider board 14, which is interconnected to other removable boards by the honeycomb of interconnected y-plane boards 10, z-plane boards 12, and z-divider boards 14.

[0039] When inserted, the removable boards on sleds 30 are parallel to sled carrier dividers 16 and approximately co-planar with some z-divider boards 14. Airflow from fan bank 20 moves across the surfaces of the removable boards on sleds 30, and also across the surfaces of z-divider boards 14, y-plane boards 10, and z-plane boards 12. None of the boards or dividers are perpendicular to the direction of airflow. Thus cooling is enhanced by the geometry of the honeycomb interconnect structure.

[0040] Figure 7 is a side view highlighting insertion of removable boards on sleds into the z-divider boards. Removable boards 50 are printed-circuit boards (PCB's) with integrated circuit chips 52 mounted thereon and connected by metal wiring traces. Connectors 42 mate with connectors 44 on z-divider boards 14 when fully inserted.

[0041] Sleds 30 are attached to removable boards 50 and have edges 26 that fit into sled guides 24 on sled carrier floors 19. Sleds 30 may be plastic or have hand grips that facilitate handling and insertion and removal. Insertion is in the $-x$ direction and removal is in the $+x$ direction. Clips or other mechanisms to secure sled 30 or removable board 50 in place may be added.

[0042] Z-divider boards 14 have connectors 44, 40 along three edges. Connectors 44 make connection to removable boards 50, while connectors 40 make connection to y-plane board 10, which are shown edge-on in Fig. 7. Metal traces on z-divider boards 14

provide portions of the interconnection among the connected boards. The center connector pads or pins in each set of connectors are connected to power traces 34, which can include power and ground traces. Z fabric traces 36 connect between connectors 40 to connect between y-plane board 10, while Y fabric traces 38 connect between connector 44 and connector 40, forming interconnect from removable boards 50 to y-plane board 10. A folded toroidal interconnect of sleds 30 may be achieved through the y-plane as well, and even through a combination with Z-divider boards 14.

[0043] Figure 8 is a top view of removable boards being inserted into the honeycomb interconnect structure. Y-plane board 10 spans and connects to several z-divider boards 14. Z-divider boards 14 and removable boards 50 are shown edge-on. Sled guides 24 on sled carrier floors 19 guide edges of sled 30 to position removable boards 50 relative to z-divider boards 14 so that connectors 42 can mate with connectors 44.

[0044] Connectors 40 on z-divider boards 14 connect to y-plane boards 10. Fan banks 20 pull air in the $-x$ direction, past the surfaces of z-divider boards 14 and removable boards 50. Fan controller boards 70 provide power to fans in fan banks 20 and may control fan speed or cycle fans on and off as needed. Power plane 66 provides power to fan controller boards 70 through connectors 74, 72, and also provides power to y-plane board 10 through connector 68. Power supply unit 60 on sled 30 has connector 62 that mates with connector 64 on power plane 66 to provide power generated by power supply unit 60, which may connect to external A.C. power.

[0045] Figure 9 shows an air flow plenum in the z-divider board. Notch 15 may be provided on the back of z-divider boards 14, on the rear edge that does not have connectors 40 or connectors 44. Notch 15 faces fan bank 20. Although the primary direction of airflow is in the $-x$ direction, notch 15 allows air to be balanced and distributed more equally in the y direction. Better distribution of airflow is possible. Fans may be located closer to the honeycomb structure when plenums are provided.

[0046] Figure 10 shows a dual-sided z-divider board. Additional connectors 82 are placed along the rear edge of z-divider boards 14, away from connectors 44. Rear board 80 has connectors 84 that mate with connectors 82, allowing z-divider board 14 to connect to rear board 80 as well as removable board 50 through connectors 44. Thus two boards with IC's 32 may connect to each z-divider board 14 in this alternate embodiment.

[0047] Figure 11 shows a small board connected to the rear of a z-divider board. Card 90 is a small board with connectors 84 that mate with connectors 82 on z-divider board 14. Card 90 fits within an opening in the rear of z-divider board 14. Card 90 may provide active circuitry such as diagnostic or monitoring circuitry.

[0048] Several other embodiments are contemplated by the inventor. For example the honeycomb structure may be expanded in any of the three dimensions. The density may be increased by tighter spacing of boards, or reduced by increased spacing. Empty areas may be added, or honeycomb cells without a sled connected may be used for various purposes, such as for additional airflow, cabling or access for diagnostics, etc. While Figs. 1A-E have shown a particular method to build the honeycomb structure, other methods or sequences of steps could be substituted. Rather than have y-plane board 10 and z-plane board 12 that span many honeycomb cells, these boards could span only one cell, and many such boards used, such as for z-divider boards 14. Boards may be standard printed-circuit boards (PCB's) made from fiberglass and metal layers, or could have other substrates, such as ceramic, glass, sapphire, rigid or flexible plastics, etc. Various components may be mounted to the boards, or may be formed integrally with the boards, such as capacitors and resistors. Flat cables (ribbon cables) could be used in place of PCBs in the Y-plane direction. In addition to card 90, connectors 84 could be used to mate with cables or could be replaced with optical transceivers.

[0049] While sled guides have been described as grooves that accept an edge of a sled, many other kinds of guiding mechanisms could be substituted, such as springs, clips, ridges, depressions, etc. Locking or securing mechanisms and eject mechanisms may also be added as part of the connectors or as part of the boards and sleds. Sleds 30 could be guided by rack guides that are mounted to sides such as sled carrier dividers 16 rather than to the bottom and top, sled carrier floors 19. Both side and top/bottom guides could be employed. Sled 30 or removable boards 50 could overlap with z-divider boards

14. Rather than connect to the front edge of z-divider boards 14, removable board 50 could connect with a connector mounted farther back on z-divider board 14.

[0050] The entire honeycomb structure, fans, and carrier guides could be mounted on racks inside an electrical cabinet or other fixture. Indicators such as lights or displays could be added to indicate functioning and non-functioning removable boards 50 or z-divider boards 14 or other components.

[0051] While one removable board 50 per sled 30 has been described, there may be a stack of removable boards 50 that fit on one sled. Just one of the removable boards 50 per sled could have a connector that mates with the edge of z-divider boards 14, with the other boards piggy-backed or otherwise connected to the removable board 50 that makes the connection, or two or more boards could have connectors to a stack of connectors on z-divider board 14. Tiled PCB's may be used to span longer distances than the size of a single Y-plane. Z-Plane or other boards may be mirrored and flipped, or may be split or combined. Connections may jump over, pass through, or skip one or more boards. Striping may be used.

[0052] Connectors may be asymmetric and keyed or offset to prevent improper or reversed insertion. Boards may be arrayed and mirrored in orientation rather than have the same orientation as shown. Sleds 30 and removable boards 50 may be much longer than shown to allow for more circuitry. Various width, height, and length ratios may be substituted for the boards, sleds, fans, and other components.

[0053] The x, y, z coordinate system used is an example for reference. Other assignments of x, y, z could be substituted, and other coordinate systems could be used, such as polar coordinates. The use of the x, y, z coordinate system is to aid understanding of the invention and is not meant to limit the invention. For example, the direction of airflow could be designated as the -z direction. Then z-plane board 12 and z-divider boards 14 are in the x plane or y plane. While airflow in the -x direction has been shown,

air could be pushed from behind into the honeycomb structure rather than pulled through, resulting in a +x airflow direction. Additional fans or vents could be added for a more complex airflow.

[0054] Notches could be added to the y-plane boards rather than to the z-divider boards. Notches may have various shapes. Rather than use a notch, a hole, or multiple holes could be used as plenums. The size and shape of various boards could be uniform or could vary, such as for other purposes, such as power or fan control. The honeycomb cells could be square or rectangular when 90-degree connectors are used, but could have other shapes such as hexagons if connectors with lower angles are used. A hexagonal cell could have six walls rather than four walls and use 60-degree connectors. Flexible boards could be used rather than rigid boards. By bending the flexible board, various angles could be achieved. A degenerated hexagonal honeycomb structure is one possibility. The boards could have both flexible and rigid parts. Flexible parts could overlap with adjacent boards and use either contact couplers or non-contact couplers. While contact-based couplers have been described, some or all of the couplers could be non-contact, such as capacitive couplers or inductive couplers.

[0055] The background of the invention section may contain background information about the problem or environment of the invention rather than describe prior art by others. Thus inclusion of material in the background section is not an admission of prior art by the Applicant.

