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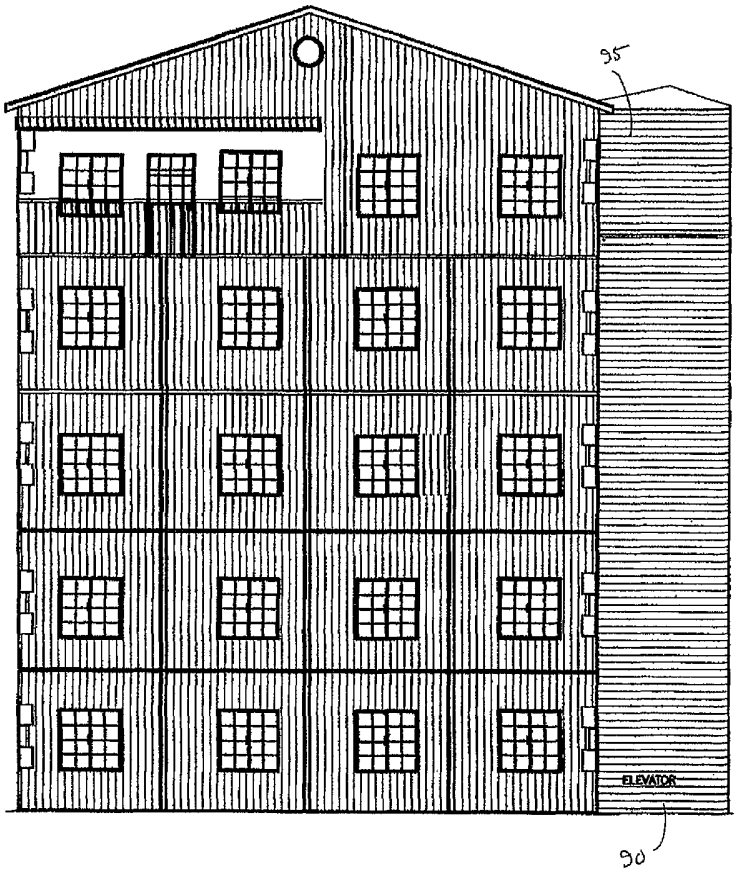
(54) **Title:** CONSTRUCTION SYSTEM FOR STEEL-FRAME BUILDINGS



(57) **Abstract:** A construction system for steel-frame buildings wherein steel shipping containers are used to furnish structural components of the building. A building includes a substantially horizontal deck and a plurality of substantially vertical columns, where the deck includes a base of a shipping container. A side wall of the shipping container is adapted to form a portion of the deck adjacent to the base. A plurality of shipping containers may be arranged in a stacked configuration so that the base of each container forms part of one deck in a multi- story building. The multi-story building may include an elevator contained in an elevator shaft and attached to the building; the elevator shaft is formed from a shipping container standing on an end wall thereof.

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CONSTRUCTION SYSTEM FOR STEEL-FRAME BUILDINGS

CROSS-REFERENCE TO RELATED APPLICATION

This application claims the benefit of U.S. Provisional Application No. 60/673,201, filed April 20, 2005.

FIELD OF THE INVENTION

This invention relates to multi-story building construction, and more particularly to construction of economical steel-frame buildings.

BACKGROUND OF THE INVENTION

Modular construction, in which portions of a building are fabricated in one location and then shipped for assembly at the building site, is well known. The underlying techniques used in conventional modular construction (e.g. framing, siding, roofing) often are little different from traditional ("stick-built") construction. Although cost savings are realized from centralized fabrication of building modules, there are added costs involved in transporting the modules.

Shipping containers, made of steel according to ISO standards, are designed to be moved about by crane and loaded on oceangoing vessels (both above and below decks) and/or railroad cars and truck beds. They may be stacked on top of one another and can withstand extreme stresses.

There is a need for a multi-story building system which permits lower cost transport and more efficient on-site assembly of the building components. In particular, in view of their durability and ease of transport, it is desirable to adapt ISO shipping containers to multi-story construction.

SUMMARY OF THE INVENTION

The present invention addresses the above-described need by providing a building construction system in which steel shipping containers are used to furnish structural components of the building. According to an aspect of the invention, a building includes a substantially horizontal deck and a plurality of substantially vertical columns, where the deck includes a base of a shipping container. A side wall of the shipping container is adapted to form a portion of the deck adjacent to the base. A plurality of shipping containers may be arranged in a stacked configuration so that the base of each container forms part of one deck in a multi-story building.

Furthermore, the multi-story building may include an elevator contained in an elevator shaft and attached to the building; the elevator shaft is formed from a shipping container standing on an end wall thereof.

According to another aspect of the invention, a method is provided for constructing a building. This method includes providing a shipping container having a base, side walls and end walls, where the side walls and end walls have hinged connections to the base. The shipping container is then opened using the hinged connections so that the base, the side walls and the end walls form a substantially horizontal deck. Vertical columns are then attached to the deck. Furthermore, a plurality of shipping containers may be stacked so as to form a plurality of decks, to form a multi-story building.

