



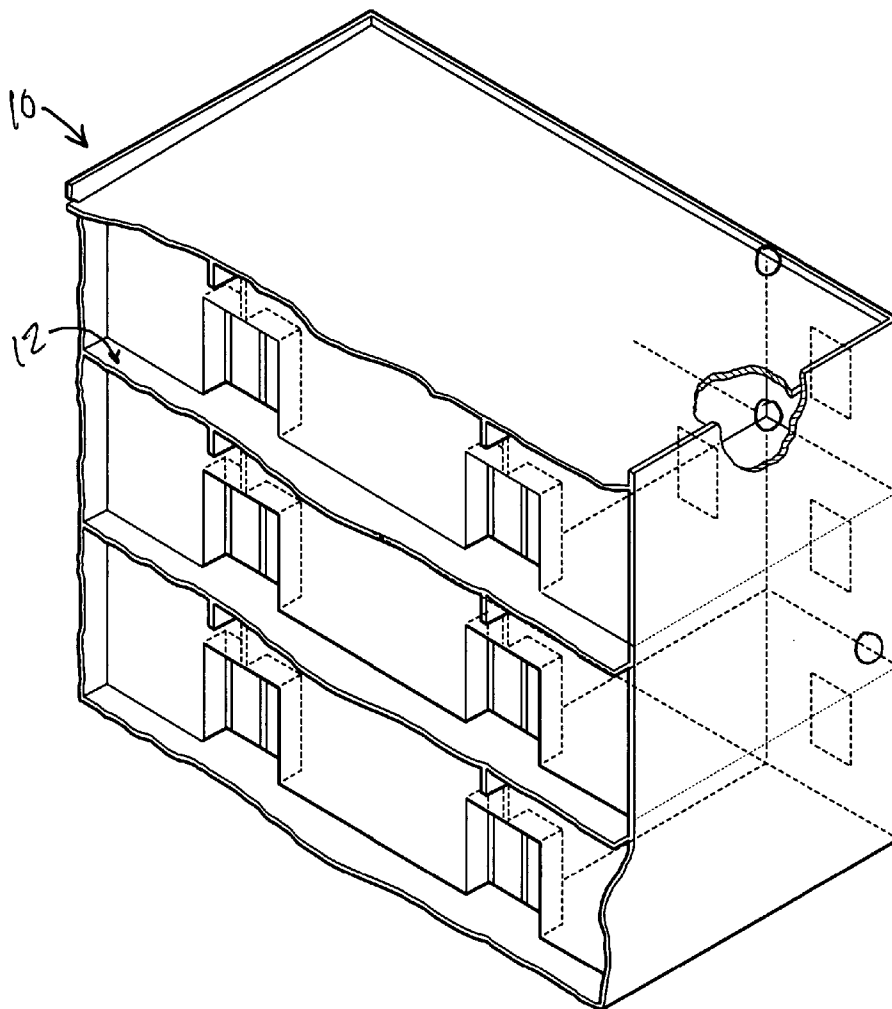
US 20040250482A1

(19) **United States**(12) **Patent Application Publication**
Jacobson et al.(10) **Pub. No.: US 2004/0250482 A1**(43) **Pub. Date: Dec. 16, 2004**(54) **CONSTRUCTION METHOD AND
APPARATUS****Publication Classification**(76) Inventors: **C. Eric Jacobson**, Columbia, SC (US);
Brian A. Mucha, Baltimore, MD (US);
Martin R. Williams, Phoenix, MD
(US)(51) **Int. Cl.⁷** **E04H 1/00**(52) **U.S. Cl.** **52/79.1**Correspondence Address:
SARA A. CENTIONI
NEXSEN PRUET, LLC
POST OFFICE DRAWER 2426
COLUMBIA, SC 29202-2426 (US)(57) **ABSTRACT**

A multi-story structure having a flooring system and method for installing the flooring system in the multi-story structure. The present invention further includes a method of constructing a multi-story structure using the flooring system of the present invention. The flooring system includes a plurality of interconnected layer, including a layer of steel deck. The flooring system is employed throughout the multi-story structure and contributes to an overall lighter weight in construction materials, as well as to a reduction in costs and labor. It is contemplated by the present invention that this flooring system can be employed in any commercial or residential structure having a variety of dimensions and stories.

(21) Appl. No.: **10/867,488**(22) Filed: **Jun. 14, 2004****Related U.S. Application Data**

(60) Provisional application No. 60/477,946, filed on Jun. 13, 2003.



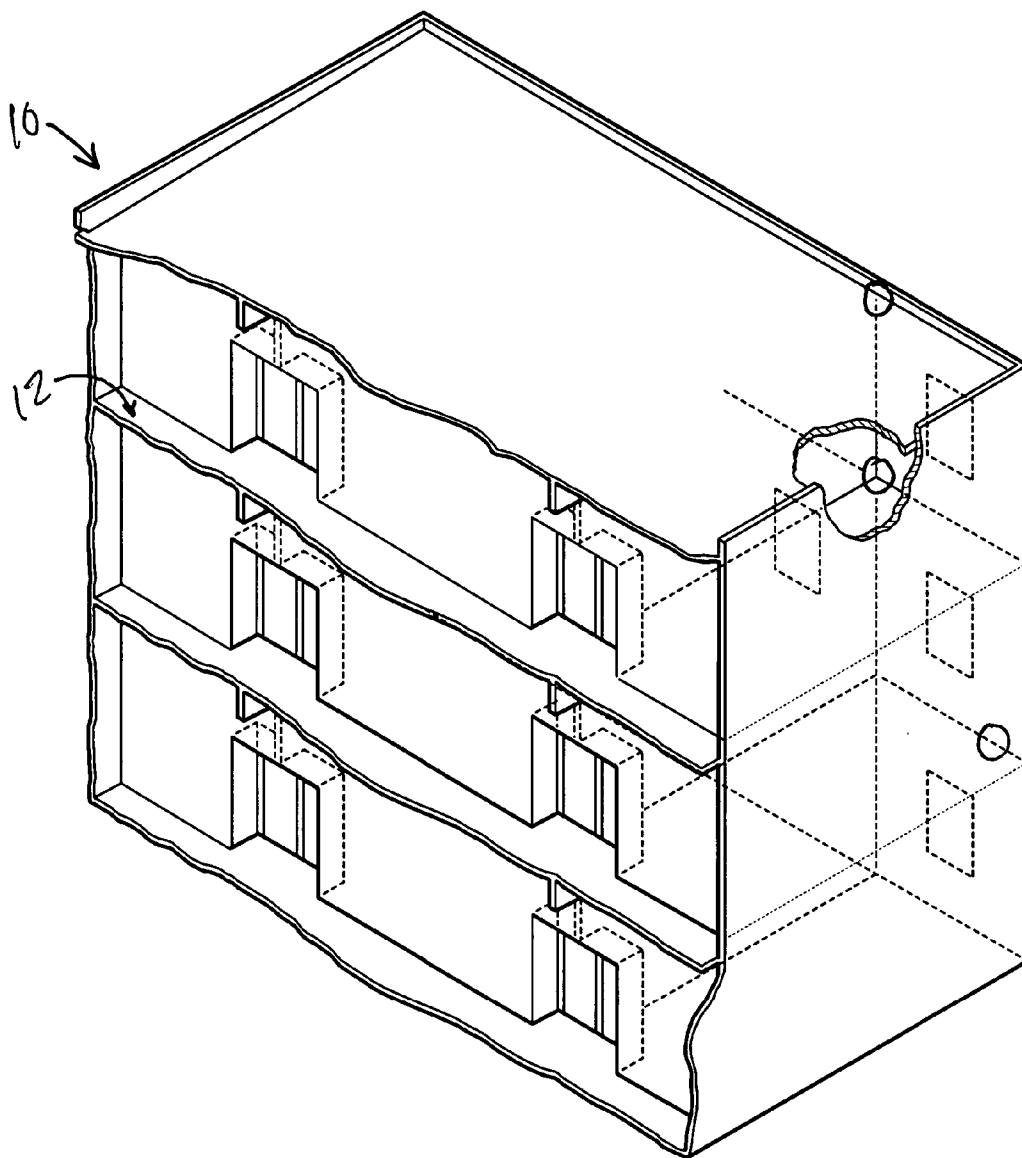


FIG. 1

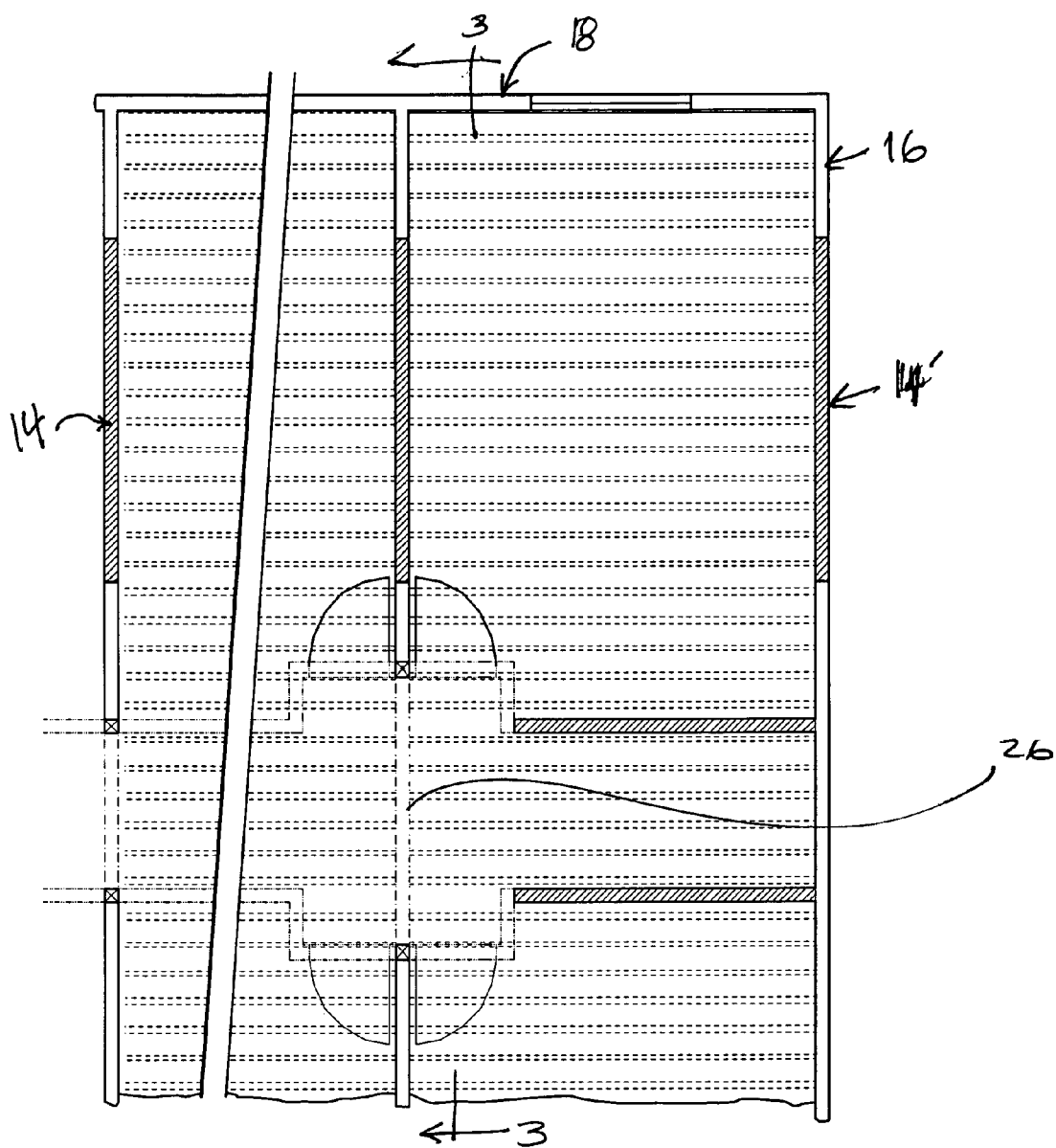
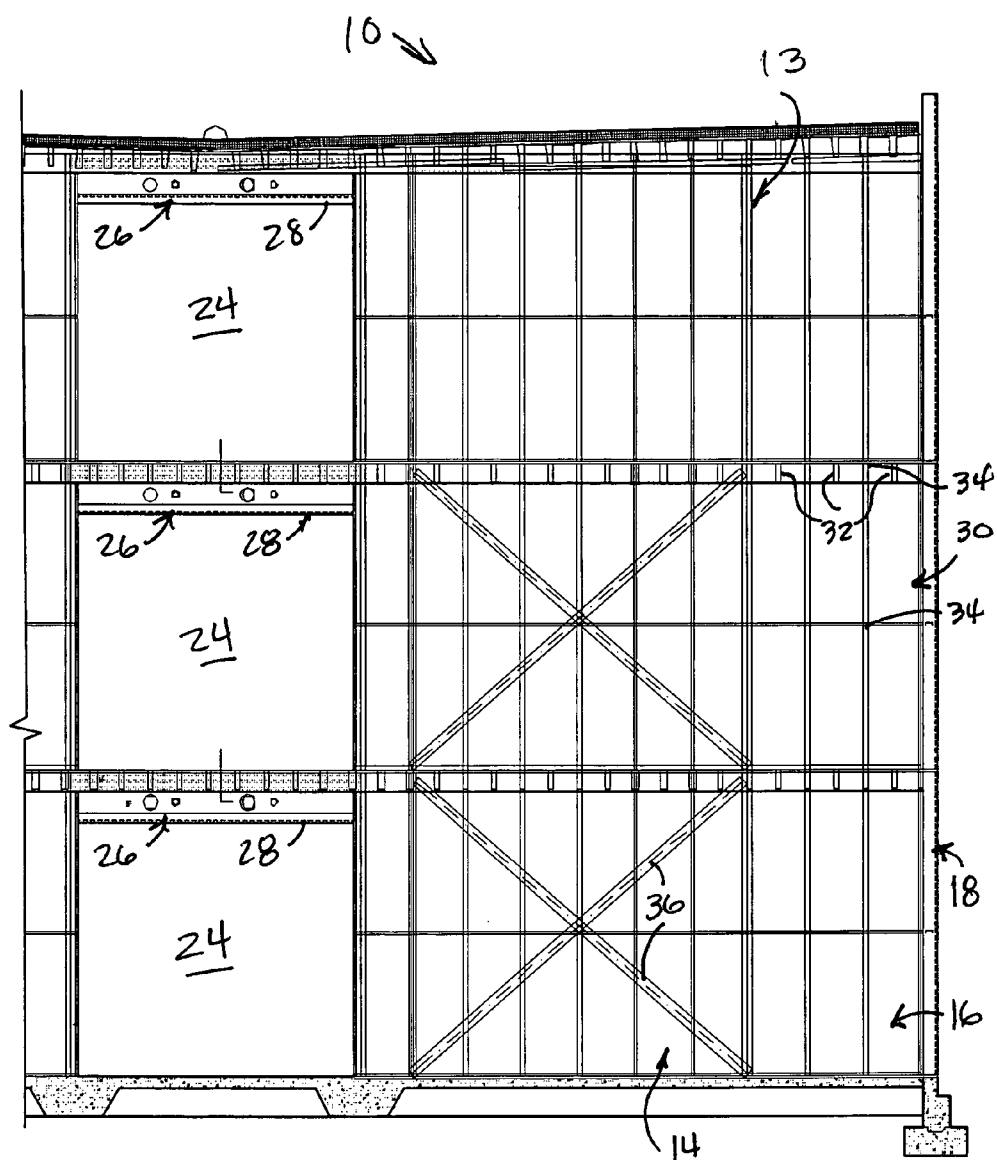