[0056] Any advantages and benefits described may not apply to all embodiments of the invention. When the word "means" is recited in a claim element, Applicant intends for the claim element to fall under 35 USC Sect. 112, paragraph 6. Often a label of one or more words precedes the word "means". The word or words preceding the word "means" is a label intended to ease referencing of claim elements and is not intended to convey a structural limitation. Such means-plus-function claims are intended to cover not only the structures described herein for performing the function and their structural equivalents, but also equivalent structures. For example, although a nail and a screw have different structures, they are equivalent structures since they both perform the function of

fastening. Claims that do not use the word “means” are not intended to fall under 35 USC Sect. 112, paragraph 6. Signals are typically electronic signals, but may be optical signals such as can be carried over a fiber optic line.

[0057] The foregoing description of the embodiments of the invention has been presented for the purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise form disclosed. Many modifications and variations are possible in light of the above teaching. It is intended that the scope of the invention be limited not by this detailed description, but rather by the claims appended hereto.

WHAT IS CLAIMED IS:

1. An electronic interconnecting chassis comprising:
a plurality of y-plane boards, each of said y-plane boards having a normal substantially parallel to a y-axis;
a plurality of z-plane boards, each of said z-plane boards having a normal parallel to a z-axis;
y-z connectors that connect z-plane boards to y-plane boards, the y-z connectors making electrical connection between the y-plane boards and the z-plane boards;
z-divider boards, each z-divider board having one or more connectors for connecting to one or more adjacent y-plane boards in the plurality of y-plane boards; and
a fan bank having fans for blowing air in an x direction that is parallel to the z-planes and to the y-planes, wherein cooling air passes in a substantially parallel path along surfaces of the y-plane boards, z-plane boards, and z-divider boards, wherein the air is not substantially blocked by the y-plane boards, z-plane boards, and z-divider boards.
2. The electronic interconnecting chassis of claim 1, further comprising:
a middle connector on the z-divider board near a middle edge between the opposing edges, wherein the z-divider board has wiring traces that electrically connect the middle connector to y-z connectors.
3. The electronic interconnecting chassis of claim 2, further comprising:
a plurality of removable boards, each removable board having integrated circuits mounted thereon and wiring traces formed therein that connect the integrated circuits to a mating connector; and
a carrier structure for supporting the plurality of removable boards and for guiding each removable board into position near a middle connector of a z-divider board so that the mating connector on the removable board makes electrical connection with the middle connector on the z-divider board;
wherein the removable boards in the plurality of removable boards are situated in z-planes that are orthogonal to the z-axis and parallel to the z-divider boards.

4. The electronic interconnecting chassis of claim 3, wherein the plurality of y-plane boards and the plurality of z-plane boards intersect to form a honeycomb interconnect structure having at least 4 honeycomb cells, each honeycomb cell having two walls formed by y-plane boards and two walls formed by z-plane boards.

5. The electronic interconnecting chassis of claim 4, wherein the carrier structure comprises a plurality of guides for guiding the plurality of removable boards into position for connection to the z-divider boards, wherein the guides are substantially parallel to a direction of airflow, whereby removable boards are inserted in a direction parallel to airflow.

6. The electronic interconnecting chassis of claim 5, further comprising:
a plurality of sleds, each sled for supporting a removable board in the plurality of removable boards, each sled having a matching guide (16, 18, 19) that slides along a guide in the plurality of guides when the sled is inserted into the carrier structure.

7. A honeycomb interconnect structure comprising:
a plurality of interconnect boards, each interconnect board in the plurality of interconnect boards having a major surface, edges, wiring traces, a fabric connector for connecting to other interconnect boards in the plurality of interconnect boards, and a target connector, wherein the wiring traces connect the target connector to the fabric connector;
a plurality of removable boards, each removable board in the plurality of removable boards having a major surface, edges, wiring traces, integrated circuits, and a local connector for connecting to the target connector on an interconnect board in the plurality of interconnect boards, wherein the wiring traces connect the local connector to the integrated circuits; and
a plurality of cells formed by the plurality of interconnect boards, each cell in the plurality of cells having a central axis;
wherein the plurality of cells comprises at least 4 cells; and
a bank of fans that generate airflow along the central axis of the plurality of cells for cooling the plurality of interconnect boards and for cooling the plurality of removable boards;

wherein airflow is parallel to the major surface of the interconnect board, wherein edges of the plurality of interconnect boards face the airflow.

8. The honeycomb interconnect structure of claim 7, further comprising:
a plurality of carrier guides for guiding the plurality of removable boards into position so that the local connector mates with the target connector for each removable board;

a carrier structure for supporting the carrier guides, the carrier structure having a plurality of carrier cells that are offset aligned with the plurality of cells, wherein each carrier cell has at least one wall that is offset to expose the target connector on the interconnect board, whereby the carrier cells are aligned with the cells and offset from the target connector.

9. The honeycomb interconnect structure of claim 8, further comprising:
a plurality of sleds, each sled being mounted to a removable board in the plurality of removable boards; and

a sled guide formed on each sled, the sled guide for sliding along a carrier guide in the plurality of carrier guides when the local connector on the removable board is inserted into the target connector.

10. The honeycomb interconnect structure of claim 8, wherein the interconnect boards have a flexible portion that is bent to form a bent wall of a cell, whereby the cells have bent walls formed by the flexible portions of the interconnect boards.

11. A y-interconnect board comprising:

a substrate which comprises a y-plane board in a y-plane that is perpendicular to a y-axis;

wherein the y-plane board is adapted to connect to and form part of a honeycomb cell structure with a plurality of z-plane boards in z-planes that are perpendicular to a z-axis and with a plurality of removable boards, each removable board having integrated circuits mounted thereon and wiring traces formed therein that connect the integrated circuits to a mating connector; and

wherein the substrate is situated to be cooled by air flow from a fan bank having fans for blowing air in an x direction that is parallel to the z-planes and to the y-

planes, wherein cooling air passes in a substantially parallel path along surfaces of the removable boards and surfaces of the y-plane board, wherein the air is not blocked by the removable boards, the z-plane boards, and the y-plane boards, whereby air flow is parallel to major surfaces of the removable boards and interconnect boards.

12. A z-interconnect board comprising:
a substrate which comprises a z-plane board in a z-plane that is perpendicular to a z-axis;
wherein the z-plane board is adapted to connect to and form part of a honeycomb cell structure with a plurality of y-plane boards in y-planes that are perpendicular to a y-axis and with a plurality of removable boards, each removable board having integrated circuits mounted thereon and wiring traces formed therein that connect the integrated circuits to a mating connector;
wherein the substrate is situated to be cooled by air flow from a fan bank having fans for blowing air in an x direction that is parallel to the z-planes and to the y-planes, wherein cooling air passes in a substantially parallel path along surfaces of the removable boards and surfaces of the y-plane board, wherein the air is not blocked by the removable boards, the z-plane boards, and the y-plane boards,
whereby air flow is parallel to major surfaces of the removable boards and interconnect boards.

13. A removable interconnect board comprising:
a substrate which comprises a removable board, the removable board having integrated circuits mounted thereon and wiring traces formed therein that connect the integrated circuits to a mating connector;
wherein the removable board is adapted to be held by a carrier structure for supporting a plurality of removable boards and for guiding each removable board into position near a middle connector of a z-divider board so that the mating connector on the removable board makes electrical connection with the middle connector on the z-divider board;
wherein the removable board in the plurality of removable boards is situated in z-planes that are orthogonal to a z-axis and parallel to the z-divider board;

wherein the removable board is adapted to connect to and form part of a honeycomb cell structure with a plurality of z-plane boards in z-planes that are perpendicular to a z-axis and with a plurality of y-plane boards in y-planes that are perpendicular to a y-axis;

wherein the substrate is situated to be cooled by air flow from a fan bank having fans for blowing air in an x direction that is parallel to the z-planes and to the y-planes, wherein cooling air passes in a substantially parallel path along surfaces of the removable boards and surfaces of the y-plane boards, wherein the air is not blocked by the removable boards, the z-plane boards, and the y-plane boards,

whereby air flow is parallel to major surfaces of the removable boards and interconnect boards.

