United States Patent [19]

Fuller

[11] **3,768,221**

[45] **Oct. 30, 1973**

[54] **ELECTRICAL SYSTEM FOR DWELLING UNITS**

[75] Inventor: **Walter Thomas Fuller,** Littleton, Colo.

[73] Assignee: **Marcor Housing Systems Incorporated,** Denver, Colo.

[22] Filed: **Mar. 1, 1972**

[21] Appl. No.: **230,804**

[52] **U.S. Cl.** **52/221,** 52/79, 52/741

[51] **Int. Cl.** **E04b 5/48**

[58] **Field of Search** 52/220, 221, 79

[56] **References Cited**

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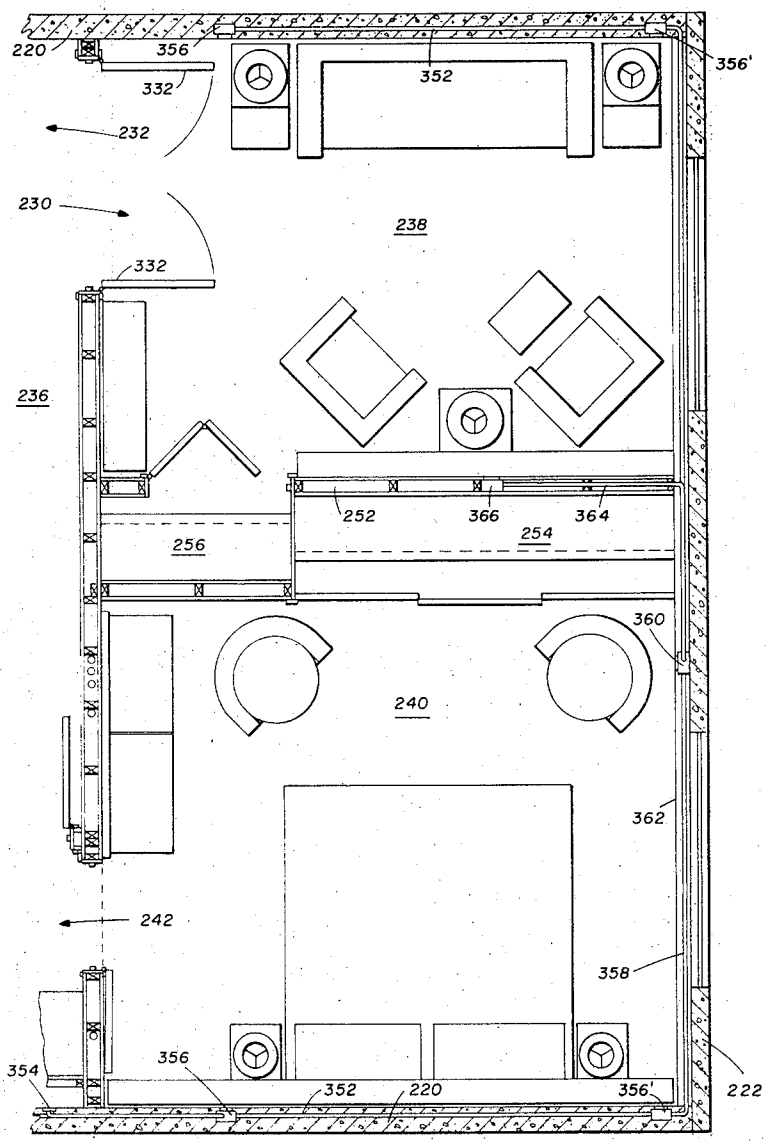
Primary Examiner—John E. Murtagh

Attorney—D. Carl Richards et al.

[57] **ABSTRACT**

In a dwelling construction system, a multi-story, multi-family building comprises prestressed concrete pallets which are supported between load bearing walls to form the floors and the ceilings of individual dwellings. Each dwelling includes a service core comprising an enclosure formed on one of the pallets and complete mechanicals for the dwelling. The service cores are fabricated by mass production techniques and are subsequently transported to the building site for installation. In some instances the service core comprises a complete dwelling, in which case the enclosure of the service core may form the exterior walls and the roof of the dwelling.

12 Claims, 54 Drawing Figures



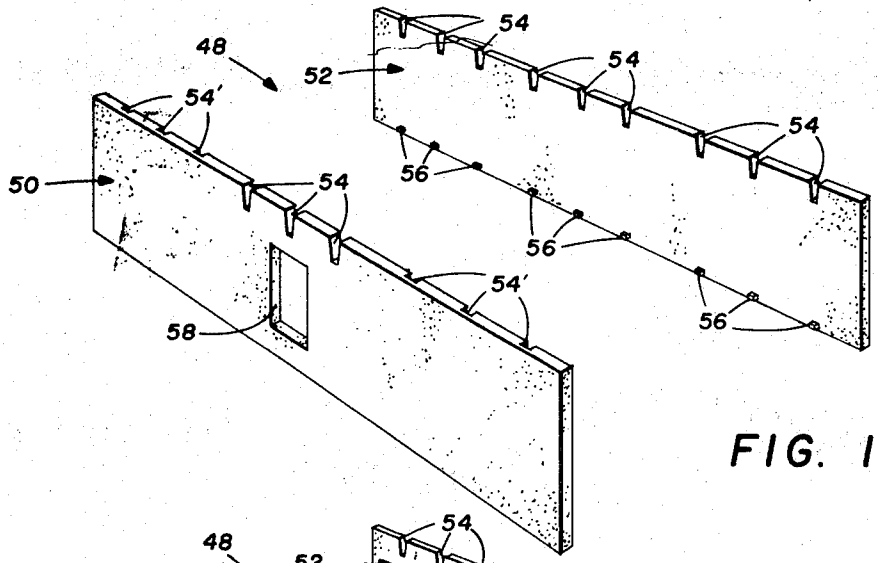


FIG. 1

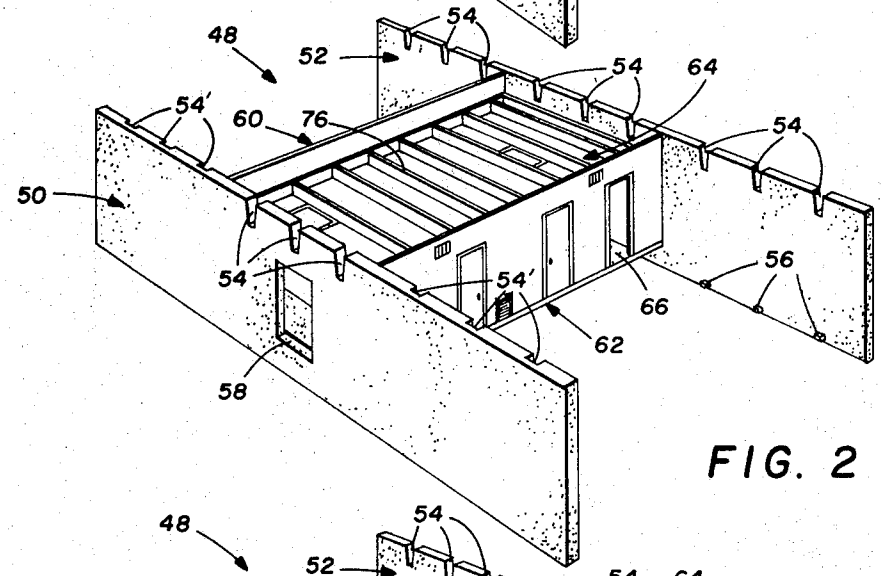


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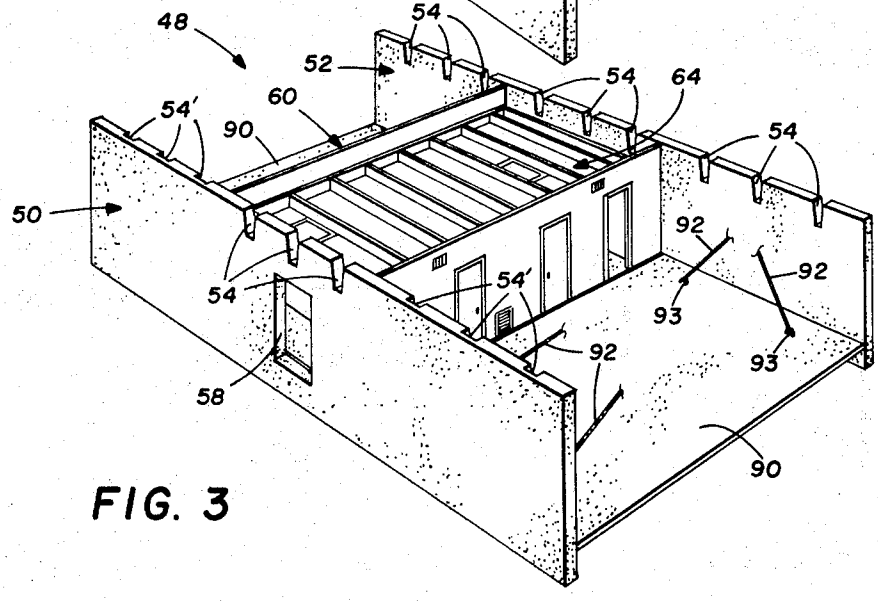


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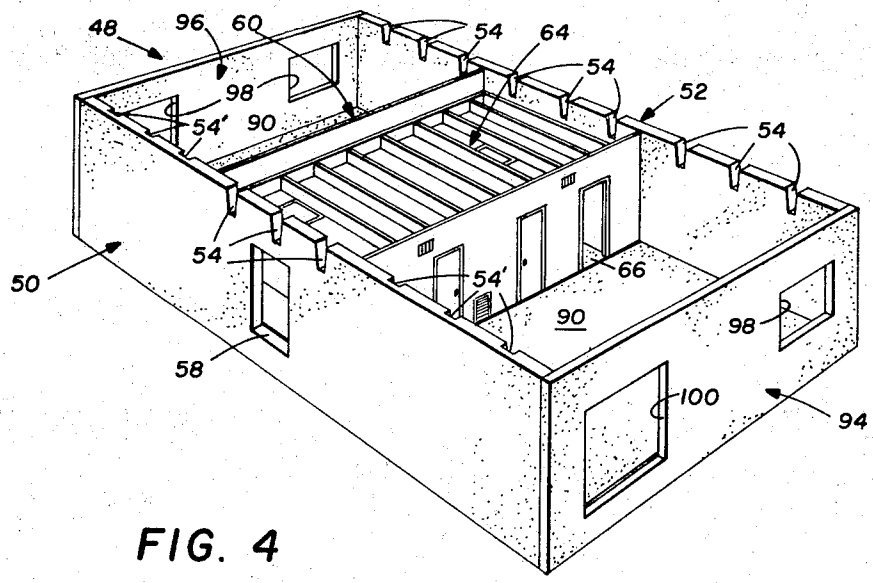

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FIG. 4

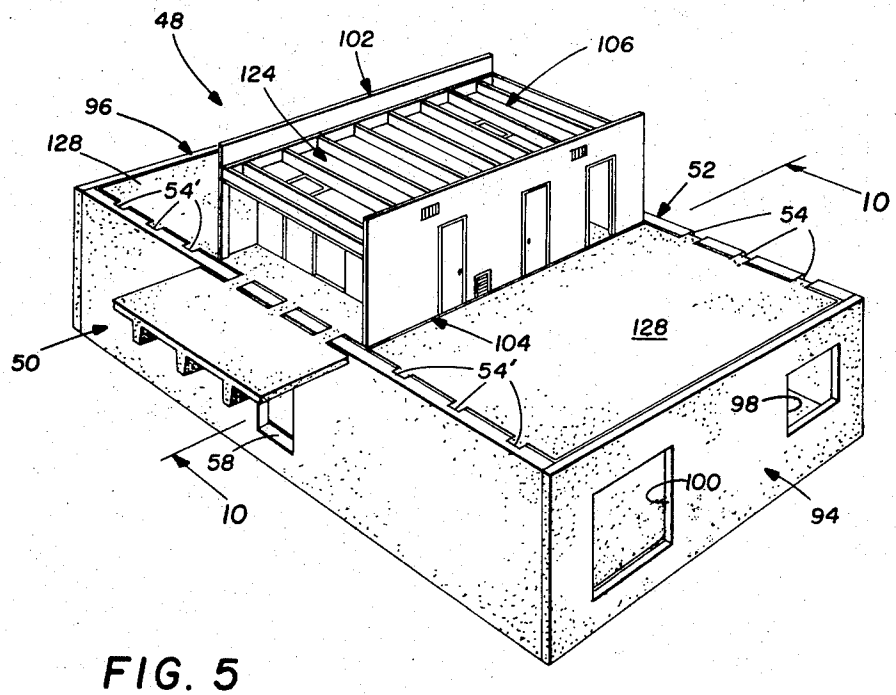

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FIG. 5

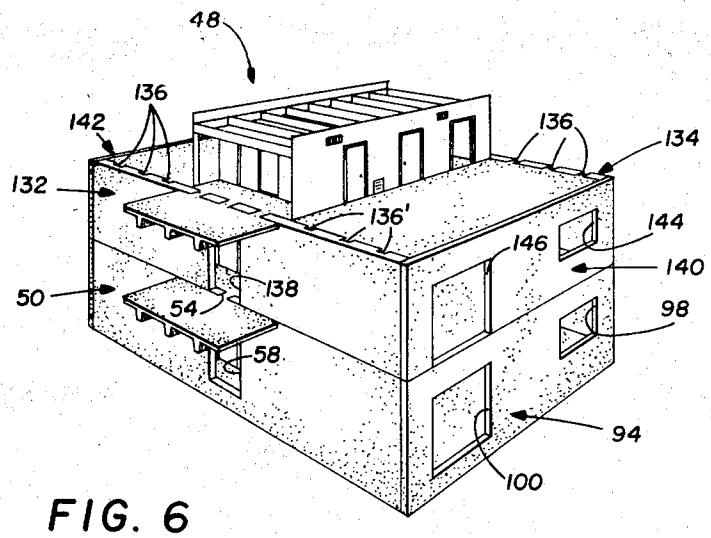

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FIG. 6

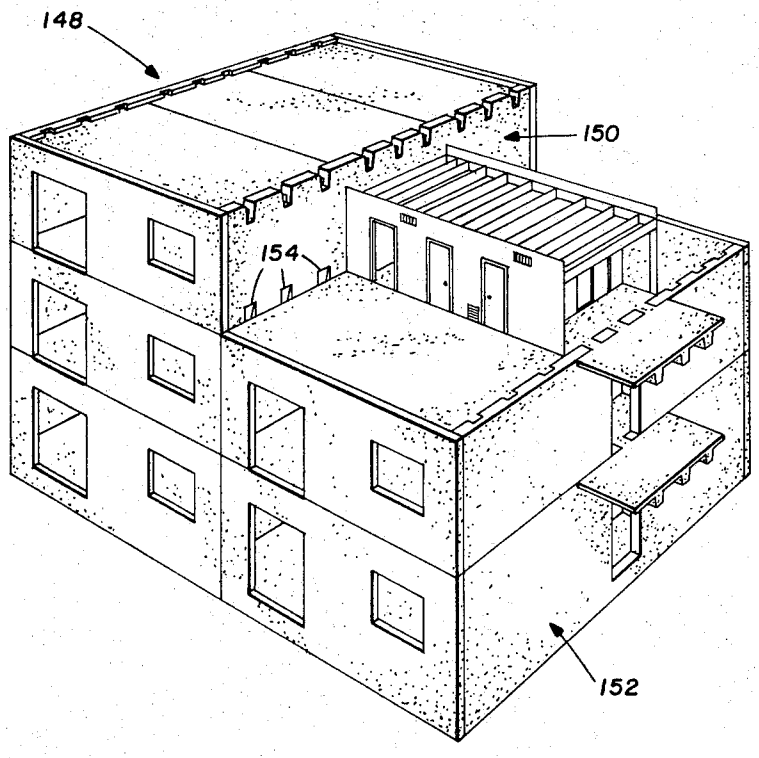

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FIG. 7

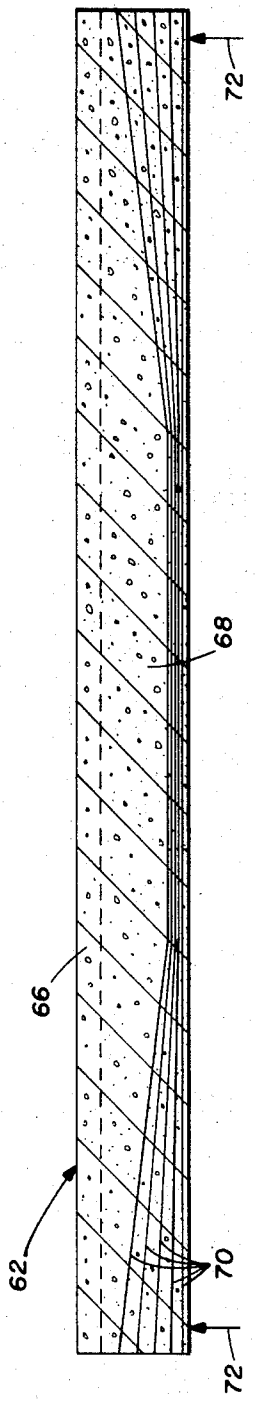


FIG. 8

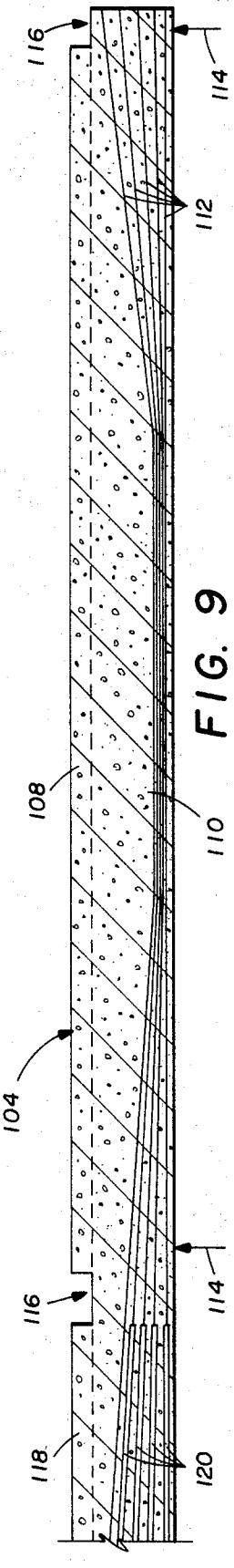


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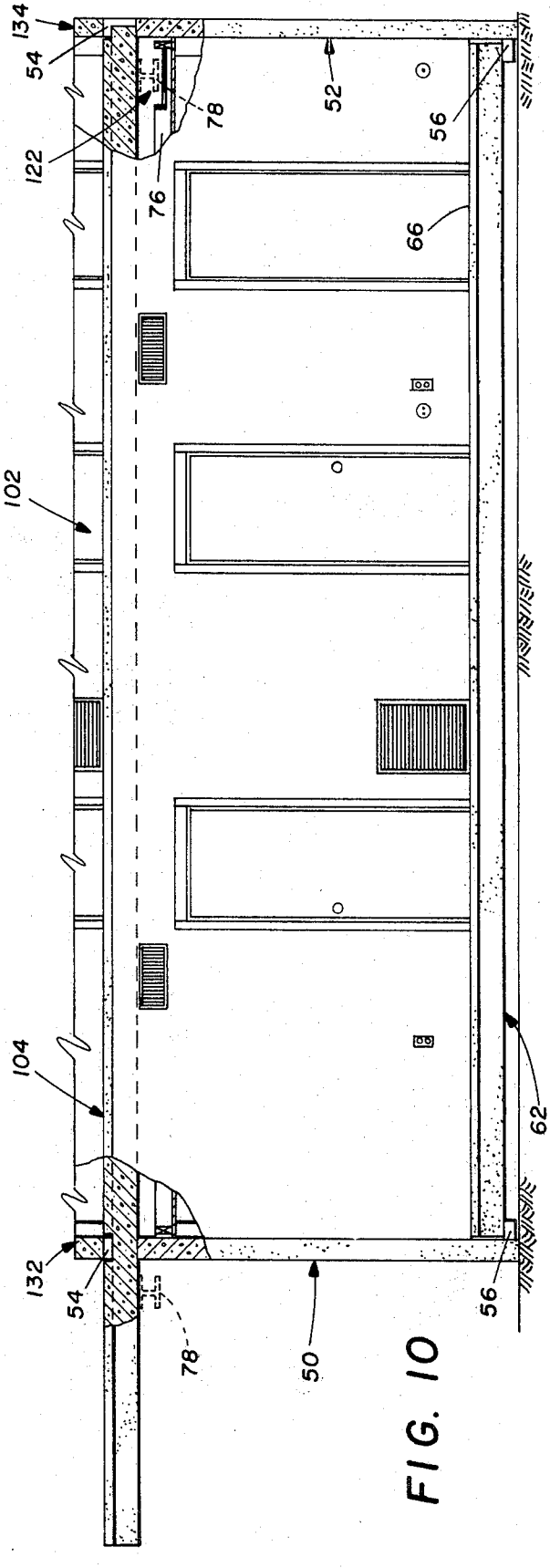
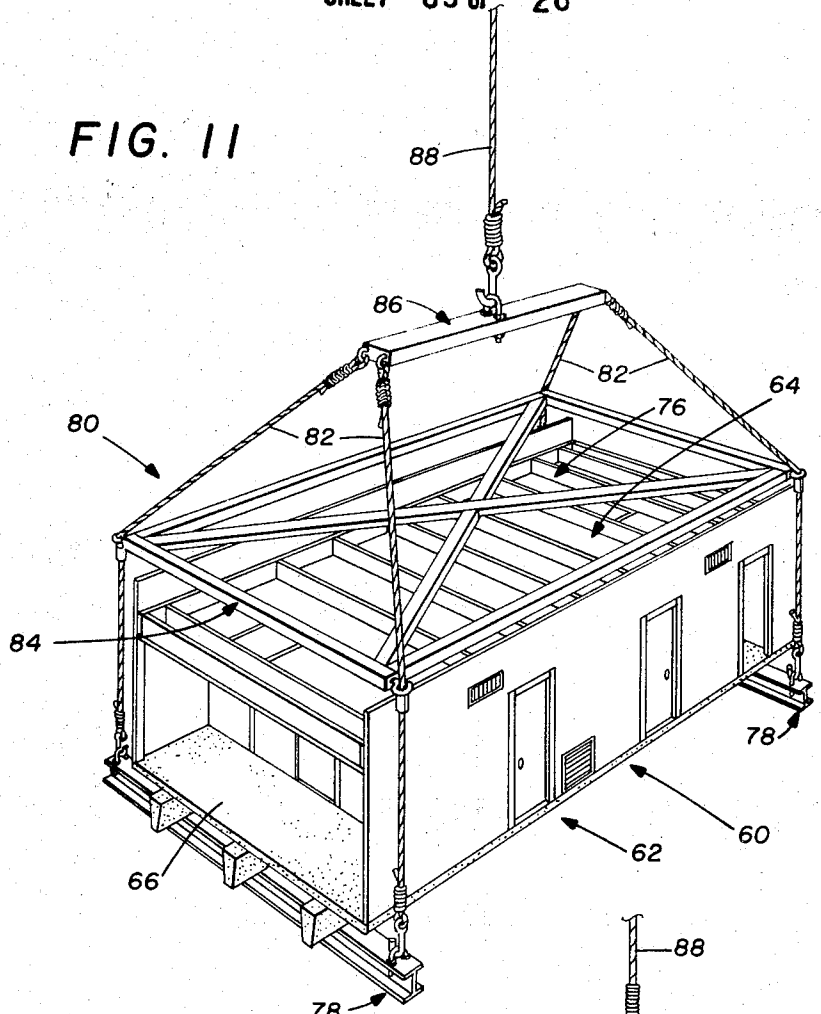


