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(54) Title: RAPIDLY DEPLOYABLE MODULAR BUILDING AND METHODS

(57) Abstract: A modular building comprises a sled comprising a rectangular box frame. A shed comprising a steel framework of spaced apart columns that are linked to one another by overhead ceiling beams to provide a rigid structural frame. A sliding expansion module is attached to the shed.

RAPIDLY DEPLOYABLE MODULAR BUILDING AND METHODS

Embodiments of the present invention relate to a modular building and related methods.

Modular buildings are pre-fabricated portable structures that are developed to facilitate shipment of building structures to building sites. The modular buildings are typically transported in large pre-assembled sections and then connected at the building site. Modular buildings can reduce the fabrication and assembly costs of building structures and can also be rapidly deployed to replace damaged or demolished buildings and houses, after natural disasters, such as hurricanes and earthquakes. Such replacement housing has to be constructed to be stored and readily deployable on short notice and tight planning cycles. To achieve such needs, it is desirable for the components and structures of the modular building to be standardized for mass production and storage. The standardization reduces fabrication costs and the warehouse storage space required to keep a large number of prefabricated components, and also allows for a wide variety of end use customization through user-selected components.

Modular buildings also have unique design requirements which are different from conventional building structures. For example, modular building should be designed to allow flexible configurations and ease of assembly on a building site. Labor resources in disaster zones are often very limited as most of the local labor resources are employed at repairing existing damaged structures to prevent further damage to these structures. Thus, it is desirable for replacement housing to be designed for easy set up and assembly by unskilled or low skill personnel. It is further desirable to have a replacement housing that is a customizable to allow configuration of the modular building at a building site to achieve unique requirements.

It is also desirable for the modular building to be structurally sound to withstand earthquakes and extreme storms such as hurricanes. When modular buildings are transported and set up in post-storm or earthquake disaster zones, such regions are often subject to other hurricanes in the same season or earthquakes aftershocks. Thus, replacement housing located in the same region should provide a seismically and hurricane resistant structural frame. This becomes even more difficult

when considering that the rapidly deployable housing has to be built from modular and transportable components and often has to be assembled on-site or is constrainced by the limitations of transportation by truck along local roads. Thus, it is desirable to have modular deployable housing that can be assembled on site with a minimum of labor and heavy equipment and still be structurally strong to resist to earthquakes and storms.

Modular buildings can also be designed to be constructed for specific applications, for example, rapidly deployable schoolrooms that can be easily transported and set up to respond to emerging demographic requirements for temporary educational space without compromising standards. Such educational housing units have specific requirements for space, lighting, and to provide a good educational environment. Also, often entire schoolhouses are destroyed in the disaster zones, and the schoolchildren have no place to go to school. It is desirable to have rapidly deployable schoolroom it can meet urgent schooling needs on short notice. Such temporary school housing such standards are not necessarily met by the 'one-size-fits-all' constraints of mobile trailer home manufacturing. Thus it is desirable to have rapidly deployable structures which provide a flexible, mobile and modular solution for learning environments such as classrooms, labs, offices and studios. It is also desirable to provide a rapidly deployed modular building designed for emergency response rooms for police and fire services.

Thus it is desirable to have modular building that can be easily stored, transported, and assembled on-site to different design configurations. It is further desirable for the modular building to be designed to meet specific applications, such as schoolrooms and emergency response rooms.

DRAWINGS

These features, aspects, and advantages of the present invention will become better understood with regard to the following description, appended claims, and accompanying drawings, which illustrate examples of the invention. However, it is to be understood that each of the features can be used in the invention in general, not merely in the context of the particular drawings, and the invention includes any combination of these features, where:

FIG. 1 is a schematic perspective view of an embodiment of a modular building showing a sled, shed, and expansion module;

FIG. 2A is a schematic perspective view showing assembly of an embodiment of a modular building;

FIG. 2B is a perspective view of an embodiment of the sled of the modular building of FIG. 2A;

FIG. 2C is a perspective view of another embodiment of the assembled modular building of FIG. 2A, in which the ceiling comprises light permeable panes;

FIG. 3A is a schematic side view of another embodiment of a modular building showing the shed resting on a sled;

FIG. 3B is a schematic perspective view of the modular building of FIG. 3A showing an expansion module attached to the shed;

FIG. 4A is a schematic perspective view of an embodiment of a modular building comprising a shed with two expansion modules;

FIG. 4B is a schematic perspective view of the modular building of FIG. 8A with a power pack module and a roof;

FIG. 5 is a schematic perspective view of another embodiment of a shed of a modular building;

FIG. 6 is a schematic perspective view of an embodiment of a power pack module for a modular building;

FIGS. 7A to 7D are perspective views showing the delivery and assembly of an embodiment of a modular building on a building site;

FIGS. 7E and 7F are perspective views showing two different internal configurations of the modular building of FIG. 7D;

FIGS. 8A to 8C are perspective views showing the delivery and assembly of another embodiment of a modular building on a building site;

FIGS. 8D is a perspective views showing an application specific internal configuration of the modular building of FIG. 8C;

FIGS. 9A and 9B are perspective views embodiment of a modular building;

FIG. 10A is a perspective view of another embodiment of a modular building showing a expansion module and pop-up roof;

FIG. 10B is a schematic top view of the internal configuration of the modular building of FIG. 10A;

FIG. 10C is a schematic side view of the modular building of FIG. 10A;

FIG. 10D is a perspective view of another embodiment of a modular building showing twin expansion modules having solar panels;

FIGS. 11A to 11i are schematic diagrams of different embodiments of modular buildings;

FIGS. 11J to 11P are schematic top views of different interior arrangements of a modular building having two expansion modules;

FIGS. 12A to 12i are schematic diagrams of different embodiments of modular buildings having three or more sheds;

FIGS. 13A to 13D are perspective views of an embodiment of a modular building having multiple sheds joined to one another;

FIGS. 14A to 14C are perspective views of an embodiment of an embodiment of a modular building showing on-site assembly and opening of the pop-up roof and expansion modules;

FIGS. 15A to 15D are perspective views showing the assembly of another embodiment of a modular building;

FIGS. 16A to 16D are perspective views showing the assembly of a modular building suitable for a conference room or offices; and

FIGS. 17A and 17B are perspective views showing the assembly of another embodiment of a modular building suitable for a theatre.

DESCRIPTION

A modular building 100 that is designed to be rapidly deployable, easily transportable, and minimize on-site assembly, comprises a structure that includes a supporting sled 102, a shed 104, and one or more optional expansion modules 106, as shown diagrammatically in Fig. 1. The sled 102 serves as a support and base for the shed 104 and can also be used to provide preassembled electrical connections for electrical services, and mechanical services such as ventilation, heating, cooling, and water plumbing. The shed 104 provides an enclosed housing structure that rests on the sled 106 which serves as the interior space of the modular building 100. The expansion modules 106 can be used to expand the interior space of the modular building 100 to provide extra space, or to contain electrical power equipment or other building service equipment. In the diagram shown, the sled 102, shed 104, and expansion modules 106, have rectangular structures, however, it should be understood that other shapes and structures, for example, cylindrical or spherical structures, can also be used as would be apparent to those of ordinary skill in the art; thus, the scope of the invention should not be limited to the illustrative embodiments described herein.

An assembly comprising a sled 102, shed 104, and an expansion module 106 that serves as a power pack module 108, is shown in Figs. 2A to 2C. Each of the sled 102, shed 104, and expansion modules 106, comprise a structural frame of modular building components, and they are transported onto a building site with essentially all labor-intensive and inspection-intensive work, such as welding, drilling and cutting, already completed. This allows a modular building 100 composed of the sled 102, shed 104, and optional expansion modules 106 to be quickly assembled on the site to provide a fully integrated housing structure. The pre-manufactured structural components comprise a "kit of parts" that only need to be joined or partially assembled without extensive on-site alterations to provide a high performance structure with an adaptable interior configuration. The structures also reduce risks associated with improper assembly by requiring only minimal skill levels for assembly and equipment usage. The assembled modular building 100 can also withstand the vertical and lateral forces generated in earthquakes and storms. Further, the structures also reduce or eliminate onsite construction waste as left over materials remain at the factory for recycling.

Various embodiments of the components of the modular building 100 will now be described. In one version, as shown in Fig. 2B, the sled 102 comprises a rectangular box frame composed of open web beams that are spaced apart and rest on underlying concrete grade beams (shown in dashed lines). The open web beams are oriented in a rectangular configuration to form a three-dimensional box comprising a upper and lower rectangular frames joined at their ends by horizontal steel beams. Suitable open web beams comprise two parallel beams joined by a web structure that includes holes which may be shaped as a triangle (as shown), circle or square. The concrete grade beams are conventional foundation support structures comprising rebar reinforced concrete beams. The beams are joined to one another by high strength bolts and can be anchored into the concrete grade beams and leveled using cast-in-place or post-poured, drilled, high strength bolts. The sled 102 comprises a plurality of sidewalls, internal and external, which are formed by vertical rectangle frames of beams. The external sidewalls are located along the perimeter of the sled 102. The internal sidewalls are spaced apart through the interior volume of the rectangular box frame, the spacing distance being, for example, about 2 feet. The sidewalls are reinforced by V-shaped welded structural tubes which are spaced apart and bolted between the beams. The sled 102 also comprises end walls that have vertical beams which join the beams forming the rectangle box structure and which can also be the and columns of the internal sidewalls. The upper rectangular frame formed by the steel beams have receiving clips at their corners or ends to receive an overlying shed 104. The constructed sled 102 provides a preassembled structural platform with good structural integrity, pre-tested bolted and welded connections, and which allows a flexible configuration of any overlying shed 104.