The foregoing has outlined, rather broadly, the preferred feature of the present invention so that those skilled in the art may better understand the detailed description of the invention that follows. Additional features of the invention will be described hereinafter that form the subject of the claims of the invention. Those skilled in the art should appreciate that they can readily use the disclosed conception and specific embodiment as a basis for designing or modifying other structures for carrying out the same purposes of the present invention and that such other structures do not depart from the spirit and scope of the invention in its broadest form.

BRIEF DESCRIPTION OF THE DRAWINGS

Other aspects, features, and advantages of the present invention will become more fully apparent from the following detailed description, the appended claim, and the accompanying drawings in which similar elements are given similar reference numerals:

FIG. 1 is a schematic illustration of an ISO shipping container used in a construction system in accordance with an embodiment of the invention.

FIG. 2 is a partial plan view of a base of a shipping container with one side folded down and adjacent to the base.

FIG. 3 is a schematic plan view of a base of a shipping container with two sides folded down to form a steel deck.

FIG. 4 is a schematic plan view of a shipping container with the sides and end walls folded down and corner plates provided to form a rectangular deck.

FIG. 5A illustrates installation of a support column on a slab.

FIG. 5B illustrates installation of support columns for a deck.

FIGS. 6A and 6B are schematic front and side views, respectively, of a stack of shipping containers for building a multi-story structure, in accordance with an embodiment of the invention.

FIG. 7 is a detail view of installation of structural insulated panels (SIP) in accordance with an embodiment of the invention.

FIG. 8A is a front view of a finished structure in accordance with an embodiment of the invention.

FIG. 8B is a side view of a finished structure in accordance with an embodiment of the invention.

FIG. 9 illustrates a self-contained elevator system for use in a multi-story building, in accordance with another embodiment of the invention.

FIG. 10 is a front view of a finished structure including an elevator, in accordance with an embodiment of the invention.

DETAILED DESCRIPTION OF EMBODIMENTS OF THE INVENTION

Figure 1 is a schematic illustration of an ISO shipping container 1 having a top 11, side walls 12, a base and end walls 13. A typical container has a height of 9.5 feet, a depth (that is, distance along edge 131) of 8 feet, and a length of 40 feet. The top 11 is supported by vertical posts (not shown) at the corners 123 where the sides and end walls meet. Horizontal beams (not shown) connect the posts along the edges 112, 121, 131, 122. The posts and beams thus form a frame to which any or all of the walls may be secured with bolts or other appropriate fasteners. Figure 1 shows side wall 12 and end wall 13 in an upright position, so that the container 1 is closed. These walls are also hinged along lower edges 121, 131 respectively. The walls may thus be lowered or raised (using a crane, forklift, come-along, winch or by another suitable method) to a position extending from the frame at an angle, including an open position where the wall is at 90 degrees to the frame and forms a continuous deck with the base 14 of the container. Figure 2 is a partial plan view of the base 14 with wall 12 folded down along the hinged edge 121. Figure 3 is a schematic plan view of base 14 with both front and rear side walls (lateral flaps) 12, 15 folded down to form a rectangular deck with dimensions 40 feet by 27 feet (when container 1 is 40 feet long). This deck may be anchored to the ground below, supported by columns above a slab, or attached to another container in a stacked configuration, as described in more detail below.

As shown in Figure 3, four vertical posts 31 are located at the corners of base 14; these posts form part of the frame of container 1. Additional support columns 32, 33 are attached to the deck at the corners and along the edges respectively. The frame of container 1, the top 11, and the added columns 32, 33 provide a support system to receive an upper floor and/or additional containers stacked on top of container 1.

Figure 4 is a schematic plan view of side walls 12, 15, and end walls 13 of container 1 lowered to form a continuous deck with base 14. As shown in Figure 4, if two contiguous walls located at right angles to each other are lowered, a corner space 41 is formed. A plate of structurally strong material is connected to the folded-down walls (e.g. along edges 43, 45) in each of the four corner spaces. This connection may be made using locking hinges, bolts or other mechanical fasteners, or welds, thereby forming a solid, continuous deck 40 with dimensions approximately 59 feet by 27 feet (when container 1 is 40 feet long). As noted above, columns 32, 33 (not shown in this plan view) extend vertically from the deck, and

columns 32 at the corners of base 14 support the top 11. Additional columns are provided at the corners 48 of the deck.

Another container may now be placed on the top 11 of container 1. This container may also have its walls folded down and plates inserted into the corner spaces; these folded-down walls and corner plates will be supported by columns 33. This additional container thus forms the floor for a second story of the structure. It will be appreciated that each shipping container in a stacked configuration provides one story of a multi-story structure.

Figure 5A is a detail view of a column 51 secured to a foundation (e.g. a slab) 53 by bolts 52 and supporting a deck 40, which in turn is formed by folding down walls of a shipping container. A simple one-story building with a concrete floor and a steel roof may thus be constructed from a single steel shipping container. As shown in Figure 5B, deck 40 in a multistory configuration may be supported by columns both above and below, so that the columns form a continuous vertical support 55. Connections 54 between the columns may be bolts or other mechanical fasteners, or welds. The columns may be located on the perimeter of deck 40, or in any other desired position to support the lowered walls of the container stacked above.