FIG. 10

FIG. 11



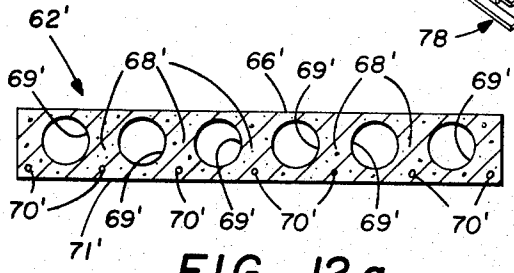


FIG. 12a

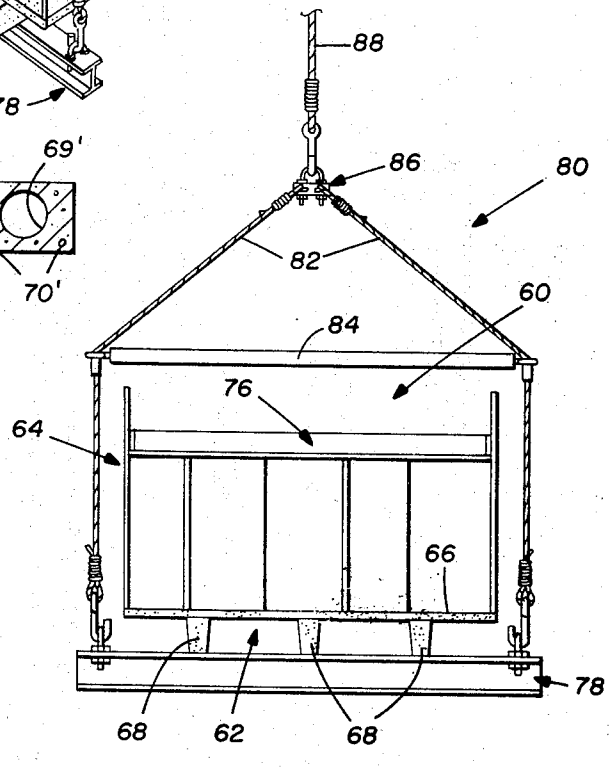


FIG. 12

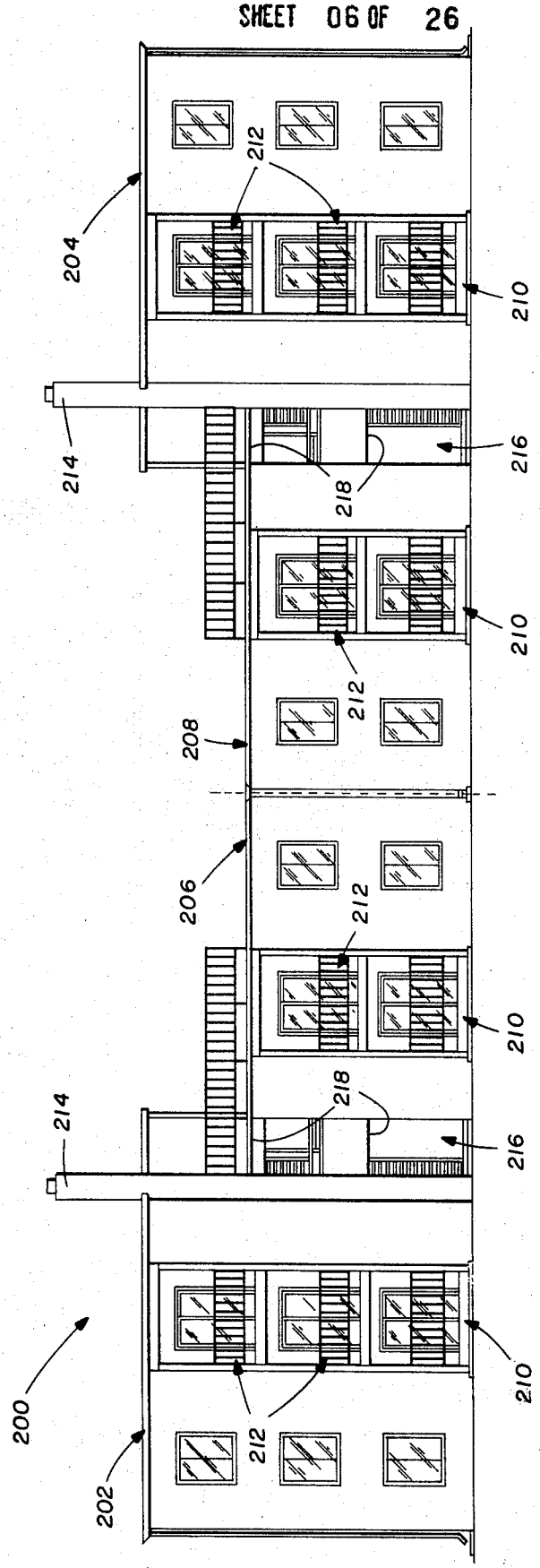


FIG. 13

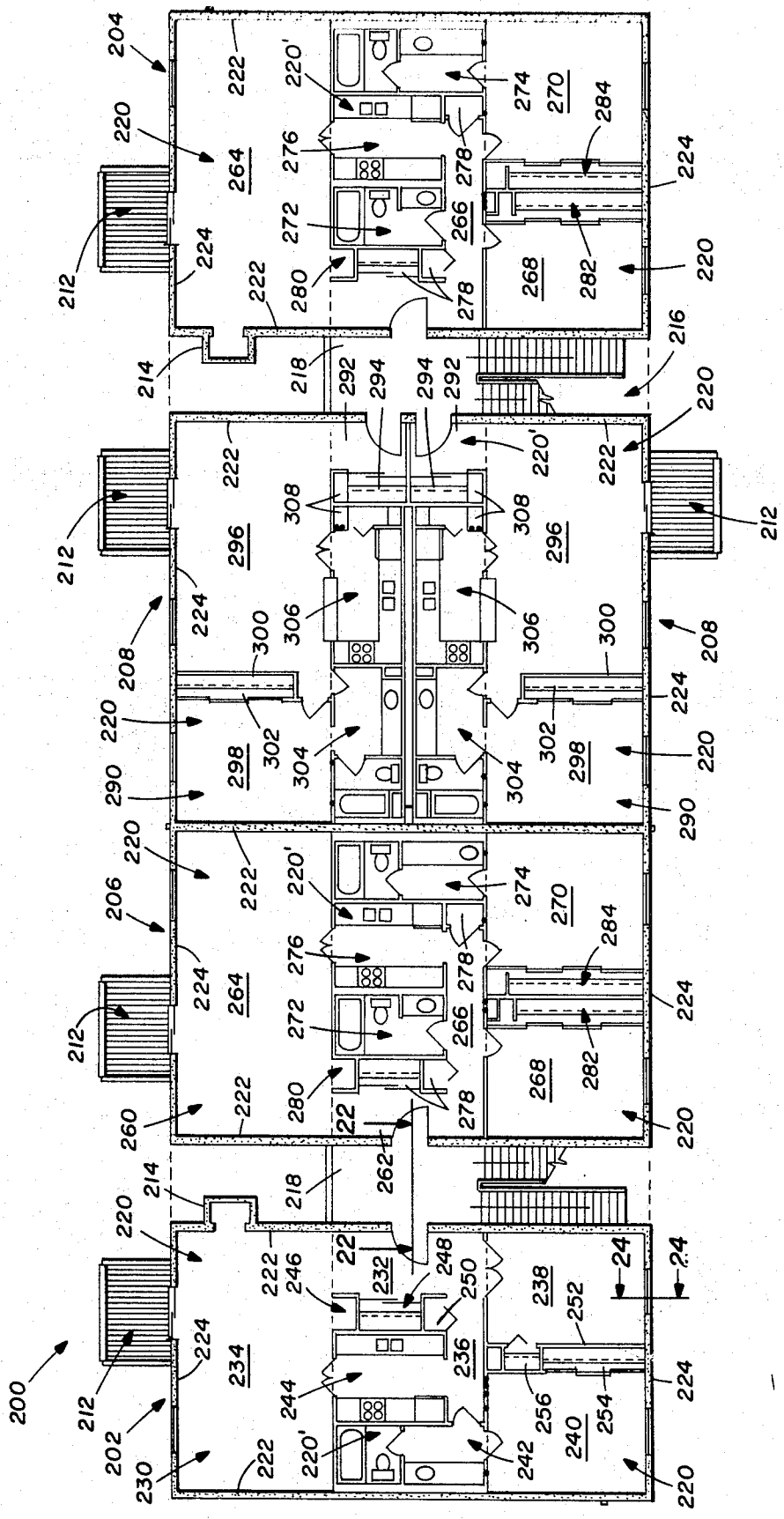

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FIG. 14

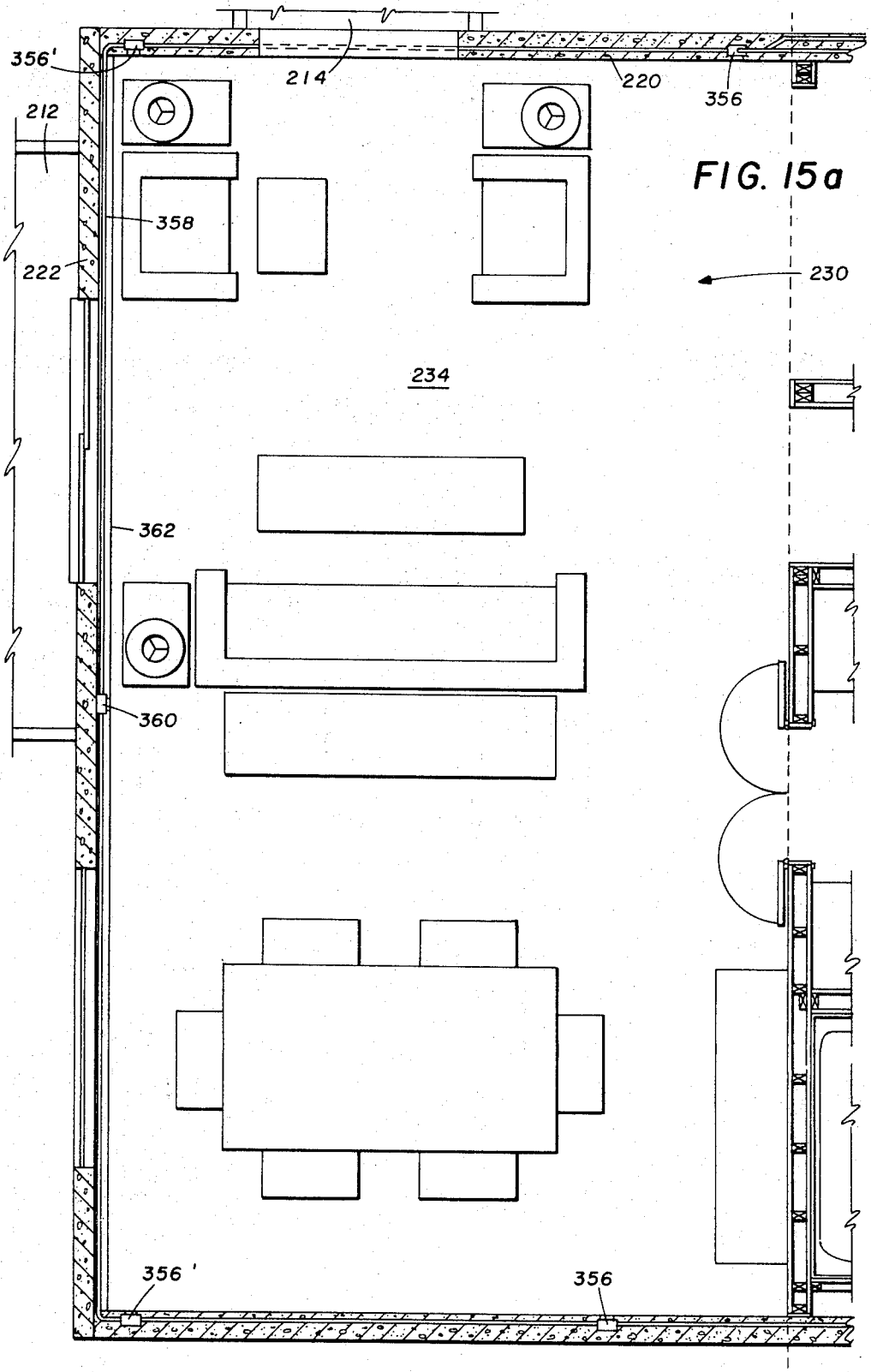


FIG. 15a

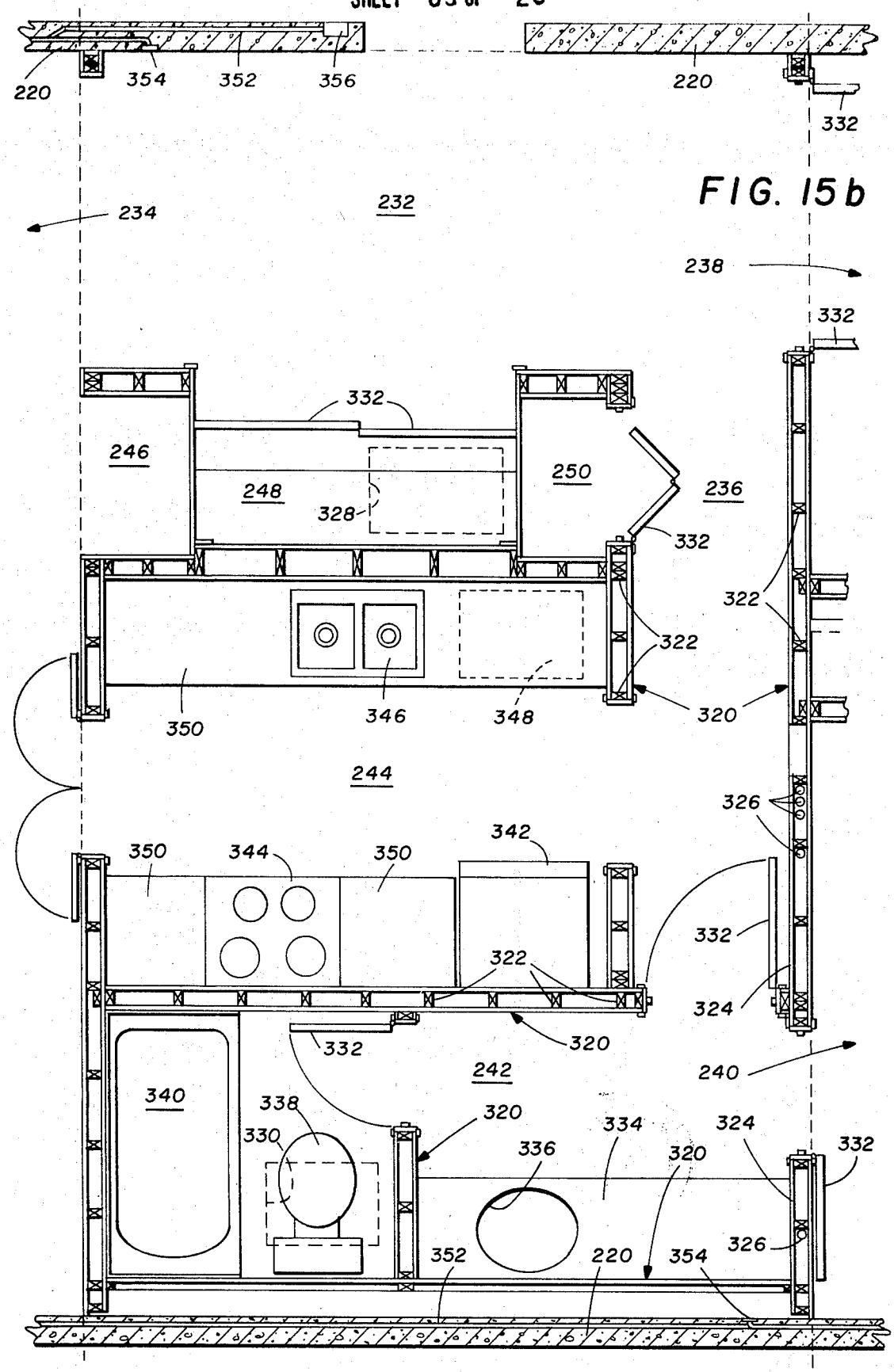

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FIG. 15b

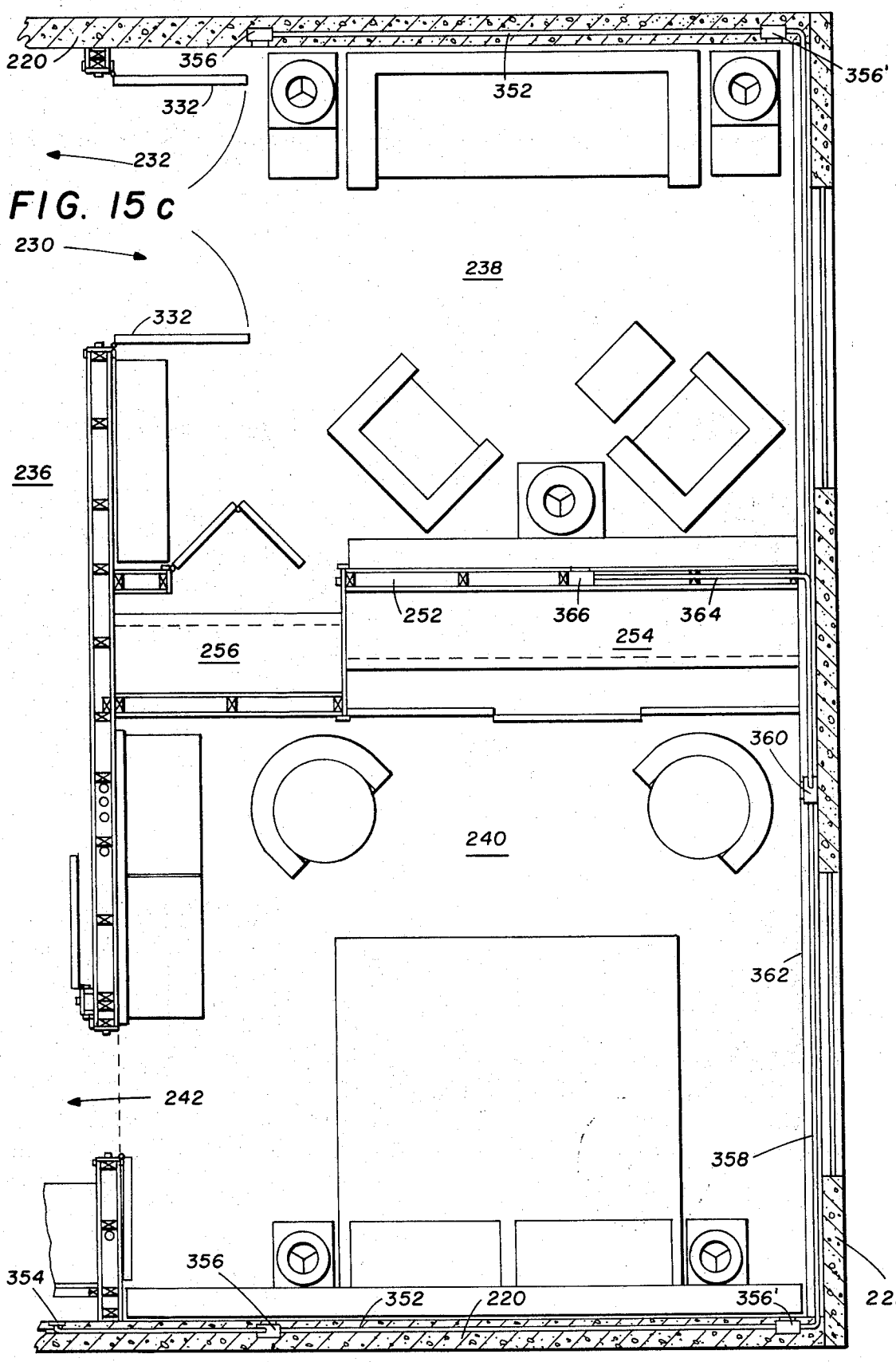
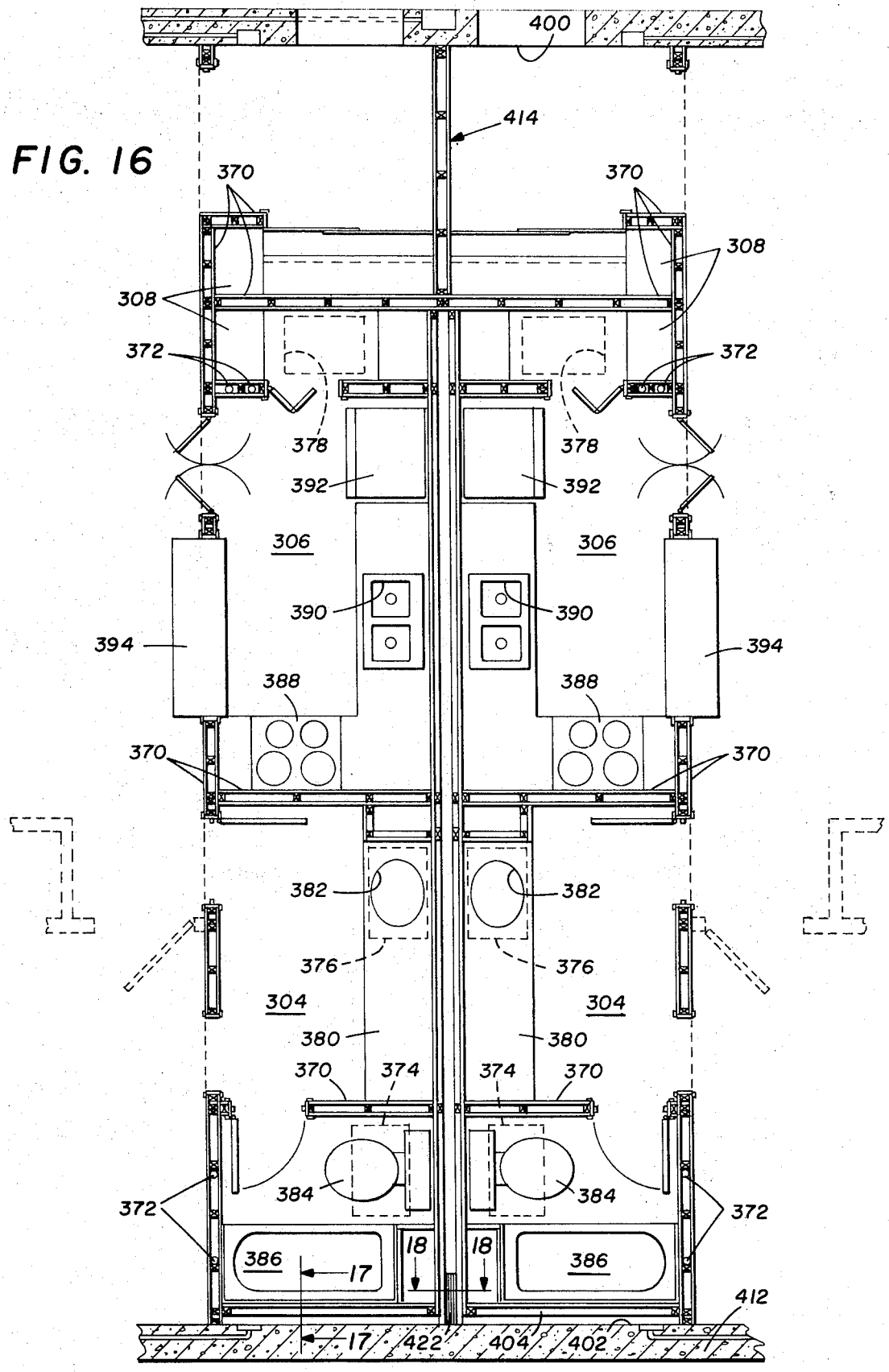

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FIG. 15c

FIG. 16


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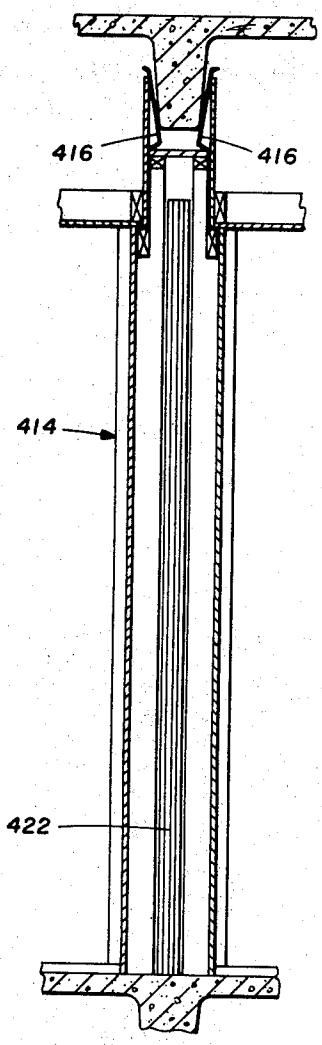