FIG. 2



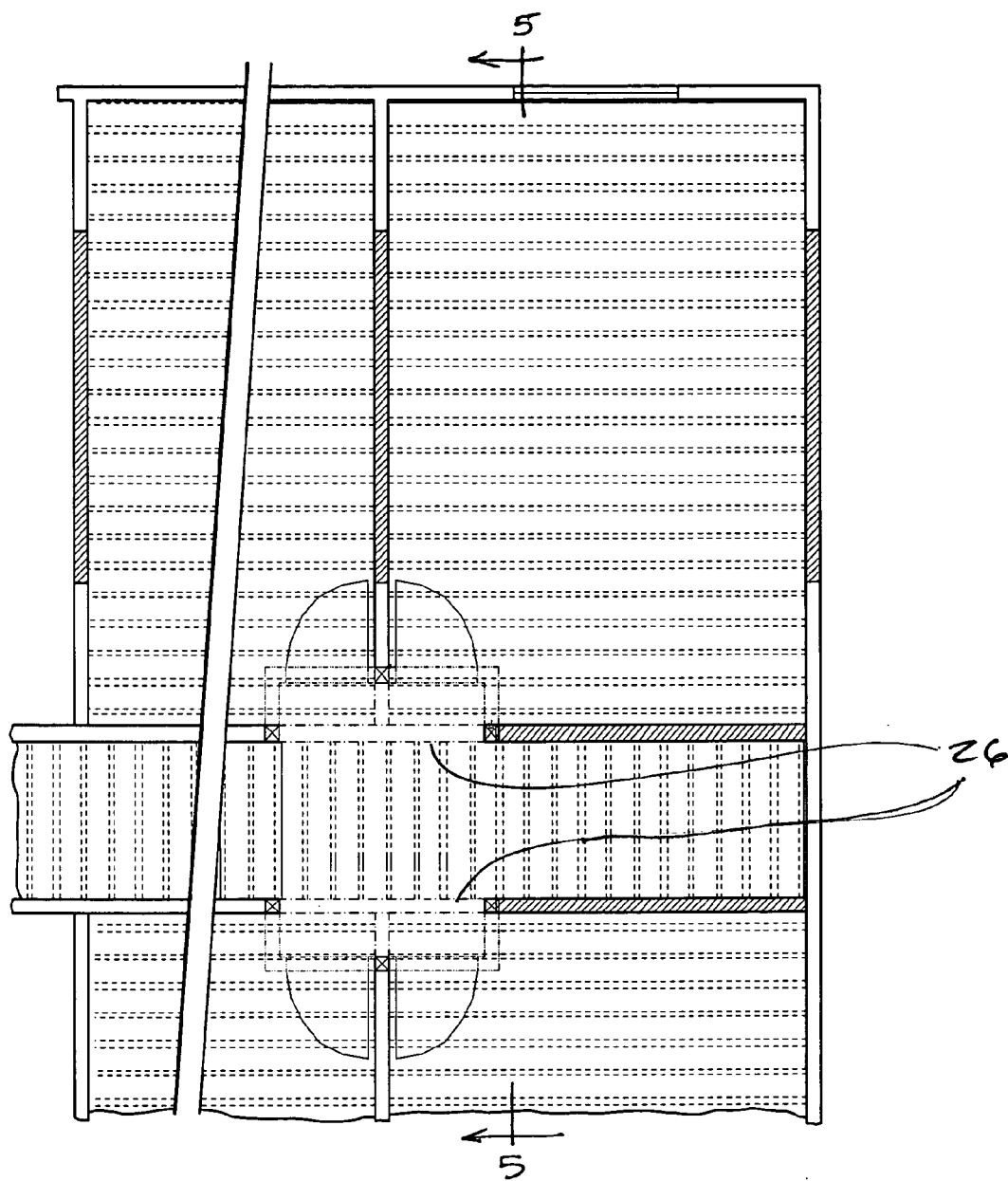


FIG. 4

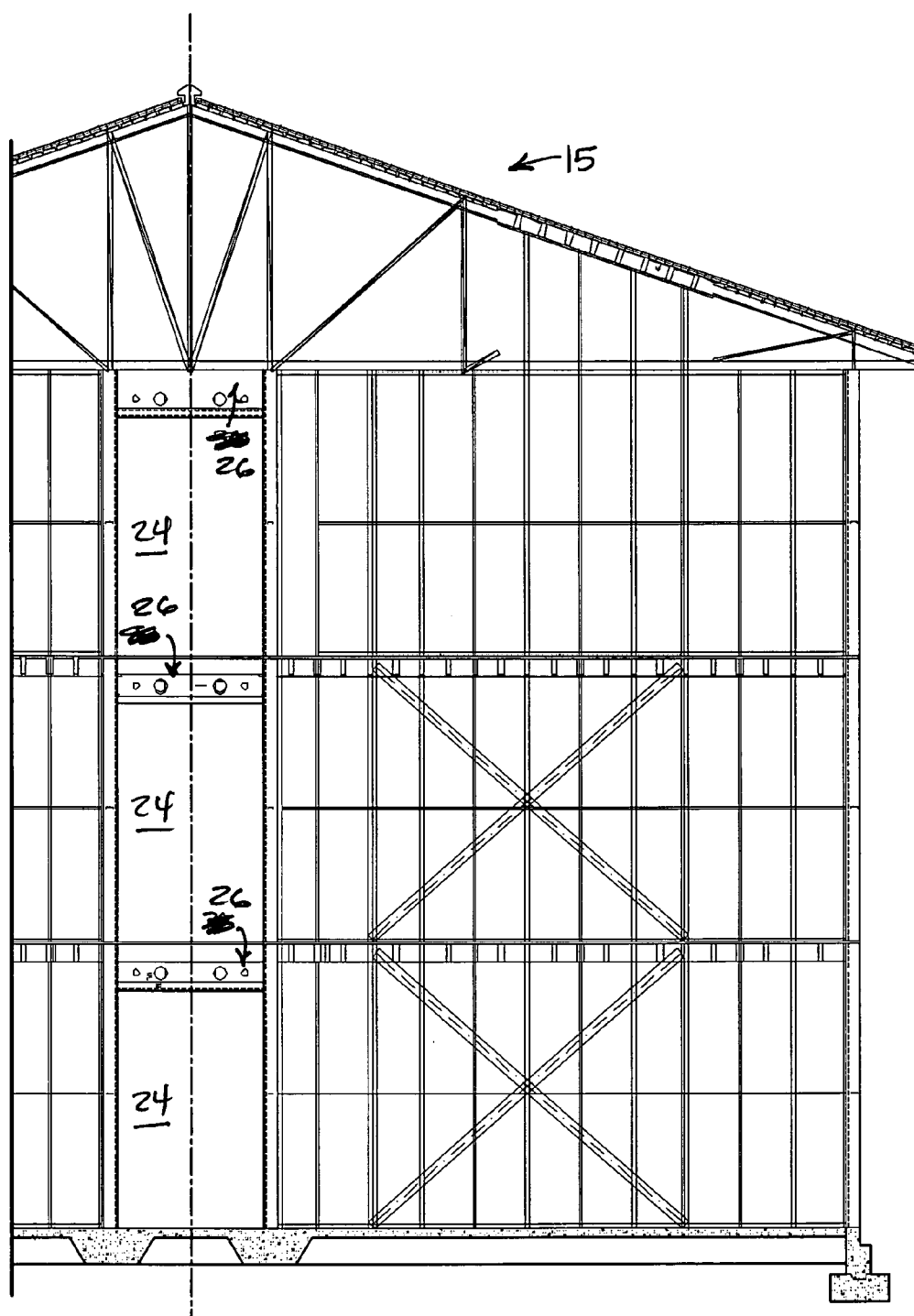
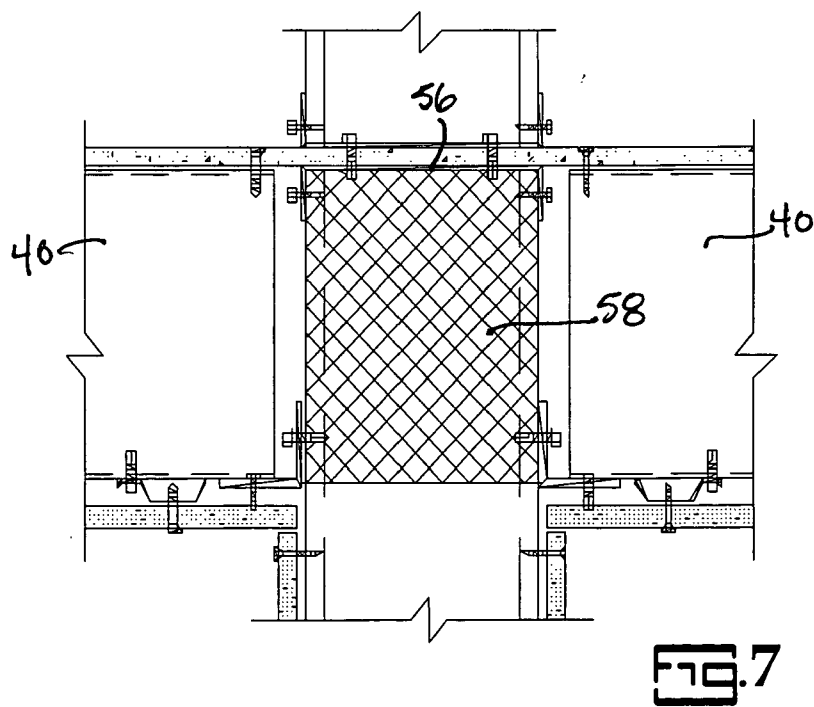
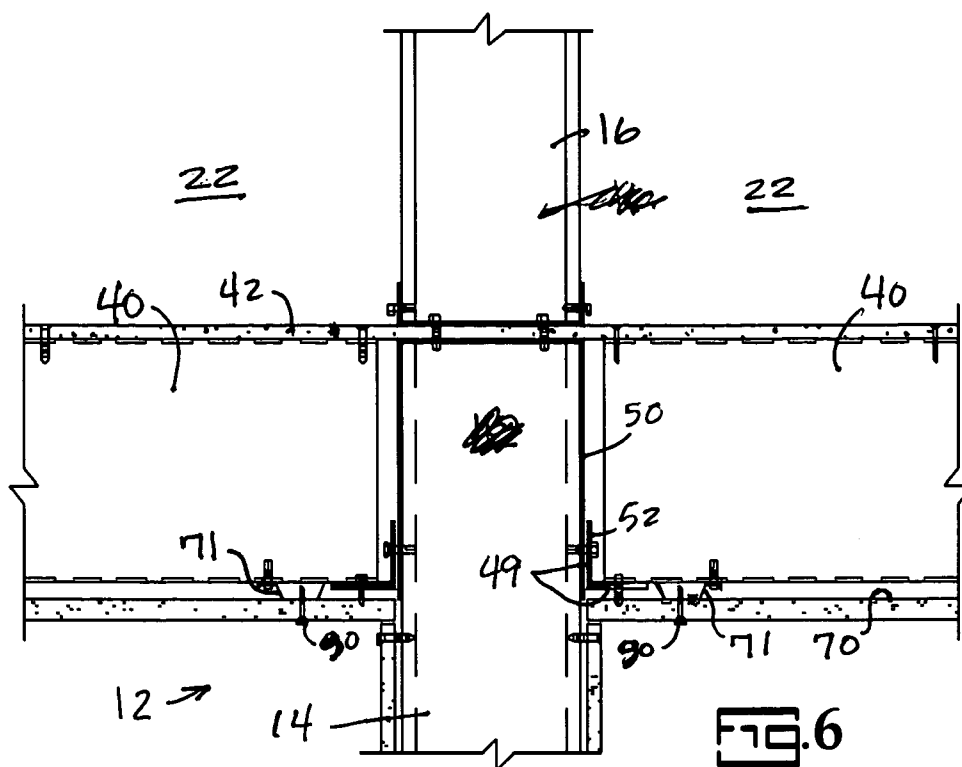