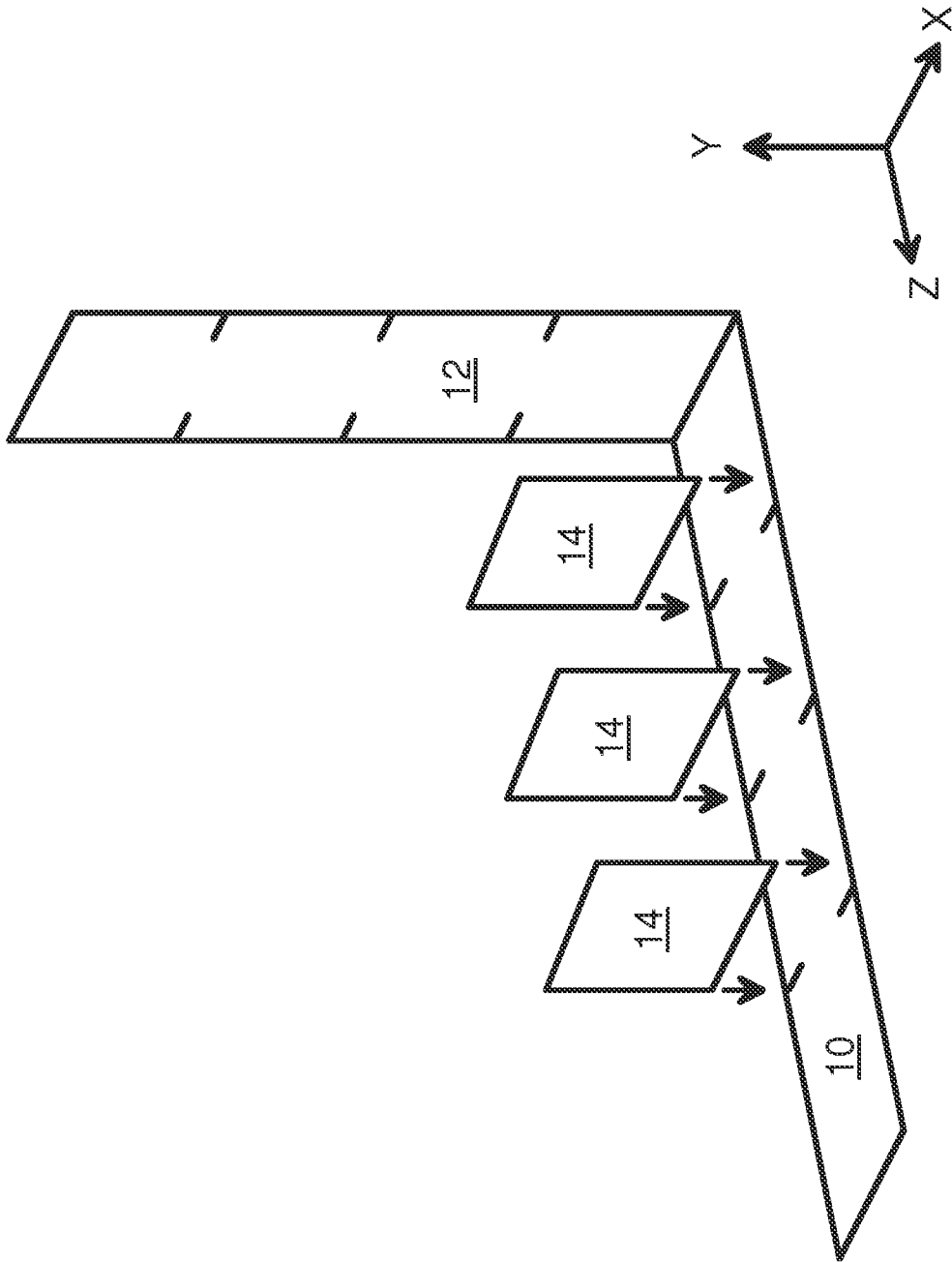


FIG. 1A

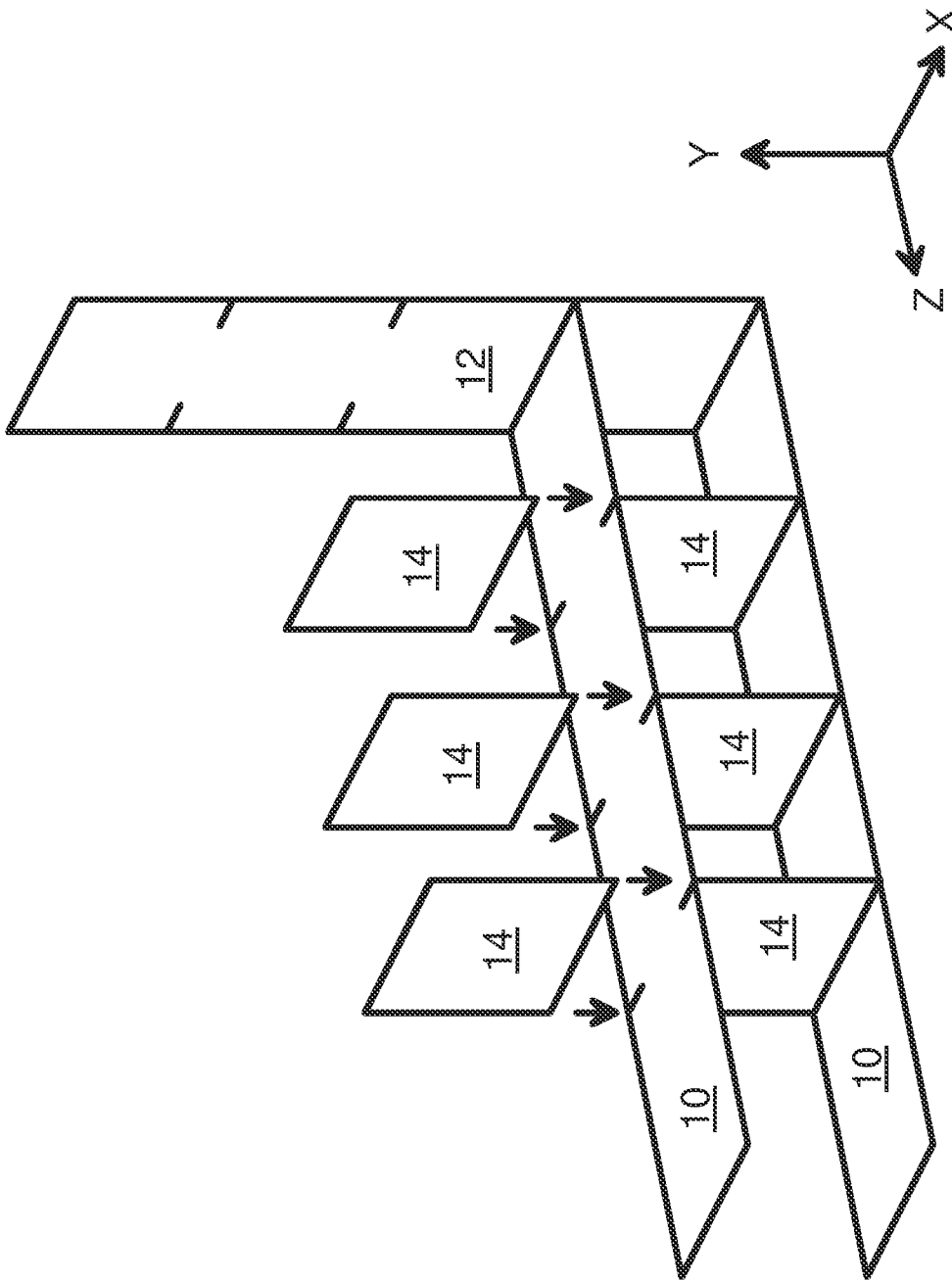


FIG. 1B