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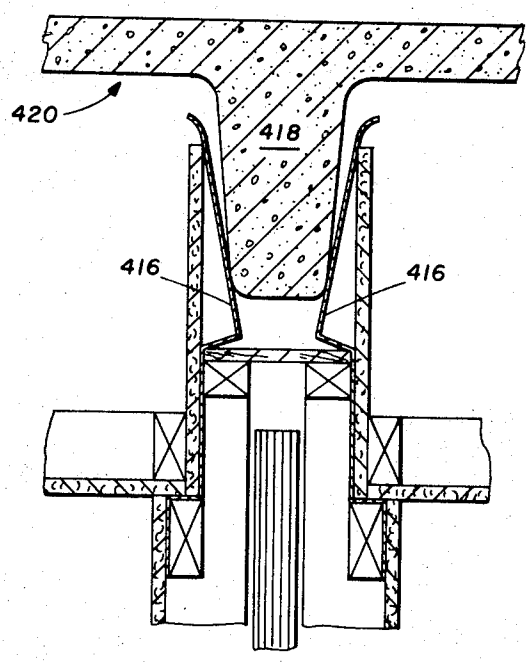


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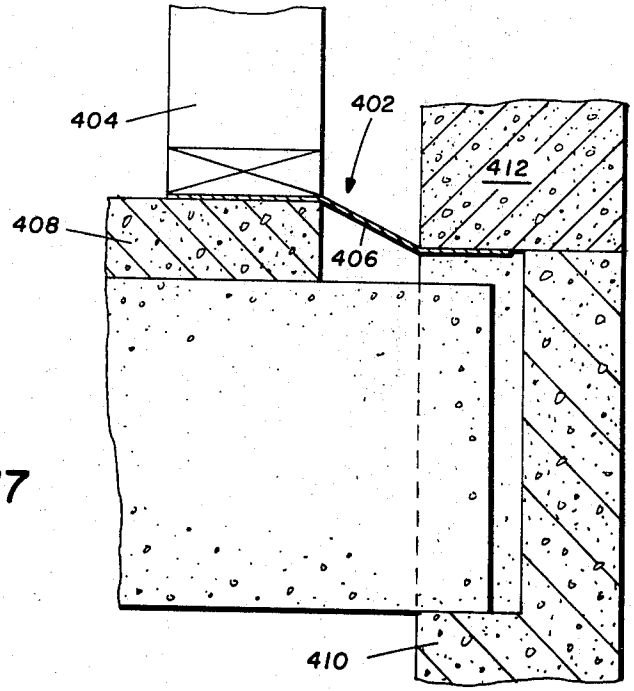


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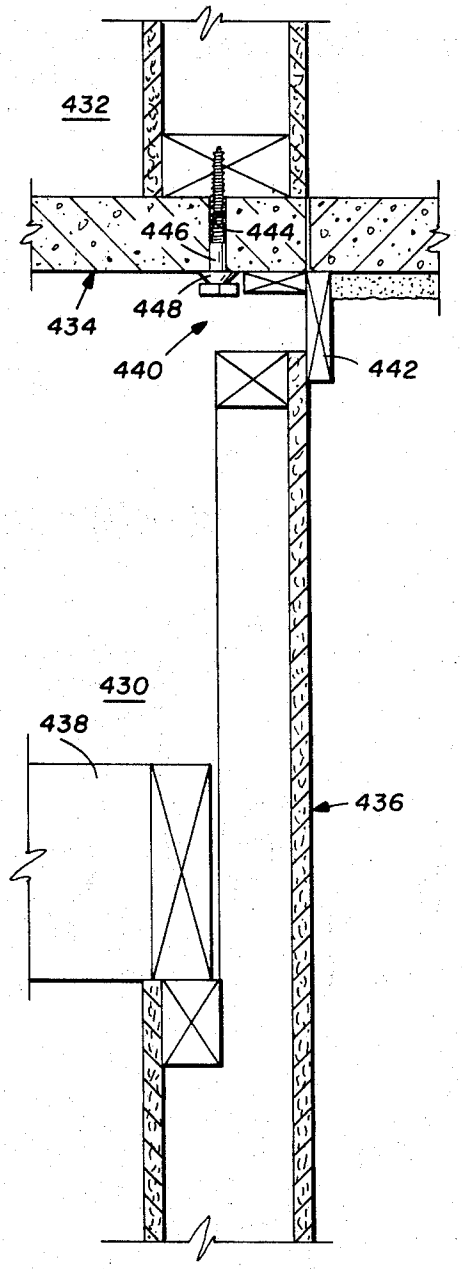


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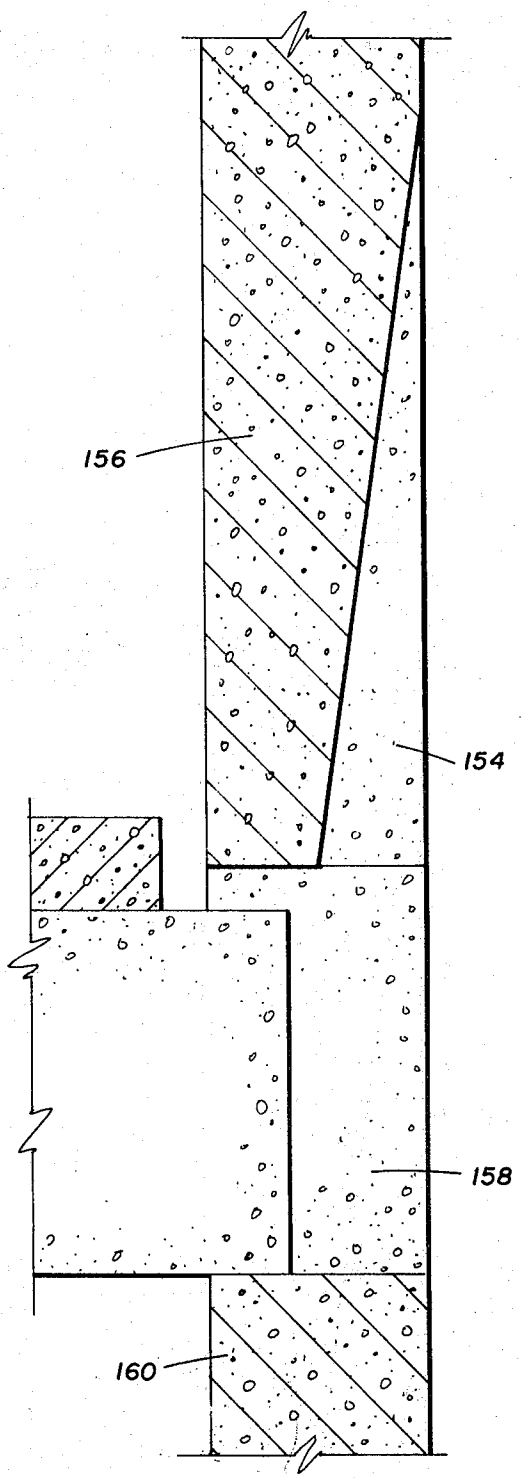


FIG. 21

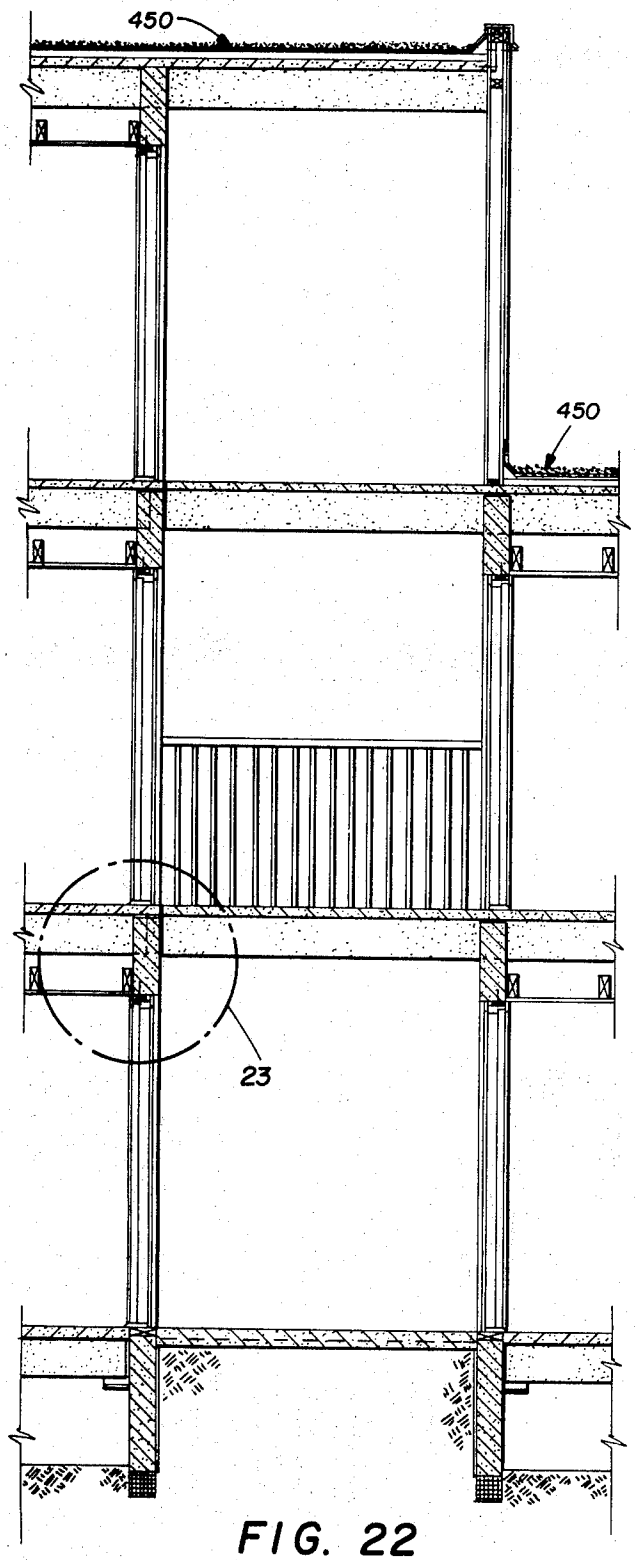


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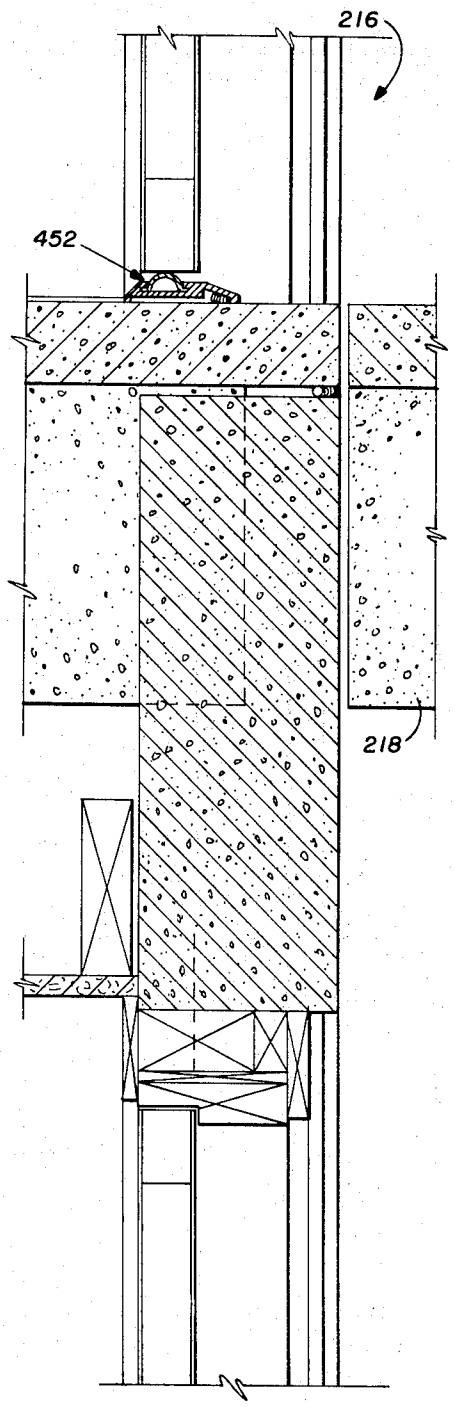


FIG. 23

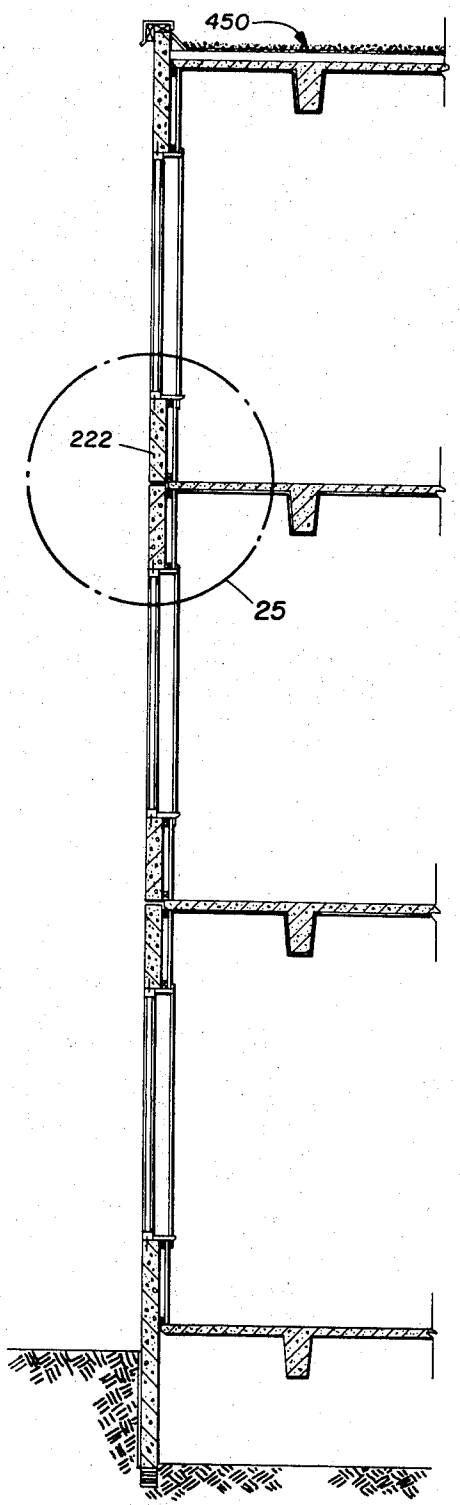


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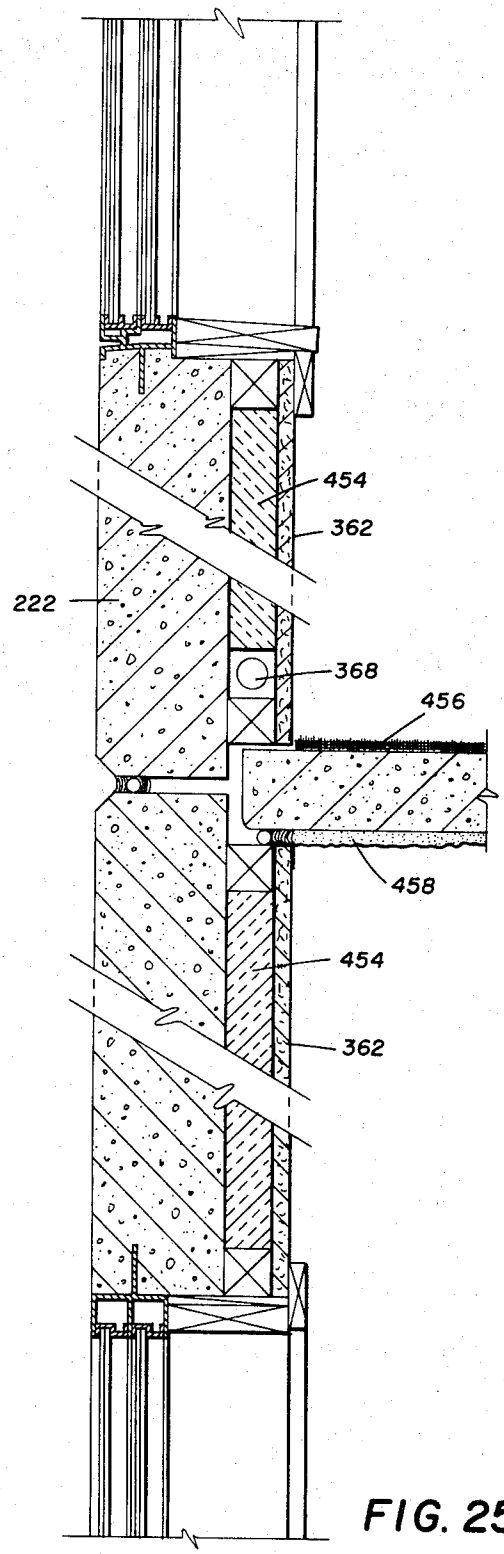