Floor joists extend across the upper surface of the sled 102 and overlap every 8 feet to provide a floor having structural rigidity and without seams. The floor joists can comprise conventional tubular sections or beams. A raised floor is formed from floor panels placed between the framework of the floor joists to provide the necessary structural diaphragm for the base of the shed 104. As one example, the floor panels can be made from structural metal decking. As another example, the floor panels can be composed of concrete filled metal pans that sit on pedestals so that the underlying cavity can house electrical and mechanical services. The floor panels can also be rearranged to move outlets, ports, and air diffusers providing the user with

maximum flexibility. The under floor distribution of mechanical services for the overlying shed 104 can include HVAC (heating, ventilation and cooling) hollow tubes are joined together in an integrated framework in the spaces between the beams and tubes that form the rectangular box frame of the sled. The hollow tubes have duct connector openings for connecting to ventilation ducts to be positioned in the overlying shed 104. Electrical junction boxes with preassembled wiring can also be located at desired positions along the sled to provide electrical and data services to the shed. Additional mechanical junction boxes for connecting mechanical services can also be provided. Locating electrical and mechanical services within a rectangular box frame of the sled provides an efficient this infrastructure for such services and can be tailored without extensive pre-wiring and ventilation planning for the overlying shed.

Another version of a sled 102 for a modular building, as shown in Figs. 3A and 3B comprises a rectangular box frame that includes a plurality of parallel and spaced apart W-flange (wide flange) beams which are made of steel and have an I-shaped structure that serve as the base of the sled. The spaced apart beams are aligned along a linear dimension of the sled and rest on the concrete grade beam foundation. The beams comprise end portions that are located along the external perimeter of the sled and which have welded-on flat plates with bolt holes. The flat plates of the end beams are bolted to the concrete grade beams by high strength bolts that are aligned perpendicularly to the linear orientation of the concrete grade beams. The beams are anchored into the concrete grade beams and leveled with the use of cast in place or post-poured, drilled, high strength bolts. An array of tubular joists are placed on top of the beams and spaced apart from one another to serve as floor joists. The tubular joists are bolted onto the pre-drilled beams. The tubular floor joists can be sized, for example, 2 x 4 inches, and spaced apart every 2 feet. The tubular joists overlap the beams by a spaced apart distance, which can be, for example, 8 feet. The floor joists located at the perimeter corners of the sled have pre-welded clips at their ends to attach to clips positioned at matching positions on an overlying shed. Overlapping deck panels can be placed on the floor joists to provide a floor for the overlying shed 104.

The shed 104 placed on the sled 102, comprises a steel framework of spaced apart columns that are linked to one another by overhead ceiling beams to provide a rigid structural frame with large spans that has minimal material usage while

providing a highly flexible and tailorable interior space, as shown in FIGS. 2C and 3A-3B. Referring to FIGS. 3A and 3B, the columns of the shed 104 can include major and minor columns, the major columns having a larger cross-sectional area than the minor columns. The major columns are located at the corners of the shed and provide vertical strength in support of the ceiling. Suitable major columns comprise, for example, structural steel tubes sized 4 x 4 inch. The major columns are attached to the overlying beams of the sled by gussets. The minor columns can be, for example, structural steel tubes sized 2 x 2 inches. The minor columns are bolted to the floor joists of the sled 102. In addition, diagonal columns comprising 4x4 structural tubes can also be used to brace the structure of the shed and increase its lateral and shear strength. All these tubes are linked together with tube steel headers and bolted together for greater strength. Connecting boxes can also be provided for connecting to the electrical and mechanical junctions in the underlying sled 102. A suitable shed 102 comprises a transportable enclosure sized approximately 700 to 100 square feet. Modular buildings 100 can be made larger by combining expansion modules 106 to the shed 104 in a variety of means as described in further detail below.

In one version, the minor columns are spaced apart a sufficient distance to allow the space between the columns to be pre-sized to dimensions suitable to receive wall panels such as light impermeable pains, light permeable panes such as windows or translucent screens, or even doors. A suitable spacing distance between the columns comprises about four feet, but can also be other distances ranging from about ___ to about ____. Advantageously, positioning the minor columns a predefined spacing distance provides a highly adaptable exterior sidewall for the shed, so that each exterior sidewall can be adapted to allow the transmission of light, serve as an opaque wall, or even provide an integrated connection of the interior space of the shed to other structures, such as an expansion module 106.

The structure of the shed 102 also enables the two long exterior sidewalls to be absent structural reinforcements which are conventionally needed to provide strength in seismic or storm locations, consequently, enabling the shed to have a variety of different external wall configurations. It also enables the ceiling or roof plane to have variable heights and provide optional clerestory natural lighting. As a result, the shed provides the ability to be tailored to a wide range of interior environments while still providing a quick-to-deploy modular building 100 that is safe and long-lasting

– such a structure is without precedent in conventional pre-engineered modular buildings.

The ceiling of the shed is designed as an open area that is suitable for receiving a variety of different ceiling panes. For example, the open ceiling can receive light impermeable panes to enclose the structure and provide good heat insulation, solar panels to receive solar energy and convert the energy to electricity or heat, or even light permeable panes to allow outside light to enter the shed. As one example, the open area of the ceiling can be sized with a width of from about _ to about __, and a length of from about __ to about ___ feet. Because the ceiling of the shed is unencumbered by infrastructure, it allows the ceiling skin to be highly flexible in its use and appearance.

In one version, the open ceiling is closed with a roof comprising onsite assembled trusses, custom aluminum extrusion rafters, and structural metal decking. The closed roof is suitable to provide a high strength structure for situations such as storm or high snow environments. It can also be used for buildings needed better heat insulation.

The open ceiling structure also provides clerestory window possibilities that allow natural light to reach deep into buildings used as classrooms or even offices. Further, the ability to position light permeable panes in either the ceiling or between the columns allows the ratio of light permeable versus light impermeable surfaces to be tailored for specific building applications. Further, ratios of glass versus wall surface are now adaptable to building use warrants and applicable code regulations. In contrast to prior art buildings, the ratio of light permeable surface to light impermeable surface can be higher than ____, or even as high as ___.

The open ceiling can also have flexible applications with both a light permeable skin and a sliding overlay that closes off the light permeable roof when desired, as for example, shown in FIG. 2C. In this structure, the ceiling comprises light permeable panes which can be closed off from the external environment by sliding panels of a light impermeable material.

The expansion module 106 comprise a steel frame designed to be attached to an open sidewall or end wall of the shed 104 to expand the usable enclosed space provided by the shed 104. For example, as shown in Fig. 3B, the expansion

module 106 comprises major columns that form the corners of its structural frame, at least two of the columns being external to the shed, and two other columns being integrated into a sidewall of the shed. The expansion module 106 also has a sidewall with minor columns that can be spaced apart as described in the minor columns of the shed to allow spaces for light permeable panes, doors, or other structures.

In one version, the expansion module 106 is sized smaller than the shed 104, showed the entire structure of the expansion module 106 can fit within the volume of the shed 104 during transportation. Advantageously, in this version, the expansion module can be transported fitting as a whole within the enclosed space of the shed so that the entire structure can sit on a single flatbed truck. At the building site, the expansion module is pulled out from within the shed, and then bolted to a major columns installed in the sidewall of the shed. A single wide flange beam bolted to a concrete grade beam can be used to support the outside sidewall of the expansion module.

The ceiling of the expansion module 106 can also be an open ceiling similar to the one described for the shed 104 or can be an enclosed ceiling formed by ceiling joists as shown in Fig. 3B. The ceiling joists is spaced apart a set distance of for example, __ feet, and linked at their ends to the ceiling beams which are connected to one another and the major and minor columns. The structure provides a more rigid framework which also allows easy expansion of the interior space provided by the shed while providing good structural strength.

Various configurations of the sled 102, shed 104, and one or more expansion modules 106 will not be described. For example, a modular building 100 comprising a shed 102 with two expansion modules attached to the sidewalls of the shed, is illustrated in Fig. 4A. I this version, the expansion modules expand the interior volume of the shed 100 to provide a larger confined space.

A modular building 100 with an expansion module that is a power pack module and a roof is illustrated in Fig. 4B. In this version, the power pack module comprises electrical and mechanical systems suitable for the selected size of the shed 104. For example, the power pack module can include an electrical generator that powers the lights and electrical appliances used in the shed. The power pack module provides a convenient, transportable solution that is preconfigured to the interior volume of the modular building that may include a shed and suitable expansion modules.

Yet another embodiment of a shed of a modular building is illustrated in Fig. 5. An embodiment of an expansion module suitable to attach to the end of a shed for a modular building, is illustrated in Fig. 6. In this version, the expansion module comprises a circular end wall comprising longitudinal slats that fit within arcuate end channels. The arcuate end channels connect the floor to the ceiling. This end expansion module can increase the interior volume of the shed. Suitable electrical and mechanical services such as a generator, heater, and air conditioner, are located beneath the floor of the expansion module, as shown.

The delivery and assembly of an embodiment of a modular building on a building site are shown in Figs. 7A to 7D. The preassembled shed 104 containing two expansion modules that are contained within the interior volume of the shed during transportation arrive on a flatbed truck as shown in Fig. 7A. The shed is placed on a sled which is mounted on a foundation of concrete grade beams as shown in Fig. 7B. Thereafter, the expansion modules are extracted from the two sides of the shed, as shown in Fig. 7C. Finally, an external antenna is pulled out from the shed as shown in Fig. 7D. The resultant modular building 100 can have different internal configurations, for example, the modular building can include a seating arrangement with angular oriented desks suitable for a classroom or discussion group as shown in Fig. 7E. in another configuration as shown in Fig. 7F, the modular building comprises a conference table surrounded by conference chairs and includes side tables with chairs.

The delivery, assembly, and interior configuration of another embodiment of a modular building on a building site is shown in Figs. 8A to 8D. In this version, the modular building 100 comprises two sheds, which are placed side by side and joined together. Each shed has three expansion modules which are wedge shaped and designed to extend from the side of the shed in an accordion shaped configuration. The resultant modular building 100 is architecturally appealing and can serve as a conference room or even a theatre as shown in Fig. 8D. The conference room has a series of chairs located in concentric arcs and which may also be partially elevated.