Figures 6A and 6B are schematic front and side views, respectively, of a four-story structure 60 according to an embodiment of the invention, where multiple shipping containers have been stacked on each other to form four stories 61-64 respectively. The first story 61, formed by the base and folded-down walls of a first container, is supported by columns (see Figure 5A) above a foundation (e.g. a concrete slab) 53. The second and third stories 62, 63 are formed by the base and folded-down walls of a second and third container respectively. The top story 64 comprises the top of the third container and additional material (steel plates, concrete board or the like). Alternatively, the first container may be anchored to the ground, so that a four-story structure requires four containers.

The columns supporting each floor (or story) are connected vertically to form continuous supports 55 (see Figure 5B). The top story 64 may be covered with roofing material or have a separate roof or an additional structure built on it.

Although the structures shown in these embodiments are three to five stories, it will be appreciated that the extremely rugged construction of ISO shipping containers permits them to be stacked to build taller structures.

The exterior walls (and interior walls, if desired) of the structure are preferably formed using structural insulated panels (SIP). Figure 7 shows installation of SIP panels in this embodiment. Panel 71 has an inner and outer skin of structural material, with insulation (typically foam 6 inches thick) therebetween, as is known to those skilled in the art. The insulation typically has an R-value of approximately 8 per inch of thickness, so that a 6-inch thick panel provides insulation of R-50. C-shaped channel 72 is affixed to the lowered walls (and additional plates) which form each deck 40; accordingly, channel 72 forms a header to receive the upper edge of panel 71. If desired, another channel may be provided to receive the lower edge of the panel. The channels are attached using bolts or other mechanical fasteners, or welds; the wall panels are secured to the channels using screws or other mechanical fasteners. In addition, the walls are connected to the floors (above and/or below) using structurally strong material (e.g. metal extrusions, such as angled strips of steel), so that the walls provide structural support for the floor(s) above. A gasketing material (e.g. a rubber membrane 73) is preferably used to protect against intrusion of air or water along surfaces where the floor and walls connect.

Assembling the upright walls serves to fully enclose the structure. It will be appreciated that the vertical support columns may be embedded in the wall panels. Furthermore, the arrangement 70 of channel and SIP wall panels may be installed as desired in the interior space of the structure, to divide the space on a given floor in accordance with any need. Doors and windows may be cut into the SIP wall panels after they are installed, or may be set into the walls in predetermined locations. Plumbing, HVAC and electric service may be installed in the structure as needed. Other structures (e.g. catwalks, fire escapes) may be attached to the exterior.

Figure 8A is a front view of a completed structure in accordance with an embodiment of the invention. A three-story structure 81, formed from stacked shipping containers, has an additional structure 82 built on the roof thereof. As shown in Figure 8A, structure 82 has a balcony with a railing and a door leading thereto, and a top floor with a peaked roof. Figure 8B is a side view of a similar structure where stacked containers form a four-story structure, and an additional structure 85 is built on the roof thereof. It will be appreciated that structure 85 may itself be largely formed from one or more additional shipping containers, oriented at right angles to the containers used for structure 84. A wide variety of configurations therefore

are possible, in accordance with the number of containers stacked, their various sizes and their orientation with respect to each other.

Figure 9 is a schematic view of an elevator that may be added to a multi-story building constructed in accordance with the invention. The elevator shaft is formed from a shipping container 90 stood on its end. The elevator cab 91 and elevator cables 92, together with the required controls, etc. are fitted inside the container. Accordingly, container 90 provides a self-contained elevator system. As shown in Figure 9, one wall of the container (facing the interior of the building) is removed. The container (combined elevator and shaft) is secured to a foundation and to the exterior of the building. The shaft may be extended in height by removing an end wall of the container, inserting extension plates (thereby lengthening the side walls of the container) and re-attaching the end wall. External stairs, overhangs, etc. may be transported inside the container, and then attached to the exterior of the shaft.

Figure 10 shows a completed structure including an elevator in container 90 attached to a side of the building. The elevator shaft includes a height extension 95 which may accommodate the mechanicals (electric motor, cable winding drum, etc.) for operating the elevator.

It will be appreciated that the shipping containers used to construct a building according to the present invention may have all the required components (support columns, channels, wall panels, roofing material, etc.) of the building packed therein for transport to the building site. This effectively permits shipping of an entire building (or one story of a multi-story building) in a single durable container of a uniform size. As described above, a building constructed in accordance with the invention may be an open, solid frame and floor structure of steel or similarly strong material, and furthermore may be a multi-story structure to serve any desired purpose. Buildings constructed in accordance with the invention may easily be engineered to meet or exceed all applicable local building code standards, including wind, snow load and seismic standards.

While there have been shown and described and pointed out the fundamental novel features of the invention as applied to the preferred embodiments, it will be understood that various omissions and substitutions and changes of the form and details of the method and apparatus illustrated and in the operation may be done by those skilled in the art, without departing from the spirit of the invention.

CLAIMS

What is claimed is:

1. A building comprising:
a substantially horizontal deck; and
a plurality of substantially vertical columns,
wherein the deck includes a base of a shipping container.

2. A building according to claim 1, wherein a side wall of the shipping container is adapted to form a portion of the deck adjacent to the base.

3. A building according to claim 1, further comprising a foundation, and wherein the columns are attached to the foundation and support the deck.