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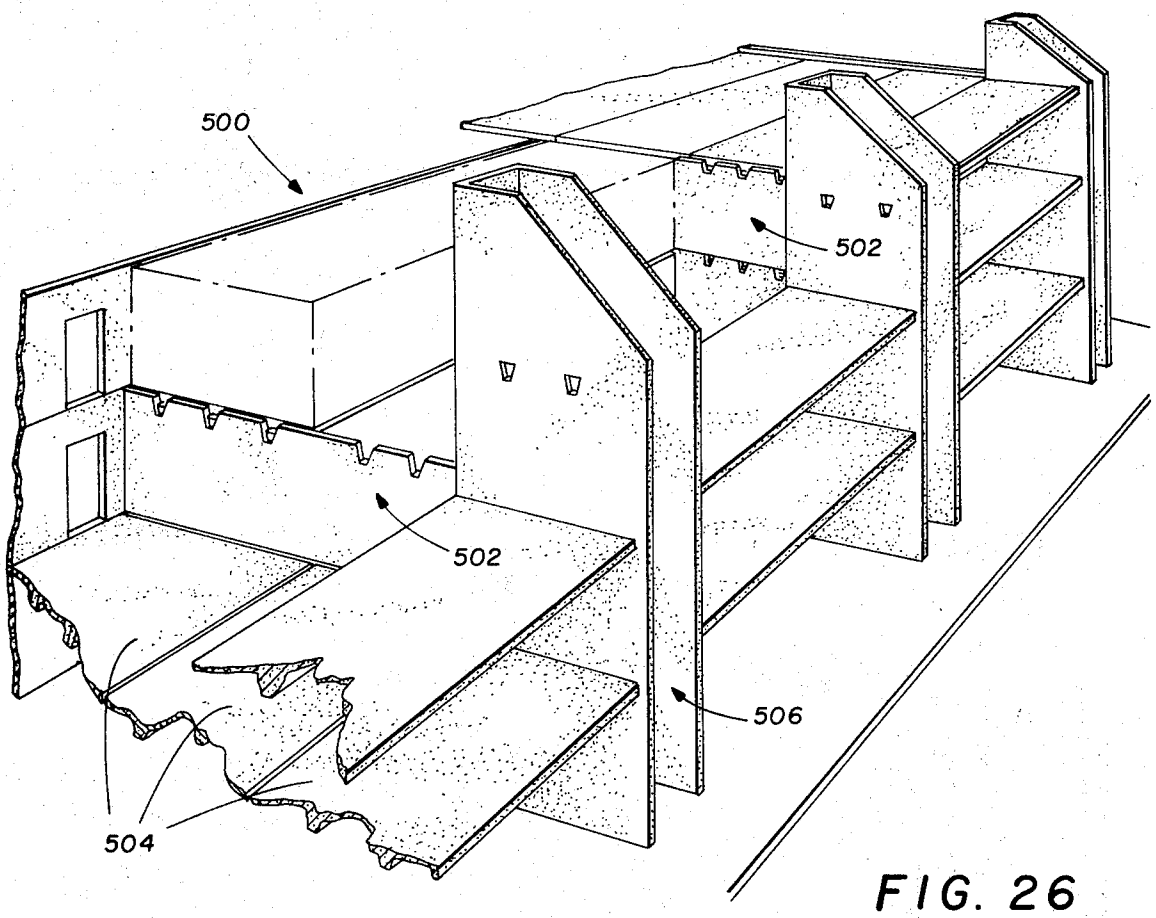

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FIG. 26

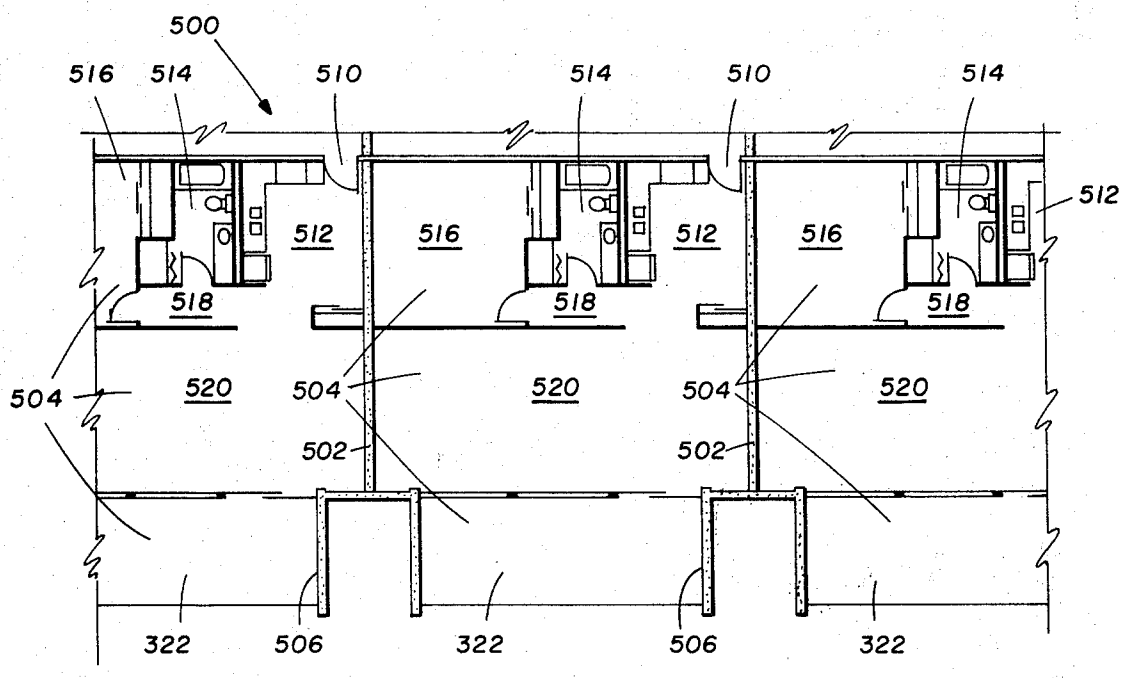

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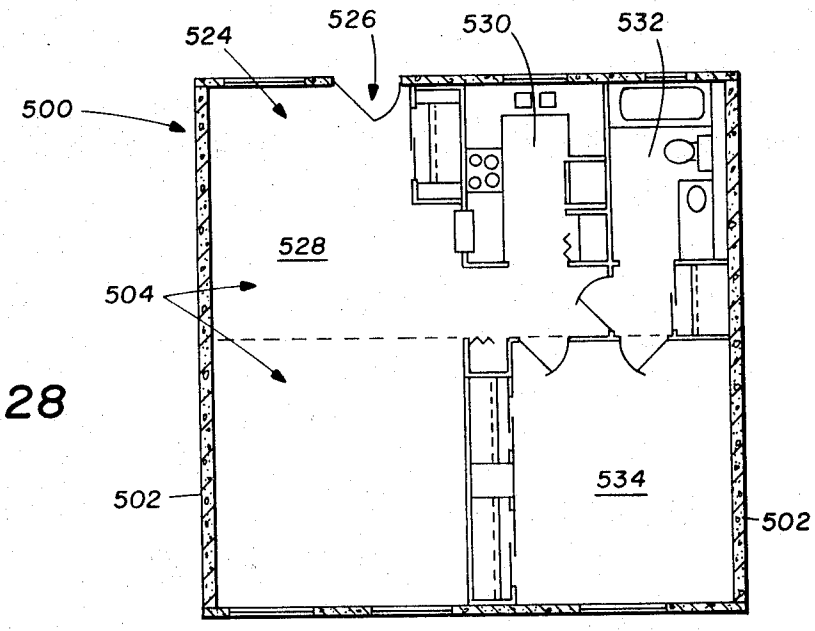

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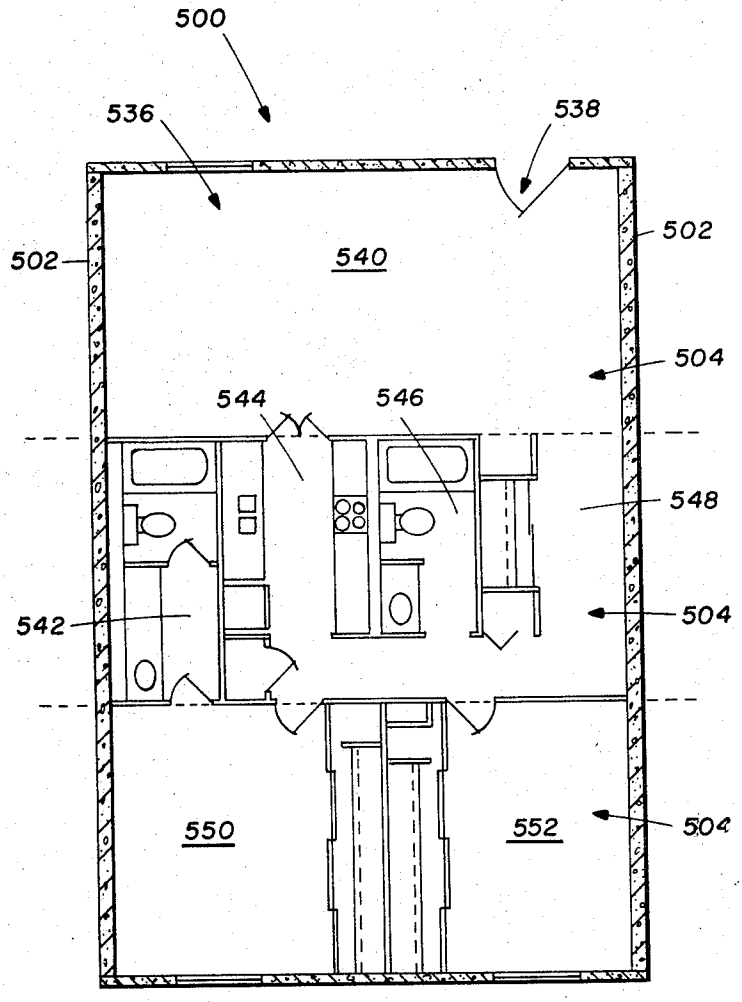

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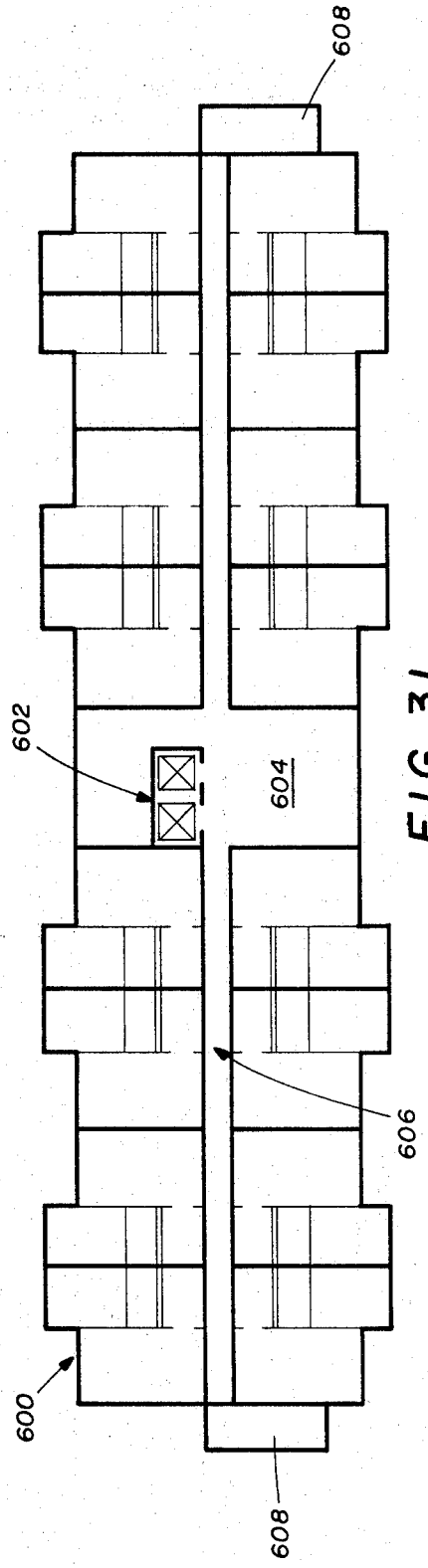

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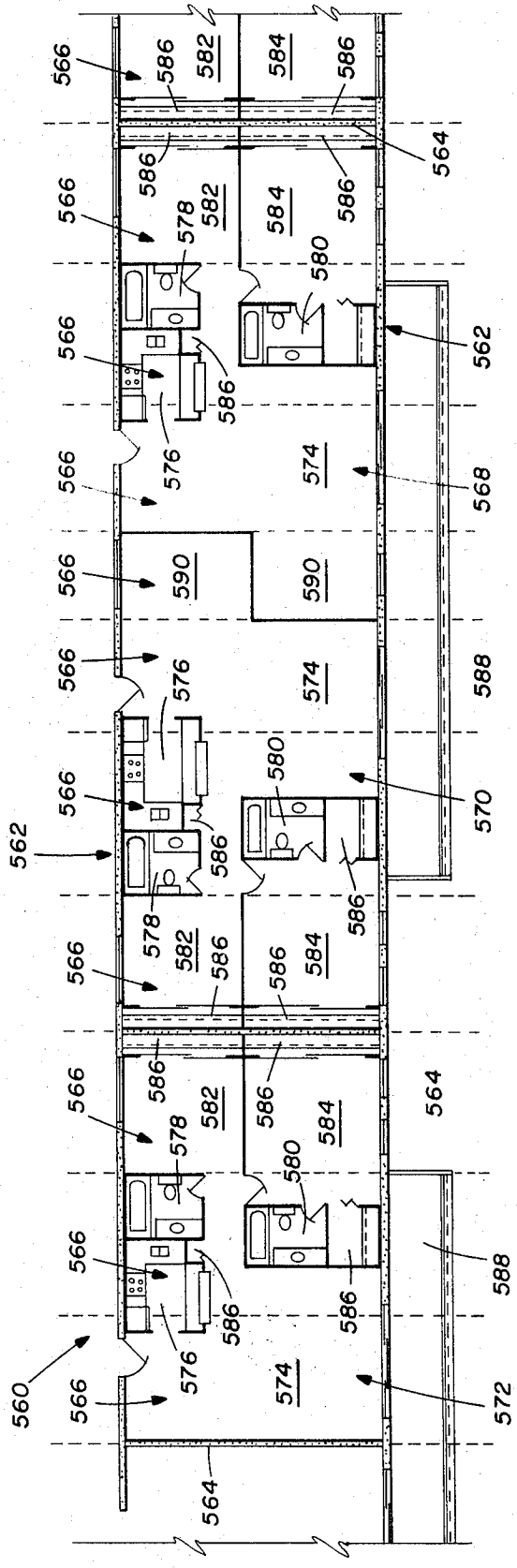
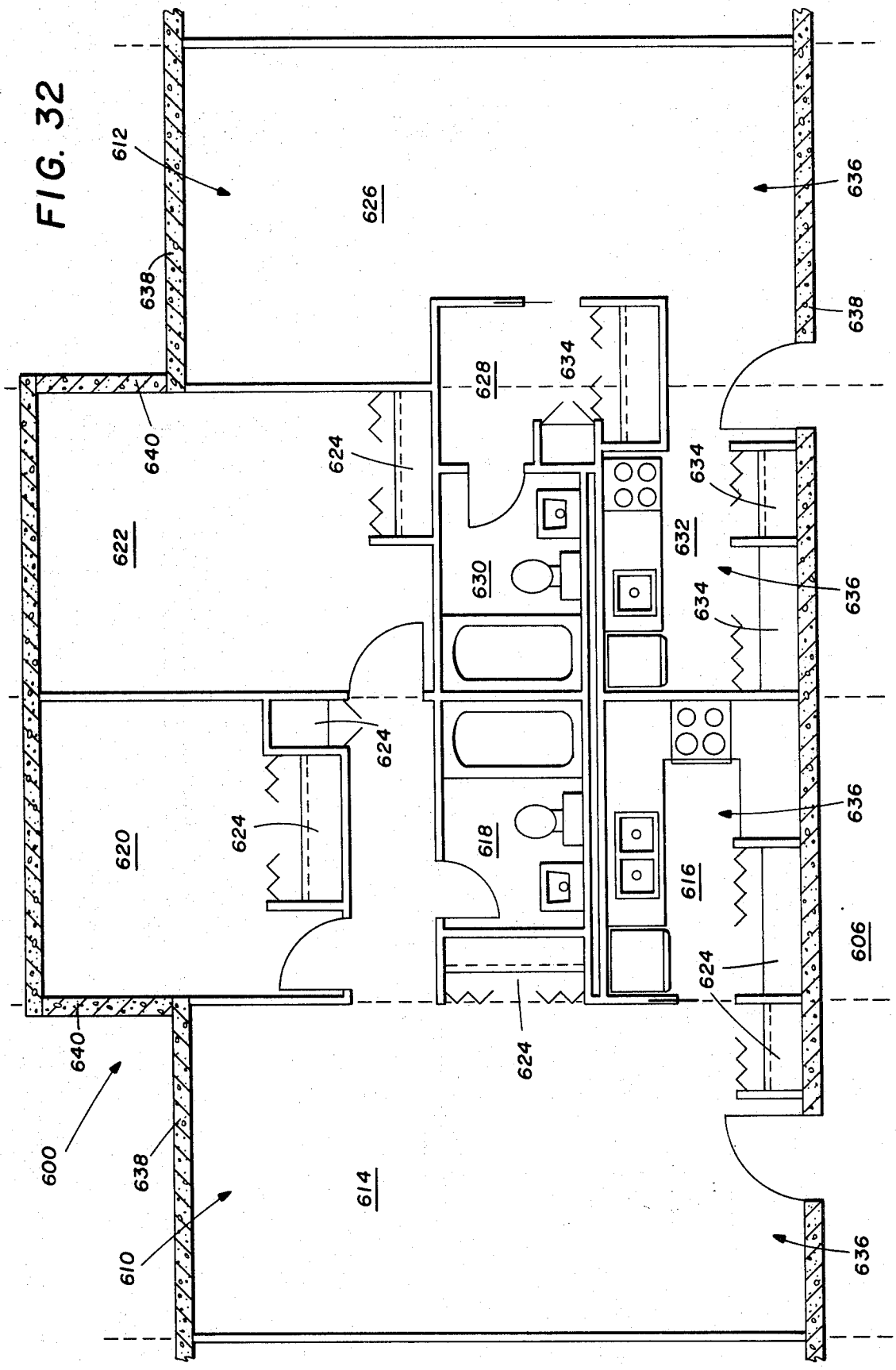

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FIG. 30

FIG. 32


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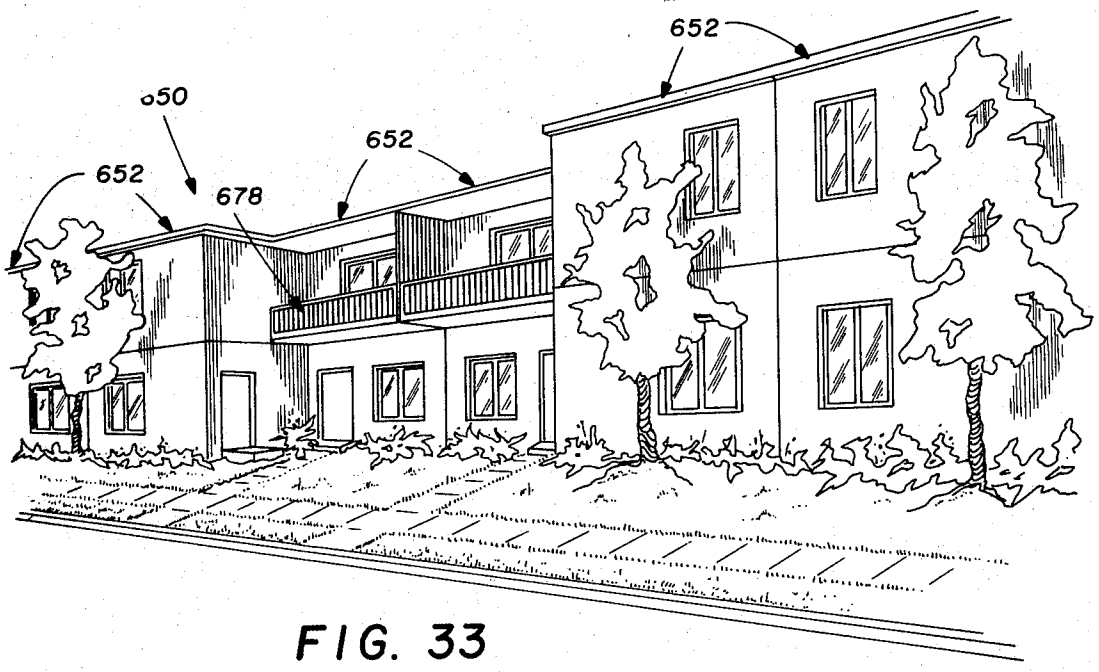