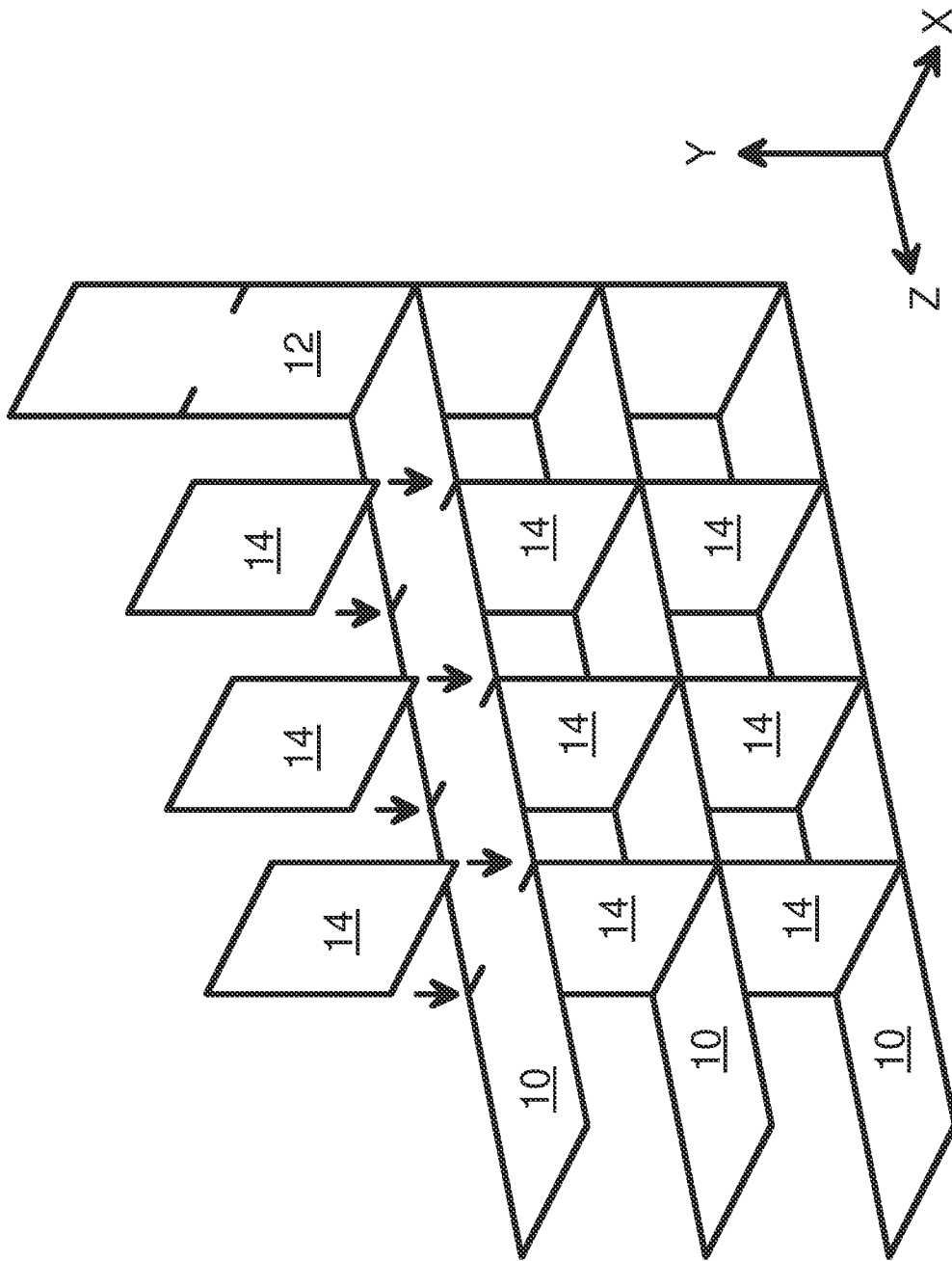


FIG. 1C

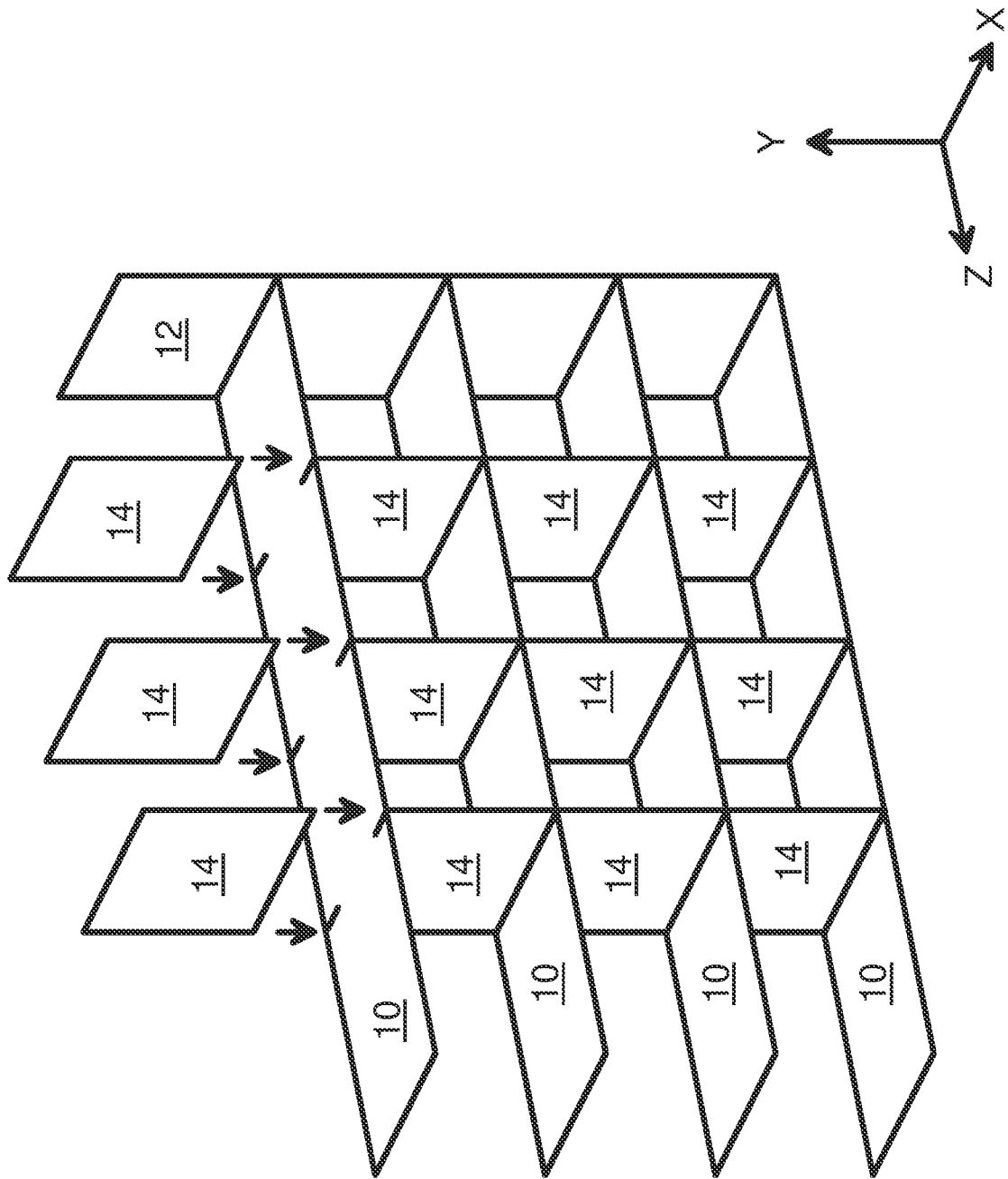


FIG. 1D