4. A building according to claim 1, wherein a plurality of shipping containers, each having a base, are arranged in a stacked configuration so that each base forms part of one of a plurality of decks in a multi-story building.

5. A building according to claim 1, further comprising an exterior wall including a structural insulated panel (SIP).

6. A building according to claim 5, wherein at least one column is embedded in the panel.

7. A building according to claim 5, further comprising a channel affixed to the deck for receiving the panel.

8. A building according to claim 2, wherein the deck includes the base, two side walls and two end walls of the container, the side walls and the end walls being adapted to form portions of the deck adjacent to the base.

9. A building according to claim 4, wherein the multi-story building includes an elevator.

10. A building according to claim 9, wherein the elevator is contained in an elevator shaft, and the elevator shaft is formed from a shipping container standing on an end wall thereof.

11. A method for constructing a building, comprising the steps of:

providing a shipping container having a base, side walls and end walls, the side walls and end walls having hinged connections to the base;

opening the shipping container using said hinged connections so that the base, the side walls and the end walls form a substantially horizontal deck; and

attaching substantially vertical columns to the deck.

12. A method according to claim 11, further comprising the step of attaching plates at corner portions of the deck, thereby forming a substantially rectangular deck.

13. A method according to claim 11, further comprising the steps of:

providing a plurality of shipping containers so as to form a plurality of decks;

stacking the shipping containers so as to form a multi-story building.

14. A method according to claim 13, further comprising the step of:

attaching an upper end of a column to one of the plurality of decks and a lower end of the column to another of the plurality of decks.

15. A method according to claim 11, further comprising the step of providing an exterior wall including a structural insulated panel (SIP).

16. A method according to claim 15, wherein at least one column is embedded in the panel.

17. A method according to claim 15, further comprising affixing a channel to the deck for receiving the panel.

18. A method according to claim 11, wherein the shipping container is an ISO steel container.

19. A method according to claim 13, further comprising the step of providing an elevator for the multi-story building.

20. A method according to claim 19, wherein the elevator is contained in an elevator shaft, and the elevator shaft is formed by standing a shipping container on an end wall thereof.

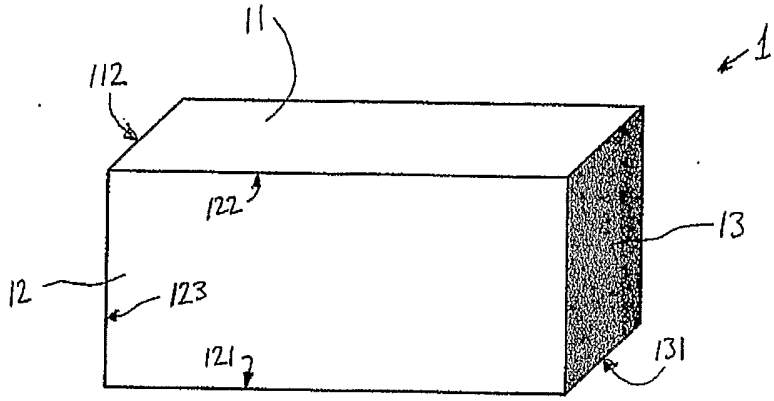


FIG. 1

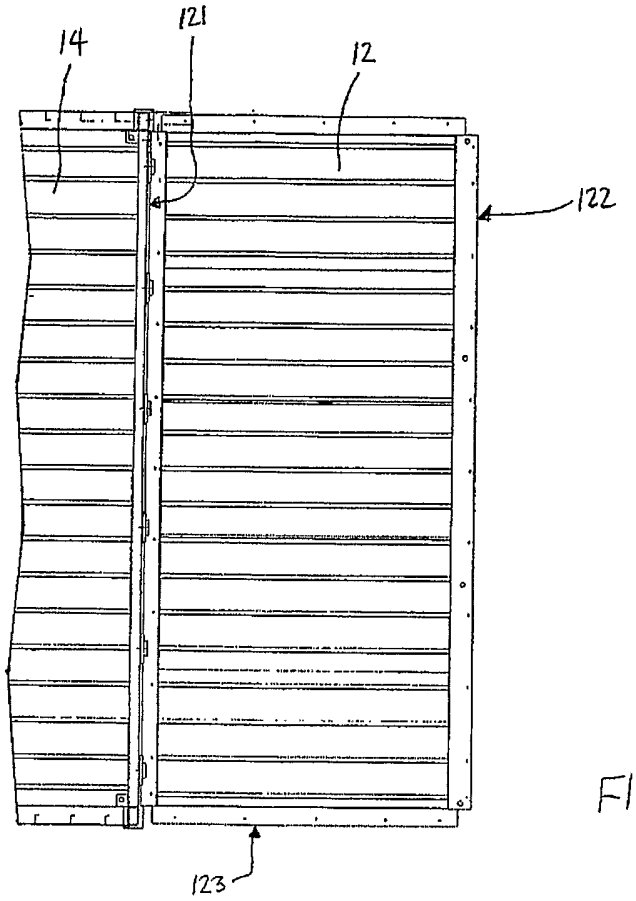
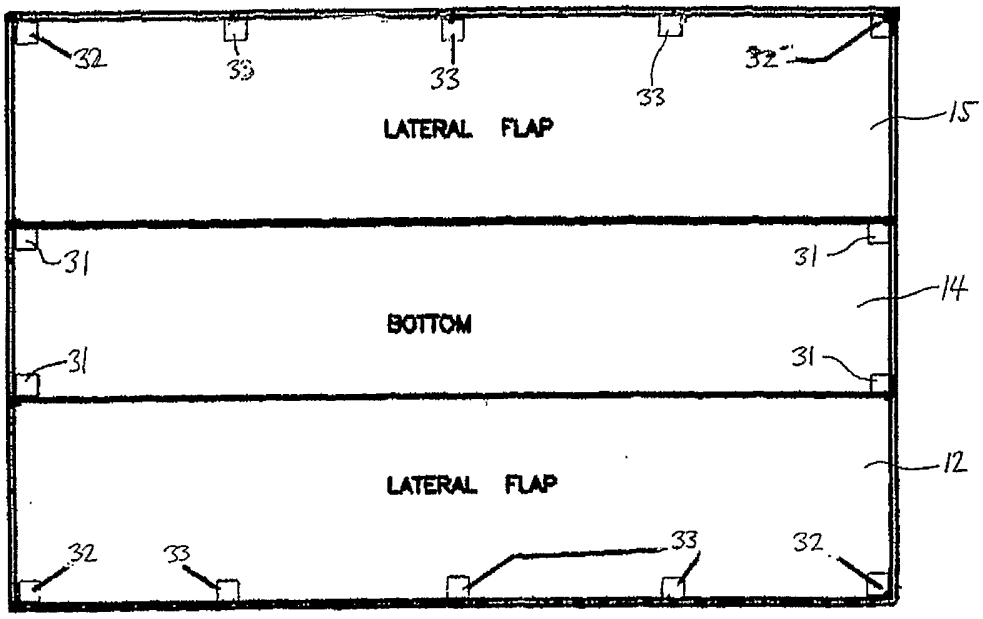