FIG. 33

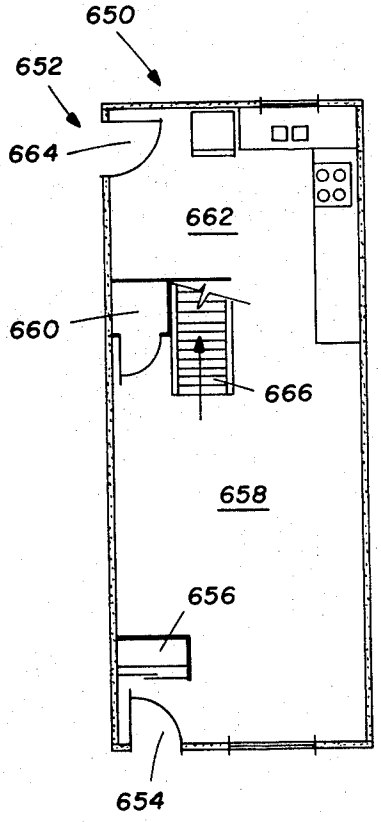


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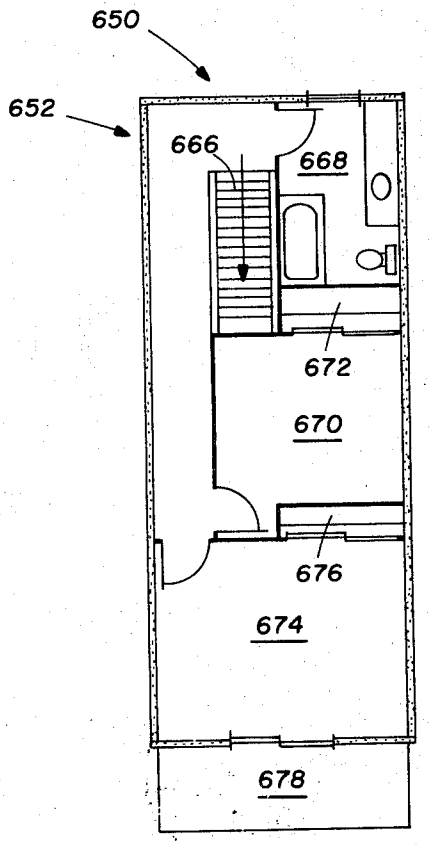


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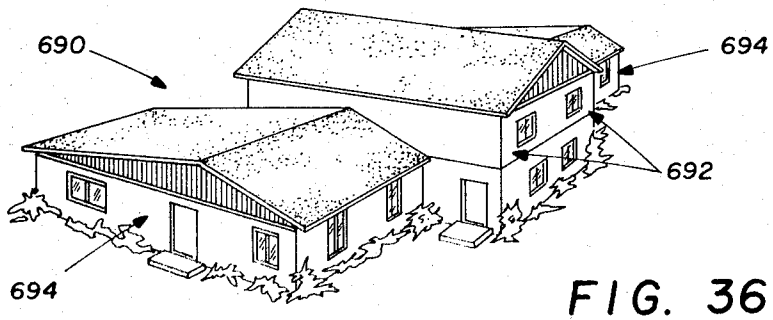