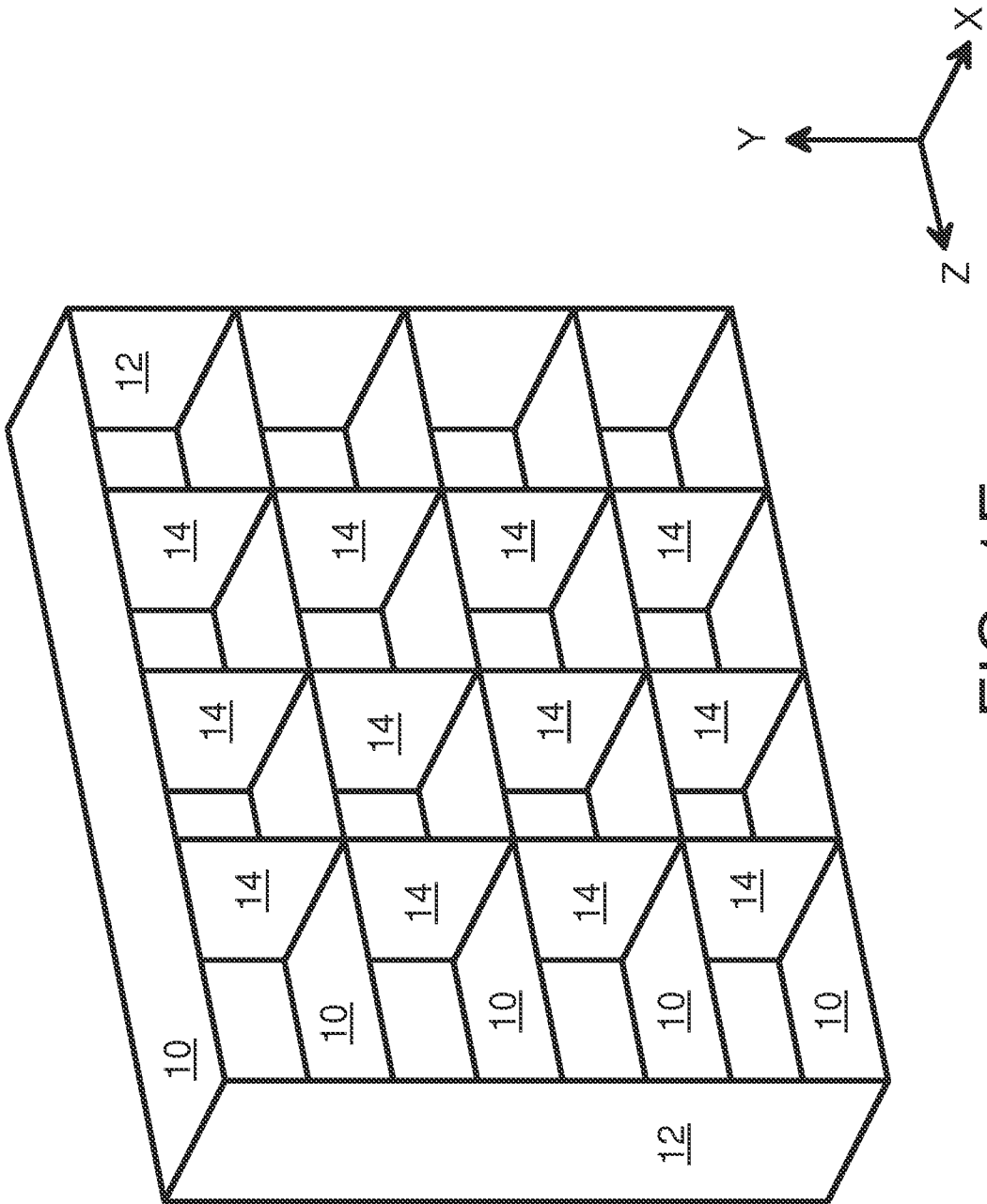


FIG. 1E

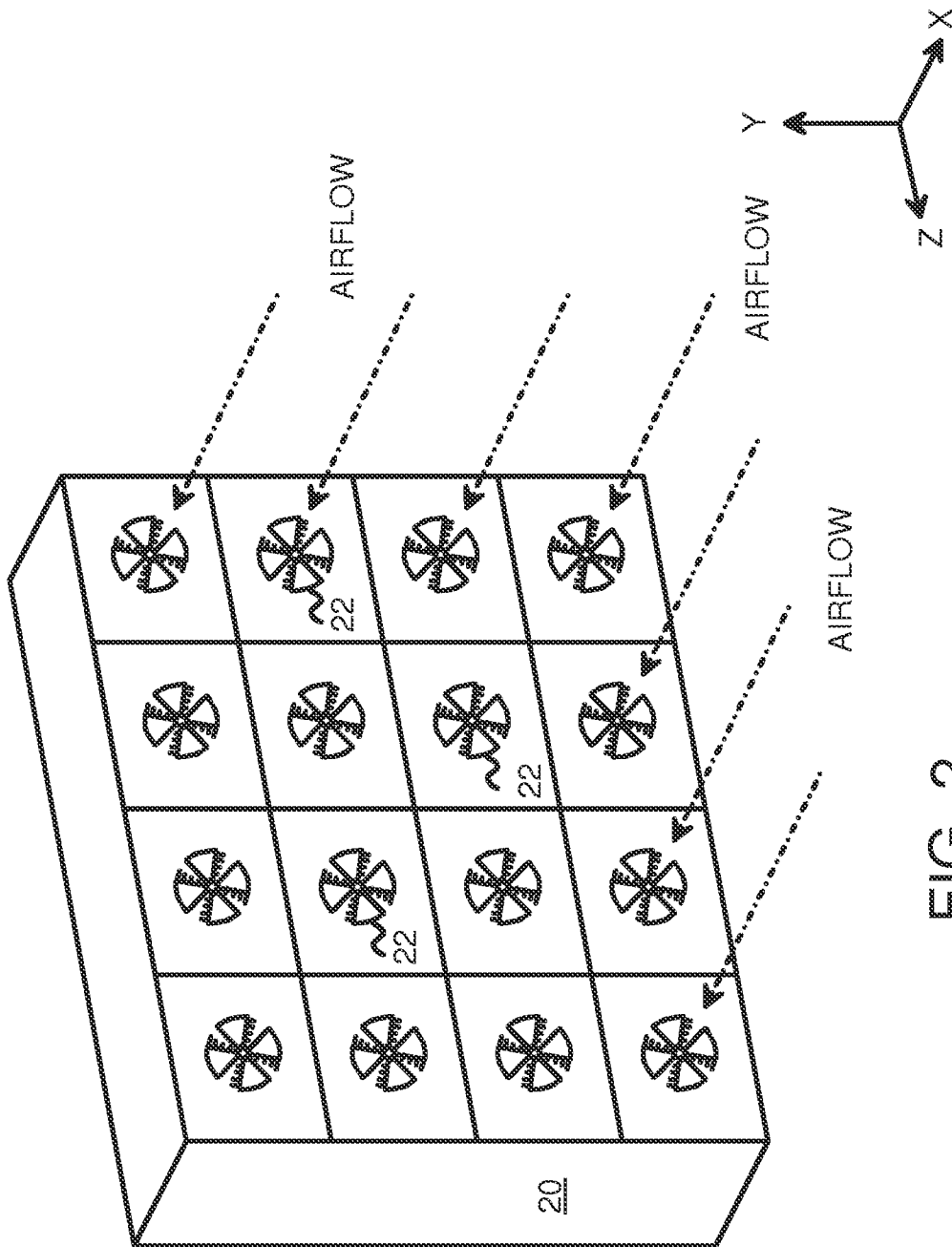


FIG. 2