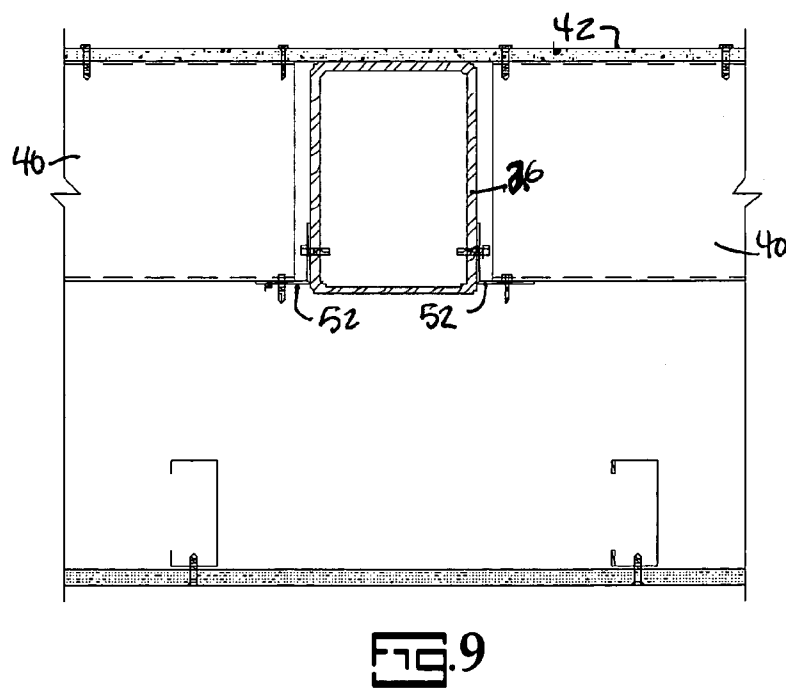
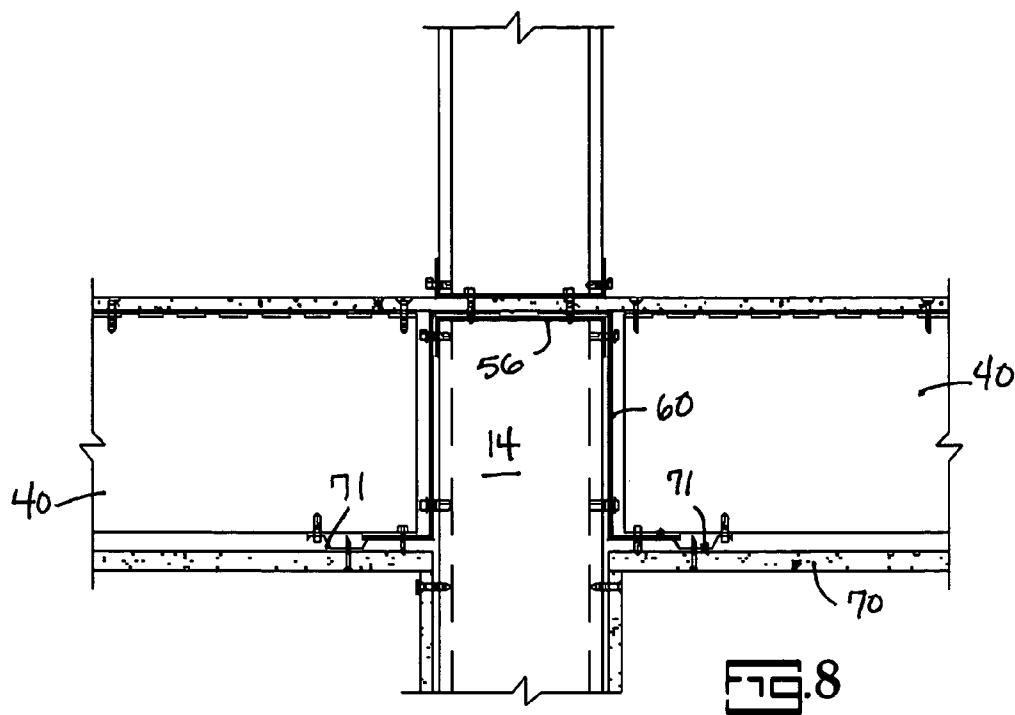
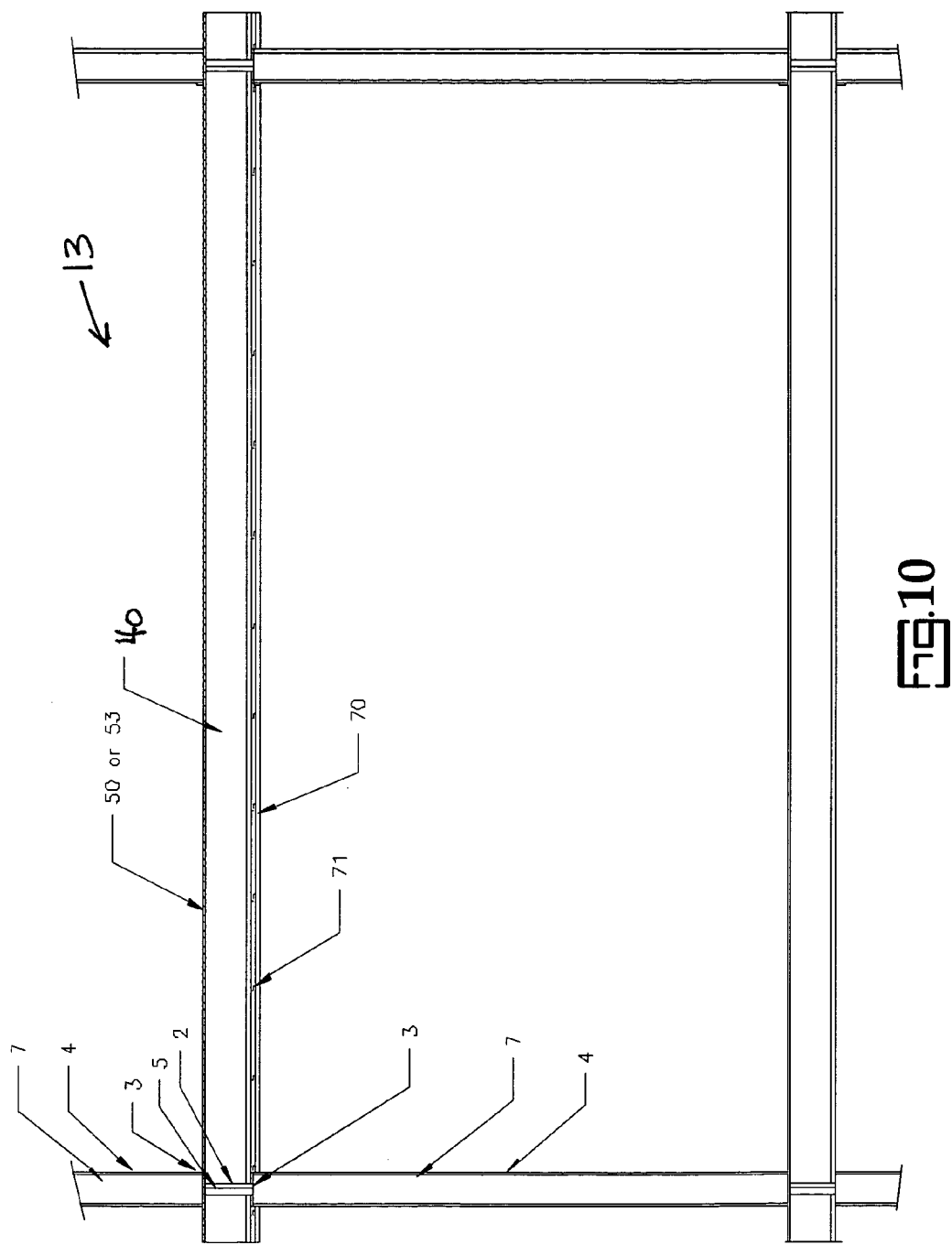
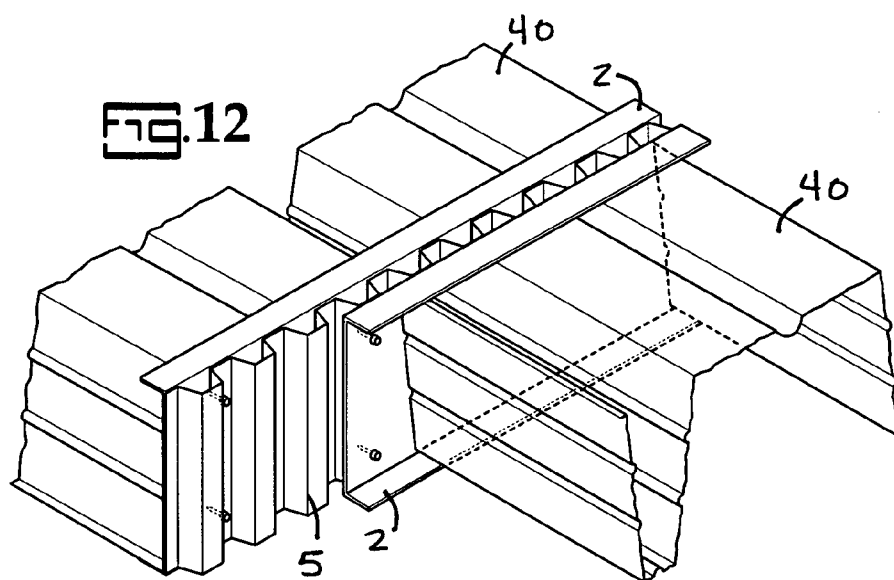
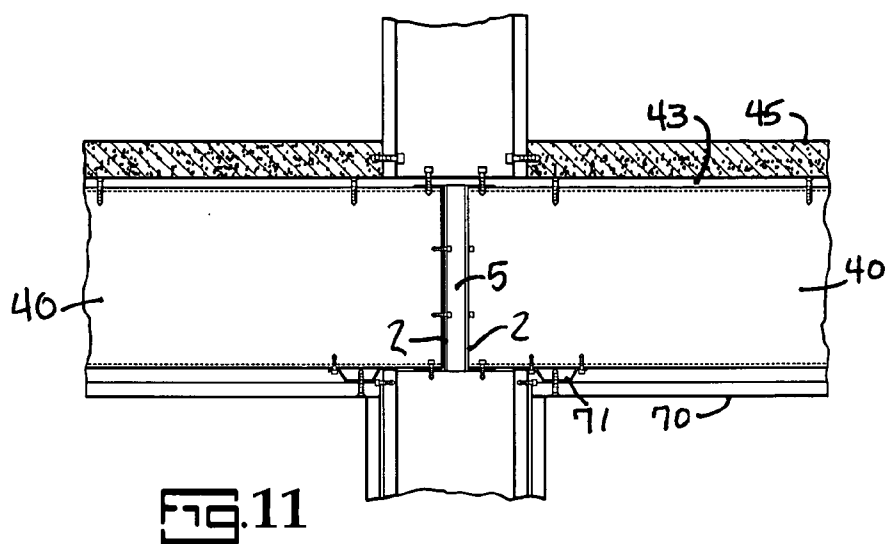