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FIG. 36

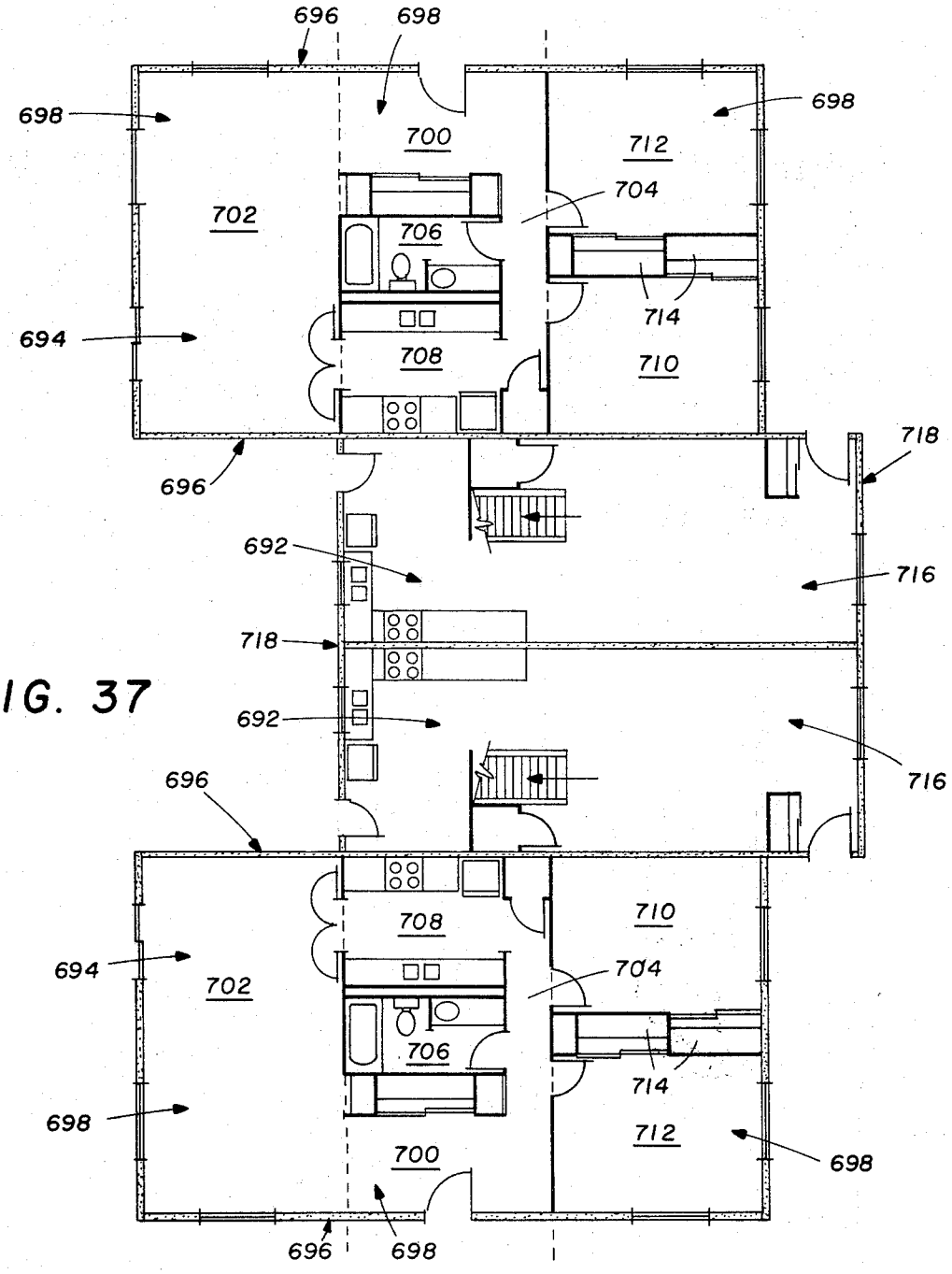

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FIG. 37

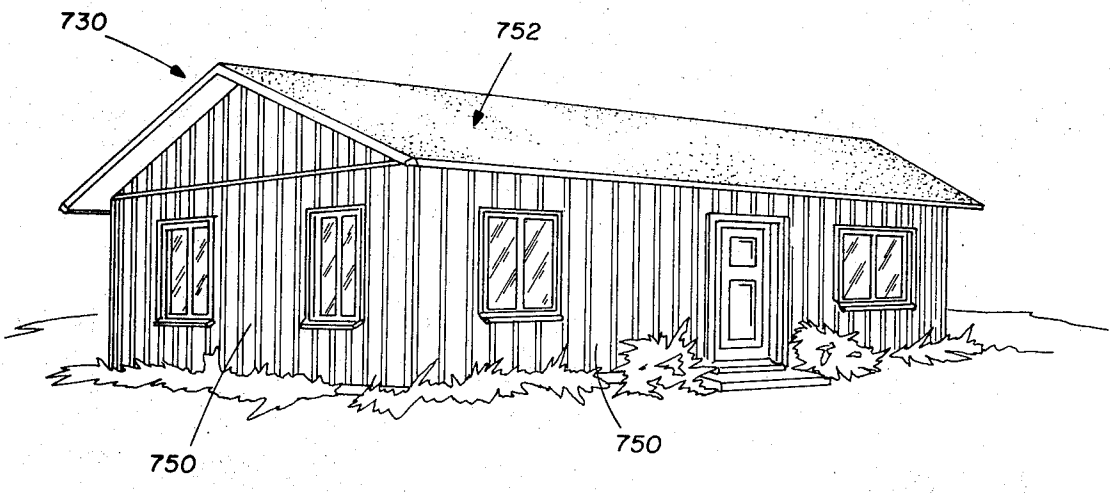

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FIG. 38

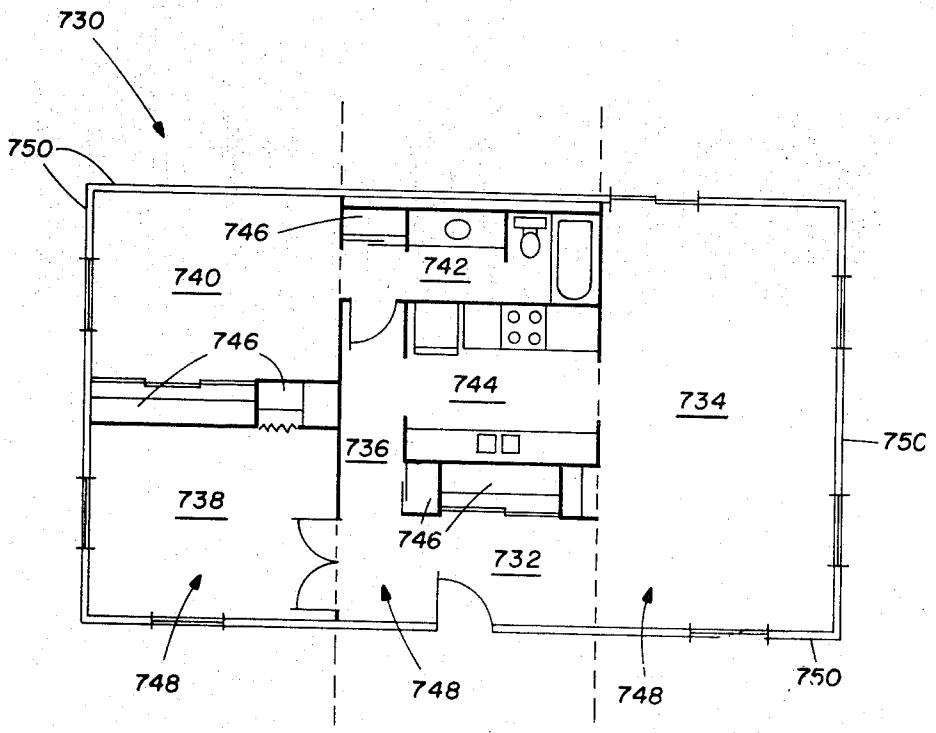

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FIG. 39

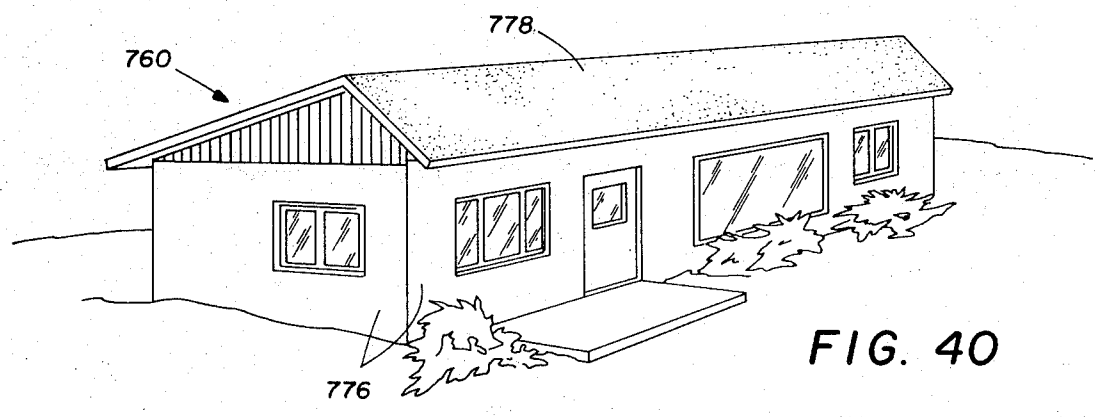


FIG. 40

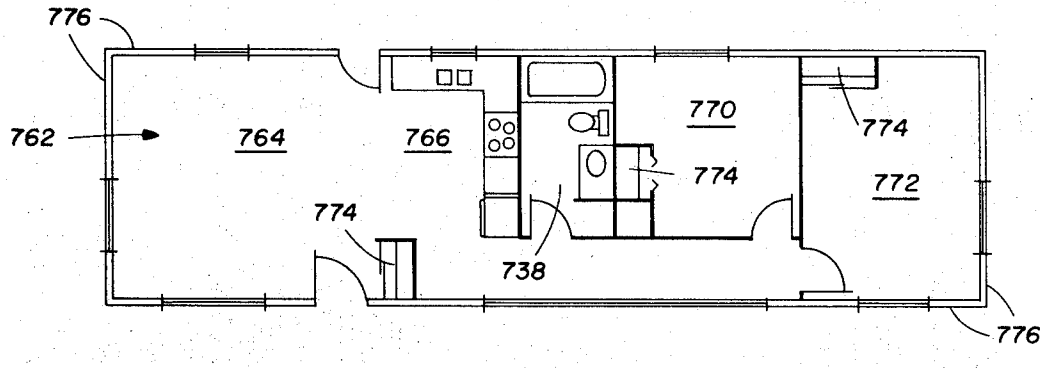


FIG. 41

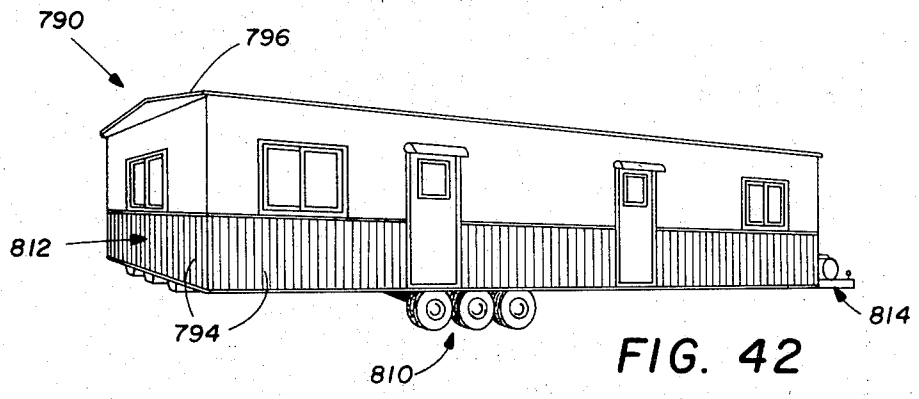


FIG. 42

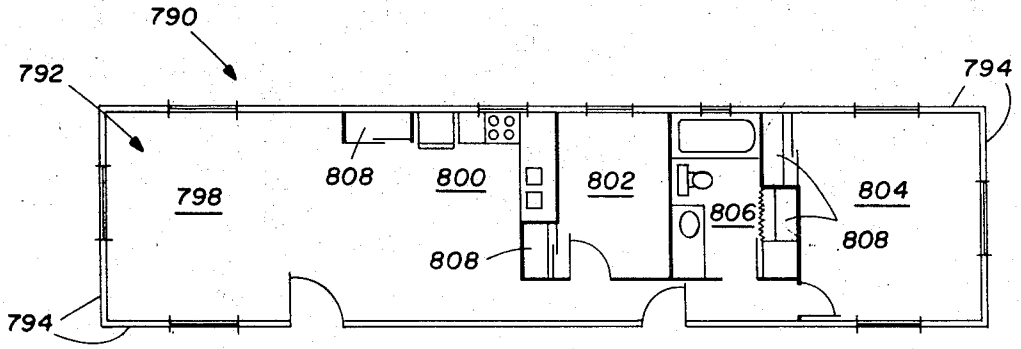


FIG. 43

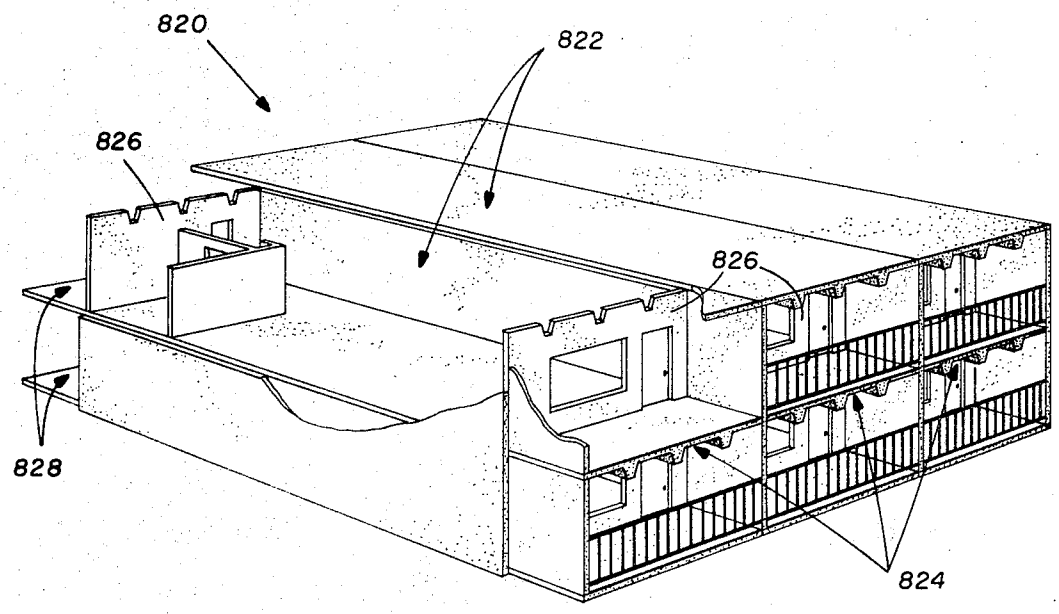

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FIG. 44

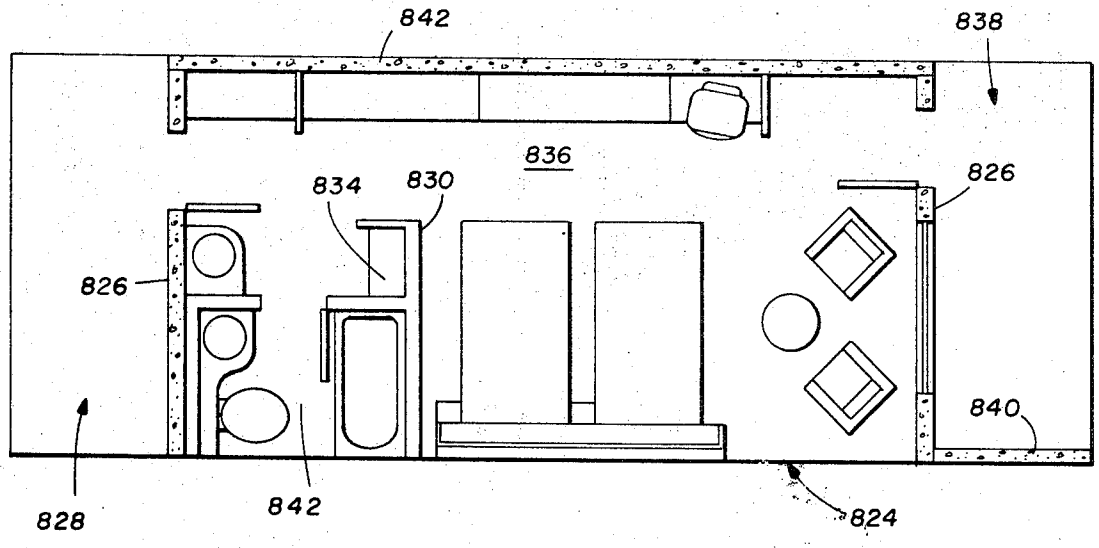

842
838
836
834
830
826
826
840
828
842
824

FIG. 45

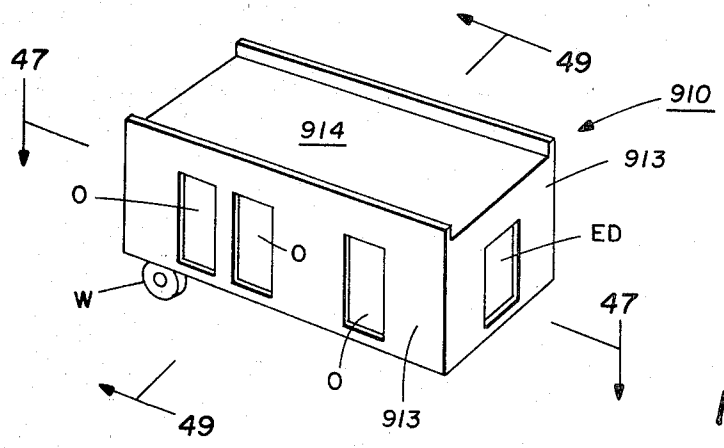

47
49
910
914
913
O
O
ED
W
47
O
913
49

FIG. 46

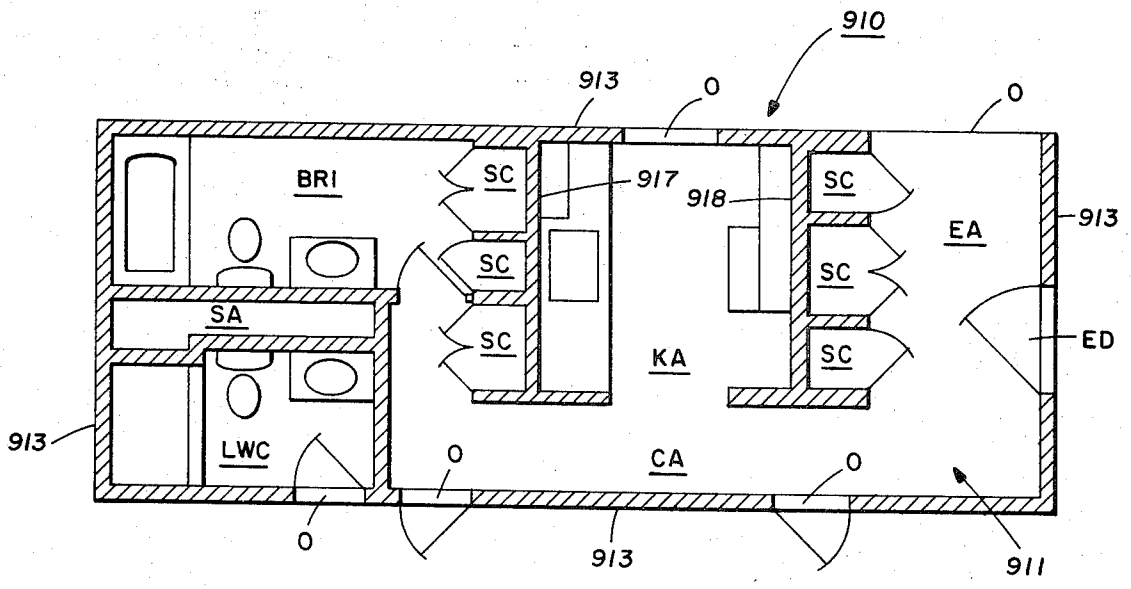

910
913
O
O
BRI
SC
917
918
SC
EA
913
SC
SC
SA
SC
SC
ED
KA
913
LWC
O
CA
O
O
O
913
911

FIG. 51

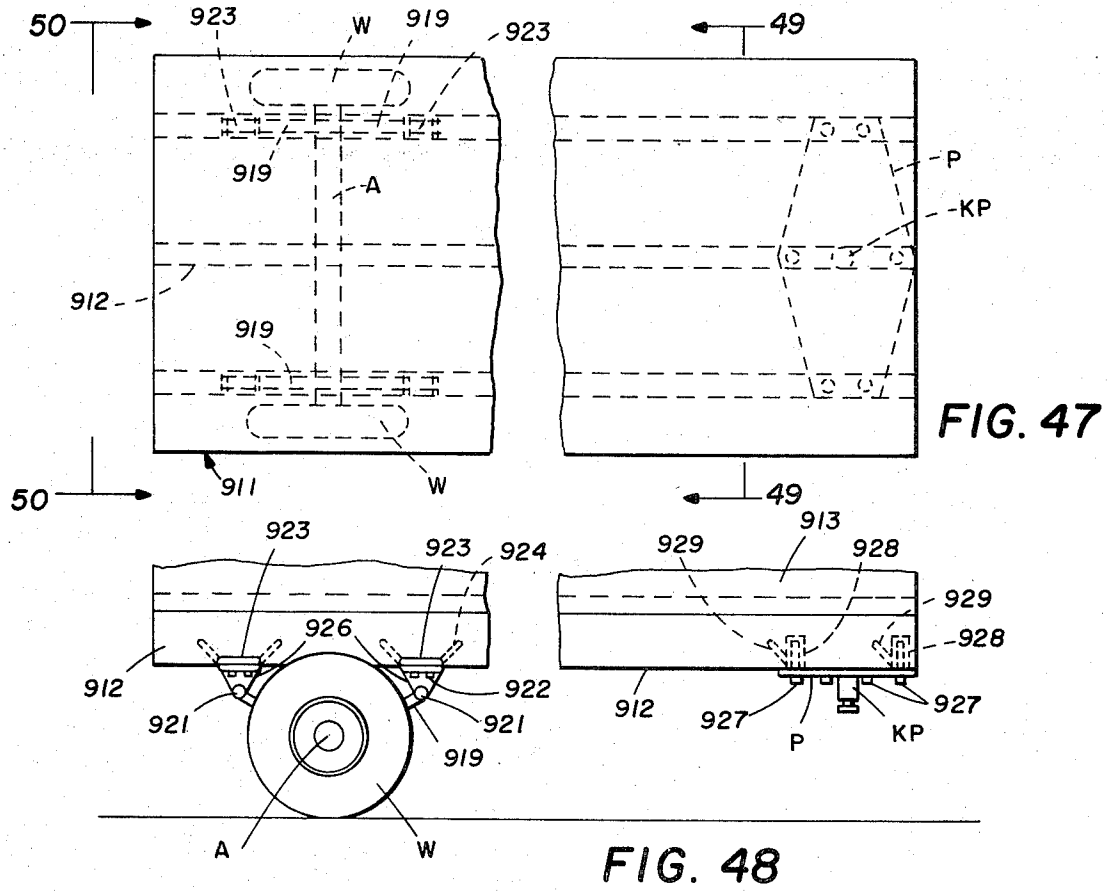


FIG. 47

FIG. 48

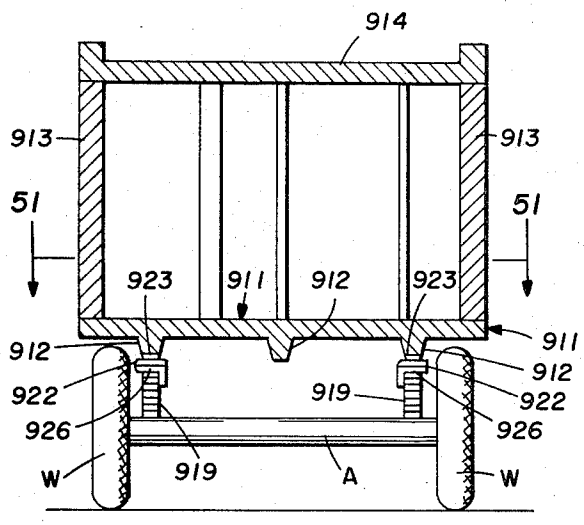


FIG. 49

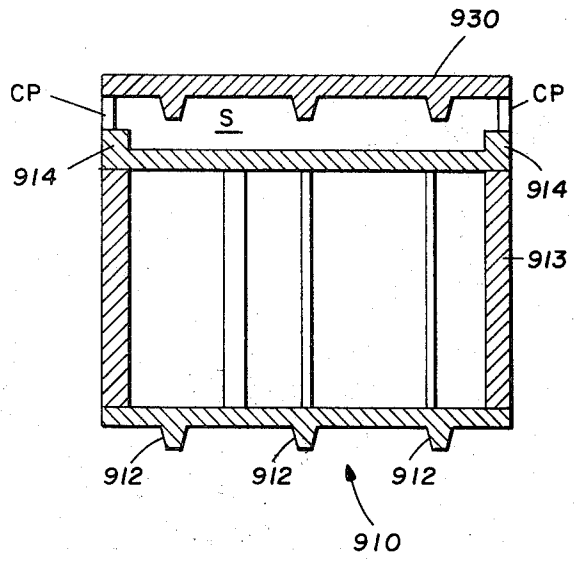


FIG. 50

ELECTRICAL SYSTEM FOR DWELLING UNITS

BACKGROUND AND SUMMARY OF THE INVENTION

This invention relates to dwelling construction systems, and more particularly relates to a system for fabricating a wide range of dwelling types using production line techniques.

Very substantial sums of money have been expended over the last decade or two to develop building systems which use production line tehniques in the construction of both single family and multi-family dwellings. The basic considerations fueling this activity are rapidly increasing labor costs of tradesmen, and the hope that use of production line manufacturing procedures would reduce or eliminate the need for the highly skilled labor of tradesmen as well as provide other cost savings.

This type of construction is particuarly promising in the case of dwellings to be erected at remote or relatively inaccessible building sites where labor and materials are not readily accessible.

To date the most successful adaptation of production line techniques to dwelling construction has been in the mobile home industry. As is well known, the fabrication of a trailer house, including the installation of "mechanicals" such as kitchen, bathroom, and temperature control facilities, is typically carried out to completion at a factory. By this means the labor required to install such a dwelling at a particular site is reduced to an absolute minimum.

A different but related method of adapting mass production to dwelling construction comprises sectionalized houses. Typically half or quarter house sections are fabricated at a factory using conventional building materials and techniques and are transported to a construction site by truck. At the site the sections are positioned adjacent one another and are joined to form a completed house.

Multi-family dwelling units have also been constructed using production line techniques. By way of example, one construction system that has been used heretofore involves the fabrication of box-like modules each including a floor, walls and a ceiling which are interconnected to form a structurally integral and transportable unit. The finishing of the modules, including the installation of mechanicals, is completed at a factory. Thereafter the modules are transported to a construction site and are stacked in various configurations to form dwelling units. In this case, the interrelationship of the floor, walls and ceilings of each module cooperates to provide the structural integrity and load bearing capacity necessary to permit the modules to be transported and handled. This type of system has the inherent disadvantage of greatly limiting flexibility of design, and also results in duplicate wall structures.

Although the modular building systems heretofore used have provided some cost reduction, the systems are inherently inflexible and greatly limit the architectural design and livability of the structures. In general, the greater the modularization of the system to achieve reduced costs, the more inflexible the system is to design change, the smaller the rooms, and the more unlivable the dwelling.

Another trend in the construction industry involves the use of prestressed concrete structural components. Thus, structures such as bridges, parking garages, warehouses and the like are presently being fabricated from various prestressed components including load bearing and non-load bearing walls, columns, beams, and floor and roof decks. Heretofore prestressed members have been used solely as structural elements. This practice necessitates the use of labor at the construction site to perform such tasks as erecting interior partitions, installing mechanicals, etc.

The present invention comprises a novel dwelling construction system which incorporates many of the advantages that are characteristic of prior art modular construction systems while eliminating substantially all of the disadvantages that have long been associated with such systems. In accordance with the broader aspects of the invention, a service core is substantially completely fabricated on an assembly line using mass production techniques. The service core is formed on a prestressed concrete pallet which is also fabricated at a plant site using automated equipment for greatest economy. The service core includes a mechanical enclosure which may be fabricated from conventional drywall building materials of the type used in building houses, and similar buildings. The mechanical enclosure may include complete mechanicals for at least one dwelling, i.e., complete kitchen facilities, complete bathroom facilities, complete temperature control equipment, and electrical systems including telephone and television wiring.

Upon completion, each service core is transported to a dwelling site. The concrete pallet provides the only structural integrity required, thus giving total flexibility in the design of the enclosures. In some instances the service core may comprise an entire dwelling. More often, however, each service core is employed in conjunction with additional prestressed concrete pallets to form a relatively large dwelling. In the latter case the pallets extend between and are supported by prestressed concrete load bearing walls to provide a clear span of substantial length. Additional combinations of service cores and pallets may also be supported on the load bearing walls to form garden apartments, high rise apartments, and the like.

In accordance with more specific aspects of the invention, the prestressed concrete pallets used in the service cores and used in conjunction with the service cores to construct dwellings each comprise a relatively thin deck, a plurality of integrally formed beams depending from the deck, and pretensioned members extending through the beams to prestress and maintain the concrete of the beams in compression such that the beams are adapted to span a substantial distance between two spaced load bearing points and still support large static and live loads on the deck. The deck may terminate at the load bearing points, in which case the deck is entirely enclosed by the load baring walls. On the other hand, the beams may be cantilevered substantially beyond either of the load bearing points to support a deck portion located outside the load bearing walls to provide a balcony, an entry corridor, etc.

In the use of the present invention to construct a multi-family dwelling such as a garden apartment, a pair of load bearing wall panels are initially erected at points spaced in accordance with the positioning of the support points of the beams of the concrete pallets. After the load bearing wall panels are in place, a service core and then one or more additional pallets are set in place on the load bearing wall panels to form the floor of a

first story dwelling. In the case of the first floor dwelling, the beams of the pallets may rest on members projecting inwardly from the load bearing wall panels. Non-load bearing shear wall panels interconnect the load bearing wall panels and serve the dual functions of enclosing the dwelling and maintaining the load bearing wall panels erect.

A service core and then additional pallets which form the ceiling of the first floor dwelling and the floor for a second story dwelling are set in place on the top edges of the load bearing walls of the first floor unit. The beams of the pallets of the second dwelling are preferably received in notches formed in the upper ends of load bearing wall panels that enclose the lowermost dwelling. Also, the decks of the pallets forming the floor of the second dwelling preferably either end at or are interrupted at points corresponding to the positioning of the load bearing wall panels. This permits mounting a second pair of load bearing wall panels directly on the first pair of load bearing wall panels to form the walls for the second floor dwelling

When the second set of pallets are in place, a second pair of load bearing wall panels and a second pair of shear wall panels are installed. Then a third set of pallets including a service core for a third dwelling are mounted on the second pair of load bearing wall panels to form a ceiling for the second floor dwelling and the floor for a third dwelling. This procedure is repeated until all of the dwellings in the apartment are formed. Then prestressed concrete pallets are mounted on the uppermost load bearing wall panels to form the roof of the uppermost dwelling, and of the stack of dwellings. The interiors of the several dwellings are then grouted, and floor and wall coverings installed, whereupon the structure is ready for occupancy.

As will be appreciated by those skilled in the art, prestressed concrete pallets of the type employed in the practice of the present invention can be supported only at the two design load bearing points. In most instances, the blank pallets are handled by means of eyes cast in the concrete. However, the pallets upon which the service core is formed make this method of handling the pallets impractical. Accordingly, each service core is set in place by means of a pair of picking bars which extend under the support points of the beams of the pallet, a harness including members for connection to the opposite ends of the two picking bars, and a crane which operates through the harness and the picking bars to lift and position the pallet. On the other hand, both for fire prevention purposes and for the sake of appearance, it is highly desirable that the enclosure of each service core extend substantially into engagemnnt with the pallet located next about the service core. To this end the enclosure of each service core is equipped with at least one picking bar slot positioned to permit withdrawal of one of the picking bars that will be used to install the service core or pallet above the service core. The picking bars used in the installation of the pallets weigh approximately 400 pounds. This necessitates reinforcing the picking bar slots to such an extent that the picking bar does not damage the service core as it is withdrawn.

The building codes of the various cities and states typically require a fire barrier having a one hour rating between adjacent dwellings in a multi-family dwelling. In the practice of the present invention this requirement is easily fulfilled with respect to pallets that do not comprise service cores by simply filling the spaces between the decks of the pallets and the load bearing wall panels and the shear wall panels with grouting. On the other hand, the enclosures of the service cores prevent access to these spaces and thereby prevent the filling of the spaces with grouting. For this reason the service cores are preferably installed with one edge of the deck engaged with the adjacent wall panel. At the other end of the deck a strip of sheet metal is secured between the enclosure and the deck. The strip of sheet metal is extended over the upper edge of the load bearing wall panels that supports the deck and is engaged by the load bearing wall panel that is mounted on the supporting panel to provide the necessary fire barrier.

In accordance with a particular embodiment of the invention, double loaded service cores are utilized in the construction of adjacent dwellings. That is, a single pre-stressed concrete pallet is equipped with two complete but separate sets of mechanicals, one for each of the adjacent dwellings. In such a case it is necessary to form a fire barrier having a one hour rating between the portion of the service core that is individual to one of the dwellings and the portion that is individual to the other dwelling.

The majority of the fire barrier for a double loaded core may comprise a wall including at least one layer of five-eighths inch sheet rock. A pair of diverging sheet metal flanges are provided at the upper end of this wall for engagement with a beam of the pallet that is installed above the double loaded core to form the upper portion of the fire barrier. The fire barrier wall is also provided with a stub wall which is slidably supported at the end of the deck that will be engaged with a load bearing wall. During installation of the double loaded core the stub wall is retracted. Then, after the load bearing wall panels adjacent the double loaded core have been installed, the stub wall is moved outwardly and is engaged with the adjacent load bearing wall panel. By this means the fire barrier between the portions of the double loaded core that are individual to the separate dwellings is extended to the full height and the full width of the core.

In addition to the foregoing, the present invention incorporates numerous features which contribute greatly to its overall practicality. For example, notwithstanding the strength of prestressed concrete pallets, it has been found that a direct connection between a particular pallet and the enclosure of a service core situated beneath the pallet is not workable. Instead a slip joint is employed to provide a pleasing appearance while permitting relative movement between the pallet and the service core as a result of live loads.

Another important feature of the invention involves the manner in which convenience outlets are provided at spaced points around each dwelling. Thus, electrical conduits are formed in the load bearing wall panels when the panels are manufactured. After the panels are installed, electric service lines are directed from the adjacent service cores through the conduits in the load bearing wall panels and along the shear wall panels. The shear wall panels are typically covered with wood panelling or the like, so that the resulting dwelling is equipped with suitable convenience outlets and yet has no exposed conduit or wiring.

Still another important feature of the invention involves an improved method of forming the enclosures of the service cores. It has been found that a great deal

of time is wasted if the enclosures are formed by finishing the walls on one side, installing the walls on the pallet by fastening through the panel frame into the pallet, and then finishing the walls on the other side of the panel. In accordance with the present invention holes are formed in the pallets along the lines that will comprise the walls of the enclosures. This permits the walls to be completely finished and then secured to the pallets by means of lag screws which are inserted through the holes in the pallets from the bottom.

DESCRIPTION OF THE DRAWINGS

A more complete understanding of the invention may be had by referring to the following Detailed Description when taken in conjunction with the accompanying Drawings, wherein:

FIGS. 1–7 are illustrations of progressive steps in a method of fabricating dwelling units incorporating the invention;

FIGS. 8 and 9 are illustrations of presetressed concrete pallets utilized in the practice of the invention;

FIG. 10 is a view taken generally along the line 10—10 in FIG. 5 in the direction of the arrows;

FIGS. 11 and 12 are perspective and end views, respectively, showing a method of and apparatus for installing service cores which is utilized in the practice of the invention;

FIG. 12A is an end view of an alternative type of prestressed concrete pallet that can be utilized in the practice of the invention;

FIG. 13 is an elevational view of an apartment complex constructed in accordance with the invention;

FIG. 14 is a plan view of the apartment complex shown in FIG. 13;

FIGS. 15A–15C are an enlarged plan view of one of the apartments comprising the apartment complex shown in FIG. 13;

FIG. 16 is an enlarged plan view illustrating the service core of one of the apartment buildings shown in FIG. 14;

FIG. 17 is a sectional view taken generally along the line 17—17 in FIG. 16 in the direction of the arrows;

FIG. 18 is a sectional view taken generally along the line 18—18 in FIG. 16 in the direction of the arrows;

FIG. 19 is an enlargement of the upper portion of FIG. 18;

FIG. 20 is a sectional view taken generally along the line 20—20 in FIG. 16 in the direction of the arrows;

FIG. 21 is an illustration of special slots which are utilized in the practice of the invention to facilitate the installation of prestressed concrete pallets on previously erected load bearing walls;

FIG. 22 is a sectional view taken generally along the line 22—22 in FIG. 14 in the direction of the arrows;

FIG. 23 is an enlargement of a portion of FIG. 22;

FIG. 24 is a sectional view taken generally along the line 24—24 in FIG. 14 in the direction of the arrows;

FIG. 25 is an enlargement of a portion of FIG. 24;

FIG. 26 is a perspective view illustrating an apartment building comprising a second embodiment of the invention;

FIG. 27 is a plan view showing a floor plan for the apartment building shown in FIG. 26;

FIG. 28 is a plan view showing another floor plan for the apartment building shown in FIG. 26;

FIG. 29 is a plan view showing still another plan for the apartment building shown in FIG. 26;

FIG. 30 is a plan view illustrating an apartment building comprising a third embodiment of the invention;

FIG. 31 is a plan view illustrating an apartment building comprising a fourth embodiment of the invention;

FIG. 32 is an enlarged plan view of a portion of the apartment building shown in FIG. 31;

FIG. 33 is a perspective view of a town house complex comprising a fifth embodiment of the invention;

FIG. 34 is a plan view of the first floor of one of the units of the town house complex shown in FIG. 33;

FIG. 35 is a plan view of the second floor of one of the town house units comprising the town house complex shown in FIG. 33;

FIG. 36 is a perspective view of a cluster house comprising a sixth embodiment of the invention;

FIG. 37 is a plan view of the cluster house shown in FIG. 36;

FIG. 38 is a perspective view of a single family home comprising a seventh embodiment of the invention;

FIG. 39 is a plan view of the single family home shown in FIG. 38;

FIG. 40 is a perspective view of a vacation house comprising an eighth embodiment of the invention;

FIG. 41 is a plan view of the vacation house shown in FIG. 40;

FIG. 42 is a perspective view of a trailer house comprising a ninth embodiment of the invention;

FIG. 43 is a plan view of the trailer house shown in FIG. 42;

FIG. 44 is a perspective view of a motel comprising a tenth embodiment of the invention;

FIG. 45 is a plan view of one unit of the motel shown in FIG. 44;

FIG. 46 is a perspective view of a transportable service module comprising an eleventh embodiment of the invention;

FIG. 47 is a view taken generally along the lines 47—47 in FIG. 46 in the direction of the arrows;

FIG. 48 is a side view of the transportable service module shown in FIG. 46;

FIG. 49 is a sectional view taken generally along the lines 49—49 in FIG. 47 in the direction of the arrows;

FIG. 50 is a view taken generally along the lines 50—50 in FIG. 7 in the direction of the arrows and showing the service module following installation; and

FIG. 51 is a sectional view taken generally along the lines 51—51 in FIG. 49 in the direction of the arrows.

DETAILED DESCRIPTION

Method of Dwelling Construction

Referring now to the Drawings, and particularly to FIGS. 1–7 thereof, a method of dwelling construction incorporating the present invention is employed to construct an apartment building 48. As is best shown in FIG. 1, the first step in the method comprises the erection of a pair of load bearing wall panels 50 and 52. The wall panels 50 and 52 are both formed from prestressed concrete and are both nominally six inches thick. The wall panels 50 and 52 are further similar in that they are both provided with a plurality of slots or notches 54 formed in the upper ends and with a plurality of support members 56 which project inwardly from points adjacent their lower ends. The notches 54 are generally U-shaped, but comprise inwardly tapered side walls, and some of the notches 54′ in the wall 50 extend only part way through the wall so as to provide a flush outer surface. The supporting members 56 may comprise any

convenient construction, but preferably comprise pipe stubs cast into the panels **50** and **52** and extending inwardly therefrom. One difference between the wall panels **50** and **52** is that the wall panel **50** is provided with a door opening **58.**

Referring now to FIG. **2,** the next step in the method of dwelling construction comprises the installation of a service core **60.** The service core **60** comprises a prestressed concrete pallet **62** and an enclosure **64** formed on the pallet **62.** The service core **60** further comprises complete "mechanicals" for a dwelling unit, i.e., complete kitchen facilities, complete bathroom facilities, and complete temperature control facilities.