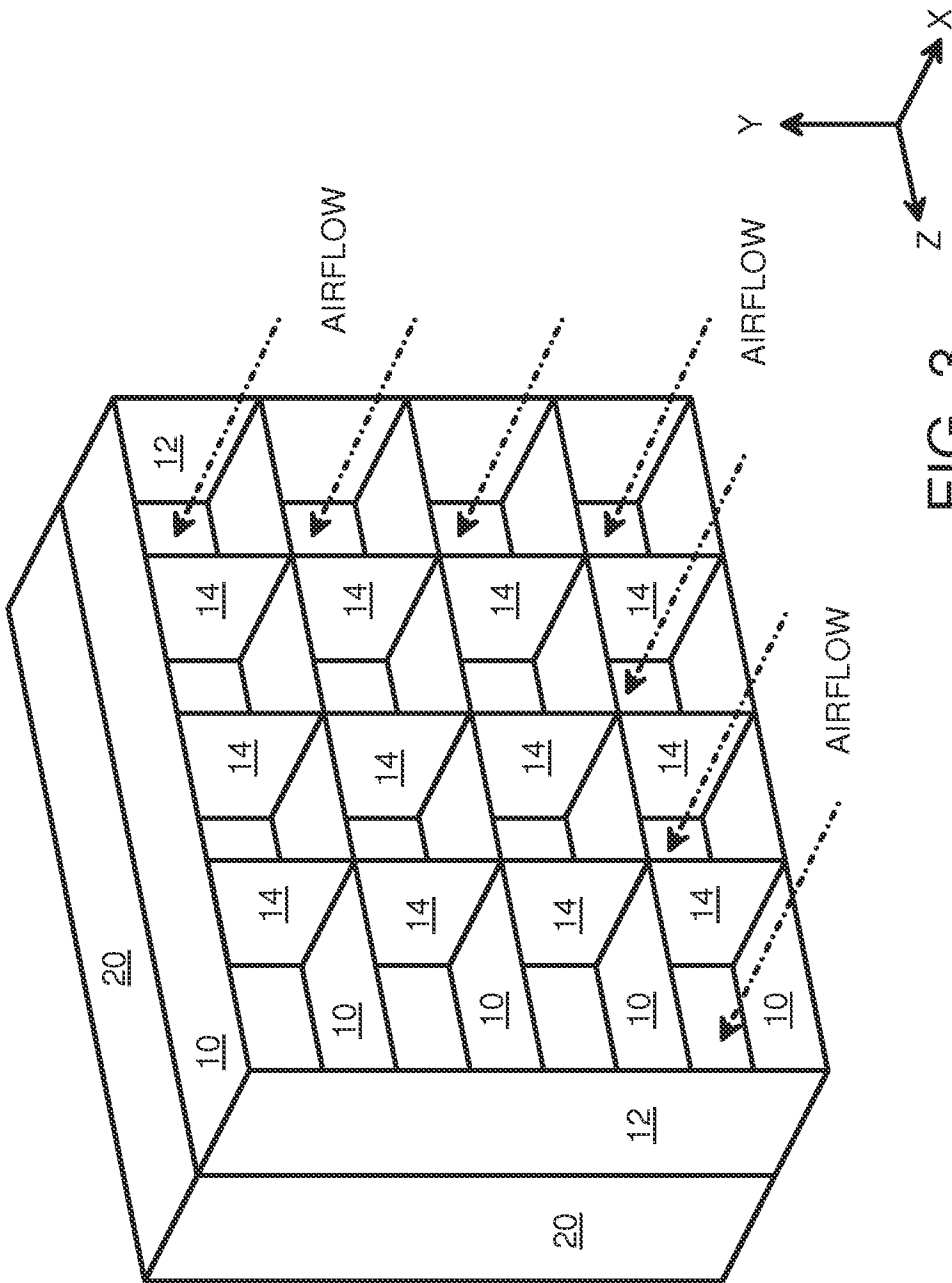


FIG. 3

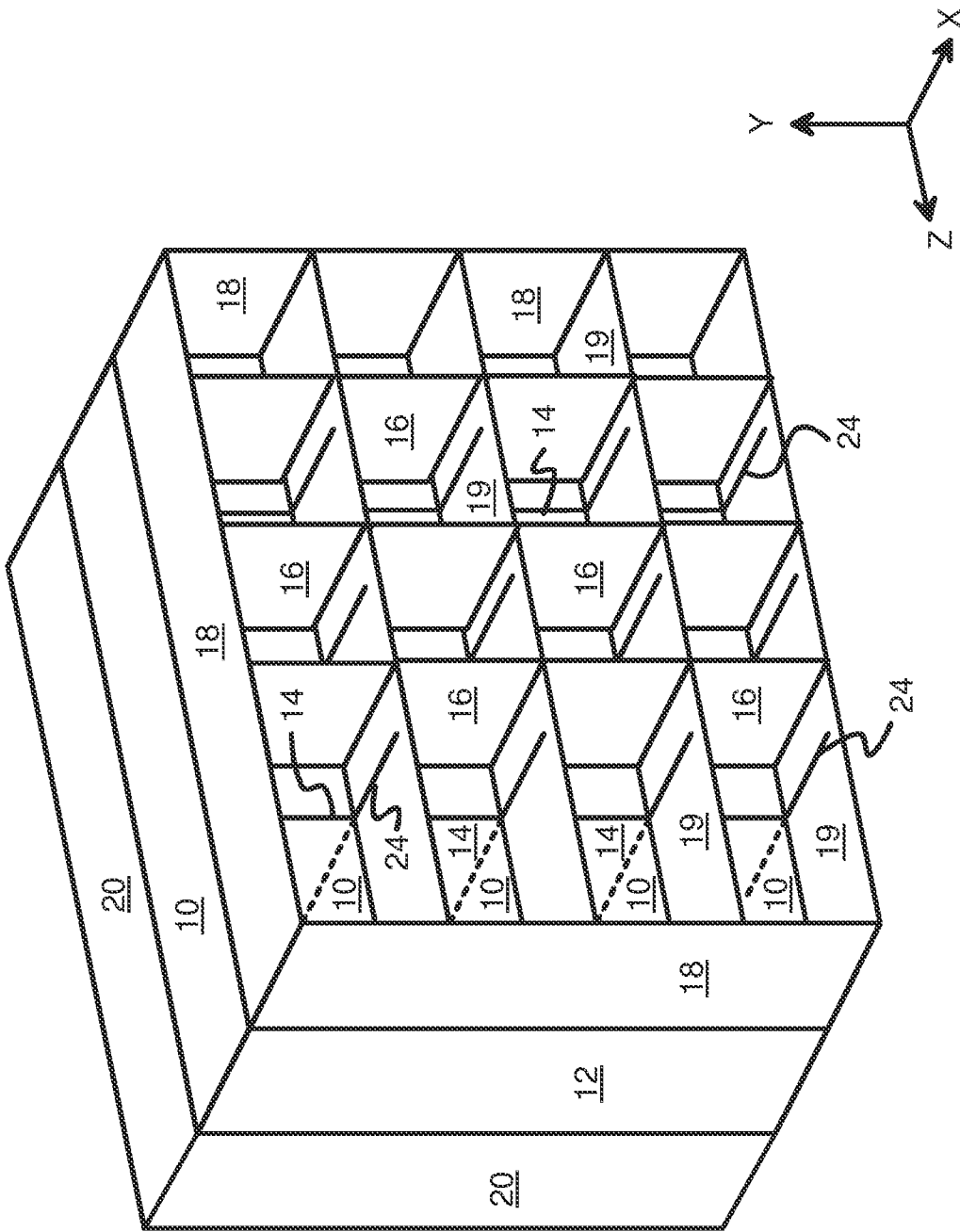


FIG. 4

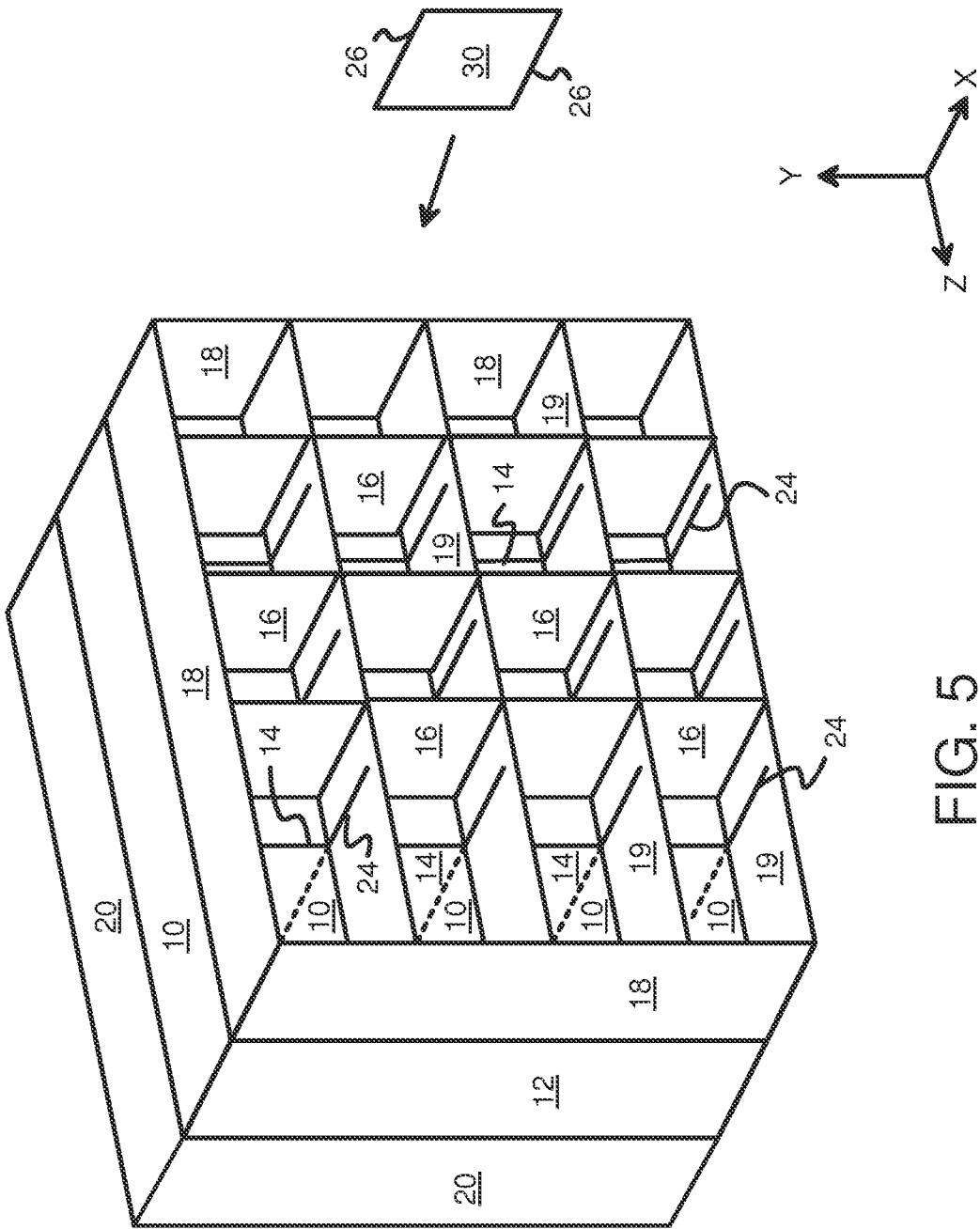