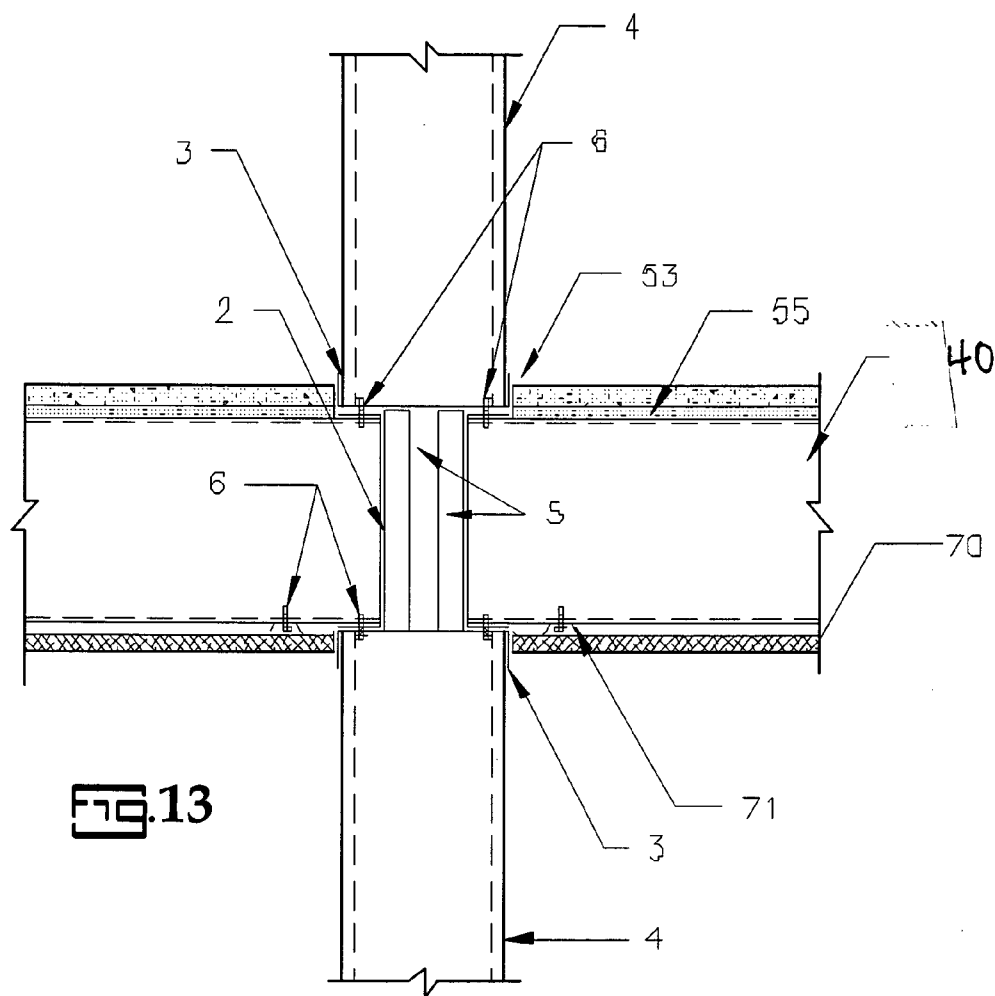
FIG. 5

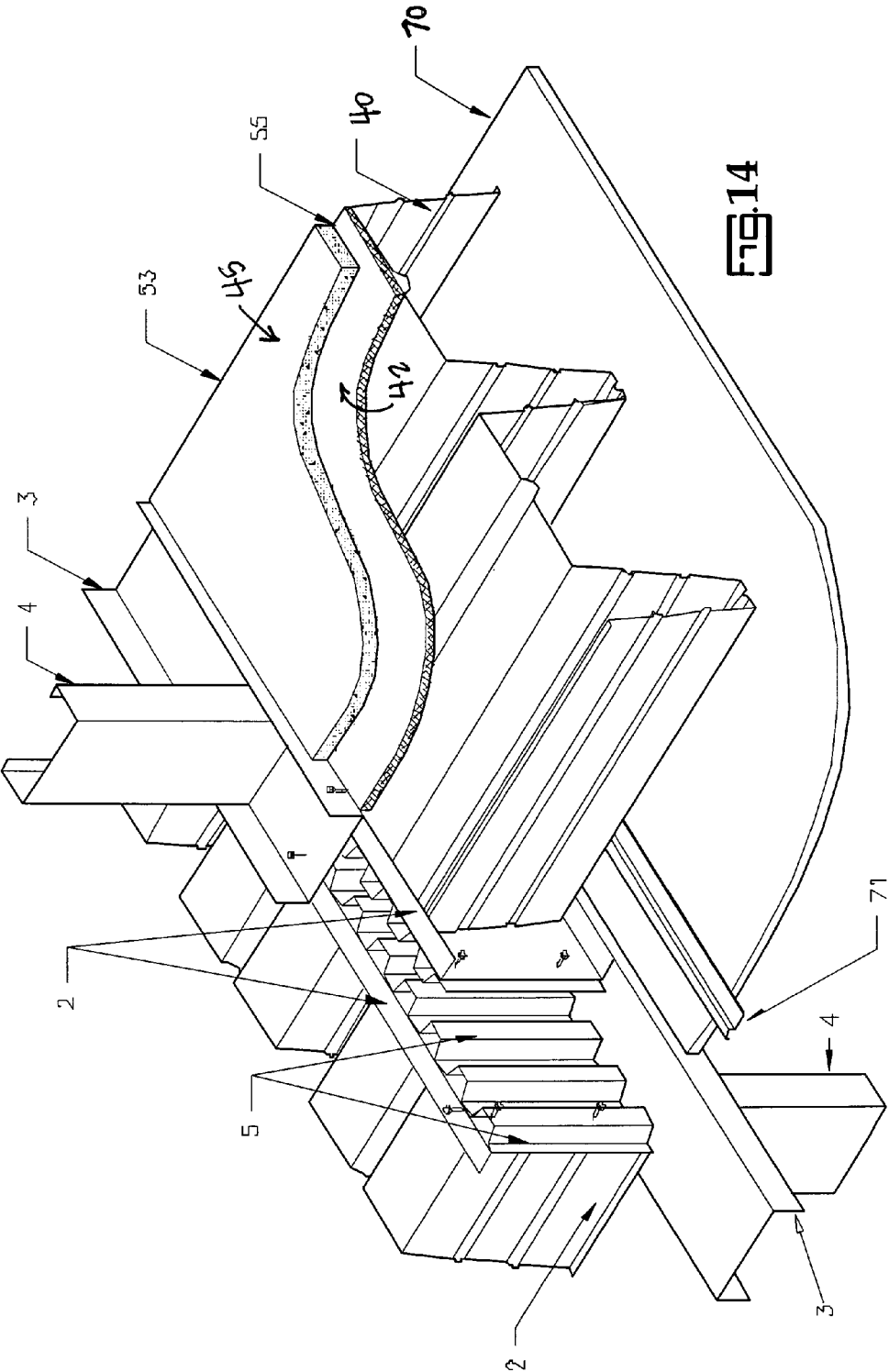


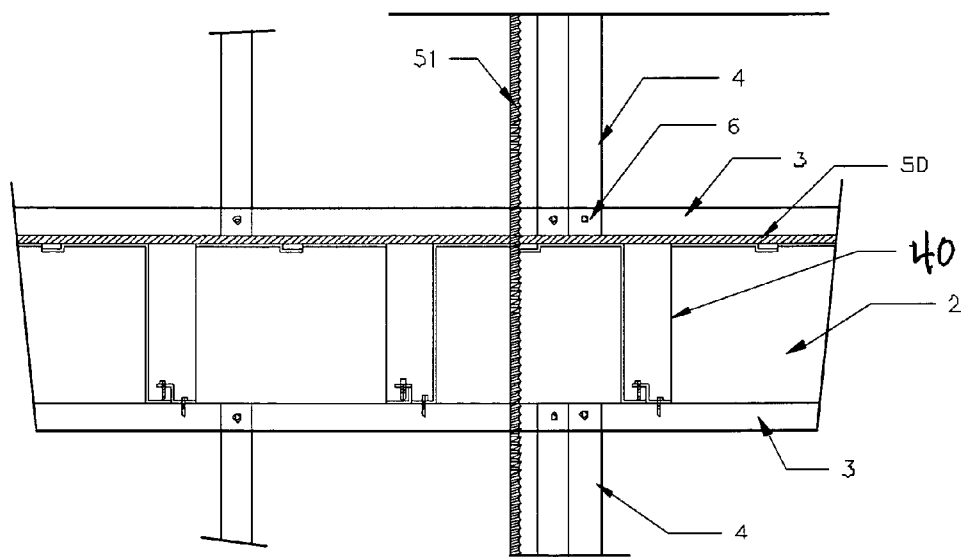
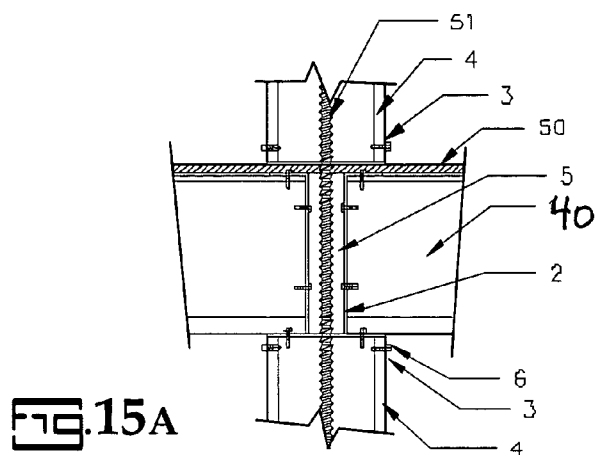












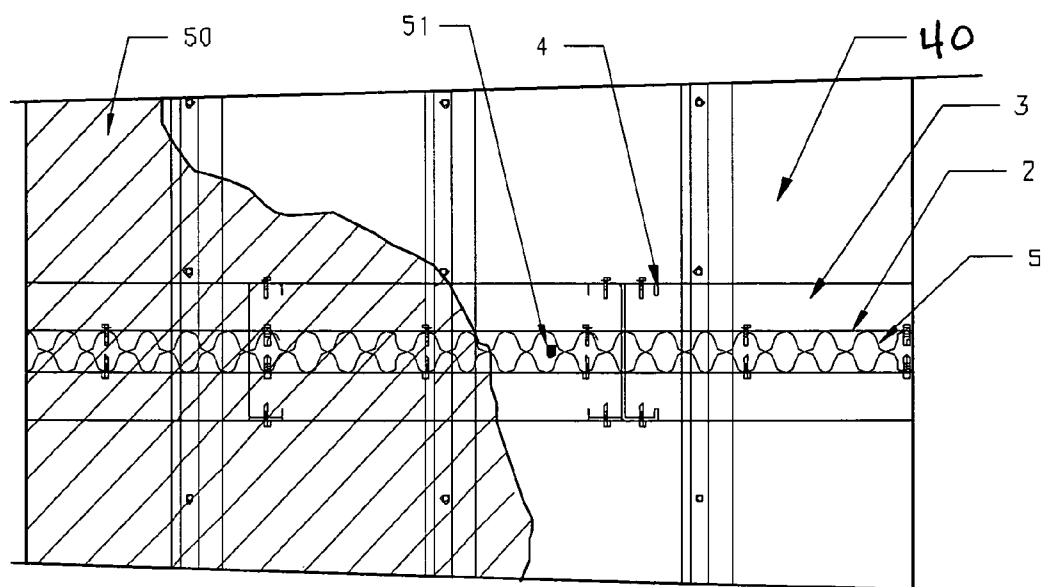
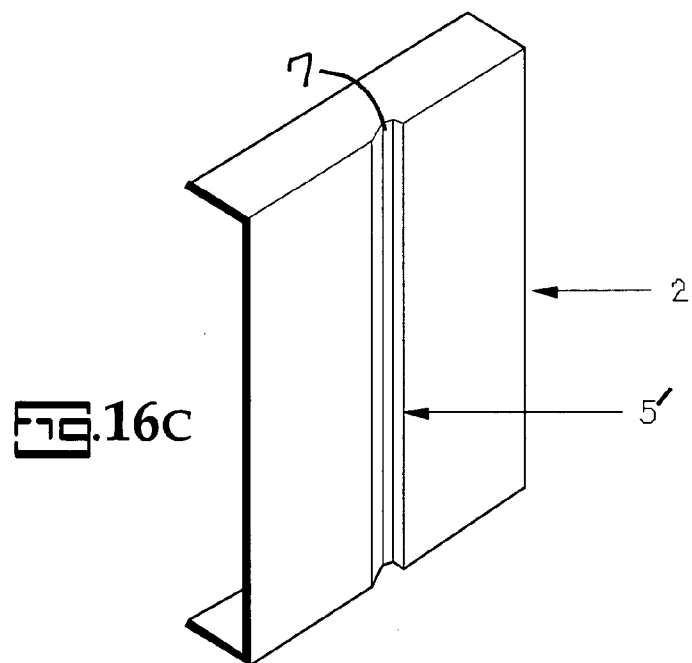
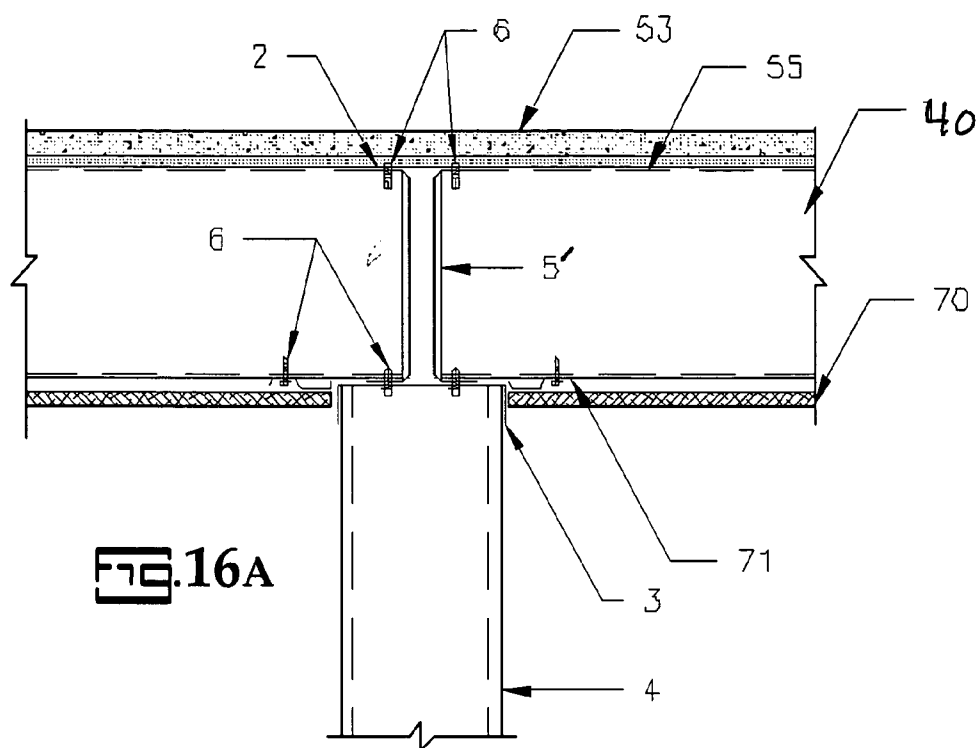
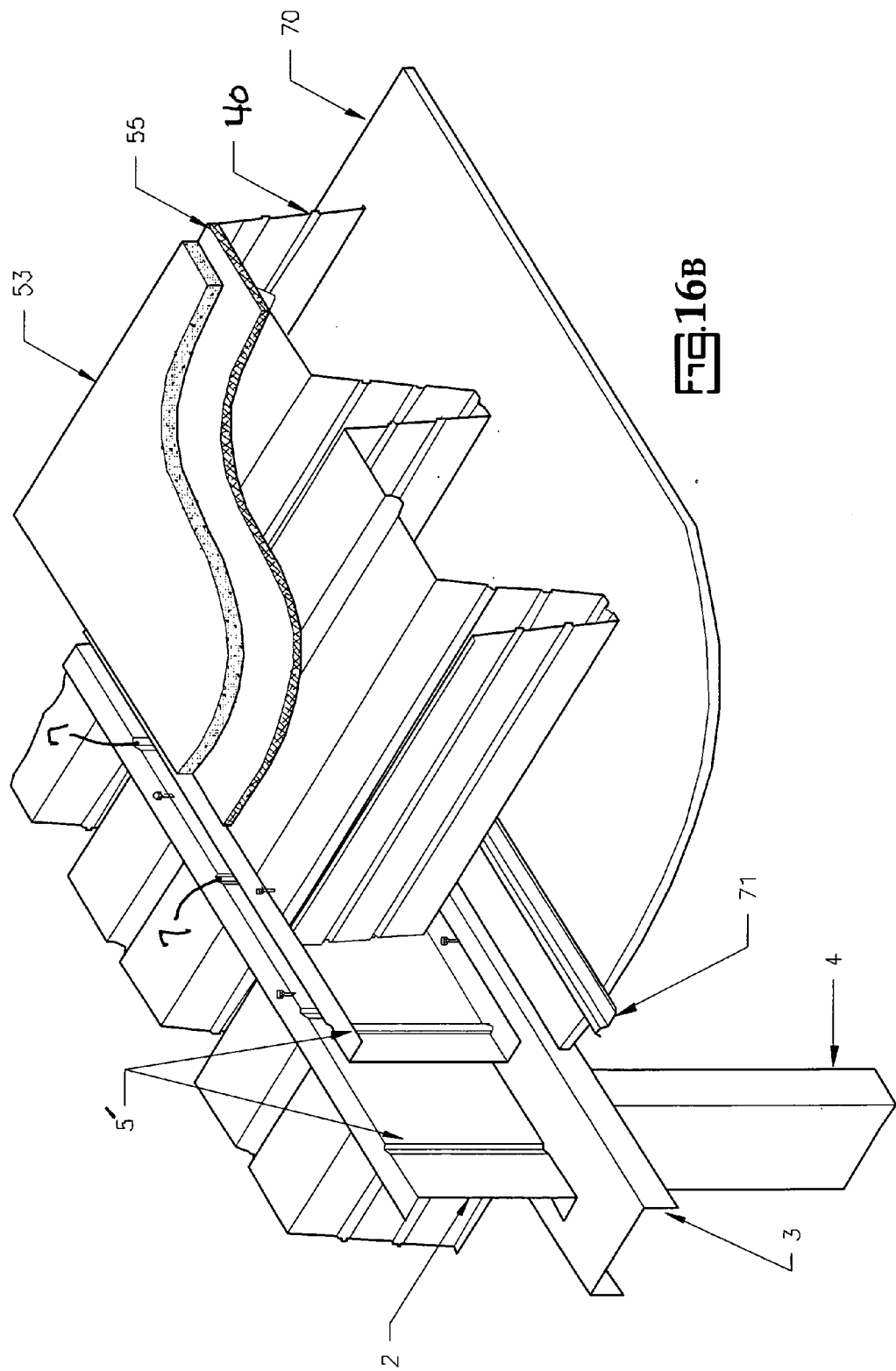