A perspective view showing the relative scale of a modular building 100 is shown in Figs. 9A and 9B. This modular building has a side expansion module and windows in the ceiling section. In this version, the modular building as an aesthetic and pleasing architectural quality, while still serving its intended function of being easily transportable and functional.

Still another embodiment of a modular building suitable for housing, a number of people and having both an end and side expansion module, is illustrated in Figs. 10A – 10D. The internal configuration of the modular building, as shown in FIG. 10B, comprises a series of double beds or other such structures located within the shed. In addition, the end expansion module can be used to house a small bathroom for the occupants, as well as a power pack containing electrical and mechanical systems. The end expansion module can also have a rear service access door to access the power pack. In this version, the ceiling comprises clerestory transparent panes to allow additional light into the shed structure. The modular building can also include an external owning that serves both as a sunshade and is made from solar panels to generate and store electricity in fuel cells. The ceiling can also be made from a material that not only provides thermal insulation but also purifies the environment by removing acid rain.

Diagrams showing different embodiments of modular buildings are shown in Figs. 11A to 11i. Each of these embodiments has a slightly different configuration and can include a modular building with open roof (Fig. 11A); roof extensions (Fig. 11B); a vertical pop-up roof (Fig. 11C); two end expansion modules that extend the length of the shed (Fig. 11D); two sheds with internally sloped roofs (Fig. 11E); a shed with a triangulated roof (Fig. 11F) and further including a two large side expansion modules (Fig. 11G); a shed with two wedge shaped side extensions and a roof comprising a rectangular inclined plane and two triangulated inclined planes (Fig. 11H); and an open shed with two linear side expansion modules with inclined roofs (Fig. 11i).

Interior arrangements of a modular building having two wedge shaped side expansion modules and two end modules, suitable for teaching, seminar, library or conference facilities, are shown in Figs. 11J to 11P. These facilities can include for example, end modules having (i) telephone, data or electrical systems, (ii) a toilet room; (iii) storage facilities, or (iv) a projection room. In addition, the site loads of the side expansion modules can be adapted to have opaque wall panels or transparent wall panels depending on the desired internal configurations.

Diagrams of modular buildings having three or more sheds are shown in Figs. 12A to 12F. These buildings can include two sheds having inclined roofs and side expansion modules that are joined together to form a single structure as shown in Fig.12A. In another version, the side expansion module to extend outwardly from sheds which are joined together as shown in Fig.12B. In a further version, two sheds

are joined at their side expansion modules have pop-up roofs with inwardly inclined roofs as shown in Fig.12C, or outwardly inclined roofs as shown in Fig.12D. In yet another version, the two sheds are joined, have angled pop-up roofs, and outwardly extending side expansion modules as illustrated in Fig. 12E. In yet another version, two sheds are joined to one another and a third shed is joined at right angles, and with an inclined awning, as illustrated in Fig. 12F.

The modular buildings having three or more sheds can have different internal configurations, as shown in Figs. 12G to 12i. These configurations can include, for example, a demonstration hall capable of seating up to 90 students, a science research lab, or a multimedia theatre for over 60 occupants. Each configuration has specific seeking arrangements, lecturing platform, laboratory benches, or projection screen.

Still other embodiments of modular buildings having three or more sheds are shown in Figs. 13A to 13D. These embodiments can include, for example, three attached shed that provide separate rooms (Fig. 13A); five co-joined sheds that form a single structure in which two of the sheds have inclined roofs and three sheds have open roofs (Fig. 13B); an arcuate shaped building composed of three rectangular sheds and 6 wedge shaped sheds or expansion modules, and having an complex shaped roof (Fig. 13C); and a housing complex formed by three sheds each with two side expansion modules and an inclined roof (Fig. 13D).

Figs. 14A to 14C show the on-site assembly and opening of a pop-up roof and expansion modules of another modular building. In this version, the shed comprises glass windows along two side extensions, and is placed over a sled comprising various heating or cooling ducts, as shown in Figs 14A and 14B. The final building with a sloped pop-up roof, sloped ramp, and curved end expansion module is shown in Fig. 14C.

The assembly of another embodiment of a modular building is shown in Figs. 15A to 15D. In this building, a class room environment with good lighting and a lift-up top roof is provided. The assembly of a modular building suitable for an expandable structure for a class room, conference room or multiple offices, is illustrated in Figs. 16A to 16D. The expandable structure has a variable number of sheds a and aside windows with closable flaps. Another embodiment of a modular building suitable for a theatre is illustrated in Figs. 17A and 17B. The theatre can have an open or closed roofing system.

While many different illustrative embodiments of the modular building are described in the present application, it should be understood that other embodiments are also possible. For example, the modular building can have other shapes and structures, and can be made from other materials, as would be apparent to those of ordinary skill in the art. Thus, the scope of the claims should not be limited to the illustrative embodiments described herein.

What is claimed is:

1. A modular building comprising:

(a) a sled comprising a rectangular box frame;

(b) a shed comprising a steel framework of spaced apart columns that are linked to one another by overhead ceiling beams to provide a rigid structural frame; and

(c) sliding expansion modules attached to the shed.

2. The modular building of claim 1 wherein the sled comprises a rectangular box frame composed of open web beams.

3. The modular building of claim 2 wherein the open web beams are oriented in a rectangular configuration to form a three-dimensional box.

4. The modular building of claim 2 wherein the sled comprises a plurality of sidewalls formed by vertical rectangle frames of beams.

5. The modular building of claim 1 wherein the sled further comprises an axle housing for receiving an axel for the attachment of wheels that allow the sled to be moved.

6. The modular building of claim 1 comprising floor joists extending across the upper surface of the sled.

7. The modular building of claim 1 wherein the sled comprises an under floor distribution of electrical and mechanical services.

8. The modular building of claim 1 wherein the sled comprises a rectangular box frame that includes a plurality of parallel and spaced apart wide flange beams.

9. The modular building of claim 9 wherein the beams comprise end portions that are located along the external perimeter of the sled and which have welded-on flat plates with bolt holes.

10. The modular building of claim 1 comprising an array of tubular joists are placed on top of the beams and spaced apart from one another to serve as floor joists.

11. The modular building of claim 1 wherein columns of the shed includes major and minor columns, the major columns having a larger cross-sectional area than the minor columns.

12. The modular building of claim 11 wherein the minor columns are spaced apart a sufficient distance to allow the space between the columns to be pre-sized to dimensions suitable to receive wall panels or doors.

13. The modular building of claim 12 wherein the wall panels are light impermeable or light permeable panes.

14. The modular building of claim 12 wherein the shed comprises long exterior sidewalls that are absent structural reinforcements.

15. The modular building of claim 1 wherein the shed comprises a ceiling that is an open area.

16. The modular building of claim 1 wherein the expansion module comprise a steel frame that is attached to an open sidewall or end wall of the shed to expand the usable enclosed space provided by the shed.

17. The modular building of claim 1 wherein the expansion module comprises major columns that form the corners of its structural frame with at least two of the columns being external to the shed, and the two other columns being integrated

into a sidewall of the shed.