FIG. 2


32
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LATERAL FLAP
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BOTTOM
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LATERAL FLAP
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FIG. 3

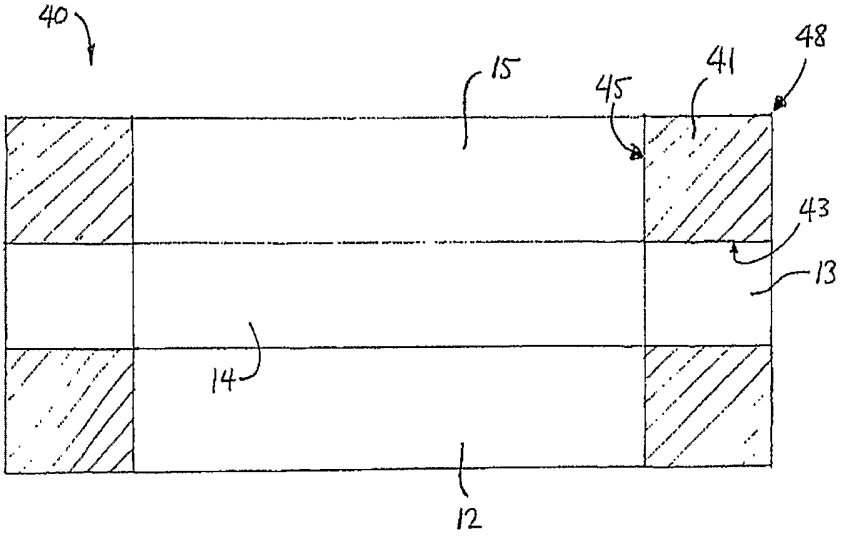

FIG. 4

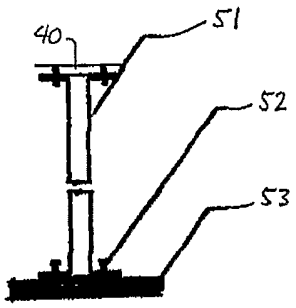

FIG. 5A