FIG. 15C





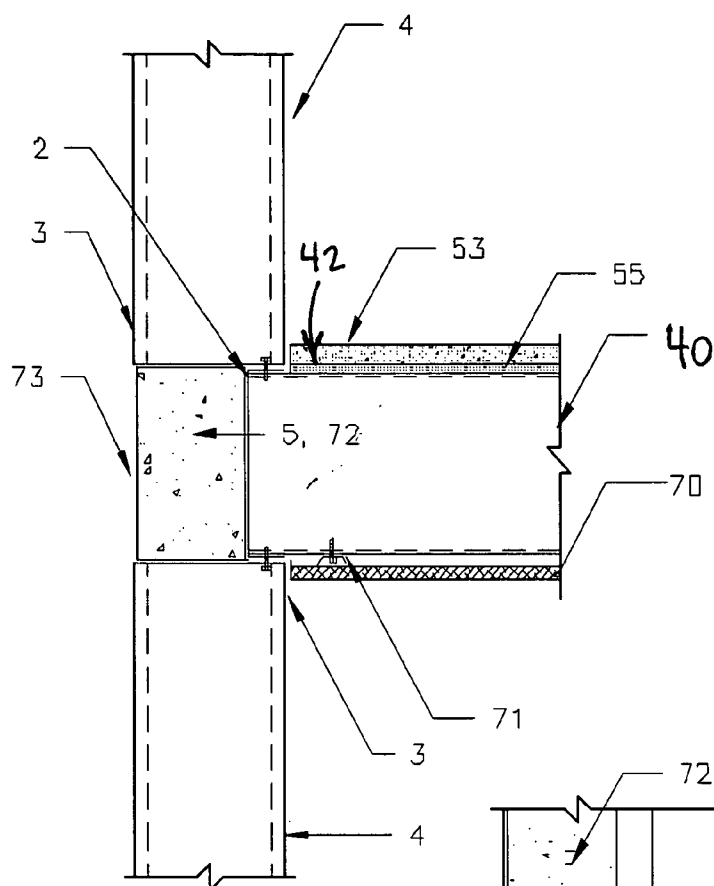


FIG. 17A

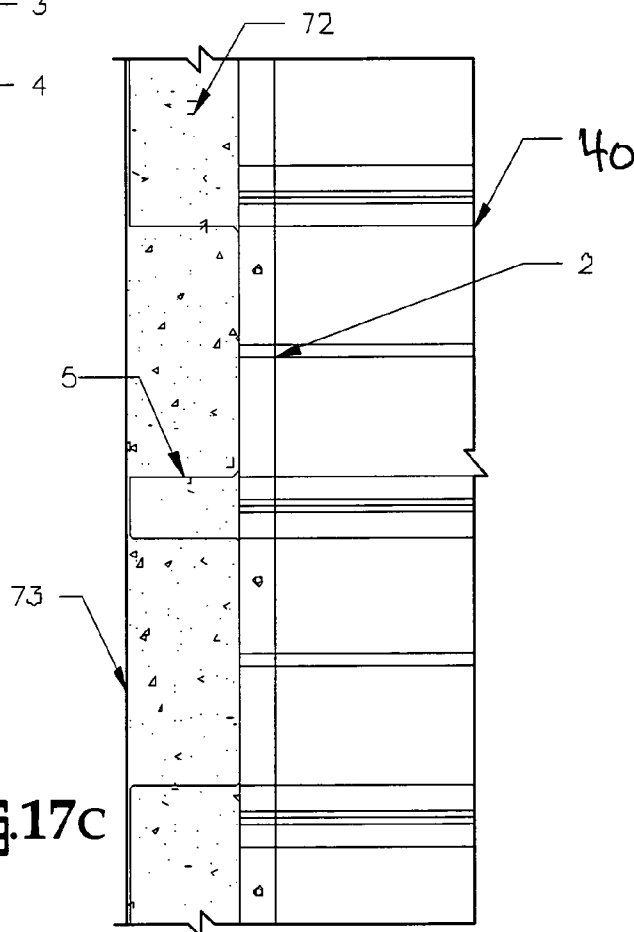
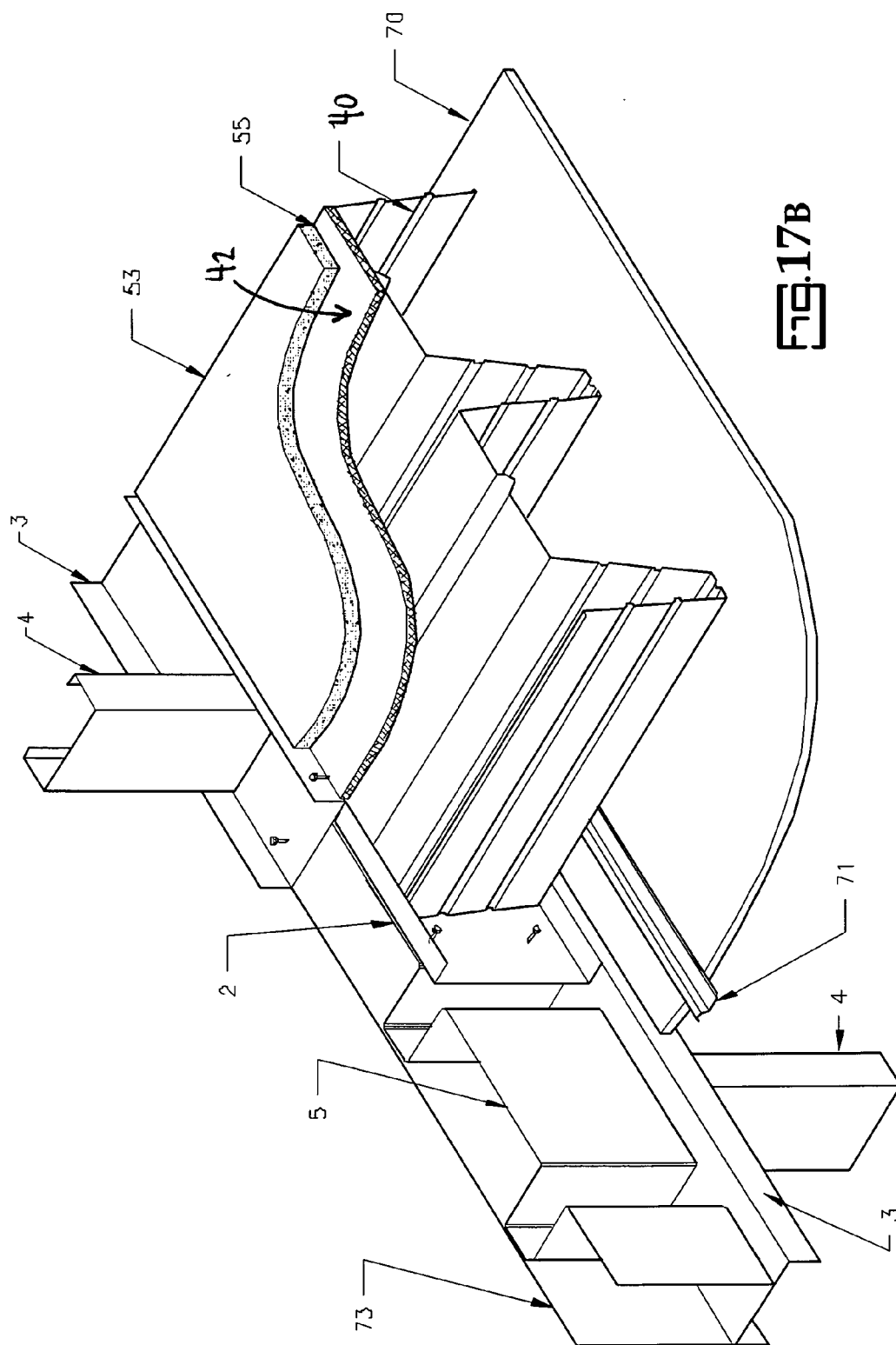


FIG. 17C



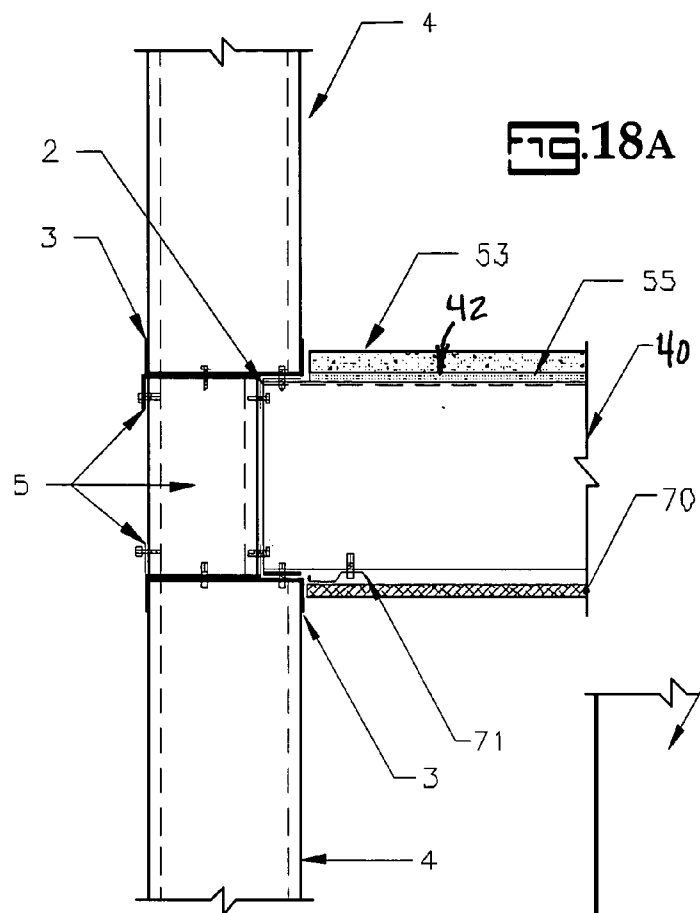
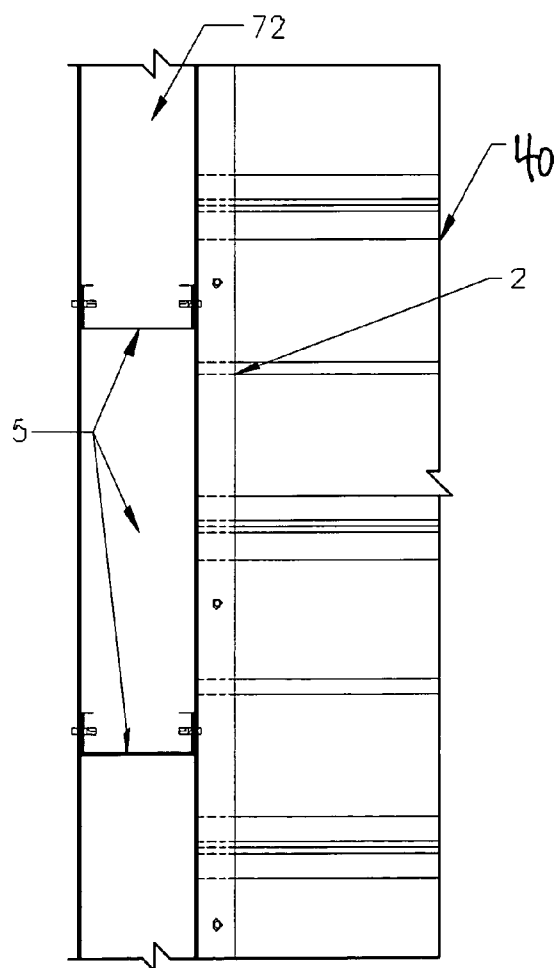
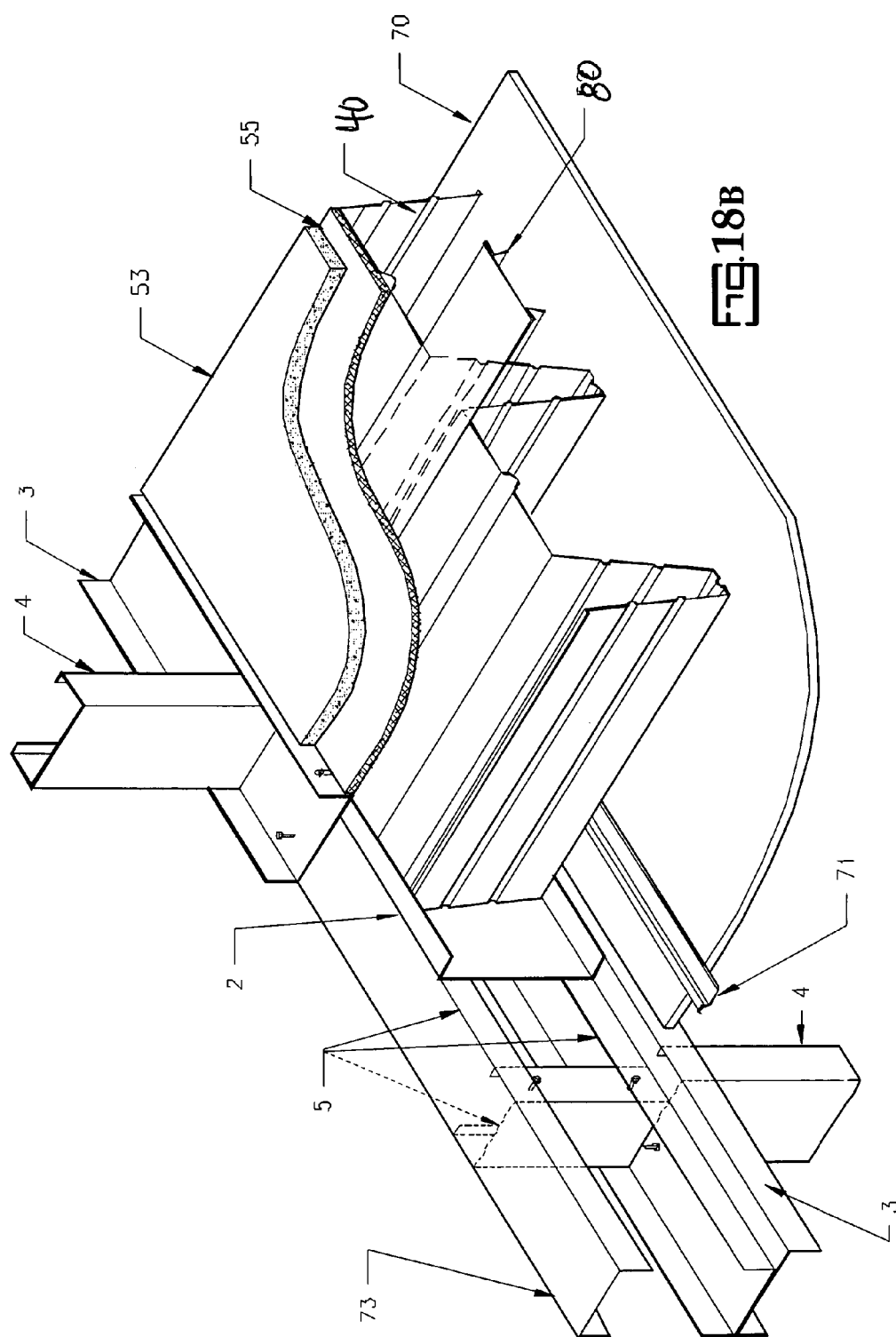