18. The modular building of claim 1 wherein the expansion module is sized smaller than the shed.

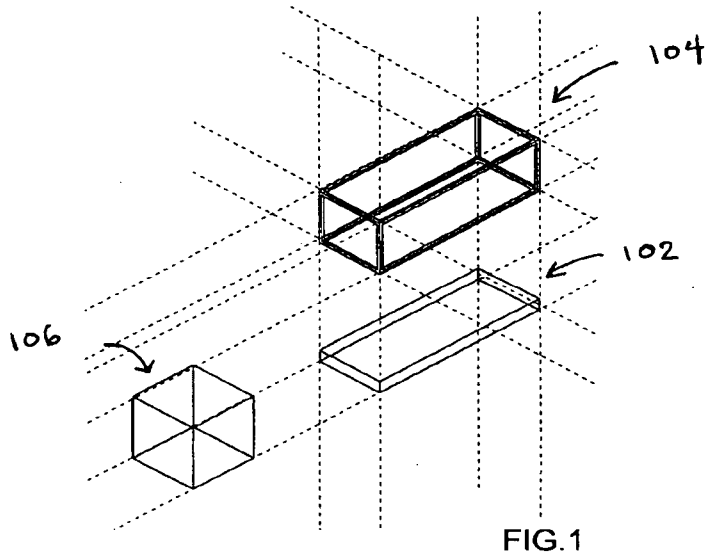


FIG.1

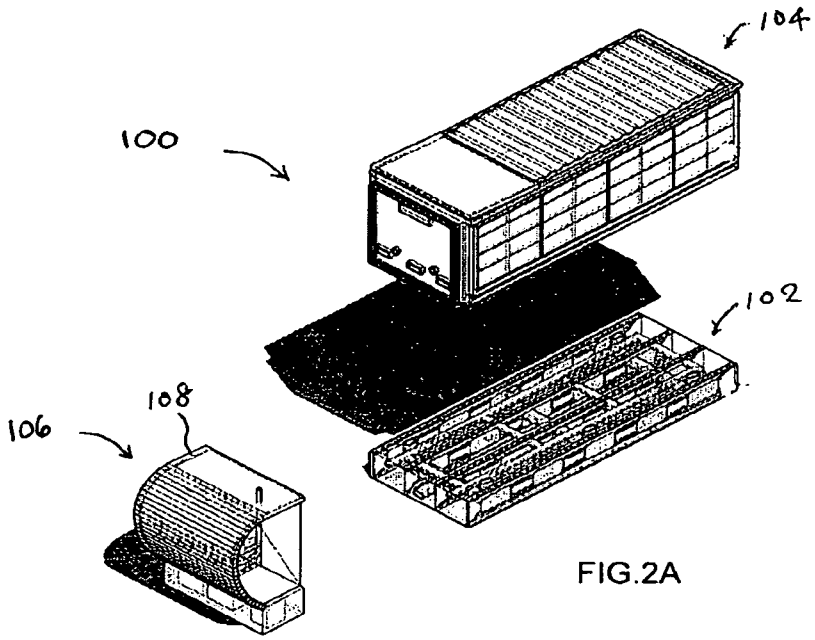


FIG.2A

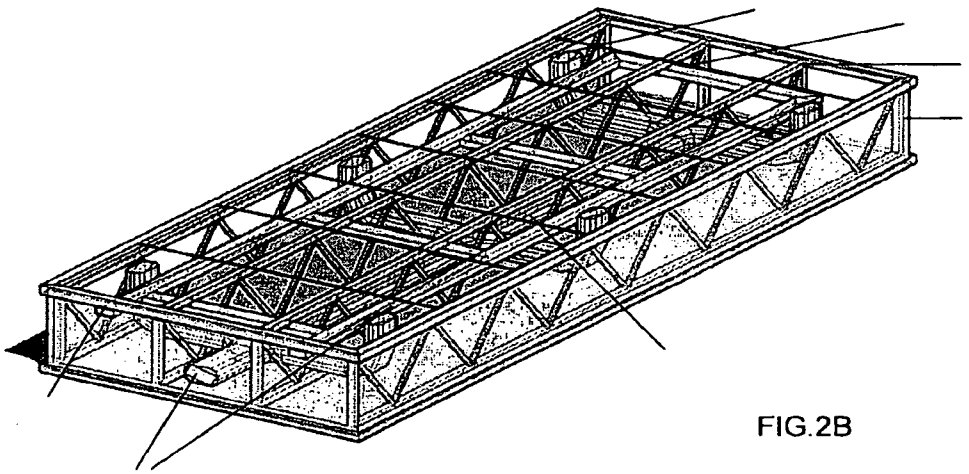


FIG.2B

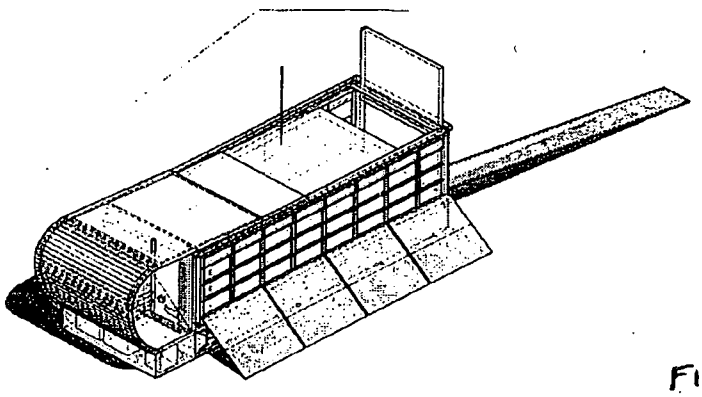


FIG. 2C

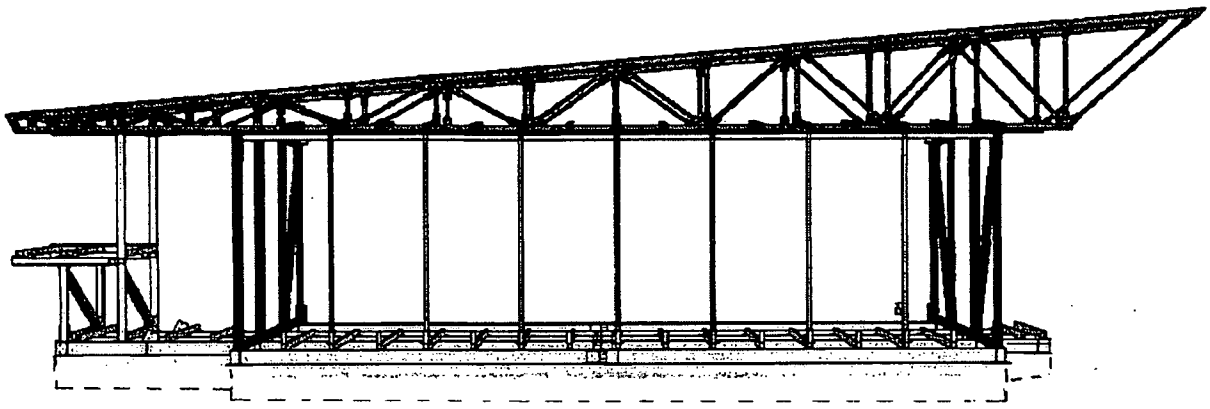


Fig. 3A

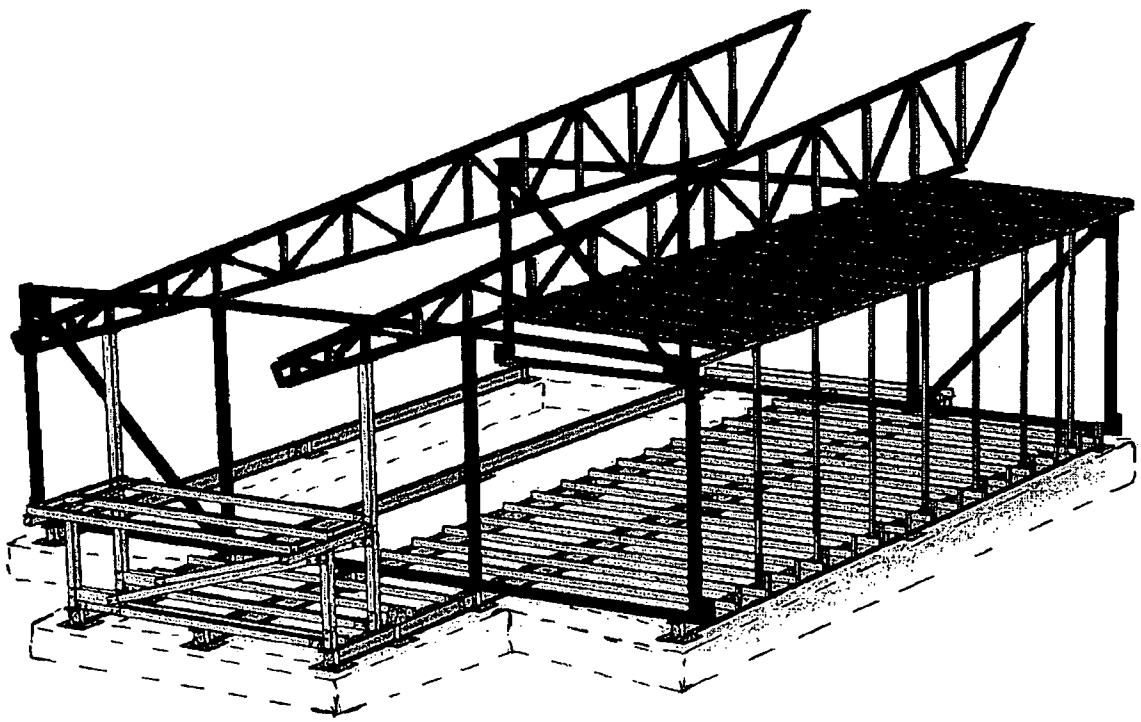


Fig. 3B

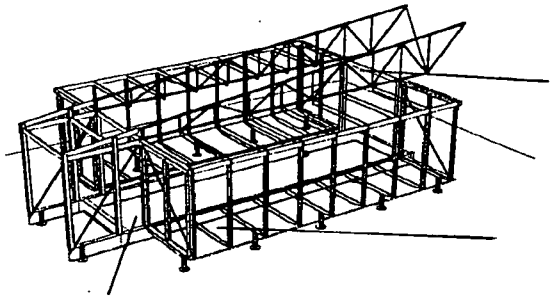


FIG.4A

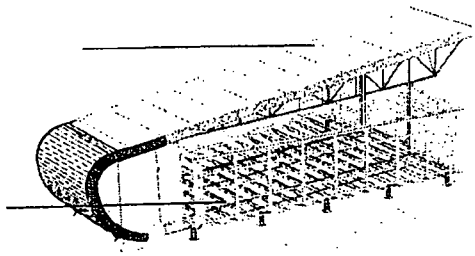


FIG.4B

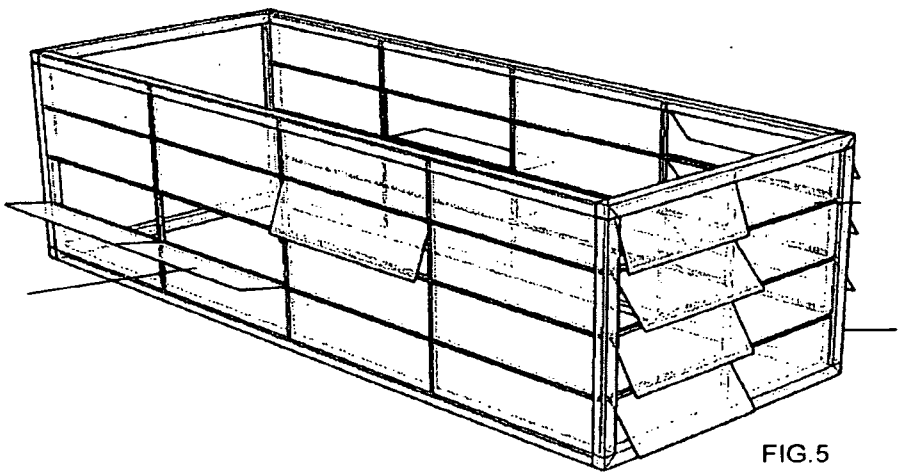


FIG.5

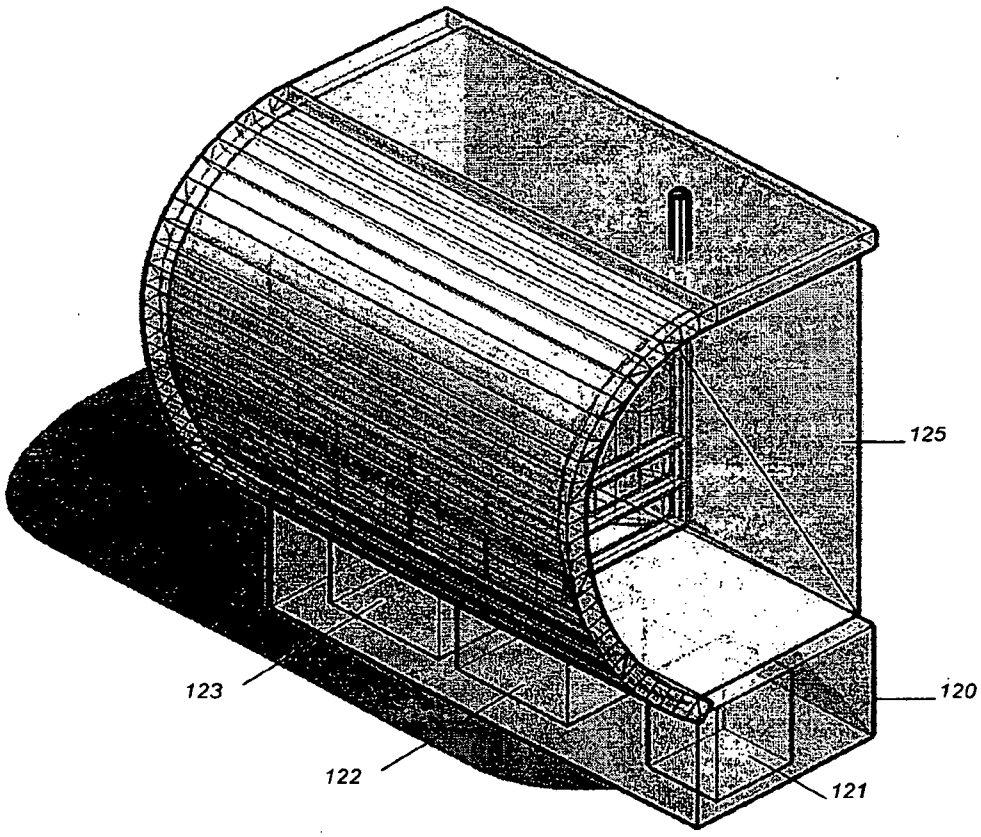


FIG.6

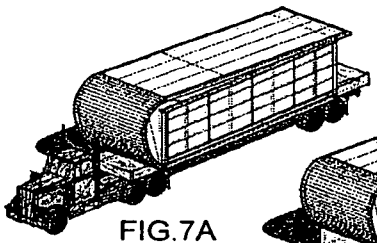


FIG.7A