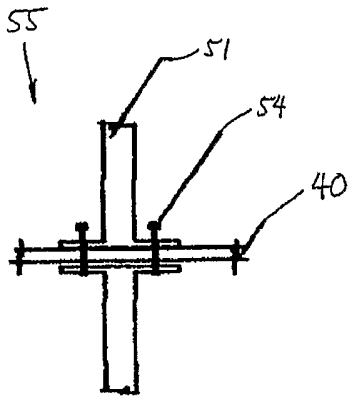

FIG. 5B

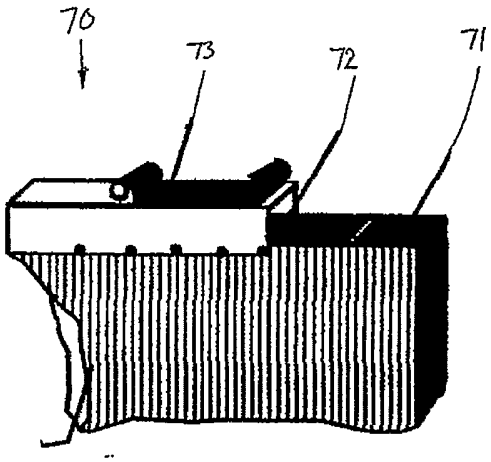

FIG. 7

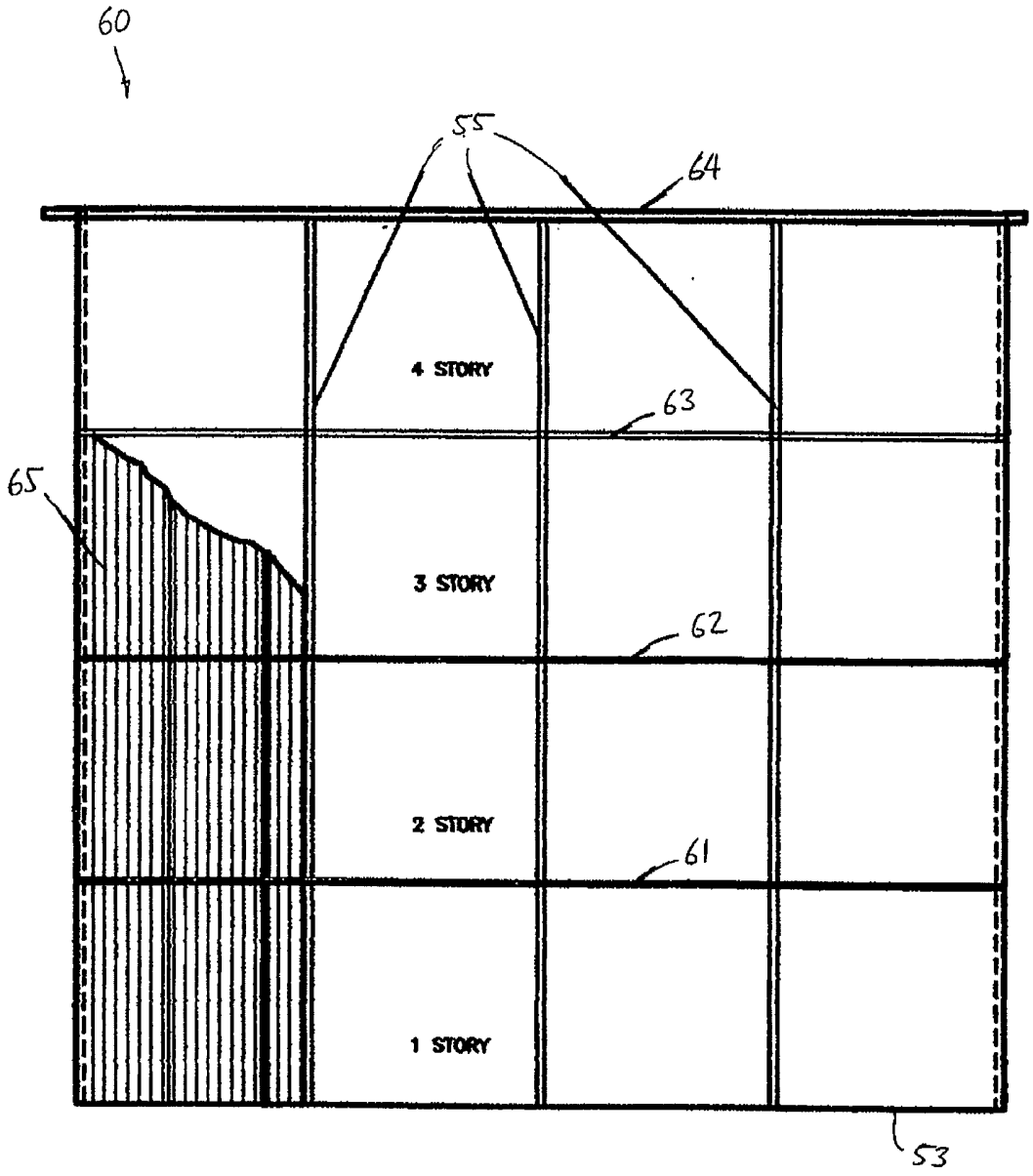

FIG. 6A

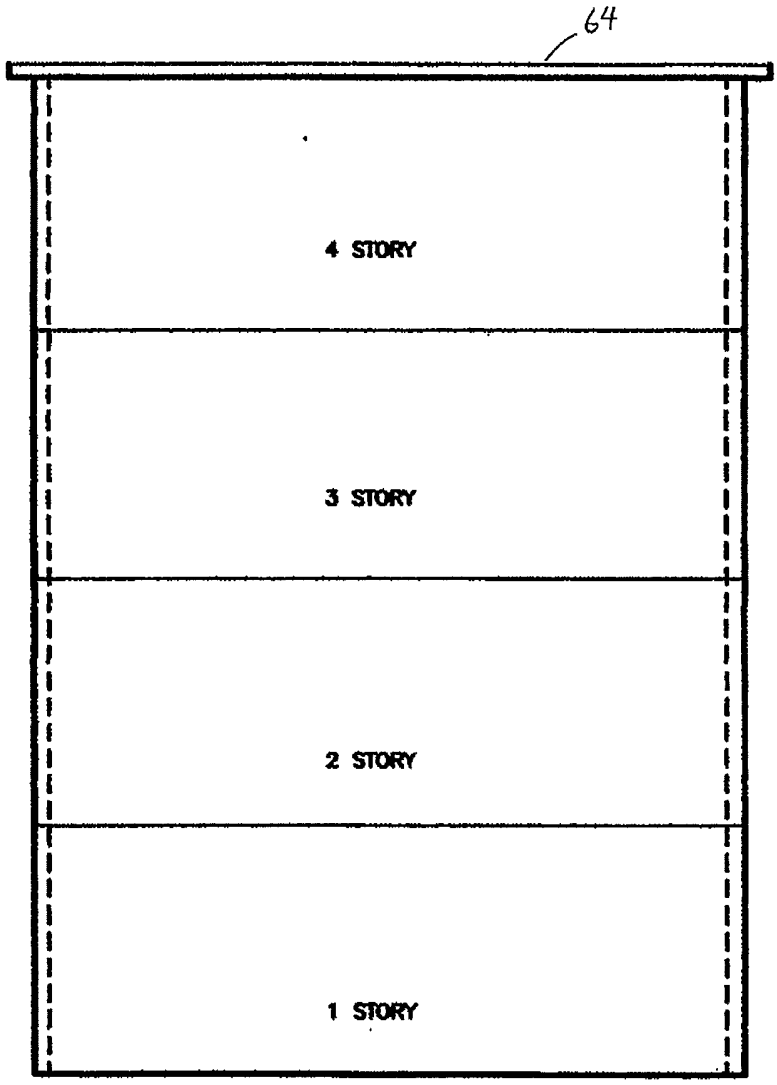

FIG. 6B