The prestressed concrete pallet **62** of the service core **60** is shown in FIG. **8.** The pallet **62** comprises a deck **66** and three beams **68** which depend from the deck **66.** Thus, the pallet **62** is of the type commonly known as a triple T deck. A plurality of tension members **70** extend through each beam **68** of the pallet **62** and serve to prestress the beams, whereby the beams **68** are adapted for support at spaced points indicated by the arrows **72** to support a load on the deck **66.** As is well known in the art, a prestressed concrete pallet of the type shown in FIG. **8** is subject to breakage unless it is properly supported.

The cross sectional configuration of the pallet **62** is show in FIG. **12.** Those skilled in the art will appreciate the fact that the invention may also be practiced using either solid core or hollow core prestressed concrete pallets **62'**partition of the type shown in FIG. **12A.** The pallet **62'** comprises a deck **66'** and a plurality of beams **68'** which depend from the deck **66'** between cylindrical passageways **69'.** A plurality of tension members **70'** extend through a lower portion **71'.** One difference between the pallet **62** and the pallet partition is that whereas the beams **68** of the pallet **62** are exposed, the bottom of the pallet **62'** is flat.

Referring again to FIG. **2,** the enclosure **64** of the service core **60** is formed on the deck **66** of the prestressed concrete pallet **62.** The enclosure **64** is preferably formed from materials of the type used in constructing conventional homes and similar buildings, i.e., two by four and two by six studs, drywall panels, and similar materials. The enclosure **64** includes interior partitions which separate the various mechanicals of the dwelling unit into kitchens, bathrooms, and the like, and further includes at least one end wall and a dropped or false ceiling **76.**

In accordance with the illustrated embodiment of the invention, the service core **60** is completely fabricated at a factory by means of mass production techniques. The fabrication of the core **60** comprises construction of the walls, partitions, and ceilings in suitable jigs and fixtures, installation of the walls, partitions, and ceilings, installation of all mechanicals, installation of electrical, plumbing, and heating/air conditioning risers for the mechanicals, installation of all doors and cabinetry, installation of floor and wall coverings, and painting. Thus, when the service core **60** is installed between the load bearing wall panels **50** and **52,** it is complete and ready for use. This feature of the invention is highly advantageous in that it not only reduces the cost of a dwelling by applying mass production techniques to the construction of the service core, but also reduces the time that is required to finish a dwelling following the beginning of construction at the dwelling site.

Upon completion of the manufacture of the service core **60** at the factory, it is transported to the site of the building **48** by truck. During such transportation, the service core **60** is supported solely at points corresponding to the support points of the beams. This is accomplished by means of members positioned under the support points of the beams to maintain the remainder of the pallet out of contact with the bed, etc. of the truck.

The service core **60** is installed by means of apparatus of the type shown in FIGS. **11** and **12.** A pair of picking bars **78** are positioned under the beams **68** of the pallet **62** at points corresponding to the support points of the beams. The picking bars **78** are engaged by a harness **80** comprising a plurality of cables **82** and a spreader frame **84** which functions to cause the cables **82** to extend vertically upwardly from the picking bars **78** to points above the enclosure **64** of the service core **60.** The cables **82** are connected to a beam **86** which is in turn supported by a cable **88** extending from a crane (not shown). By this means the crane functions through the harness **80** and the picking bars **78** to lift and position the service core **60.**

Referring again to FIG. **2,** the service core **60** is installed between the load bearing wall panels **50** and **52** with each beam **68** of the pallet **62** engaged with one of the support members **56.** It will be appreciated that due to manufacturing tolerances and in order to facilitate the installation of the core **60** between the wall panels **50** and **52,** the length of the pallet **62** is necessarily somewhat less than the distance between the interior surfaces of thewalls. The resulting gap is accommodated by positioning the deck **66** closely in engagement with the wall panel **50,** whereupon a suitable entry in the enclosure **64** is aligned with the door opening **58** in the wall panel **50.** This forms a small gap between the deck **66** and the wall panel **52.** However, an end wall is provided at the end of the enclosure **64** remote from the door opening **58,** whereby the gap is not visible from within the service core **60.**

The next step in the method of dwelling construction comprises the installation of a pair of blank prestressed concrete pallets **90** between the load bearing wall panels **50** and **52.** The pallets **90** are handled by means of cables **92** which are connected to eyes **93** in the pallets. The same procedure could be employed in handling service cores except that the enclosures of the service cores prevent access to the eyes of the pallets. Thus, the service cores must be handled by means of picking bars.

The blank pallets **90** are identical to the pallet **62** of the service core **60** in that they each comprise a deck, three beams depending from the deck, and tension members extending through the beams for prestressing the pallets. The pallets **90** are positioned between the wall panels **50** and **52** with their respective beams engaged with the support members **56** of the walls. The decks of the pallets **90** are therefore aligned with the decks **66** of the pallet **62,** whereby the pallets **90** cooperate with the pallet **62** to form the floor of a dwelling unit.

As is best shown in FIG. **4,** the installation of the pallets **90** is followed by the installation of a pair of shear wall panels **94** and **96.** The wall panels **94** and **96** are formed from prestressed concrete, but differ from the load bearing wall panels **50** and **52** in that they are nominally four inches thick. The shear wall panels in-

clude window openings **98** and a door opening **100** and serve the dual functions of enclosing the ends of the dwelling unit and maintaining the load bearing walls erect.

The shear wall panels **94** and **96** are preferably connected to the load bearing wall panels **50** and **52** by forming welds between suitable members which either comprise part of or are connected to the reinforcing structure of the wall panels. The load bearing wall panels and the shear wall panels may also be joined by other techniques of the type commonly employed in the construction industry to connect prestressed concrete structural members. The various prestressed concrete pallets which are employed in the practice of the invention may be connected to the load bearing wall panels by similar techniques, however, it has been found that it is often unnecessary to connect the pallets to the load bearing wall panels in any fashion.

Upon the installation of the shear wall panels **94** and **96**, the lowermost apartment of the apartment building **48** is structurally complete. Thereafter, a service core **102** for a second dwelling unit is mounted on the load bearing wall panels **50** and **52**. As is shown in FIG. **5**, the service core **102** comprises a prestressed concrete pallet **104** and an enclosure **106** formed on the pallet **104**. The service core **102** further comprises complete mechanicals for the second apartment.

The pallet **104** of the service core **102** is illustrated in FIG. **9**. The pallet **104** is similar to the pallet **62** in that it comprises a deck **108** and three beams **110** which depend from the deck. A plurality of tension members **112** extend through the beams **110** to prestress the beams and thereby adapt the beams for support at spaced points indicated by the arrows **114** to support a load on the deck **108**.

The pallet **104** also differs from the pallet **62** in several important respects. First, the deck **108** is discontinued at spaced points **116** corresponding to the positioning of the load bearing wall panels **50** and **52**. Second, the deck **108** and the beams **110** extend beyond one of the support points **114** to form a cantilever portion **118** of the pallet **108**. At least some of the tension members **112** extend through plastic tubes **120** or are otherwise disengaged from the material of the beams **110** in the cantilever portion **118**. This is necessary in order that the portion **118** can be supported in cantilever fashion.

The installation of the service core **102** is illustrated in FIG. **10**. The picking bars **78** of the lifting and positioning apparatus shown in FIGS. **11** and **12** are engaged with the beams **110** of the pallet **104** at points adjacent the support points **114**. At the end of the pallet **104** comprising the cantilever portion **118**, a picking bar **78** may be positioned at a point located outside the positioning of the load bearing wall panel **50**. Therefore, no problem is encountered in removing the picking bar after the service core **102** is installed. On the other hand, at the opposite end of the core **102**, a picking bar **78** must be engaged with the core **102** at a point located within the positioning of the load bearing wall panel **52**. To this end the service core **60** is provided with a picking bar slot **122**.

The picking bar slot **122** comprises a reinforced portion of the false ceiling **76** of the core **60** which is purposely constructed to have sufficient strength to support the picking bar after it is disengaged from the harness **80**. By way of example, picking bars suitable for use in the practice of the present invention typically weigh approximately 400 pounds. In such a case the picking bar slot **122** is preferably formed from two by twelves and two by sixes so as to have sufficient strength to support the picking bar.

Referring again to FIG. **5**, the enclosure **106** of the service core **102** is similar to, and may in fact be identical to, the enclosure **64** of the service core **60**. The enclosure **106** includes a dropped or false ceiling **124** including a picking bar slot **126** and also includes an end wall which is situated at the end of the enclosure **106** remote from the cantilever portion **118** of the prestressed concrete pallet **104**. Like the enclosure **64**, the enclosure **106** is preferably completely fabricated by mass production techniques prior to the installation of the service core **102**.

The service core **102** is installed on the load bearing wall panels **50** and **52** with each beam **110** of the pallet **104** engaged with one of the notches **54** of the load bearing wall panels. As has been indicated, the deck **108** of the pallet **104** is discontinued at points corresponding to the positioning of the load bearing wall panels. This permits the positioning of the upper surface of the deck **108** of the pallet **104** either in alignment with, above or below the upper surfaces of the load bearing wall panels **50** and **52**, as desired.

Those skilled in the art will appreciate the fact that due to the nature of prestressed concrete pallets, the service core must be supported at points corresonding to the positioning of the load bearing wall panels **50** and **52**. However, notwithstanding this requirement, it has been found that the service core **60** may be provided with members extending into engagement with the pallet **104** of the service core **102**. These members do not support the pallet in the true sense, but merely limit and control deflections of the pallet due to varying live loads thereon.

Following the installation of the service core **102**, a pair of blank prestressed concrete pallets **128** are mounted on the load bearing wall panels **50** and **52**. The pallets **128** are similar to the pallet **104** of the service core **102** in that they each comprise a deck, three beams depending from the deck, and tension members extending through the beams to prestress the pallet. Also, the decks of the pallets **128** are discontinued at points corresponding to the positioning of the load bearing wall panels. The pallets **128** are mounted on the load bearing wall panels with each beam of the pallet engaged with one of the notches **54** or **54'** of the load bearing wall panels.

Referring now to FIG. **6**, the next step in the method of dwelling construction comprises the positioning of a second set of load bearing wall panels **132** and **134** on the load bearing wall panels **50** and **52**. The wall panels **132** and **134** are similar to the wall panels **50** and **52** in that they are constructed from prestressed concrete and in that they are nominally 6 inches thick. Also, the wall panels **130** and **132** are provided with notches **136** and **136'** in their upper edges which are identical to the notches **54** and **54'**, and the wall panel **132** is provided with a door opening **138** which is similar to the door opening **58** in the load bearing wall panel **50**.

Following the installation of the load bearing wall panels **132** and **134**, a pair of shear wall panels **140** and **142** are mounted on the shear wall panels **90** and **96**, respectively. The wall panels **140** and **142** are formed from prestressed concrete and are nominally 4 inches

thick. A plurality of window openings **144** and a door opening **146** are formed in the walls **140** and **142** at points corresponding to the window openings **98** and the door openings **100** of the shear wall panels **94** and **96.** The shear wall panels **140** and **142** function to enclose the ends of the second apartment of the apartment building **48** and to maintain the load bearing wall panels **132** and **134** erect.

Upon completion of the foregoing steps, the second apartment of the apartment **48** is structurally completed. Thereafter the steps are repeated to form additional apartments. It will be understood that the additional apartments are positioned directly above the previously formed apartments and thereby function to increase the height of the apartment building **48.** When all of the apartments comprising the apartment building **48** have been constructed, prestressed concrete pallets similar to the pallets **90** are positioned on the uppermost load bearing wall panels to form the roof of the apartment building. At this point the apartment building **48** is complete insofar as its structural components are concerned.

After the roof of the apartment building **48** has been installed, the interiors of the various apartments comprising the apartment building are finished. This involves filling the gaps between the wall panels and the pallets and between the wall panels per se with grouting, forming connections between the electrical, plumbing, and heating/air conditioning risers of the service cores of the apartments, constructing interior partitions to define bedrooms, closets, and the like, installing electrical wiring, including telephone and television wiring, installing doors and windows in the door and window openings of the wall panels, and the like. The interiors of the apartments are also finished. This involves installing carpeting, painting the interior surfaces of the load bearing wall panels, installing thermal insulation and paneling on the interior surfaces of the shear wall panels, and spraying the under surfaces of the pallets which do not comprise service cores with an asbestos material. The latter procedure has been found to be highly advantageous in that it provides the interiors of the apartments with a "beamed" ceiling effect which is highly pleasing in appearance, in that it provides sound deadening qualities, and in that it provides increased fire protection for the apartments. Upon completion of the finishing of the interiors of the apartments, the apartment building **48** is ready for occupancy. In actual practice it has been found that when the present invention is utilized, a three story apartment building can be completed and ready for occupancy within a few weeks following the start of construction. This extremely short completion time is made possible because the service cores of the dwelling units of the apartment building are completely fabricated before construction at the dwelling site is commenced.

Referring now to FIG. **7,** there is shown a completed three story apartment building **148** constructed in accordance with the present invention. The building **148** includes a load bearing wall **150** which does not have pallet portions extending cantilever from it. In many building projects utilizing the present invention, such a wall will be a "double loaded" wall in that prestressed concrete pallets will be supported from both sides of the wall.

It is preferable that one apartment building such as the apartment building **148** be completed at least to the extent that the roof is installed prior to starting an adjacent apartment building. This is to facilitate the complete enclosure of the first apartment building and thereby eliminate any possibility of damage to the interior of the building due to weather. Then, after the first apartment building has been completed, the construction of the next adjacent apartment building is commenced.

The construction of the adjacent apartment building involves the erection of a load bearing wall **152** in spaced relation to the load bearing wall **150** of the first apartment building and then supporting prestressed concrete pallets between the load bearing walls **150** and **152.** As has been described previously, at least one prestressed concrete pallet of each dwelling unit of the second apartment building will have a service core formed on it. In the typical apartment building, each dwelling unit will also include blank prestressed concrete pallets.

The only substantial difference between the construction of the first apartment building and the construction of the second apartment building is due to the fact that one of the load bearing walls of the second apartment building has previously been completed to its entire height. This causes the positioning of the beams of prestressed concrete pallets in the notches of the double loaded load bearing wall to be somwhat more involved than is the case when the adjacent load bearing wall panes have not been installed prior to the installation of the pallets. To this end, notches **154** are preferably formed at the lower edges of each panel of the double loaded load bearing wall to facilitate the installation of the beams of prestressed concrete pallets in the notches formed in the upper ends of the next adjacent panel of the load bearing wall.

The notches **154** are best shown in FIG. **22.** Each notch **154** comprises an inwardly tapered portion formed in an upper load bearing wall panel **156** at a point aligned with a U-shaped notch **158** formed in load bearing wall panel **160** positioned just below the panel **156.** The notches **154** are equal in width to the notches **158,** whereby the positioning of the beams of prestressed concrete pallets in the notches **158** is facilitated.

FIRST EMBODIMENT

Referring now to FIG. **13,** a garden apartment complex **200** constructed in accordance with the present invention is shown. The complex **200** comprises a pair of three story garden apartment buildings **202** and **204** and a pair of two story garden apartment buildings **206** and **208.** The lowermost apartments of the apartment buildings comprising the complex **200** are provided with patios **210** and the upper apartments are provided with balconies **212.** The apartments in the three story apartment buildings **202** and **204** are provided with fireplaces **214.** "Double loaded" entry ways **216** are utilized in the complex **200.** These comprise cantilever portions **218** of prestressed concrete pallets utilized in the three story apartment buildings **202** and **204.**

A typical floor of the apartment complex **200** is shown in FIG. **14,** it being understood that the various floor plans illustrated in the Drawings are representative only and that none of the specific floor plans shown comprises part of the present invention. Each floor of

each apartment building in the apartment complex 200 comprises three prestressed concrete pallets 220 including a center pallet 220' having a service core formed on it. The pallets 220 comprising the apartment buildings 202 through 208 are supported on load bearing walls 222 and are enclosed by shear walls 224. It will be noted that the pallets 220 comprising the apartment buildings 206 and 208 are partially supported by a double loaded load bearing wall 222'. As has been indicated, the double loaded entry ways 216 comprise cantilever portions 218 which extend inwardly from the service core pallets of the apartment buildings 202 and 204.

The apartment building 202 comprises apartments 230 each including an entry 232 comprising part of the service core and extending to one of the double loaded entry ways 216. The entry 232 of each apartment 230 interconnects a living room 234 and a hallway 236 which extends to a den 238 and a bedroom 240. The service core further includes a bathroom 242 and a kitchen 244, and is completed by an enclosure 246 for the heating/air conditioning facilities of the apartment, a closet 248 in the entry 232, and a closet 250 in the hall 236. A partition 252 extends between the den 238 and the bedroom 240 to define a pair of closets 254 and 256.

The apartment buildings 204 and 206 comprise apartments 260 which are somewhat larger than the apartments 230 of the building 202. Each apartment 260 includes an entry 262 which extends to one of the double loaded entry ways 216. The entry 262 interconnects a living room 264 and a hall 266 which extends to a pair of bedrooms 268 and 270. The service core of each apartment 260 includes the entry 262, two bathrooms 272 and 274, a kitchen 276, a plurality of closets 278, and an enclosure 280 which houses the heating/air conditioning apparatus for the dwelling unit 260. The bedrooms 268 and 270 are separated by a pair of closets 282 and 284.

Each floor of the apartment building 208 comprises two relatively small apartments 290. The apartments 290 each comprise an entry 292 which extends to one of the double loaded entry ways 216 and which is provided with a closet 294. The entry 292 extends to a living room 296 which in turn extends to a bedroom 298. The living room 296 and the bedroom 298 are separated by a partition 300 defining a closet 302. Each apartment 290 of the apartment building 208 is completed by a bathroom 304, a kitchen 306 and enclosures 308 for heating/air conditioning equipment, all of which are mounted on the service core.

The apartment building 208 differs significantly from the buildings 202, 204, and 206 in that each floor of the building 208 comprises a double loaded service core including complete and separate mechanicals for two dwelling units. This comprises a highly important feature of the present invention in that it facilitates the construction of relatively small dwelling units on a very efficient and economical basis. One important aspect of the double loaded service core concept is that since each service core is common to two dwelling units, it is necessary to establish a fire barrier having at least a one hour rating between the portion of the core common to one dwelling unit and the portion of the core common to the other dwelling unit.

The various features of the dwelling units 230 of the apartment building 202 are shown in greater detail in FIGS. 15A, 15B, and 15C. The service core of the dwelling unit 230 comprises walls and partitions 320 which are formed from materials of the type commonly employed in the construction of conventional houses and similar buildings, i.e., two by four and two by six studs 322, dry wall panels 324, and the like. The walls 320 enclose telephone, television, electrical and plumbing risers 326, and additional risers extend through the enclosure 246. Access panels 328 and 330 are provided to permit interconnecting the electrical, plumbing, and heating/air conditioning facilities of adjacent dwelling units 230 in the apartment building 202. The various closets and rooms of the dwelling unit 230 are provided with hollow core doors 332 of the type commonly employed in houses, apartment buildings, and the like.

The bathroom 242 of each apartment comprises a dressing table 334 including a sink 336, a toilet 338, and a bathtub 340. The kitchen 244 is similarly completely equipped in that it comprises a refrigerator 342, a stove 344, a sink 346 and a dishwasher 348. Full cabinet facilities 350 are also provided in the kitchen 244.

One of the most important aspects of the present invention comprises a system for providing electrical outlets at convenient points around the periphery of each of the rooms of an apartment. Each load bearing wall 222 is equipped with electrical conduits 352 which are formed in the wall when it is cast. The conduits 352 comprise inlets 354 formed at points aligned with and positioned above the false ceiling of a service core. the conduits 352 further comprise various outlets 356 including outlets 356'. The outlets 356' of each conduit 352 are positioned at the outer ends of the load bearing wall 252.

When each apartment is finished additional conduits 358 are connected to the conduits 352 at the outlets 356'. The conduits 358 are secured to the inner surfaces of the shear walls 224 and extend to outlets 360 positioned at convenient points along the shear walls. During subsequent finishing the inner surfaces of the shear walls 224 are covered wth paneling sections 362 so that both the conduits 352 and 358 are completely hidden from view in the finished dwelling unit. The conduits 358 may include portions 364 extending through the interior partitions of the apartment to suitable outlets 366, if desired.

It will be understood that although the system for providing convenient electrical outlets in apartments constructed according to the present invention has been illustrated in conjunction with an apartment 230 of the apartment building 202, the same system is utilized in the apartments comprising the apartment buildings 204, 206 and 208. Of course, the routing of the various electrical conduits and the positioning of the various outlets will vary in accordance with particular requirements. However, in each instance the load bearing walls are equipped with suitable conduits, including inlets that will ultimately be aligned with a service core during manufacture and the conduits of the load bearing walls are connected to conduits secured to the interior surfaces of the shear walls during finishing.

Referring now to FIG. 16, the double loaded service core which is employed in the apartments of the apartment building 208 is shown in greater detail. The double loaded core comprises walls and partitions 370 formed from wooden studs and drywall panels. The walls 370 enclose electrical and plumbing risers 372.

Additional risers extend through the enclosures **308.** Access panels **374, 376,** and **378** are provided for facilitating the interconnection of the electrical, plumbing, and heating/air conditioning facilities of adjacent apartments.

The bathrooms **304** of the apartments **290** each comprise a dressing table **380** equipped with a sink **382,** a toilet **384** and a bathtub **386.** The kitchens **306** of the apartments **290** are similarly fully equipped. Thus, each kitchen **306** comprises a stove **388,** a sink **390,** and a refrigerator **392.** Each kitchen **306** is further provided with a pass through **394** which is situated at counter height.