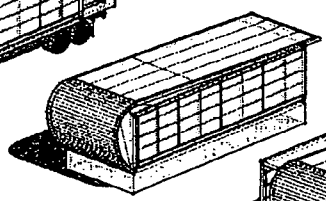


FIG.7B

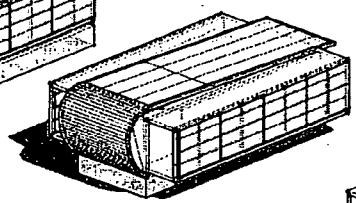


FIG.7C

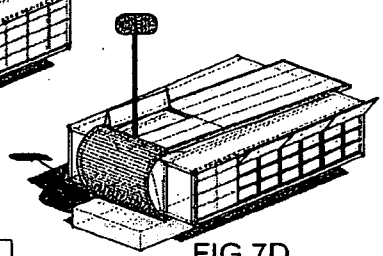


FIG.7D

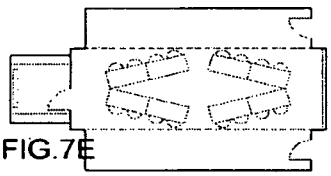


FIG.7E

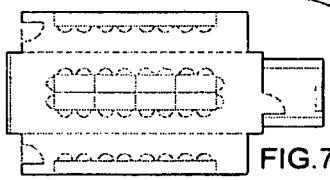


FIG.7F

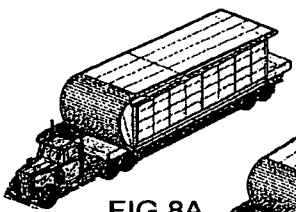


FIG.8A

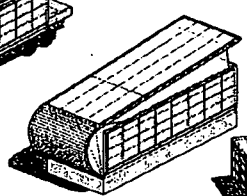


FIG.8B

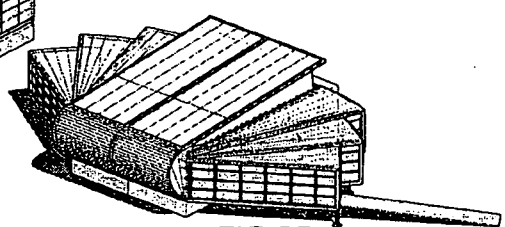


FIG.8C

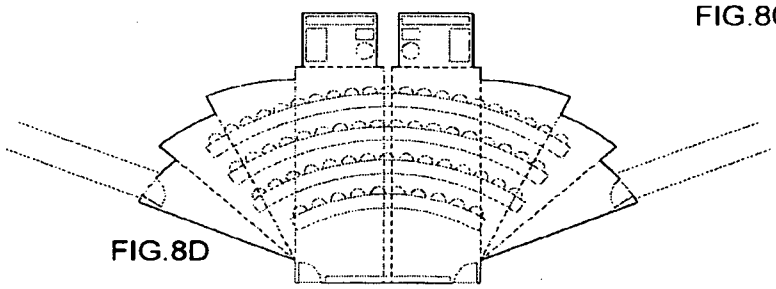


FIG.8D

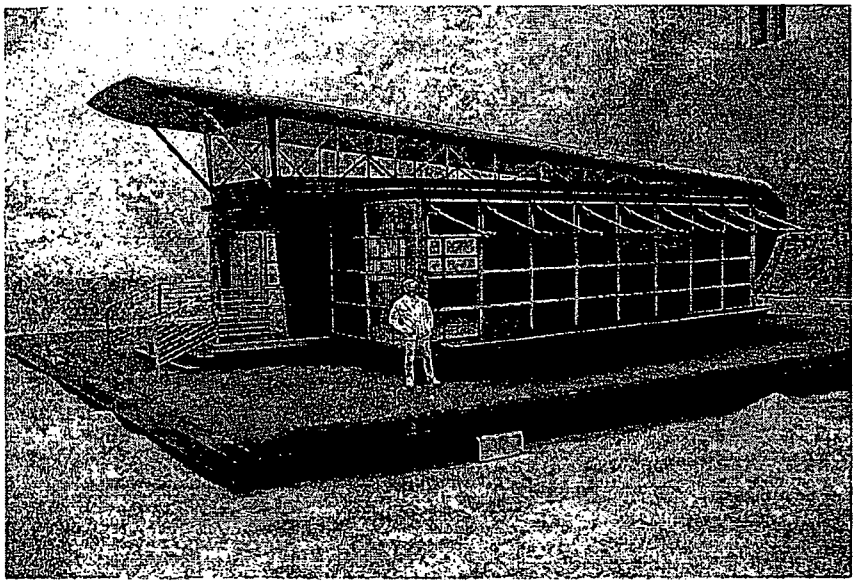


FIG.9A

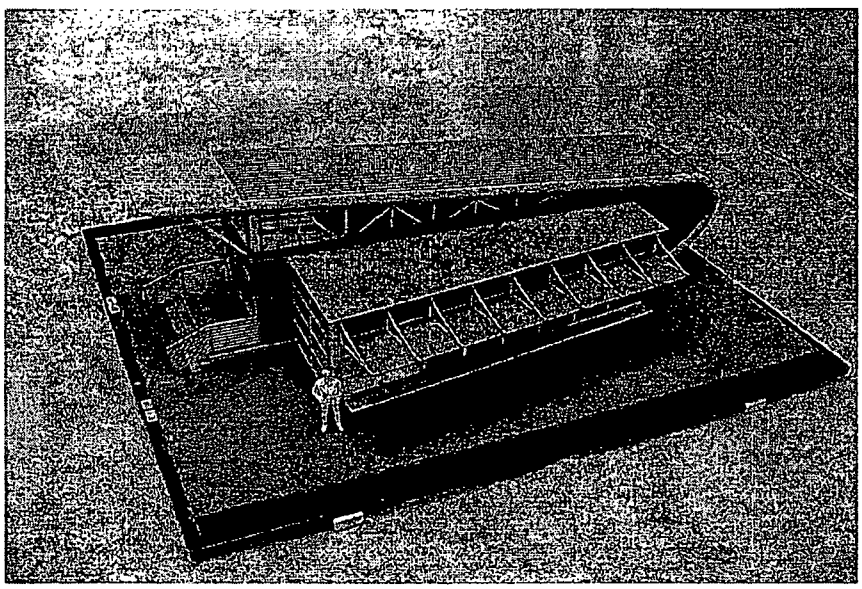


FIG.9B

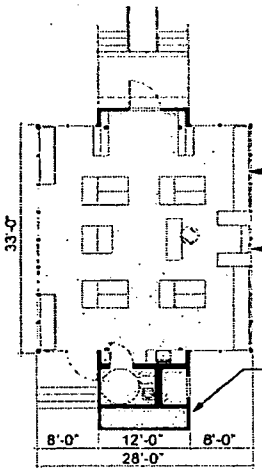


FIG.10A

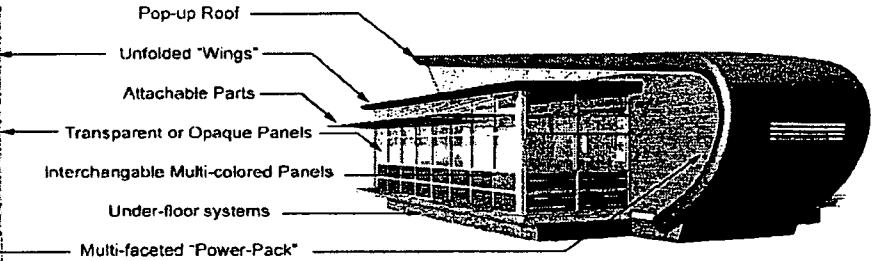


FIG.10B

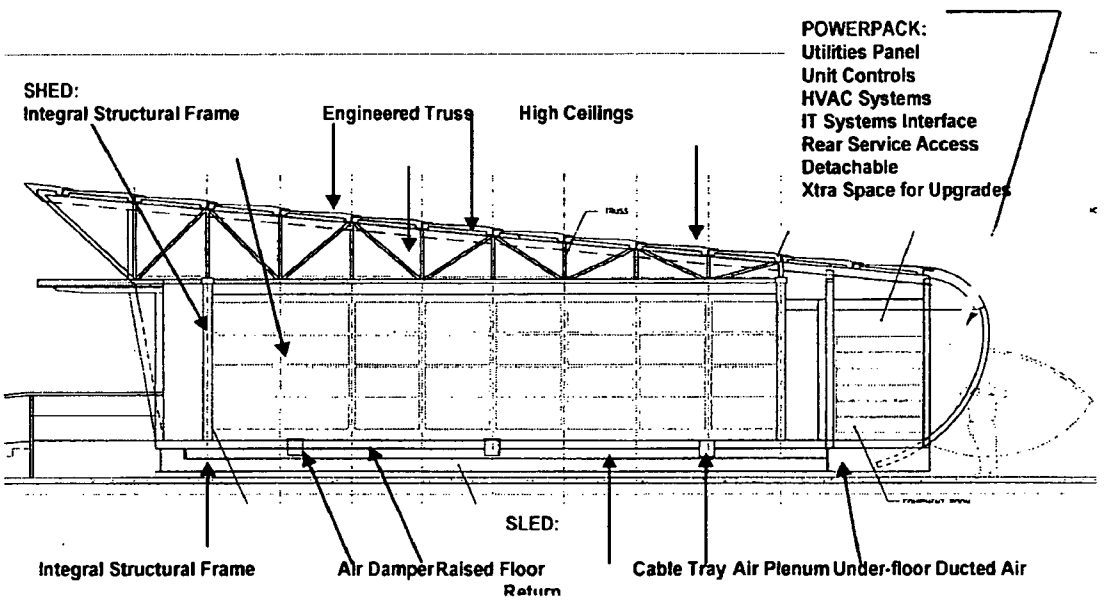