FIG. 18C





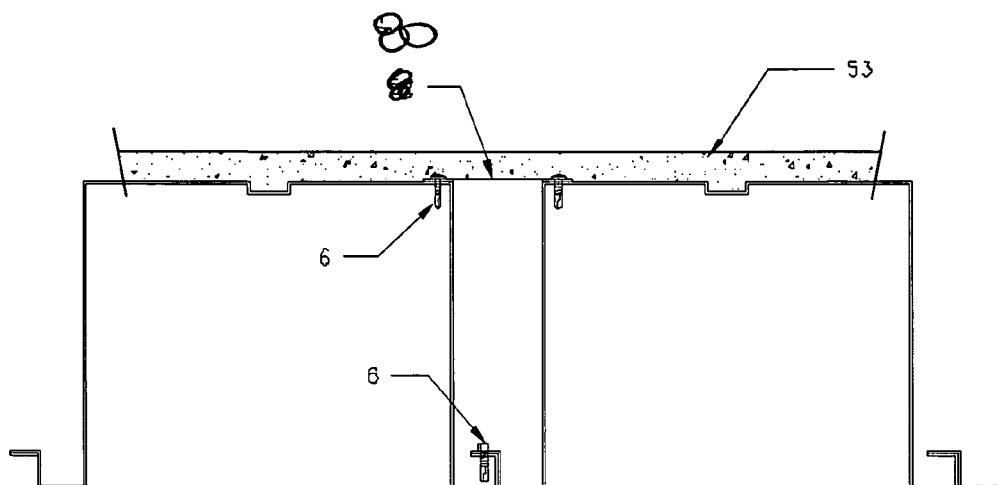


FIG. 19

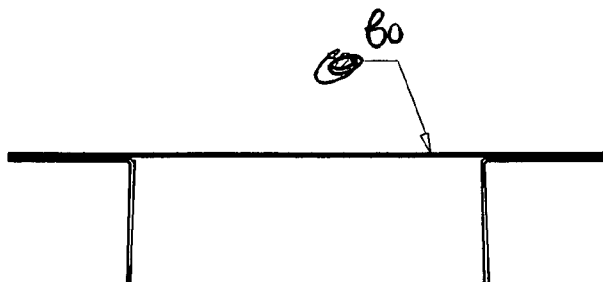


FIG. 20

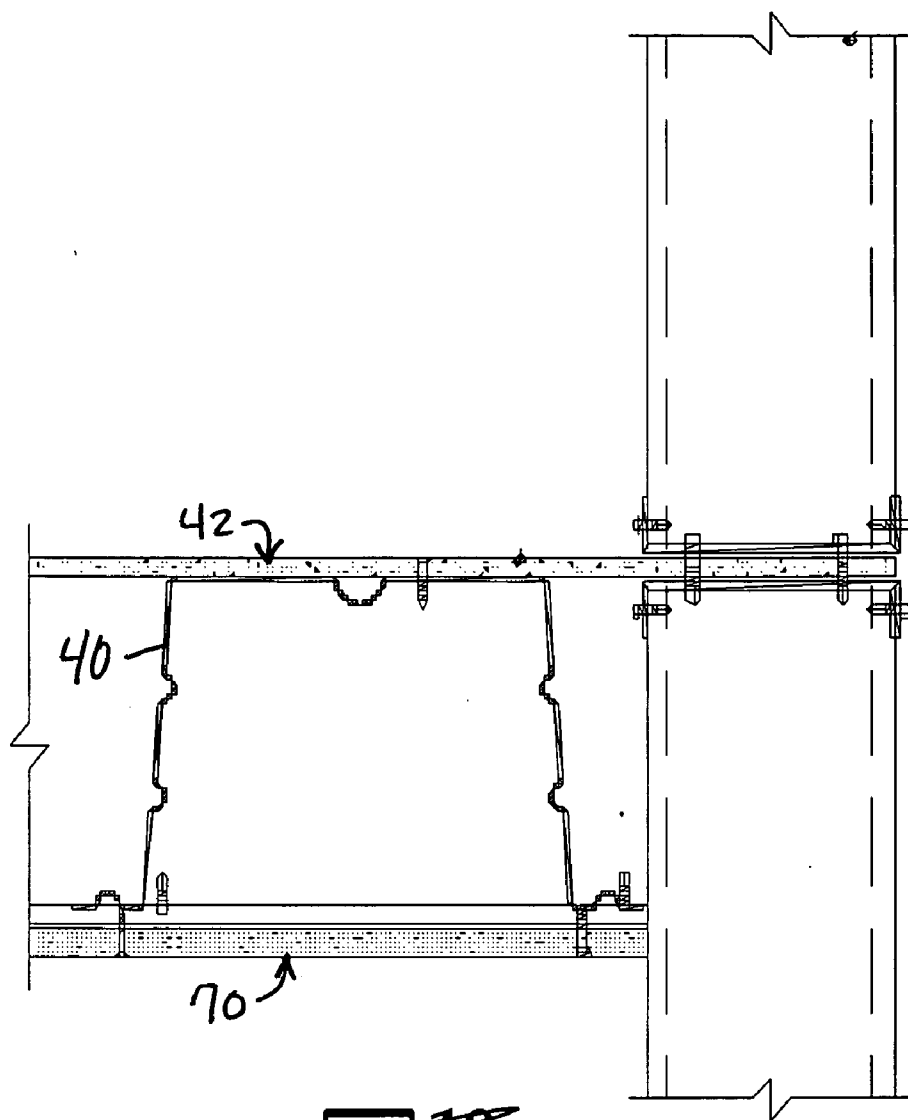


FIG. 19
~~FIG. 19~~ 21

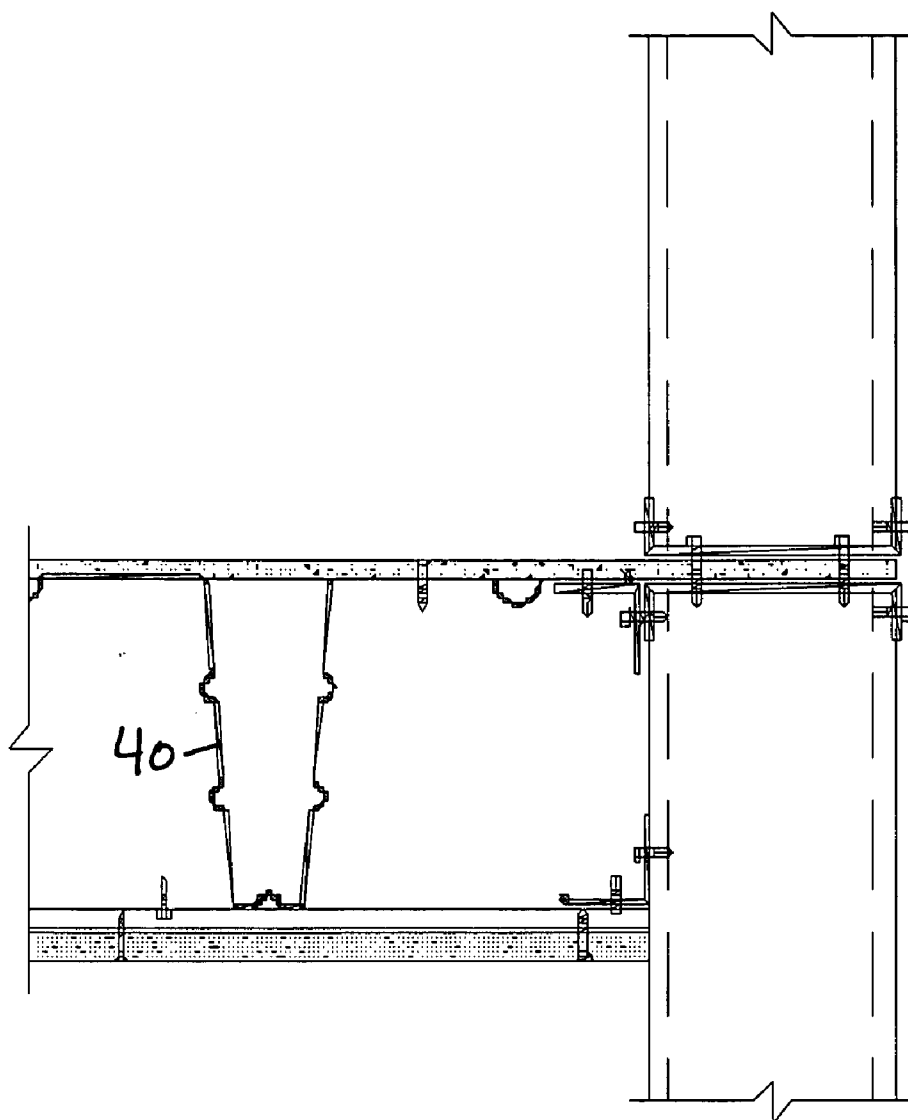


FIG. 22

22

CONSTRUCTION METHOD AND APPARATUS**CROSS REFERENCE TO RELATED APPLICATIONS**

[0001] The present application claims the benefit of priority of U.S. Provisional Application No. 60/477,946, filed on Jun. 13, 2003.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

[0002] Not Applicable.

REFERENCE TO A SEQUENCE LISTING, A TABLE, OR A COMPUTER PROGRAM LISTING COMPACT DISK APPENDIX

[0003] Not Applicable.

BACKGROUND OF THE INVENTION

[0004] Generally, the present invention relates to flooring systems of multi-story constructions. In particular, the present invention relates to an apparatus for use as a floor and ceiling system in multi-story structures, as well and methods for installing and using this apparatus.

[0005] Floor systems for buildings are varied in the types of materials used and in the configuration of the materials. Materials commonly used in floor construction are wood, concrete, steel, and a combination of these materials.

[0006] Wood floors, while generally lightweight, are combustible and can contribute to fire spread. Additionally, wood floors are generally constructed using joists spaced some distance apart covered with a sheathing product such as plywood. The spaces between the floor joists result in a work platform that workers can and do fall through, thus creating a safety hazard.

[0007] Furthermore, multi-story structures such as hotels, apartments, office buildings, and dormitories typically employ concrete and steel as construction materials for floor systems. Because of the combustibility of wood, many building and life-safety codes typically limit the height of wood-framed buildings to four stories. Therefore, concrete and steel structural members are often used to construct a building having more than four stories.

[0008] Although concrete framed floors are noncombustible, they are also very heavy. Including heavy floors in multi-story structures increases the overall building cost, because more time and expense must be spent on reinforcing the framing of the structure. Not only are heavy floors a detriment to multi-story structures, but also heavy floors are a detriment to most structures in high seismic areas, as the lateral force generated by a structure during an earthquake is directly proportional to the weight of the structure. Further, construction time for concrete structures can be significant due to the time required for concrete to cure. The complexity associated with the use of concrete as a construction material requires highly skilled professionals who are also highly compensated, which increases the overall cost of the building.

[0009] Similarly, although steel framed buildings are non-combustible, these buildings require highly skilled labor to erect the structure. Further, the use of steel alone in a floor

system typically promotes what is termed "web crippling." As used herein, web crippling refers to the yielding or buckling of a steel web under a load. Accordingly, concrete reinforcement is often used with the steel to form the floors of multi-story structures. The combination of steel and concrete again generates a heavy floor that is a detriment to multi-story structures and structures in areas of high seismic activity.

[0010] Traditional systems used in the construction of multi-story structures that employ concrete and steel materials include precast plank systems, composite concrete deck systems, and open web steel joist systems. Precast prestressed hollow core concrete slabs or planks are machine-extruded in long continuous beds and cut into planks based on the final dimensions needed for the structure. Precast planks are set on walls by crane and anchored with bent reinforcing bars set into the shear key joint between planks. The joints must then be grouted to complete the installation. Accordingly, the handling and setting of the planks can be time consuming and cumbersome. Further, the use of precast planks in multi-story structures involves the use of multiple trades, including precast plank manufacturers, precast plank installers, ironworkers for the weld plates, and spray ceiling applicators. Finally, the increased dead weight of the precast planks results in increased bearing wall, transverse beam and foundation sizing to support the weight. In turn, this increased mass aggravates the seismic bracing analysis, requiring additional support structures.

[0011] Composite concrete decks typically include metal decks made from plain or galvanized steel sheet rolled into ribbed profiles for use to form concrete floor slabs. When steel deck is used as part of a composite design, the deck and concrete act together structurally. To form this construction, steel deck with "dimples" are formed into vertical flutes to create a physical bond with the concrete that is used. Because these constructions typically lack sufficient depth and stiffness for multi-story structures, the use of composite concrete decks creates shoring and vibration issues. Similar to the use of precast planks, increased dead weight of concrete decks, adversely affects the bearing walls, beams, foundations and seismic bracing of the construction, necessitating additional engineering and support structures. Further, to eliminate costly distribution headers, every other deck flute must align with studs. Continuous steel re-bar is required to be centered with the bearing walls to act as a beam capable of transferring the reaction of the intermediate deck flutes to studs. Finally, multiple trades are required to use composite concrete decks in multi-story units, including deck installers, concrete finishers, and drywall ceiling contractors.

[0012] The use of open web steel joists, or composite concrete and steel joists, employs the use of steel joists supporting concrete on a steel deck or steel pan. An example of such a system includes the HAMBRO® system, which uses sheets of plywood temporarily held between joists with removable roll bars. In this system, steel mesh is draped over the joist, and then topped with concrete, bonding it to the top chord and creating a reinforced composite deck. These systems can be somewhat lighter than plain joists and steel deck combinations, but still require the support of a heavy, concrete-based load. Further, the use of joists fails to provide an immediate work surface when forming a floor and ceiling. Heavy distribution headers are required to accom-

moderate the offset between the studs and the joists. Irregularities can also occur in the concrete as a result of aged plywood, which affects the ceiling and wall installation. Finally, as with the other systems, the use of open web steel joists necessitates the use of multiple trades, including joist erectors, concrete finishers, deck installers, and drywall ceiling contractors.

[0013] Accordingly, the use of concrete, and concrete combined with steel, can be problematic when constructing a multi-story structure, or structures in high seismic areas. Because the additional height in a multi-story structure can require supporting structural members in a diversity of sizes, the use of concrete creates concerns about the weight, shear, and wind loads as more floors are added. Furthermore, the positioning of the exterior load bearing walls becomes a significant issue, thus reducing the flexibility in floor plan design.