FIG. 5

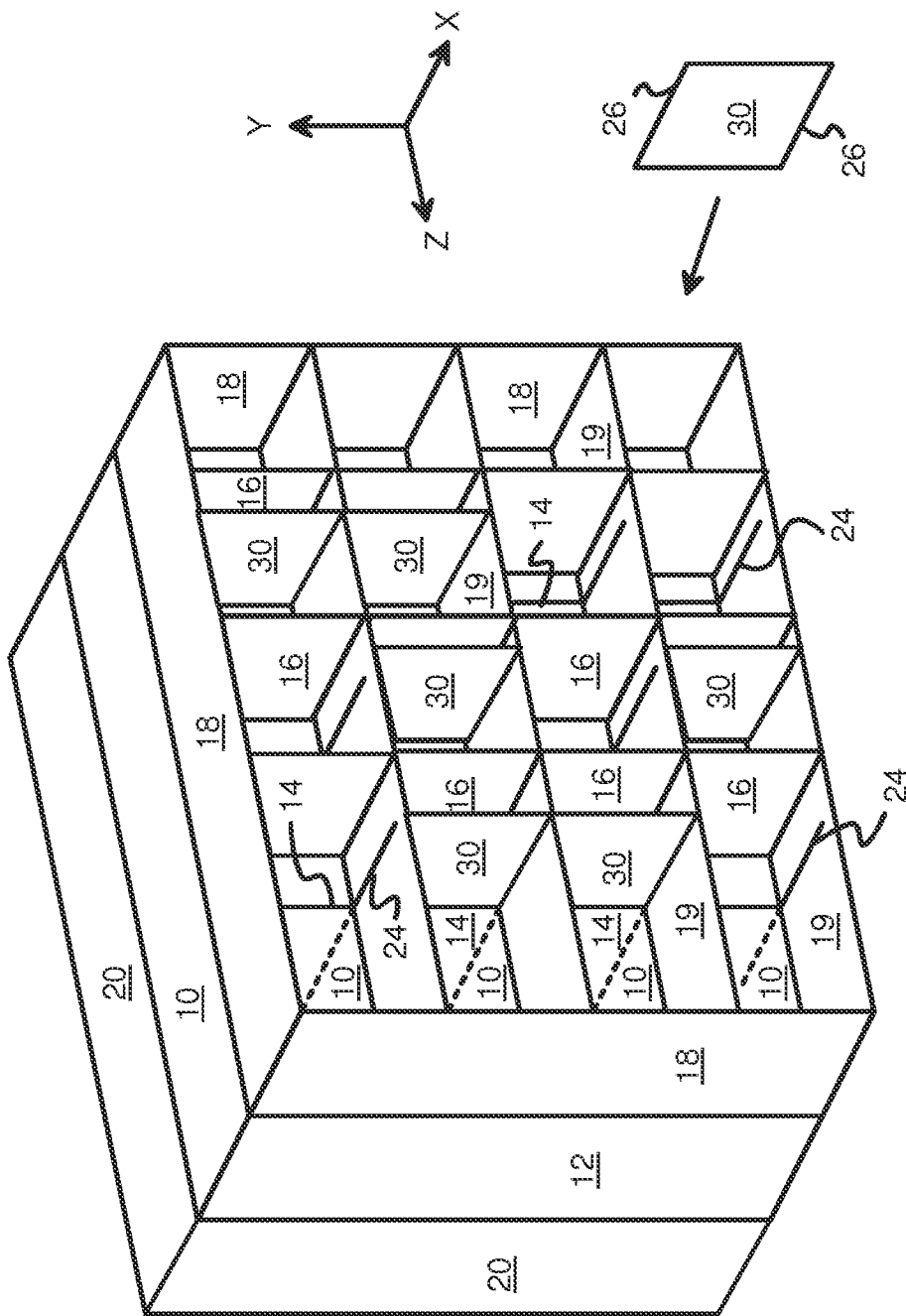
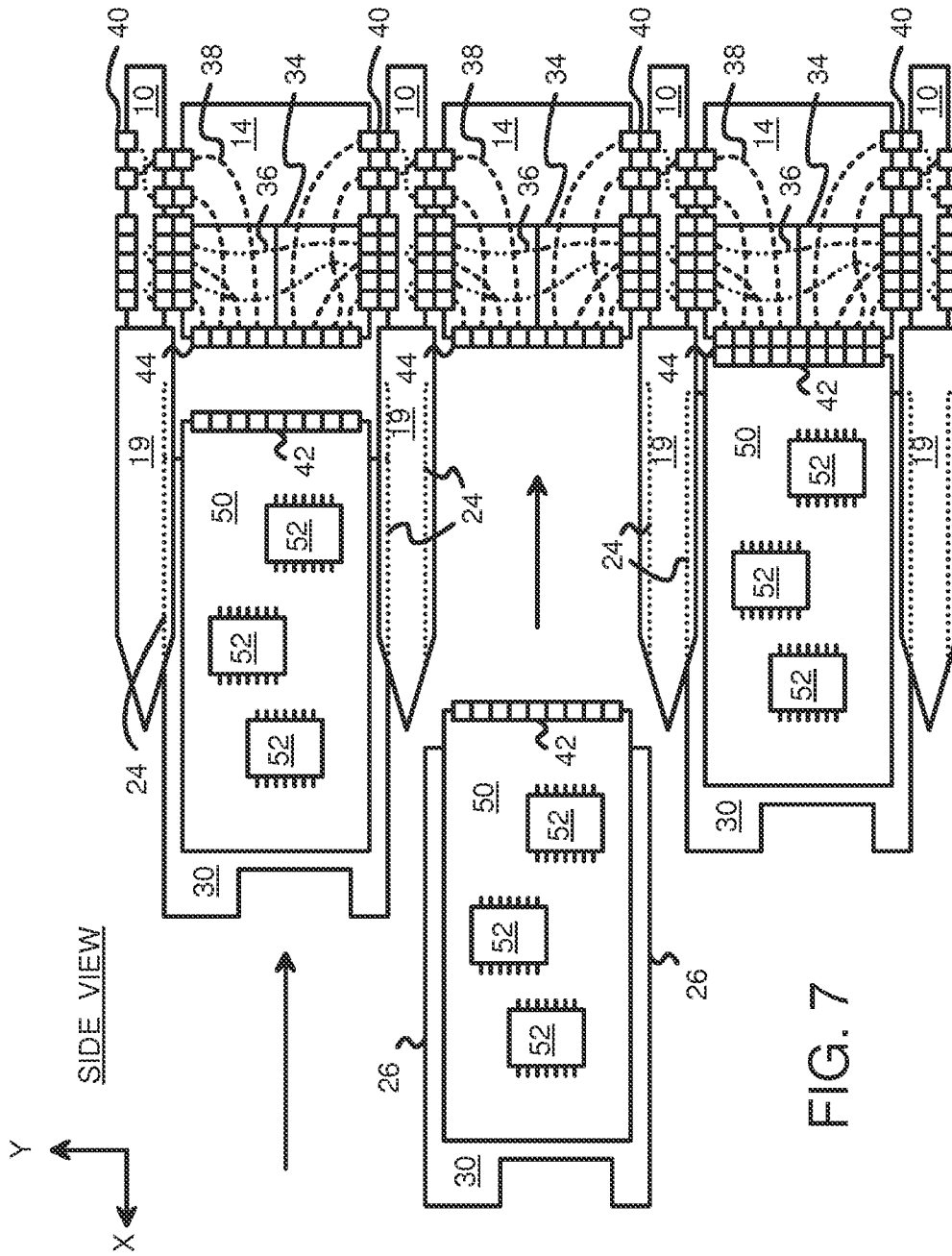