FIG.10C

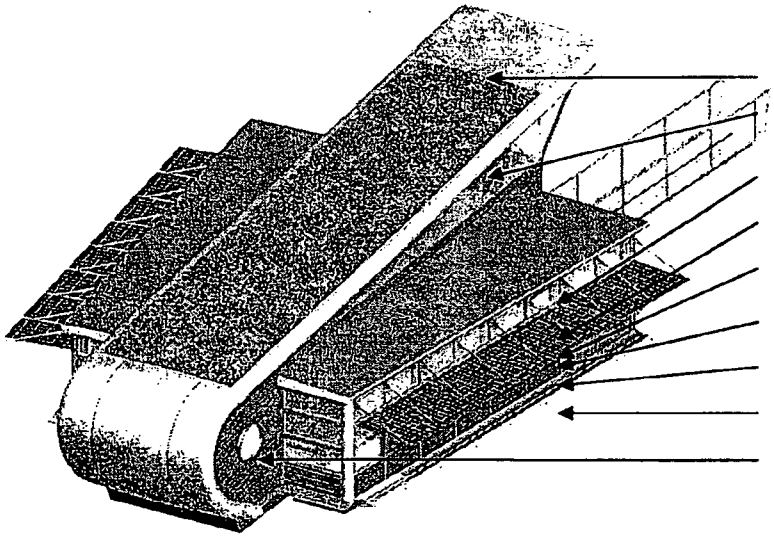


FIG.10D

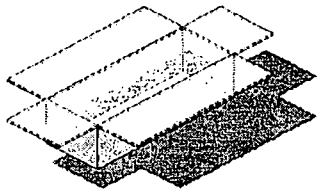


FIG.11A

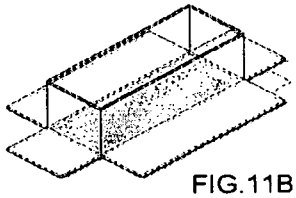


FIG.11B

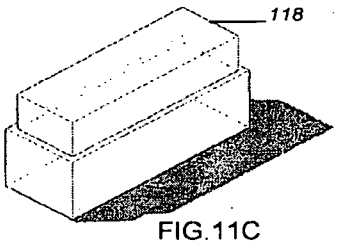


FIG.11C

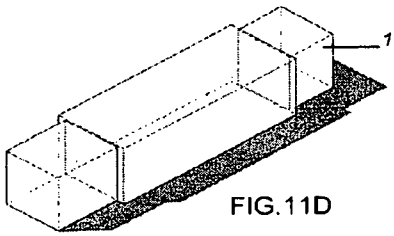


FIG.11D

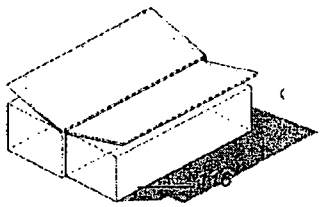


FIG.11E

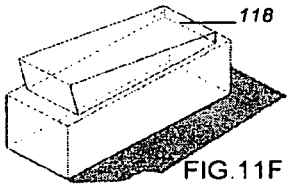


FIG.11F

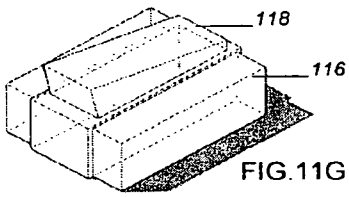


FIG.11G

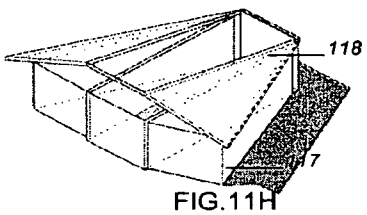


FIG.11H

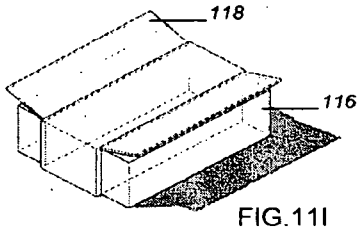


FIG.11I

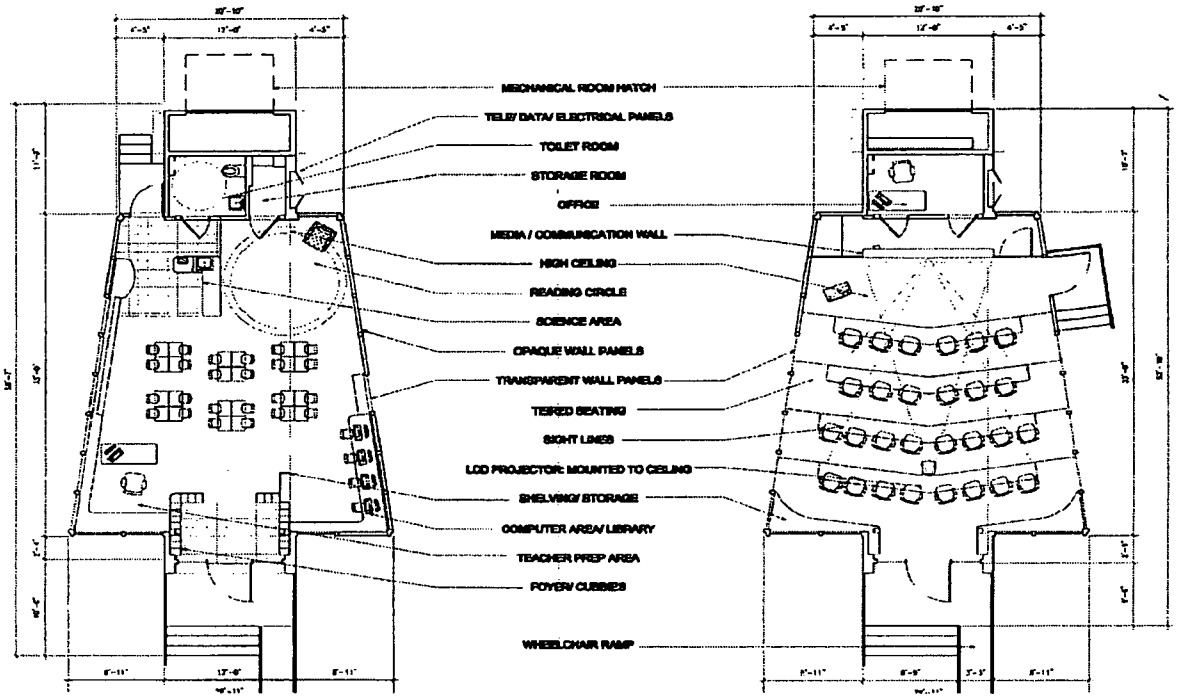
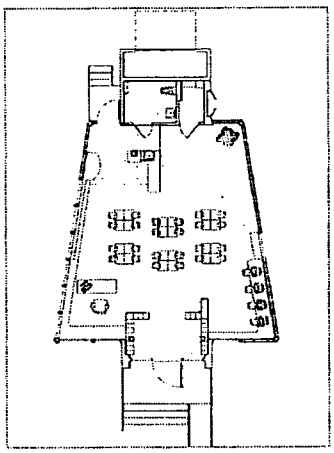
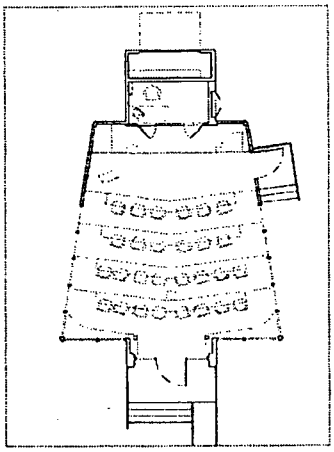