[0014] Consequently, there exists a need for a system that ameliorates the time-consuming form preparation and complicated handling considerations typically associated with the use of concrete for the floors and ceilings of multi-story constructions.

SUMMARY OF THE INVENTION

[0015] The following presents a simplified summary of the invention in order to provide a basic understanding of some aspects of the invention. This summary is not an extensive overview of the invention. It is not intended to identify key or critical elements of the invention or to delineate the scope of the invention. Its sole purpose is to present some concepts of the invention in a simplified form as a prelude to the more detailed description that is presented later.

[0016] According to its major aspects, and briefly stated, the present invention includes a multi-story structure having a flooring system and method for installing the flooring system in the multi-story structure. The present invention further includes a method of constructing a multi-story structure using the flooring system of the present invention. It is contemplated by the present invention that this flooring system can be employed in any commercial or residential structure having a variety of dimensions and stories. However, the present description will focus on low to mid-rise structures.

[0017] The flooring system of the present invention includes a plurality of layers that are combined to form the floor and ceiling of a multi-story structure. Among these layers is included a layer of steel deck dimensioned to span from bearing wall to bearing wall of the multi-story structure. As used herein, steel deck refers to a steel sheet that has been formed into a fluted platform, which can be positioned on transversely extending purlins or beams that are connected to a building superstructure, such as load bearing walls. The steel deck of the present invention can be dimensioned to span from bearing wall to bearing wall of the multi-story structure.

[0018] In addition to the layer of steel deck, the flooring system can include various types of sheathing products to cover the flutes of the steel deck layer. For example, a layer of plywood can be located on the top surface of the steel deck layer to form a floor of the multi-story structure, and a layer of sheet rock can be located on the bottom surface of

the steel deck layer to form a ceiling of the multi-story structure. Alternatively, the flooring system can include a layer of cementitious material, such as gyp-crete, to add rigidity to the resulting floor. The flutes of the steel deck can also be coupled with a flute cap and then covered with a thin, light cementitious topping. Including a U-shaped track along the opposite ends of the steel deck can also be used to reinforce the deck. To this U-shaped track can be attached a stiffening element to add additional reinforcement and strength.

[0019] As discussed, the present invention also includes a method of constructing a multi-story structure that employs the present flooring system. The method includes the steps of providing a multi-story frame having bearing walls and shear walls, providing a flooring system, installing the flooring system, and finishing the frame of the multi-story system through the use of finishing materials such as sheet rock. Additionally, the flooring system of the present invention can also be employed when constructing the roof of a multi-story structure.

[0020] The present invention also has industrial applicability, because it allows the construction of multi-story structures more quickly and with less expense. Furthermore, the overall weight of the multi-story structure becomes reduced without compromising the structural integrity of the structure. This results in additional flexibility in floor plan designs. Therefore, the use of the present apparatus and method can be used to construct various types of multi-story buildings, such as office buildings, apartments, and dormitories. Although this invention has industrial applicability, it is in no way limited to this application.

[0021] A feature of the present invention is the use of a flooring system including a steel deck layer. The dimensions of the steel deck layer contribute to the strength and structural integrity of the flooring system. Accordingly, the use of concrete can be eliminated from the flooring system, which significantly reduces the weight of the floor. Depending on the load to which the flooring system will be subjected, the system can also include a layer of cementitious material to reinforce the steel deck layer. However, even when cementitious material such as gyp-crete is included in the floor system, the overall weight of the floor system is still significantly lower than traditional systems. By providing a noncombustible and lightweight flooring system, the gravity and seismic forces within the multi-story structure are substantially reduced. This result creates a safer overall structure that is more economical to construct.

[0022] Another feature of the present invention is the use of a flooring system including a steel deck layer that is roll formed. If the steel deck layer of the present system is roll formed rather than brake formed, the floor system can be custom designed with predetermined deck lengths and widths, thus eliminating cutting and waste of steel.

[0023] Yet another feature of the present invention is the use of a flooring system having a steel deck layer with covered flutes. If the flutes of the steel deck are covered either by a sheathing layer, or by flute caps, the floor system can immediately become a working platform. Because concrete does not need to be poured and cured over the present flooring system, the flooring system can provide a continuous, safe, non-combustible working platform upon installation. Even if a cementitious layer is included to cover the deck

layer of the flooring system, the covering procedure need not occur before additional levels of the multi-story structure are installed. By allowing the construction of the overall structure to continue independent of the deck covering operation, the overall construction speed is increased.

[0024] Still another feature of the present invention is the use of a flooring system that can be prefabricated. Capping the ends of the steel deck with U-shaped tracks allows for platform framed construction and prefabrication of floor panels. Underlayment may also be pre-attached to floor panels in a shop setting.

[0025] Another feature of the present invention is the use of floor system that includes a steel deck layer that is not combined with concrete. No specialized skills are required to install the steel deck layer and flooring system. Accordingly, one contractor can essentially design, fabricate, and install the primary frame of the multi-story structure, as well as the walls, floors, underlayment, roof trusses, sheathing, and wind bracing.

[0026] Yet another feature of the present invention is the use of a flooring system having a steel deck layer with a stiffening member. For example, the deck ends can be capped with a U-shaped track section. To this track section, can be attached a continuous stiffening element composed of a steel deck section orientated vertically. This vertical orientation can provide a space by which other structural systems have access from one level of the multi-story structure to another level without having to perform substantial preparation procedures such as drilling deep holes or performing extensive pre-installation surveys. These spaces also provide a space for electrical, mechanical and plumbing systems. Further, this stiffening member is of sufficient strength to transfer gravity loads from ascending levels in the structure through the steel deck assembly without crushing the steel deck. The stiffening of the end track can also be achieved by using C-stud section orientated vertically at discrete locations aligning with the load bearing studs, thus allowing the transfer of gravity loads without crushing the flooring system.

[0027] Another feature of the present invention is the use of a flooring system including a steel deck having ducts. By sealing the flutes of the steel deck, ducts are created that can be used for a variety of applications including the creation air ventilation ducts. Additional benefits to the formation of ducts within the floor system are increased head clearances, reduced building heights and increased erection time.

[0028] Still another feature of the present invention is the use of a flooring system including a plurality of layers. If the steel deck is combined with a cementitious topping, the result is a noncombustible flooring system. Accordingly, the system is not limited to the height restrictions imposed on combustible wood construction. Further, the flooring system weighs approximately half of a concrete and steel structure resulting in less seismic and gravity loads even when combined with a cementitious topping.

[0029] Another feature of the present invention is the use of a method for constructing a multi-story structure that employs the present flooring system. Because of the advantageous features of the present flooring system, including its dimensions and weight, the method of construction of the multi-story structure includes great flexibility. In the con-

struction of the multi-story structure, the flooring system of the present invention can be employed in a variety of frames. For example, the floor system can be incorporated into either a balloon framed bearing wall structure or a platform bearing wall structure. Additionally, the roofs constructed for the multi-story structure can also be diverse, including either flat roofs or pitched roofs. Moreover, the location and make up of the bearing walls, and exterior and interior shear walls of the multi-story structure can also vary depending on purpose of the multi-story structure.

[0030] Yet another feature of the present invention includes the use of a multi-story structure having a lightweight flooring system combined with light gauge steel framed bearing walls that will allow for reduced seismic forces, non-combustibility, quick erection times with low skilled labor forces, and the ability to transfer gravity loads through stiffened bearing interfaces. Further, by providing a solid work platform, other structural systems within the multi-story structure can interface more easily.

[0031] Still another feature of the present invention is the use of a multi-story structure having a flooring system and bearing wall assemblies that provide a one to two hour fire rating, which allows for increased building heights and floor areas.

[0032] Yet another feature of the present invention is the use of a multi-story structure having a roof that employs the steel deck layer of the flooring system. By installing the roof trusses spaced 4 feet OC instead of the traditional 2 feet OC, costs are decreased. Generally, the labor savings in the fabrication and erection offset the addition per truss material price and the cost difference of providing steel deck instead of traditional plywood sheathing.

[0033] Yet another feature of the present invention is the use of a multi-story structure having a modified top track to support floor and roof loads over openings in the structure up to 8 feet wide, thus eliminating traditional boxed stud headers. Eliminating the boxed header also negates shoulder studs at the jamb along with time-consuming interconnections.

[0034] Still another feature of the present invention is the use of a multi-story structure having wall-to-wall balloon framing. This framing system facilitates the alignment of studs and shear wall posts, because bolts connecting posts between shear wall frames do not have to pass through a joist cavity.

[0035] Yet another feature of the present invention is the use of diaphragm rated sheathing on the shear walls of the multi-story structure. This sheathing negates the issues plaguing diagonal flat strap assemblies. Other issues eliminated by this feature include expensive strap splicing, shop attachment details, strap loosening occurring anytime after the wall is fabricated, and the unsightly bulging drywall associated with attempting to cover thicker diagonal straps crossing over the face of the shear walls.

[0036] Other features and advantages of the present invention will be apparent to those skilled in the art from a careful reading of the Detailed Description of the Invention presented below and accompanied by the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0037] In the drawings:

[0038] **FIG. 1** is a perspective view of a multi-story structure according to an embodiment of the present invention;

[0039] **FIG. 2** is a floor plan view of a multi-story structure according to an alternative embodiment of the present invention;

[0040] **FIG. 3** is a front view of the framework of a multi-story structure according to an alternative embodiment of the present invention;

[0041] **FIG. 4** is a floor plan view of a multi-story structure according to an alternative embodiment of the present invention;

[0042] **FIG. 5** is a front view of the framework of a multi-story structure according to an alternative embodiment of the present invention;

[0043] **FIG. 6** is a sectional detailed view of a flooring system of a multi-story structure according to an alternative embodiment of the present invention;

[0044] **FIG. 7** is a sectional detailed view of a flooring system of a multi-story structure according to an alternative embodiment of the present invention;

[0045] **FIG. 8** is a sectional detailed view of a flooring system of a multi-story structure according to an alternative embodiment of the present invention;

[0046] **FIG. 9** is a sectional detailed view of a flooring system of a multi-story structure according to an alternative embodiment of the present invention;

[0047] **FIG. 10** is a front view of a flooring system of a multi-story structure according to an alternative embodiment of the present invention;

[0048] **FIG. 11** is a sectional detailed view of a flooring system of a multi-story structure according to an alternative embodiment of the present invention;

[0049] **FIG. 12** is a sectional detailed view of a flooring system of a multi-story structure according to an alternative embodiment of the present invention;

[0050] **FIG. 13** is a sectional detailed view of a flooring system of a multi-story structure according to an alternative embodiment of the present invention;

[0051] **FIG. 14** is a sectional detailed view of a flooring system of a multi-story structure according to an alternative embodiment of the present invention;

[0052] **FIG. 15A** is a sectional detailed view of a flooring system of a multi-story structure according to an alternative embodiment of the present invention;

[0053] **FIG. 15B** is a side view of a flooring system of a multi-story structure according to an alternative embodiment of the present invention;

[0054] **FIG. 15C** is a top view of a flooring system of a multi-story structure according to an alternative embodiment of the present invention;

[0055] **FIG. 16A** is a sectional detailed view of a flooring system of a multi-story structure according to an alternative embodiment of the present invention;

[0056] **FIG. 16B** is a sectional detailed view of a flooring system of a multi-story structure according to an alternative embodiment of the present invention;

[0057] **FIG. 16C** is a perspective view of a stiffening member of a flooring system of a multi-story structure according to an alternative embodiment of the present invention;

[0058] **FIG. 17A** is a sectional detailed view of a flooring system of a multi-story structure according to an alternative embodiment of the present invention;

[0059] **FIG. 17B** is a sectional detailed view of a flooring system of a multi-story structure according to an alternative embodiment of the present invention;

[0060] **FIG. 17C** is a top view of a flooring system of a multi-story structure according to an alternative embodiment of the present invention;

[0061] **FIG. 18A** is a sectional detailed view of a flooring system of a multi-story structure according to an alternative embodiment of the present invention;

[0062] **FIG. 18B** is a sectional detailed view of a flooring system of a multi-story structure according to an alternative embodiment of the present invention;

[0063] **FIG. 18C** is a top view of a flooring system of a multi-story structure according to an alternative embodiment of the present invention;

[0064] **FIG. 19** is a cross-sectional view of a flooring system of a multi-story structure according to an alternative embodiment of the present invention;

[0065] **FIG. 20** is a cross-sectional view of a flute cap of a flooring system of a multi-story structure according to an alternative embodiment of the present invention.

[0066] **FIG. 21** is a sectional detailed view of a flooring system of a multi-story structure according to an alternative embodiment of the present invention;

[0067] **FIG. 22** is a sectional detailed view of a flooring system of a multi-story structure according to an alternative embodiment of the present invention;

DETAILED DESCRIPTION OF THE INVENTION

[0068] As illustrated in **FIG. 1**, the present invention includes a multi-story structure **10** having a flooring system **12**, a framing system **13**, and a roof assembly **15**. Although the following description will focus on a low to mid-rise structure, such as a three-story structure having multiple adjacent rooms on each story, it is contemplated by the present invention that many variations in the number of stories and in the floor plans of the multi-story structure **10** can be employed. Therefore, the present invention is in no way limited to a three-story structure.

[0069] **FIG. 2** illustrates an exemplary floor plan of the multi-story structure **10**. This floor plan is more suited for multi-story structures **10** having flat roofs (shown in **FIG. 3**). As shown, the multi-story structure **10** includes a framing

system 13 having a plurality of interior and exterior shear walls 14, 14', load bearing walls 16, and non-load bearing walls 18. These walls form adjacent rooms 22 that can be used for residential or commercial purposes. In the case the flat roofs are included in the multi-story structure 10, the roof can include the flooring system 12 as will be described shortly. To achieve a minimum 2/4:12 roof pitch, tapered insulation is installed over level decking. Alternatively, the deck assembly is pitched and insulation of uniform thickness is installed. Stepping the height of a common bearing wall may be required to assure that the top of the wall does not extend above the deck bearing points.

[0070] A front view of an embodiment of the multi-story structure 10 is illustrated in FIG. 3. As shown, the multi-story structure 10 can include corridors 24, which have corridor headers 26. Preferably, the corridor headers 26 include tube headers that are supported by stud posts 28. A feature of the present invention is the use of a modified header to support floor and roof loads over openings in the structure 10, such as corridors up to 8 feet wide, thus eliminating traditional boxed stud headers. Eliminating the boxed header also negates shoulder studs at the jamb along with time-consuming interconnections.