FIG. 6



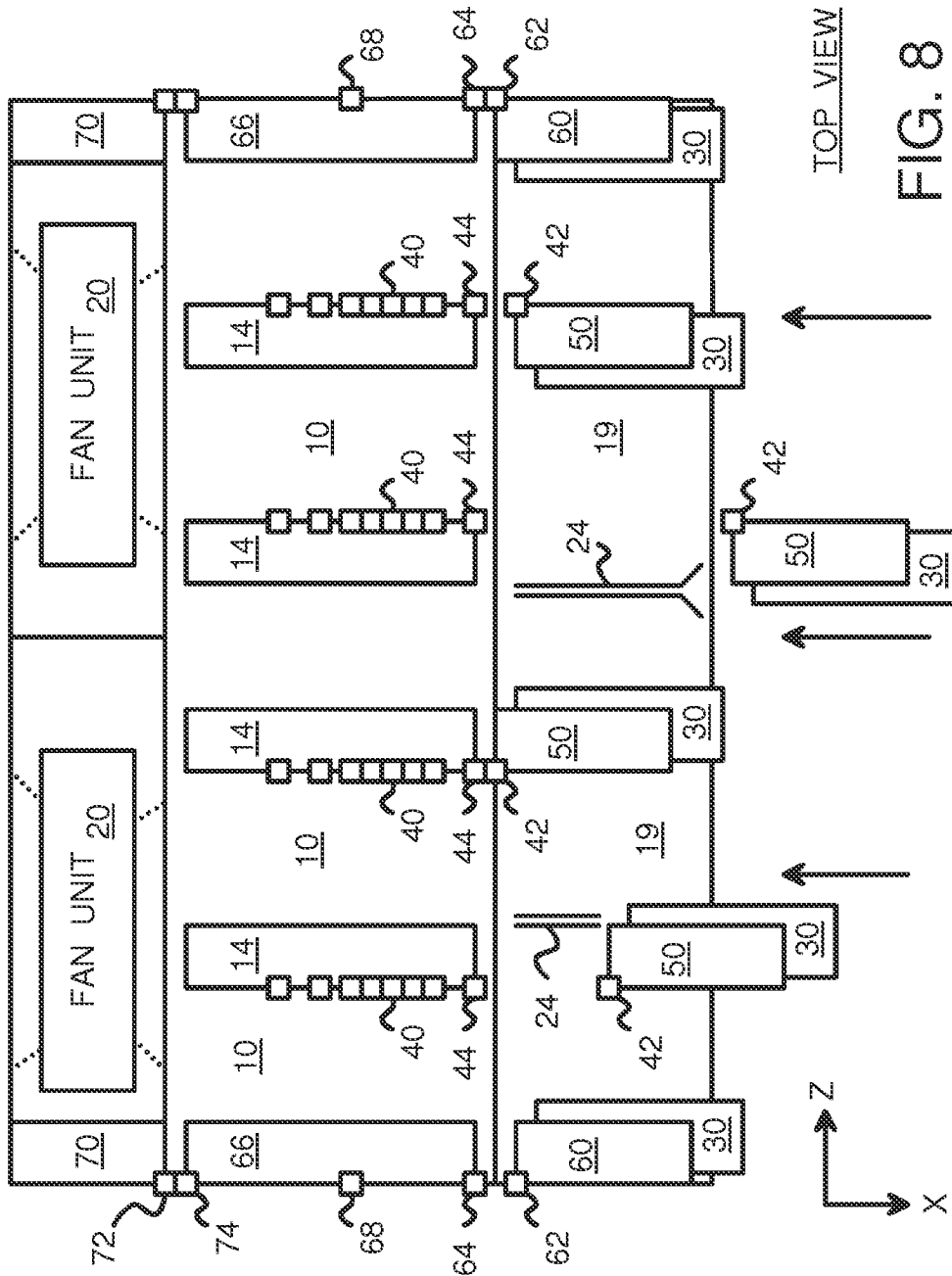


FIG. 8

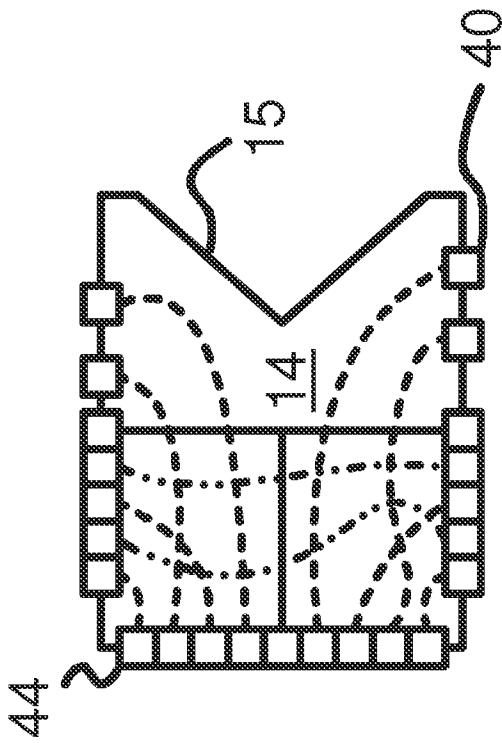


FIG. 9



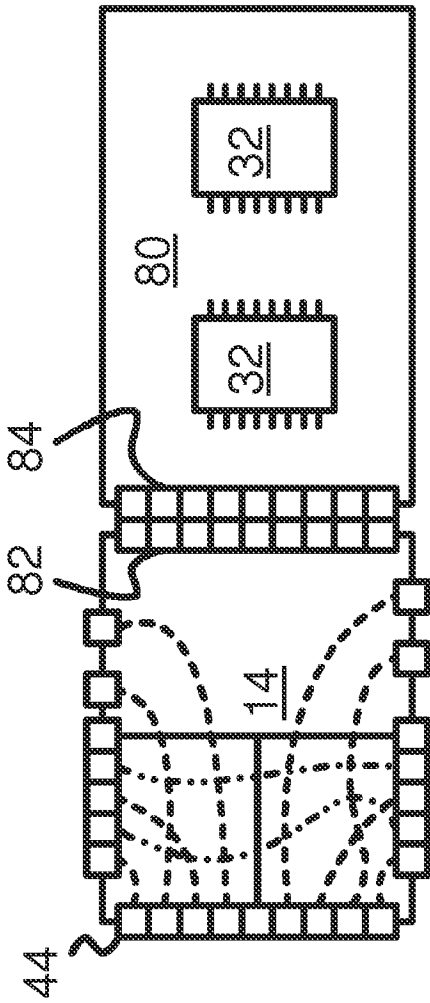
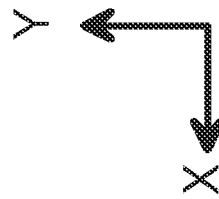


FIG. 10

SIDE VIEW



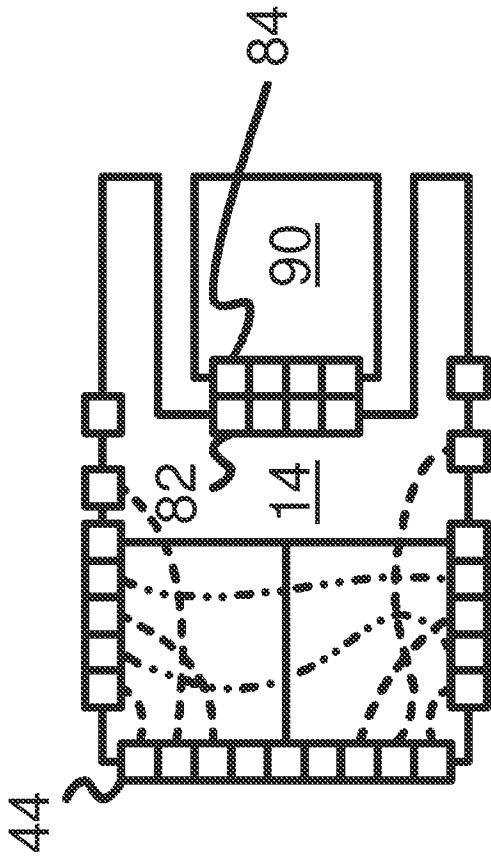
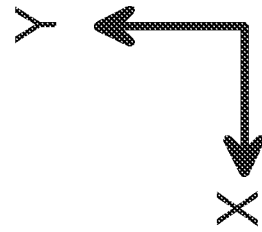


FIG. 11



SIDE VIEW

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2013/046942

A. CLASSIFICATION OF SUBJECT MATTER
INV. H05K7/14
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED
Minimum documentation searched (classification system followed by classification symbols)
H05K

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)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2002/182899 A1 (DEBORD PIERRE [FR] ET AL) 5 December 2002 (2002-12-05) paragraph [0008] - paragraph [0009] paragraph [0016]; figure 2 paragraph [0018] paragraph [0021] - paragraph [0023]; figures 3(b)-3(d) -----	1-13
X	US 2004/001311 A1 (DOBLAR DREW G [US] ET AL) 1 January 2004 (2004-01-01)	1
A	paragraph [0091]; figures 11a, 12c -----	2-13
A	US 5 329 418 A (TANABE NOBORU [JP]) 12 July 1994 (1994-07-12) column 4, line 14 - line 30; figure 1 column 5, line 24 - line 50; figure 6 -----	1-13

Further documents are listed in the continuation of Box C.

See patent family annex.

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"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 25 November 2013	Date of mailing of the international search report 03/12/2013
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Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer Rubenowitz, Astrid
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2013/046942

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2002182899 A1	05-12-2002	US 2002182899 A1	05-12-2002
		US 2005042893 A1	24-02-2005

US 2004001311 A1	01-01-2004	NONE	

US 5329418 A	12-07-1994	JP H05145208 A	11-06-1993
		US 5329418 A	12-07-1994