FIG.11J FIG.11K



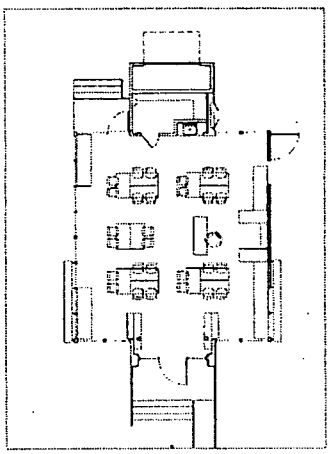
Kindergarten

FIG.11L



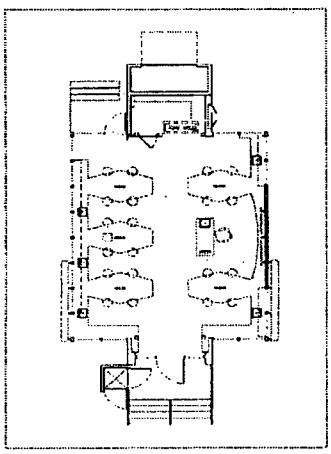
Graduate School

FIG.11M



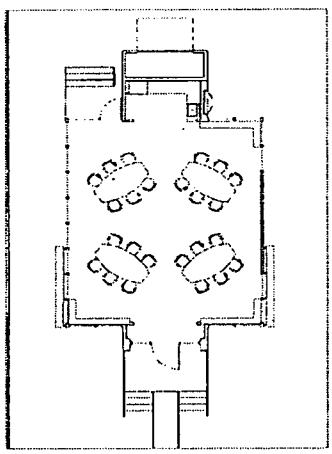
Classroom Studio

FIG.11N



Science Teaching Lab

FIG.11O



Seminar Room

FIG.11P

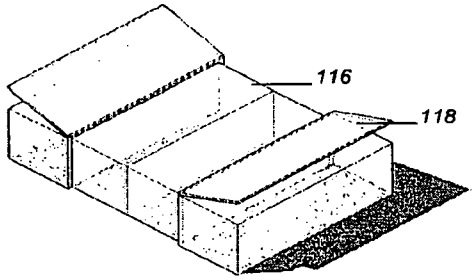


FIG.12A

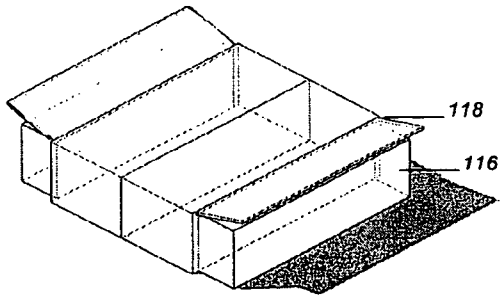


FIG.12B

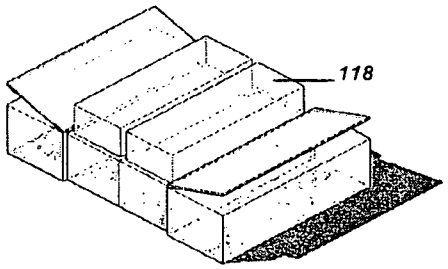


FIG.12C

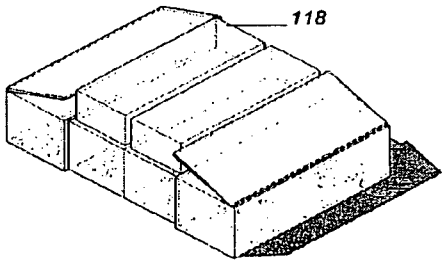


FIG.12D

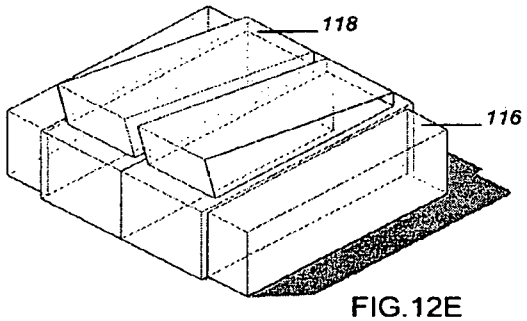


FIG.12E

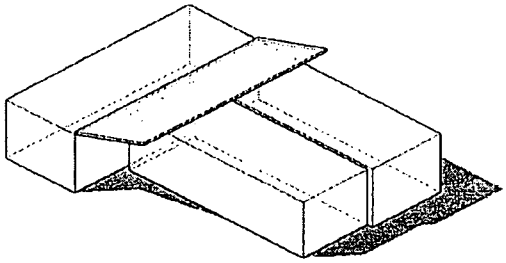
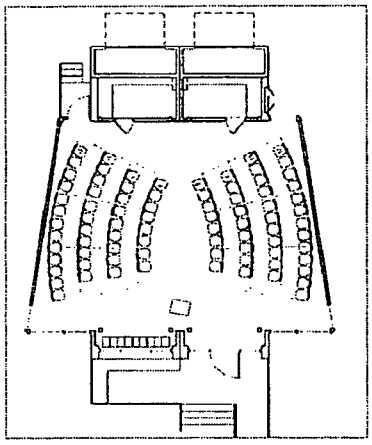
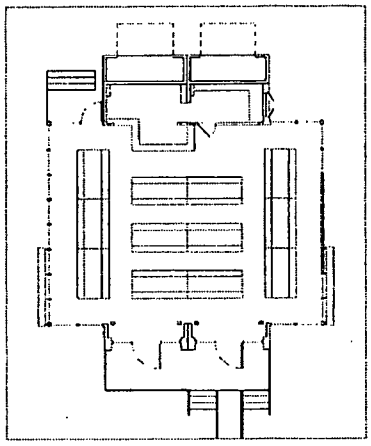