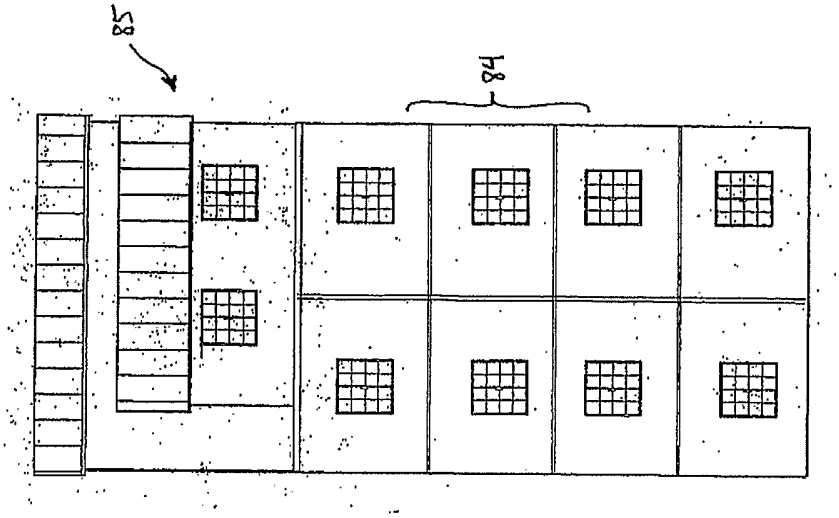

FIG. 8B

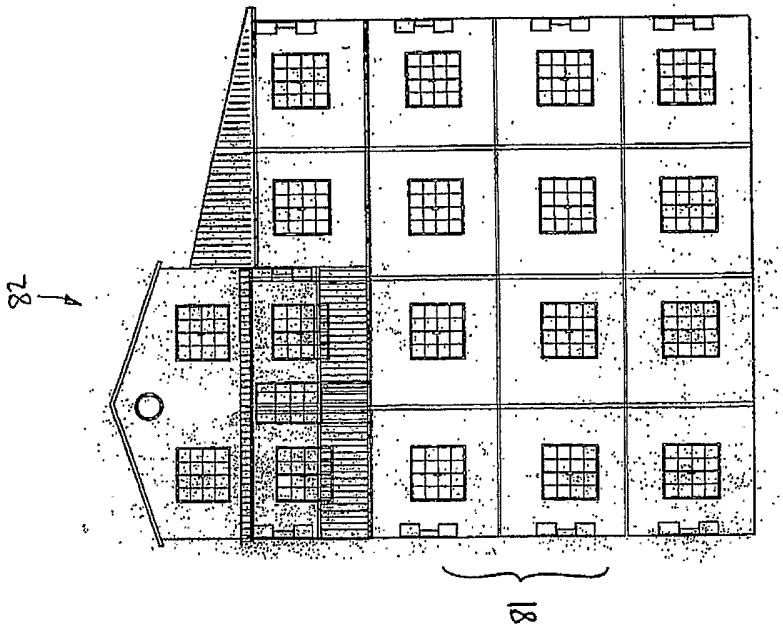

FIG. 8A

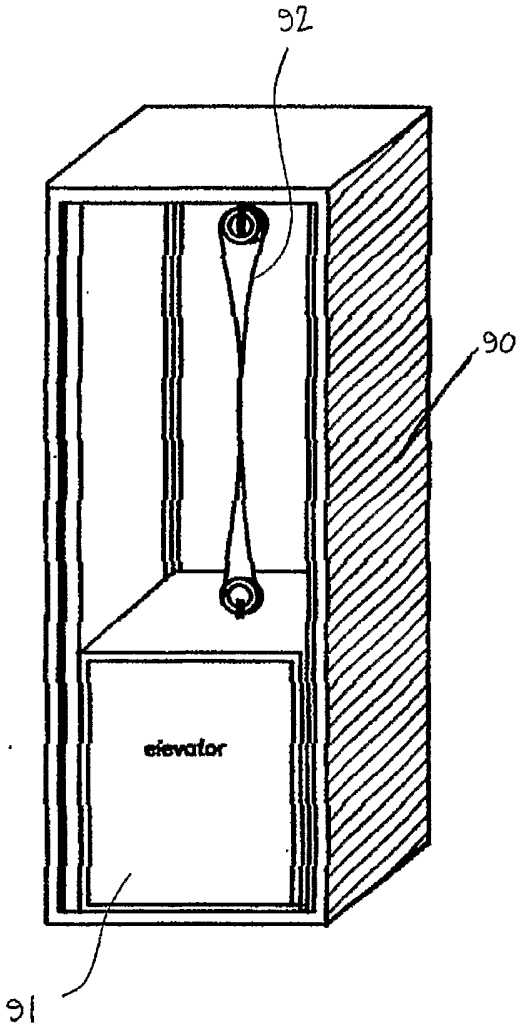

FIG. 9

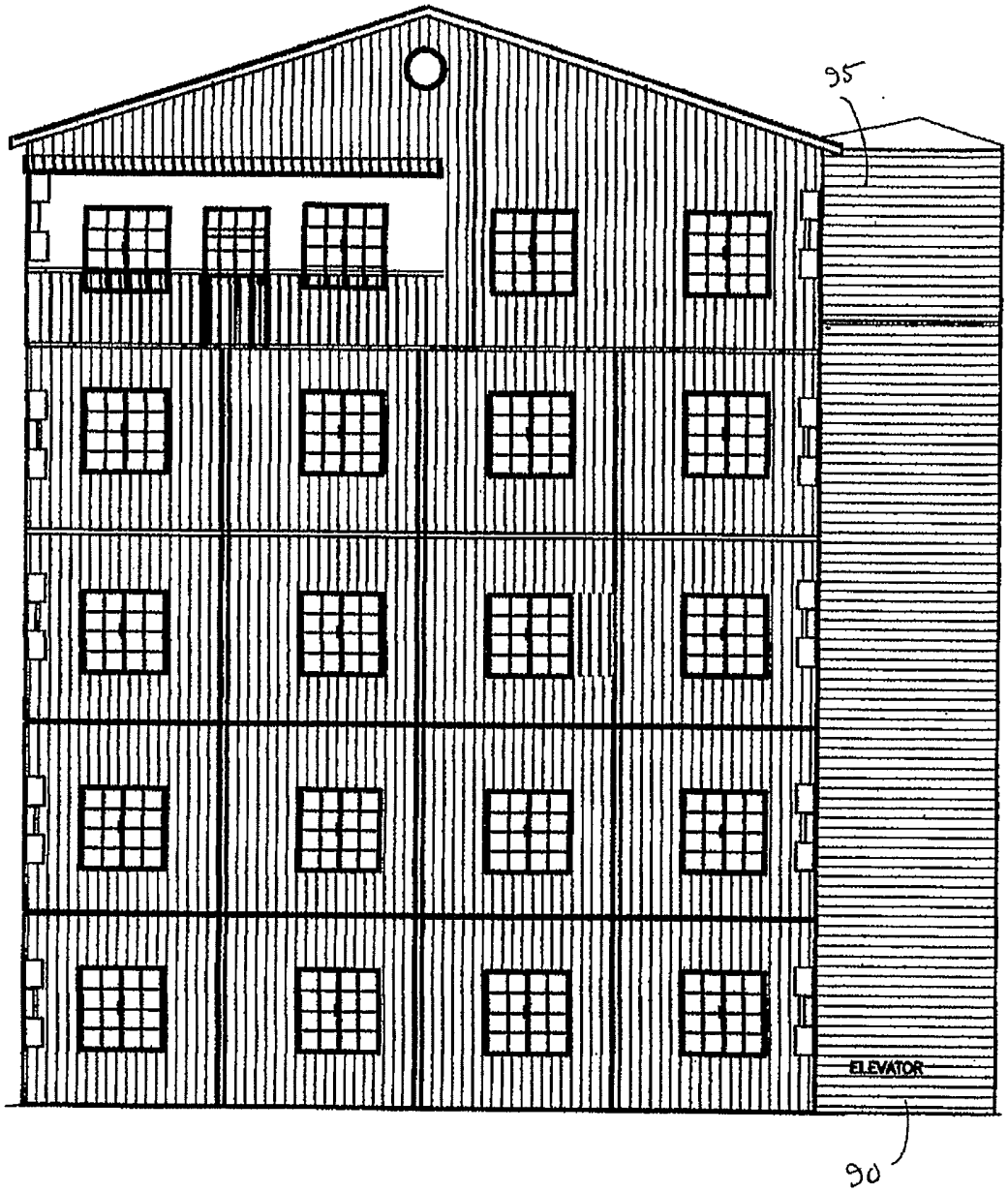

FIG. 10