[0071] Another feature of the present invention is the use of the framing system 12 having shear walls 14, 14', that contribute to the strength of the multi-story structure 10. As shown in FIG. 3, the framing system 13 can include any traditional system for framing walls, such as a steel frame 30 having a plurality of steel studs 32 that are connected to top and bottom tracks 34 for support. However, other types of walls, such as masonry walls and wood stud walls, can be employed in the present invention. Shear strength can be provided to this framing system 13 by facing interior partitions with 1/2" gypsum drywall on each side of the interior shear walls 14 at lighter load locations, such as the upper levels of the multi-story structure 10. At the higher load locations, such as the lower levels of the multi-story structure 10, X-braced strap assemblies 36 can be provided in the interior shear walls 14. For exterior shear walls 14', shear strength can be provided by facing these walls on the exterior with 7/16" OSB or 15/32" plywood sheathing and 1/2" thick gypsum drywall on the interior face of the walls at the lighter load locations. At the higher load locations, the exterior shear walls 14' can be provided with X-braced strap assemblies 36.

[0072] FIGS. 4 and 5 show an alternative embodiment of the multi-story structure 10. The main distinction between the alternative embodiment and the embodiment previously discussed is that the roof assembly 15 discloses a pitched roof rather than a flat roof. In the case pitched roofs are included, steel trusses can be spaced 48"OC with perimeter bearing walls and interior corridor wall supports as required.

[0073] Additionally, the location of the corridor headers 26 are distinct between the flat roof option and the pitched roof option multi-story structure 10. As shown, in the floor plan of FIG. 2, the corridor headers 26 transverse the corridors 24. However, in the floor plan of FIG. 4, the corridor headers 26 lie parallel to the corridors 24.

[0074] The remaining figures and discussion focus on the detailed specification of the features of the flooring system 12 and how this flooring system is interconnected with the framing system 13 and the roofing assembly 15 of the

multi-story structure 10. A feature of the present invention is the use of flooring system 12 that can be used as both the floor the adjacent an upper story and the ceiling of the adjacent lower story of the multi-story structure 10. FIG. 6 illustrates an embodiment of the flooring system 12. The flooring system 12 is shown in detail from a section of the multi-story structure 10 in which two adjacent rooms 22 are interconnected by load bearing walls 16. In this embodiment, the load bearing walls 16 include balloon framing. The flooring system 12 includes a plurality of layers. In these layers is included a layer of steel deck 40. Although dimensions may vary depending on the strength required by the layer of steel deck 40, the steel deck layer 40 can have a depth of approximately 7 1/2". The span of the steel deck layer 40 can also vary. Preferably, the steel deck layer 40 spans from bearing wall 14 to bearing wall 14 of each room in the multi-story structure 10.

[0075] Above the steel deck layer 40 is included a layer of sheathing material 42, such as plywood or glass fiber reinforced cement board underlayment. Below the layer of steel deck 40 is included a layer of ceiling material 70, such as gypsum board. Alternatively, furring channels 71 are located directly below the layer of steel deck 40, and the layer of ceiling 70 is located below the furring channels 71. These layers are all interconnected by fasteners 90, including any number of mechanical fasteners such as nails, screws, nuts, bolts, etc. Because the bearing walls 16 are balloon framed in this embodiment, the sheathing layer 42 of one adjacent room 22 can cover the top of the bearing walls 16 and form the sheathing layer 42 of the other adjacent room 22. Accordingly, the flooring system 12 can be level with the bearing walls 14. Further, by extending the sheathing layer 42 over the bearing walls 14 results in shear transfer and verifies bearing strength between walls.

[0076] To increase the support of the flooring system 12, the bearing wall 14 is provided with an oversized top track 50. As used herein, "oversized top track" refers to a track having approximately 8" flanges and approximately a 6 1/4" web. Preferably, the flanges of this top track 50 have a depth that is at least equal to or greater than the depth of the steel deck layer 40. The oversized track 50 provides a continuous fire break between adjacent floors while serving as a header over openings in the wall 14. To this oversized top track 50 is connected a ledger angle 52. Although the dimensions of the ledger angle 52 can vary depending on the size of the steel deck layer 40, preferably, the ledger angle 52 is continuous along the bearing wall 14, and includes 2.5"x 2.5" projecting legs 49 if the steel deck layer 40 does not exceed a span of approximately 16 feet between bearing wall 14 to bearing wall 14. The steel deck layer 40 is supported by and connected to this ledger angle 52. Again, the interconnections between the features of the flooring system 12 are made by any number of mechanical fasteners.

[0077] In an alternative embodiment shown in FIG. 7, the oversized top track 50 is substituted with regular sized top track 56. Additionally, fire safing 58 is applied between the ends of the steel deck layer 40.

[0078] FIG. 8 illustrates another alternative embodiment of the flooring system 12 and how it is connected to the bearing walls 14 of the multi-story structure 10. As before, the flooring system 12 includes steel deck layer 40 that is between sheathing layer 42 and ceiling layer 70. Alterna-

tively, furring channels 71 are located between the layer of steel deck 40 and the layer of ceiling 70. Additionally, the steel deck layer 40 in this embodiment is attached to a Z-shaped deck support 60 rather than the ledger angle 52. As shown, the Z-shaped deck support 60 is dimensioned to receive the top of the bearing wall 14 and the bottom of the steel deck layer 40. Preferably, the deck support 60 is connected to the regular sized top track 56, as well as to the bottom of the steel deck layer 40 by fasteners.

[0079] FIG. 9 illustrates the flooring system 12 in detail from a section of the multi-story structure 10 including the corridor 24. As shown, the steel deck layer 40 of the flooring system 12 is connected to the corridor header 26 through the use of ledger angle 52. Similarly to the adjacent rooms 22, the sheathing layer 42 can cover the corridor header 26 and connect the floor across the corridor 24. The ledger angle 52 can be connected to the corridor header 26 by welding, riveting, or fastening.

[0080] An alternative embodiment of flooring system 12 is shown in FIGS. 10-12. The multi-story structure 10 can also include bearing walls 14 that are platform framed. Because in platform framing, the steel deck layer 40 becomes subjected to the load of the bearing walls 14, stiffeners must be employed to alleviate the potential for web crippling. As illustrated, the platform framing system 13 includes top and bottom bearing wall studs 4 that sit in and are connected to top and bottom bearing wall tracks 3. Between the top and bottom bearing wall tracks 3 is located the flooring system 12. Similar to the flooring system 12 previously described, there is included steel deck layer 40 between sheathing layer 42 and ceiling layer 70. Alternatively, the sheathing layer 42 can include two layers of materials wherein the bottom layer 43, which is connected to the steel deck layer 40 is a layer of plywood underlayment, and wherein the top layer 45 is a layer of gyp-crete topping. If a two-material sheathing layer 42 is included, the bottom layer of plywood underlayment 43 can extend under the bearing wall track 3 to connect the floors of the adjacent rooms 22. However, the gyp-crete top layer 45 preferably does extend below the top bearing wall stud 4. Alternatively, the gyp-crete layer can be substituted with liquid applied flooring. The ceiling layer 70 of the flooring system 12 is similar to other embodiments, and can include either a layer of gypsum ceiling board, or a combination of furring channels 71 and a layer of gypsum ceiling board.

[0081] As shown in FIG. 12, the steel deck layer 40 is reinforced by connecting the ends of the steel deck layer 40 to deck tracks 2. Between these deck tracks 2 is included a deck stiffener 5. Although various dimensions of the deck stiffener 5 can be employed, preferably, the stiffener 5 includes a vertically oriented fluted steel deck, wherein the height of the vertically oriented fluted deck is approximately equal to the depth of the steel deck layer 40. The deck tracks 2 and the stiffener 5 are interconnected by a variety of mechanical fasteners.

[0082] An alternative embodiment of the flooring system 12 of the present invention is illustrated in FIGS. 13 and 14. Similar to the previously described platform framing system 13, top and bottom bearing wall studs 4 sit in and are connected to top and bottom bearing wall tracks 3. Between the top and bottom bearing wall tracks 3 is located the flooring system 12. Again, steel deck layer 40 is located

between sheathing layer 42 and ceiling layer 70. However, sheathing layer 42 includes sound reduction mat 55 as the bottom layer, and liquid applied flooring 53 as the top layer. Preferably, neither of these layers extends beneath the top bearing wall track 3. Alternatively, the liquid applied flooring layer can be substituted with a gyp-crete layer. The ceiling layer 70 of the flooring system 12 is similar to other embodiments, and can include either a layer of gypsum ceiling board, or a combination of furring channels 71 and a layer of gypsum ceiling board.

[0083] Another distinction with this alternative embodiment is that there are included two deck stiffeners 5. As shown in FIG. 14, each deck track 2 is connected to a deck stiffener 5. Space is left between these deck stiffeners 5. By including this void between the deck stiffeners 5, the multi-story structure 10 can be further reinforced through the installation of vertical shear wall tension members 51. As illustrated in FIGS. 15A-15C, these shear wall tension members 51 can be included within the framing system 13 of the multi-story structure 10.

[0084] FIGS. 16A-16C illustrate another alternative embodiment of the present flooring system 12. In the case that the flooring system 12 is just below the roofing assembly 15 of the multi-story structure 10, only bottom bearing walls 4 and bearing wall tracks 3 are included. Similar to the other embodiments, flooring system 12 includes steel deck layer 40 between sheathing layer 42 and ceiling layer 70. Sheathing layer 42 may include a layer of liquid-applied flooring 53 and a sound reduction mat layer 55. Further, ceiling layer 70 may include a layer of gypsum ceiling board, or a combination of furring channels 71 and a layer of gypsum ceiling board. A distinction with this embodiment from the previously described embodiment is that the deck stiffener 5 has been replaced by deck tracks including a stamped stiffener feature. As shown, the deck track stiffeners 5' are shaped similar to deck tracks 2, except along the web of the deck track is included vertically aligned indentions 7, which are grooved.

[0085] Yet another embodiment of the flooring system 12 of the present invention is illustrated in FIGS. 17A-17C. In this view, the flooring system 12 is shown in connection with load bearing sidewalls. As shown, the flooring system 12 again includes steel deck layer 40 combined with sheathing layer 42 and ceiling layer 70. Sheathing layer 42 can include a layer of liquid applied flooring 53 or, alternatively, gyp-crete topping, as well as a layer of sound reduction mat 55. The ceiling layer can include a layer of gypsum ceiling board, or a combination of furring channels 71 and a layer of gypsum ceiling board. The steel deck layer 40 is connected to deck track 2, and the deck track 2 is connected to one side of deck track stiffener 5. Because this perspective is of a sidewall of the multi-story structure 10, the opposing side of the deck stiffener 5 is connected to a closure plate 73. Similar to the previously described deck stiffener 5, the deck stiffener 5 used in this application can be a fluted steel deck that is vertically aligned. However, the ribs of the fluted steel deck can be wider on the side of the stiffener 5 that is connected to deck track 3 if additional reinforcement is required.

[0086] FIGS. 18A-18C illustrate yet another alternative embodiment of the flooring system 12 taken from the view of a load-bearing sidewall of the multi-story structure 10.

Similar to the previously described embodiments, the flooring system **12** again includes steel deck layer **40** combined with sheathing layer **42** and ceiling layer **70**. Sheathing layer **42** can include a layer of liquid applied flooring **53** or, alternatively, gyp-crete topping, as well as a layer of sound reduction mat **55**. The ceiling layer can include a layer of gypsum ceiling board, or a combination of furring channels **71** and a layer of gypsum ceiling board. The stiffening of the flooring system **12** is accomplished by interconnecting a number of stiffeners **5** resembling deck tracks **2**, but having varying dimensions. As shown, two horizontally aligned stiffeners **5** are dimensioned to receive and are connected to a vertically aligned stiffener **5**. The flanges of the horizontally aligned stiffeners **5** are connected to the deck track **5** along the web of the deck track **5**. As an option, the space formed within the stiffeners **5** can be filled with high compressive strength grout. Additionally, the flutes of the steel deck layer **40** can be covered by a flute cap **80**. This feature can provide an immediate working platform for installers of the flooring system **12**.

[0087] The cooperation between flute cap **80** and the flutes of the steel deck layer **40** is shown in detail in **FIGS. 19 and 20**. As shown, flute cap **80** is T-shaped, wherein the top of the flute cap **80** is flat and is wide enough to rest over the flutes of the steel deck layer **40**. The sides of the flute cap **80** preferably rest along the sides of the flutes of the steel deck layer **40**, so that when the flute cap **80** is inserted, the flutes of the steel deck layer **40** are effectively sealed. The flute caps **80** can extend the length of the steel deck span so that an instant working platform is provided.

[0088] **FIGS. 21 and 22** illustrate cross-sectional views of the flooring system along non-bearing sidewalls. As shown, the flooring system **12** includes steel deck layer **40** between top layer of sheathing **42** and bottom layer of ceiling **70**. Sheathing layer **42** can include either a layer of plywood underlayment or a layer of glass fiber reinforced cement board underlayment. The ceiling layer **70** can include either a layer of gypsum ceiling board or a combination of a layer of gypsum board and furring channels **71**. In this embodiment, the flooring system **12** is connected to a balloon framing system **13**. Accordingly, the sheathing layer **42** extends beyond the steel deck layer **40** and between the non-bearing sidewalls **18**. These non-bearing sidewalls **18** each include track members **19** that are interconnected through the layer of sheathing **42**. The steel deck layer **40**

can either be directly connected to ceiling layer **70** (**FIG. 21**), or it can alternatively be connected to ledger angles **52** (**FIG. 22**).

[0089] It will be apparent to those skilled in the art that many changes and substitutions can be made to the preferred embodiment herein described with departing from the spirit and scope of the present invention as defined by the appended claims.

What is claimed is:

1. A flooring system, comprising:
 - a layer of sheathing;
 - a layer of steel deck; and
 - a layer of ceiling, wherein said sheathing layer, said steel deck layer, and said ceiling layer are all interconnected.
2. A multi-story construction, comprising:
 - a flooring system;
 - a framing system, wherein said flooring system is attached to said framing system; and
 - a roof assembly, wherein said flooring system, said framing system, and said roof assembly are all interconnected.
3. A method for installing a flooring system, comprising:
 - providing a flooring system;
 - providing a framing system; and
 - connecting said flooring system to said framing system.
4. A method for constructing a multi-story structure, comprising:
 - providing a flooring system;
 - providing a framing system;
 - connecting said flooring system to said framing system
 - providing a roof assembly;
 - connecting said roof assembly to said framing system.
5. A kit for constructing a flooring system, comprising:
 - a layer of steel deck;
 - a layer of sheathing;
 - a layer of ceiling; and
 - a plurality of fasteners.

* * * * *