FIG.12F



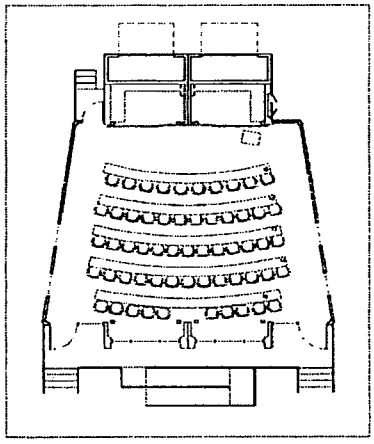
Demo Hall for 90

FIG.12G



Science Research Lab

FIG.12H



Multi Media Theater for 60

FIG.12I

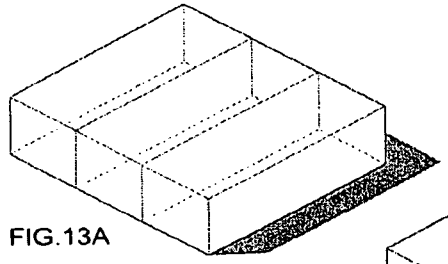


FIG.13A

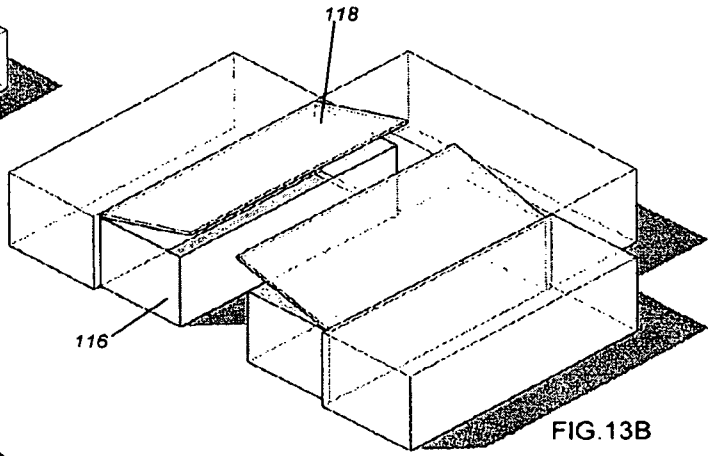


FIG.13B

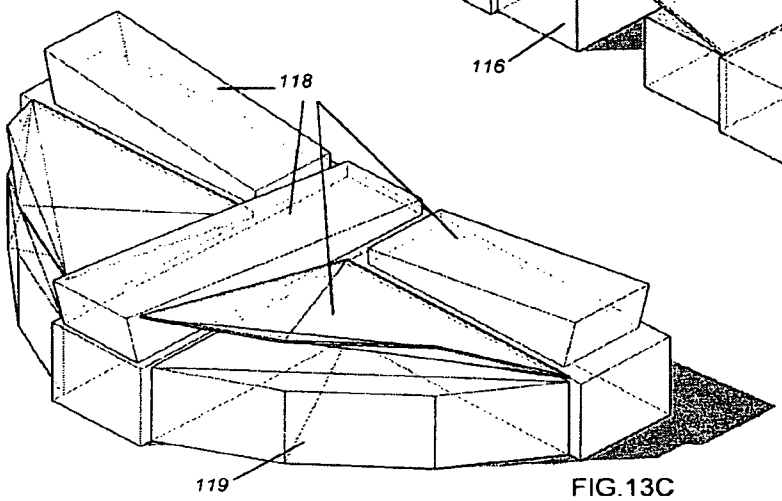


FIG.13C

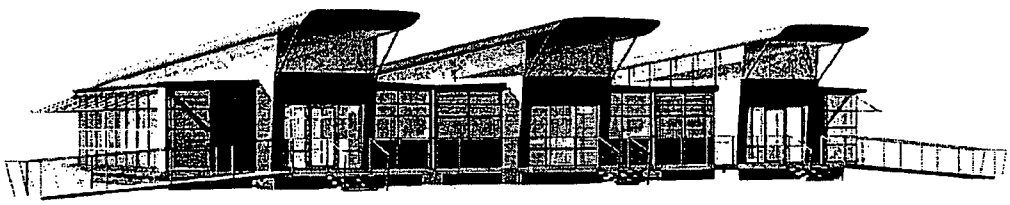


FIG.13D

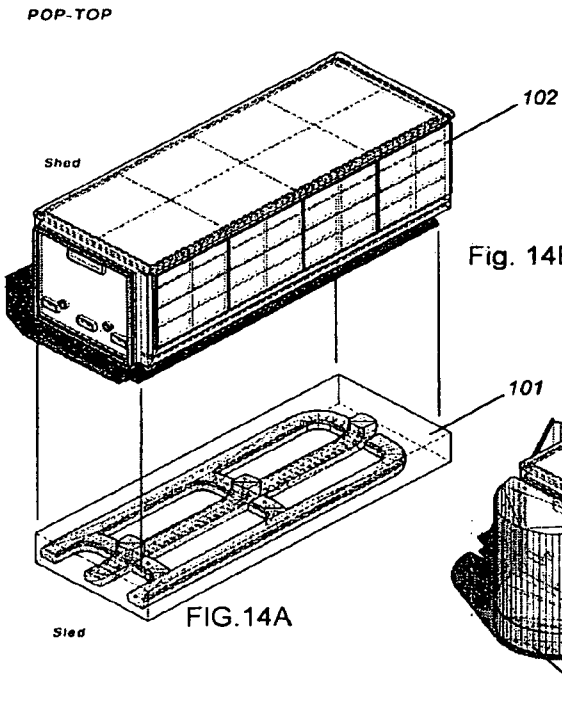


FIG.14A

Fig. 14B

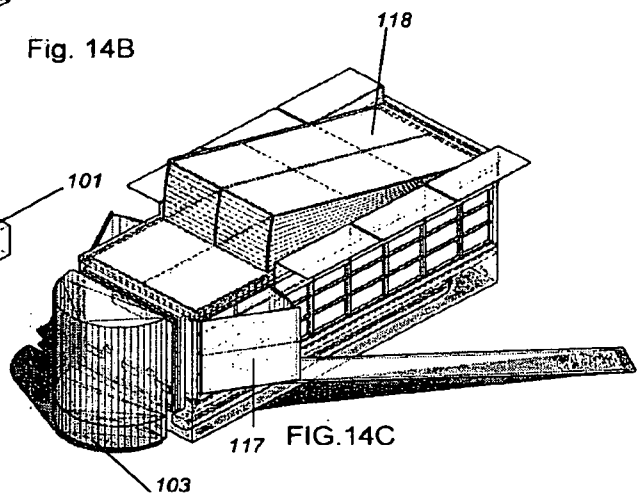


FIG.14C

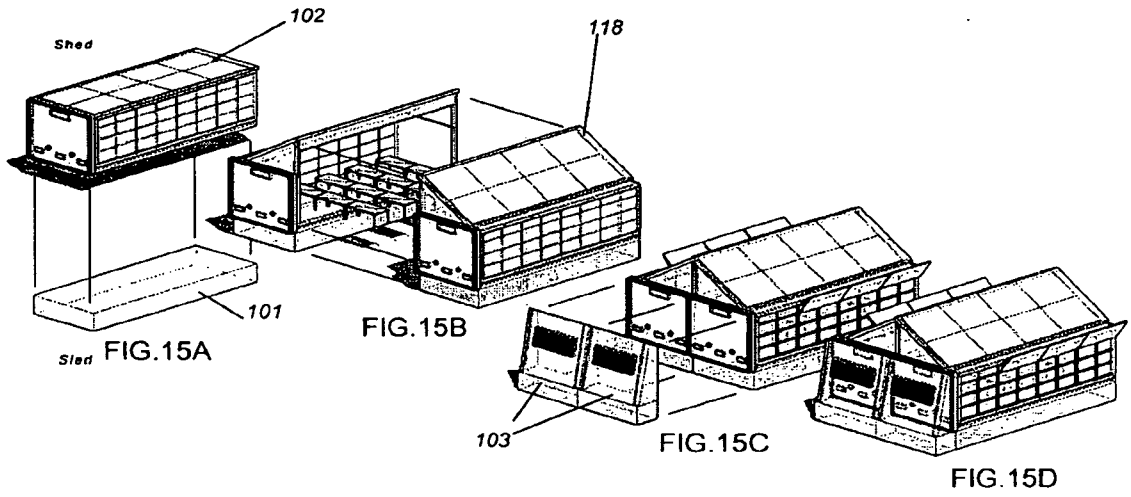


FIG.15A FIG.15B FIG.15C FIG.15D

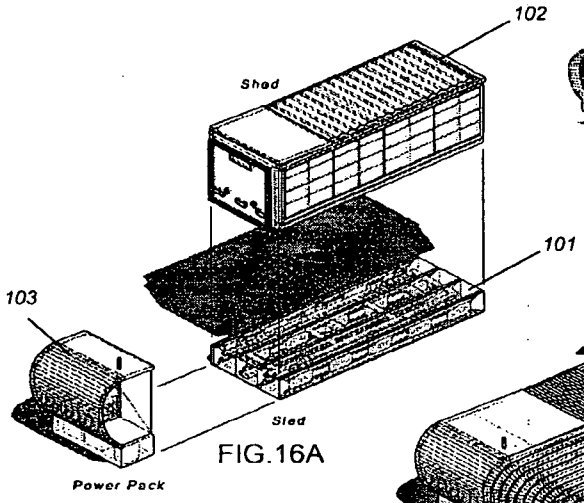


FIG.16A

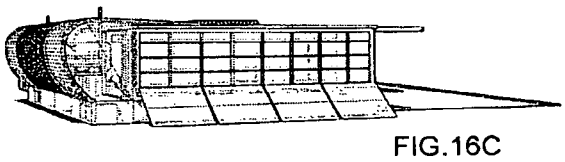


FIG.16C

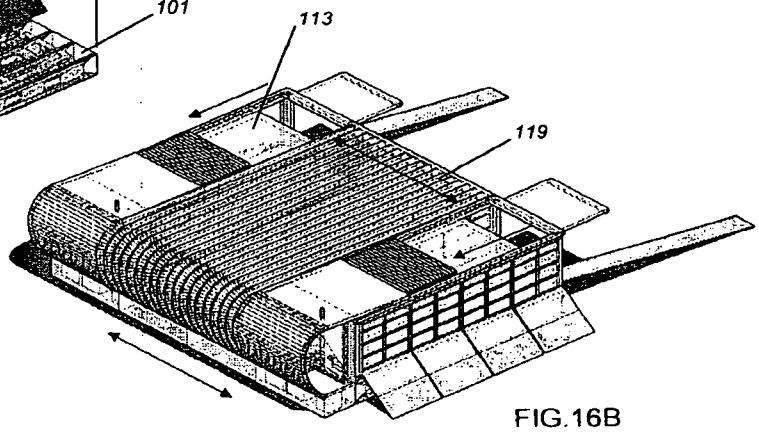


FIG.16B

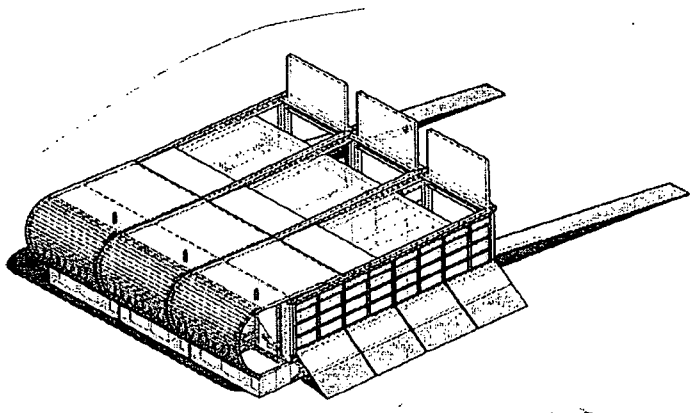


FIG. 16D

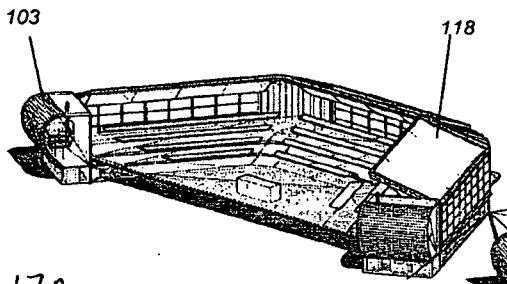


FIG. 17A

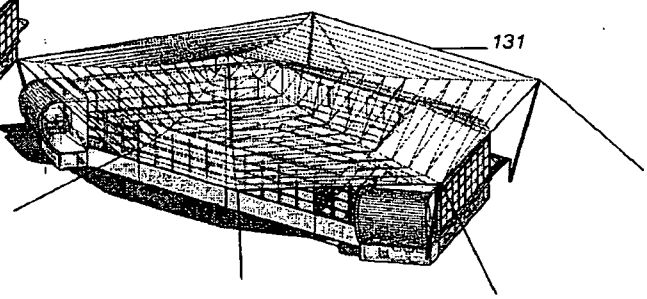


FIG. 17B