As will be appreciated by those skilled in the art, one problem that is encountered in the construction of multi-family dwelling units comprises fire protection. The building codes of most cities and other jurisdictions require a fire barrier having at least a one hour rating between adjacent dwelling units of a multi-family building. The present invention comprises various systems for providing such a fire barrier while at the same time adapting dwelling unit construction to mass production techniques. Many of these systems are illustrated in conjunction with FIG. **16** and the sectional views taken therefrom.

When a service core for a dwelling unit comprising the present invention is installed, the end of the service core comprising the entry is positioned as close as possible to the adjacent load bearing wall. This results in a very small gap **400** at the entry end of the service core. The gap **400** is easily filled with grouting to provide the necessary fire barrier. On the other hand, the positioning of the entry end of the service core as close as possible to the adjacent load bearing wall results in a relatively large gap **402** at the opposite end of the service core. Since the end of the core remote from the entry is normally equipped with an end wall **404,** access to the relatively large gap **402** is not readily available.

Referring now to FIg. **17,** a system for providing a fire barrier having at least a one hour rating in the gap **402** is shown. A sheet metal lip **406** is secured between the end wall **404** and its supporting deck **408.** When the service core including the deck **408** and the wall **404** is installed, the lip **406** is extended over the upper edge of the load bearing wall section **410** which supports the service core. Thereafter, when the next load bearing wall section **412** is mounted on the load bearing wall section **410,** the lip **406** is trapped between the bottom of the wall section **412** and the top of the wall section **410.** By this means the lip **406** forms a fire barrier across the gap **402.**

Since each service core of the apartment building **208** serves two dwelling units, it is necessary to form a fire barrier between the portions of each service core individual to one dwelling unit and the portion of each core individual to the other dwelling unit. As is best shown in FIG. **16,** each service core of the apartment building **208** comprises a wall **414** comprising at least two layers of five-eighths inch drywall sheets. The wall **414** extends the entire length of the service core and forms the majority of the fire barrier between the opposed portions of the service core.

Referring now to FIGS. **18** and **19,** the upper end of the wall **414** comprises a pair of opposed flanges **416** formed from sheet metal. The flanges **416** are positioned to receive a beam **418** comprising a portion of a prestressed concrete pallet **420** which is installed above the service core. By this means the flange **416** and the beam **418** cooperate to complete the upper portion of the fire barrier between the opposed portions of the service core.

As has been indicated, the service cores of dwelling units comprising the present invention are installed with the entry end positioned as close as possible to the adjacent load bearing wall. In the case of double loaded cores, this practice results in a gap between the end of the wall **414** remote from the entry and the load bearing wall adjacent thereto. To this end, the wall **414** is equipped with a stub wall **422** which is formed from sheets of five-eighths inch drywall or some other fire retardant material.

The stub wall **442** is slidably supported in the wall **414** and is retracted during the installation of the service core. Following installation of the service core and the adjacent load bearing walls, the stub wall **422** is moved outwardly and into engagement with the adjacent load bearing wall. By this means the fire barrier provided by the wall **414** is extended across the entire distance between the load bearing walls which enclose the service core.

It will be appreciated that notwithstanding the use of the flanges **416** and the stub wall **422,** it is possible that small gaps may remain in the fire barrier between the opposed portions of the service core following the installation of the adjacent load bearing walls, the positioning of the stub wall **422** and the mounting of a prestressed concrete pallet above the service core. In such a case, pieces of five-eighths inch drywall are employed to close any such gaps. Access to such gaps for use in installing the drywall pieces is gained through the access panels **374, 376,** and **378** of the service core.

Referring now to FIG. **20,** several important features of the present invention are shown. As will be appreciated from the foregoing, the prestressed concrete pallets which are utilized in the practice of the invention are supported entirely by prestressed concrete load bearing walls. That is, the enclosures of the service cores which are utilized in the practice of the invention to house the mechanicals of one or more dwelling units are not used in any way as structural or supporting members. This fact is clearly illustrated in FIG. **20** wherein portions of a lower service core **430** and an upper service core **432** which is supported on a prestressed concrete pallet **434** are shown. The service core **430** includes an outer wall **436** which extends above a false ceiling **438.** The wall **436** does not, however, engage the pallet **434.** Quite to the contrary, a gap **440** is purposely maintained between the upper end of the wall **436** and the pallet **434.**

Nothwithstanding the high strength of prestressed concrete pallets, it has been found that such pallets exhibit certain flexibility. This is especially noticeable when a large number of persons is supported on a particular pallet. As has been indicated it has been determined that members may be extended between pallets to limit this flexure. However, it cannot be completely eliminated. The gap **440** is therefore provided in order to permit the prestressed concrete pallet **434** to flex downwardly without damaging the wall **436.**

It will be appreciated that the gap **440** would be objectionable if it could be observed from within the dwelling unit incorporating the service core **430.** To this end a strip **442** is secured to the underside of the pallet **434** and extends downwardly beyond the upper

end of the wall 436. The strip 442 thus cooperates with the wall 436 to form a slip joint between the underside of the pallet 434 and the upper end of the enclosure of the service core 430. Such a slip joint hides the gap 440 and yet permits movement of the pallet 434 relative to the core 430.

In the practice of the present invention the various walls and partitions of the service cores are assembled in suitable jigs and fixtures. It has been determined that considerable time and expense can be saved if the walls and partitions are completely finished on both sides while they are in the jigs and fixtures. However, such practice would appear to be negated since it would then be impossible to secure the walls and partitions to the deck of a prestressed concrete pallet.

This difficulty can be overcome by boring holes 444 through the deck of a prestressed concrete pallet along lines that will comprise the walls and partitions of a service core. The walls and partitions are then completed on both sides in suitable jigs and fixtures. The completed walls and partitions are positioned at their proper places on the pallet and are secured to the pallet by lag screws 446 which are inserted through the holes 444 and threadedly engaged with the walls and partitions. This technique has been found to be highly satisfactory in that it permits complete finishing of the walls and partitions on both sides and yet provides means for rigidly securing the completed walls and partitions to the decks of prestressed concrete pallets.

As has been indicated, the pallets that are utilized in the practice of the present invention are apt to flex subjected to varying live loads. On the other hand, the walls and partitions of the enclosures of the service cores are relatively inflexible, at least insofar as bending with the pallets is concerned. To this end the connections between the pallets and the walls are preferably rendered somewhat resilient, for example by mounting springs, such as the Belleville washers 448 shown in FIG. 20, at suitable locations to accommodate relative flexure between the walls and the pallets.

Various additional details of the apartment complex 200 are illustrated in FIGS. 22–25. Referring first to FIG. 22, the various apartment buildings comprising the complex 200 are provided with roofs 450 which are formed on prestressed concrete pallets, but which are otherwise finished by conventional techniques to prevent moisture from entering the apartments of the complex. As is best shown in FIG. 23, the cantilever portions 218 comprising the double loaded entry ways 216 extend adjacent to but do not engage the load bearing walls comprising the next adjacent apartment buildings. As has been indicated, the decks of the prestressed concrete pallets are normally discontinued at points corresponding to the positioning of the load bearing walls. The decks, may, however, be extended at points corresponding to the door openings to provide a suitable door sill 452.

Referring now to FIGS. 24 and 25, the structural details of the dwelling units at the shear walls 224 are shown. Sections of thermal insulation 454 are mounted on the inner surfaces of the shear walls 224 and are covered by the paneling sections 362. As has been indicated, the conduits 368 also extend behind the paneling sections 362 and are therefore fully hidden from view. FIG. 25 further illustrates the use of carpeting 456 and a sprayed asbestos coating 458 on the upper and lower surfaces of blank prestressed concrete pallets.

ALTERNATIVE EMBODIMENTS

Referring now to FIGS. 26–29, a low rise apartment complex 500 comprising a second embodiment of the invention is shown. The apartment complex 500 is similar to the apartment complex 200 in that it utilizes prestressed concrete load bearing walls 502 which support prestressed concrete pallets 504. Also, at least one pallet of each dwelling unit comprising the complex 500 comprises a service core.

One difference between the complex 500 and the complex 200 is that the load bearing walls 502 of the complex 500 are maintained erect by end columns 506, rather than by shear walls. Another difference is that door openings for the apartments of the complex 500 are not formed in the load bearing walls, but rather in walls extending perpendicular to the load bearing walls. This causes the entry corridors for the apartments to extends parallel to the major dimensions of the prestressed concrete pallets 504 as opposed to perpendicular to the major dimension of the pallets as is the case in the complex 200.

Referring now to FIG. 27, there is shown a floor plan of a typical dwelling unit 508 of the low rise apartment complex 500. The dwelling unit 508 includes an entry 510 which extends to a service core including a kitchen 512 and a bathroom 514. The pallet 504 of the dwelling unit 508 including the kitchen and bathroom also comprises a bedroom 516 and a hallway 518. The next adjacent pallet 504 comprises a living room 520, and the third pallet of the dwelling unit 508 comprises a balcony 522 which is accessible from the living room 520. It should be noted that the third pallet is supported by adjacent end columns 506.

A dwelling unit 524 of the complex 500 comprising an alternative room arrangement is shown in FIG. 28. The dwelling unit 524 includes an entry 526 which opens to a living room 528 that extends across both pallets 504 comprisng the dwelling unit 524. One of the pallets 504 comprises a service core and includes a kitchen 530 and a bathroom 532. The other pallet 504 includes a bedroom 534 in addition to part of the living room.

A dwelling unit 536 comprising still another arrangement for the complex 500 is shown in FIG. 29. The dwelling unit 536 comprising an additional pallet and is arranged somewhat similarly to the dwelling units of the apartment complex 200. Thus, the dwelling unit 536 includes an entry 538 which extends to a living room 540. The central pallet 504 of the dwelling unit 536 comprises the service core and includes a first bathroom 542, a kitchen 544, a second bathroom 546, and an L-shaped hall 548. The third pallet 504 of the dwelling unit 536 comprises first and second bedrooms 550 and 552.

The parallel type core arrangements as exemplified by the dwelling units comprising the low rise apartment complex 500 is advantageous in that dwelling units can be made as long as desired. On the other hand, the perpendicular dwelling unit arrangement as exemplified by the apartment complex 200 is advantageous in that the dwelling units can be as wide as desired. It will be appreciated that either of these arrangements may be advantageous in a particular instance, and that the two arrangements can be combined in a single apartment complex, if desired.

Referring now to FIG. 30, there is shown an apartment building 560 comprising load bearing walls 562, shear walls 564, and prestressed concrete pallets 566 which are supported between the load bearing walls 562. As has been indicated, one of the principle functions of the shear walls 564 is to maintain the load bearing walls 562 erect.

The apartment building 560 comprises numerous individual apartments, including an apartment 568, an apartment 570 which is the mirror image of the apartment 568, and a somewhat smaller apartment 572. Each apartment in the apartment building 560 comprises a living/dining room 574, a kitchen 576, two bathrooms 578, and 580, a den 582, and a bedroom 584. Each apartment further comprises a plurality of closets 586 and a portion of a balcony 588. The principal difference between the apartments 568 and 570 and the apartment 572 is that the living/dining rooms 574 of the apartments 568 and 570 include an el 590 and are therefore somewhat larger than the living room 574 in the apartment 572.

It should be noted that the kitchen 576, the bathroom 578 and the bathroom 580 of each apartment of the apartment building 568 are formed on a single prestressed concrete pallet 566. This pallet thus comprises a service core and is preferably completely fabricated at a factory by mass production techniques. The various walls and partitions which are installed on the remaining pallets 576 to define the rooms and closets of the apartment may be installed at a factory or at the building site, as desired.

One of the most interesting aspects of the apartment building 560 involves the fact that various rooms of the apartment in the building extend across the boundary between adjacent prestressed concrete pallets 566. Also, the various pallets 566 used in constructing the building 560 are not equal in width. These two characteristics of the embodiment shown in FIG. 30 combine to permit great flexibility in the use of the present invention and serve to demonstrate the fact that the constraints that have heretofore been characteristic of modular dwellings are not encountered in the use of the present invention. However, it should be noted that when rooms extend across pallet boundaries it may be necessary to use grouting in order to provide a level floor.

FIGS. 31 and 32 illustrate a high rise apartment building 600 constructed in accordance with the present invention. Referring first to FIG. 31, the high rise apartment building 600 comprises elevators 602, a central area 604 which may include a lobby off the elevators 602, laundry facilities, and the like, hallways 606 extending off the central area 604, and end units 608 which may include stairwells and risers for electrical, plumbing and heating/air conditioning facilities. The apartment building 600 further includes a plurality of apartments each accessible from one of the hallways 606.

Referring now to FIG. 32, there is shown a two bedroom apartment 610 and an effeciency apartment 612 of the high rise apartment building 600. The two bedroom apartment 610 includes a living room 614, a kitchen 616, a bathroom 618, a small bedroom 620, a large bedroom 622, and a plurality of closets 624. The apartment 612 includes a living/bedroom 626, a dressing room 628, a bathroom 630, a kitchen 632, and numerous closets 634.

FIG. 32 also illustrates the construction of the apartment building 600 which comprises prestressed concrete pallets 636 that are supported between load bearing walls 638. The entire kitchen and bathroom facilities for each apartment of the apartment building 600 are formed on a single pallet 636. This pallet thus comprises a service core which is preferably completely fabricated at a factory by assembly line techniques. It is noted that the various apartments comprising the apartment building 600 include only a minimum number of partitions, etc., which are not situated on the same pallet as the kitchen and bathroom facilities. These partitions are therefore readily installed at the building site.

One of the most interesting features of the apartment building 600 relates to the use of prestressed concrete pallets 636 which are unequal in length. Another important aspect of the design relates to the fact that the bedroom 622 of the apartment 610 is situated on the same pallet as the bathroom 630 and the kitchen 632 of the apartment 612. This further demonstrates the flexibility of design that is possible in the practice of the present invention.

Perhaps the most important feature of the embodiment of the invention illustrated in FIGS. 31 and 32 comprises the fact that shear walls are not relied upon to maintain the load bearing walls 638 erect. Rather, the load bearing walls 638 include perpendicularly extending portions 640 which serve the function normally served by the shear walls. This is believed to demonstrate very vividly the fact the the use of the shear walls is not essential to the practice of the invention and that shear walls can be dispensed with entirely in particular instances.

Referring now to FIGS. 33, 34, and 35, there is shown a town house complex 650 incorporating the present invention. The town house complex 650 includes a plurality of town house units 652 which are arranged in pairs. Adjacent pairs of town house units face in opposite directions so as to afford maximum privacy.

The lower and upper floors of the typical town house unit 652 of the complex 650 are shown in FIGS. 34 and 35, respectively. The lower floor includes an entry 654 including a closet 656, a living/dining room 658 including a closet 660, and a kitchen 662 including a rear door 664. A stairway 666 extends to the upper floor which comprises a bathroom 668, a small bedroom 670 including a closet 672, and a large bedroom 674 including a closet 676. The large bedroom 674 extends to a balcony 678 which overhangs the entry 654 of the lower floor to provide a sheltered entry for the unit 652.

The various components of both floors of the town house units 652 are formed on prestressed concrete pallets and are preferably completely fabricated at a factory by production line techniques. At the construction site the pallets are supported by load bearing walls situated at the opposite ends of the town house units. The offset positioning of the units in the town house complex 650 eliminates the need for the use of shear walls as such. It will be appreciated that the balconies 678 of the upper floors of the town house units comprise cantilever portions of the prestressed concrete pallets comprising the upper floors.

One important aspect of the town house units 652 comprises the stairways 666 which extend through the prestressed concrete pallets forming the upper floors of

the town house units. The positioning of the stairways 666 is not critical in that the decks of prestressed concrete pallets of the type utilized in the practice of the present invention may be interrupted at any particular point to suit particular needs. The only limiting factor in the positioning of the stairways 666 comprises the necessity of positioning the stairway between the beams of the prestressed concrete pallets.

FIGS. 36 and 37 illustrate a cluster house 690 incorporating the present invention. The cluster house 690 includes a two story central portion 692 constructed somewhat similarly to the town house units shown in FIGS. 33-35 and a pair of single story end units 694. It is contemplated that cluster house units incorporating the invention could be constructed in groups as is the case with most cluster house building projects which are undertaken at the present time.

The single story units 694 of the cluster house 690 each comprise load bearing walls 696 which support prestressed concrete pallets 698. Each cluster house includes an entry 700 which extends to a living room 702 and a hall 704. A bathroom 706 and a kitchen 708 are situated on the same pallets 698 as the entry 700 and the hall 704 and thus comprise a service core. Each unit 694 further includes a pair of bedrooms 710 and 712 and a plurality of closets 714.

The two story units 692 of the cluster house 690 comprise upper and lower prestressed concrete pallets 716 which are supported by load bearing walls 718. At least one of the walls 718 extends between the load bearing walls 696 of the single story units 694. For this reason, the use of shear walls to maintain the load bearing walls 718 erect is not necessary. The lay out of the upper floor of the two story unit 792 is substantially identical to the lay out of the upper floor of the town house unit 652 described hereinbefore in conjunction with FIGS. 33–35.

Referring now to FIG. 38, there is shown a single family house 730 comprising a seventh embodiment of the present invention. A typical arrangement for the single family house 730 is shown in FIG. 39 and comprises an entry 732 which extends to a living room 734 and a hall 736. A den 738 and a bedroom 740 are provided at the opposite ends of the house 730 from the living room 734. The house further includes a bathroom 742, a kitchen 744, and a plurality of closets 746.

The various facilities of the house 730 are formed on three prestressed concrete pallets 748. The central pallet 748 comprises a service core in that it includes complete mechanicals for the house. At least the service core of the house is preferably completely fabricated and then transported to the building site. The partitions of the left end (FIG. 39) pallet which defines the den 738 and the bedroom 740 may also be fabricated at a factory and then transported to the building site, if desired.

The pallets 748 of the house 730 are enclosed by walls 750 and a roof 752. The walls 750 and the roof 752 may be supported on the pallets 748, in which case the entire house is shipped to the building site by truck and the only on site labor that is necessary is joining the portions of the walls and the roof that are mounted on the several pallets. On the other hand, since the house 730 is a single story structure, it is equally feasible to support the pallets 748 on suitable pilings and then construct the walls 750 from conventional building materials, such as wooden studs and conventional exterior and interior panels of the type commonly employed in forming exterior and interior walls in conventional houses, and the like.

Referring now to FIGS. 40 and 41, there is shown a vacation house 760 constructed in accordance with the present invention. The vacation house 760 is formed on a single prestressed pallet 762 and comprises a living/dining room 764 including a kitchen area 766, a bathroom 768, two bedrooms 770 and 722 and various closets 774. The house 760 is enclosed by a wall 776 and a roof 778. The walls 776 are preferably formed on the same pallet as the remaining components of the house and serve to support the roof 778. This permits complete fabrication of the vacation house 760 in a factory by mass production techniques. Following manufacture of the house, it is transported to a dwelling site intact whereupon it is positioned on a suitable foundation and is immediately ready for use. By this means the labor required at the building site is reduced to an absolute minimum.

FIGS. 42 and 43 illustrate a trailer house 790 comprising a ninth embodiment of the invention. The trailer house 790 is similar to the vacation house 760 in that it comprises a single prestressed concrete pallet 792 which supports four walls 794. The walls 794 in turn support a roof 796.

The interior of the trailer house 790 comprises a living/dining room 798 including a kitchen area 800, a small bedroom 802, a large bedroom 804, and a bathroom 806. Various closets 808 are also provided at convenient locations within the trailer house 790. Of course, as is the case with the other dwelling units illustrated in the Drawings, the interior of the trailer house 790 can be arranged in any convenient manner.

Referring specifically to FIG. 42, the trailer house 790 is supported on a wheel assembly 810. The prestressed concrete pallet 792 of the trailer house 790 is purposely constructed to provide a rear support point located somewhat forwardly from the extreme rear end of the trailer house. For this reason, the rear portion 812 of the trailer house 790 comprises a cantilever portion of the pallet 792. The pallet 792 is also designed to provide a forward support point at the extreme front end of the trailer house. This permits the use of a connection assembly 814 which extends forwardly from the front end of the prestressed concrete pallet 792.

A motel 820 comprising a tenth embodiment of the invention is shown in FIGS. 44 and 45. The motel 820 comprises a plurality of individual motel units 822, each comprising a prestressed concrete pallet 824 which is supported on spaced load bearing walls 826.

As is best shown in FIG. 45, each pallet 824 extends cantilever from the load bearing walls 826 at one end of the motel unit 820 to define an entry corridor 828. Within eacn unit 822 there is provided a parititon 830 which separates a bathroom 832 and an entry way 834 from a main living/sleeping area 836. The pallets 824 also extend cantilever at the opposite end of the motel unit 820 to define balconies 838. The balcony 838 of each unit 822 of the motel 820 is separated from the balcony of the adjacent unit by a paritition 840.

An important feature of the motel 820 is that each unit 822 comprises a single wall 842 extending longitudinally of the pallet 824 of the unit 822. The wall 842 is finished on both sides and serves as the sole partition between adjacent motel units 822. This is very economical in that it completely eliminates duplicate walls be-

tween motel units. Also, by reversing the positioning of the wall **842**, and/or by eliminating the wall **842**, it is possible to provide a motel unit extending over two or more pallets **824**.

The individual motel units **822** of the motel **820** are preferably completely finished at a factory, even to the extent of installing the furniture. By this means the only on site finishing work that is required is extending the carpeting to the next adjacent wall **842**, installing a few minor molding pieces, and forming electrical and plumbing connections to the motel unit, whereupon the unit is ready for occupancy. It has been found that the technique, the total time that is required to construct a finished motel can be reduced by a factor of one half.

One of the most important differences between the motel **820** and the other embodiments of the present invention comprises the mounting of the load bearing walls **826**. These walls are preferably mounted directly on the decks of the prestressed concrete pallets **824**, that is, the decks of the pallets **824** are not interrupted to receive the walls **826**. This has been found to be highly advantageous in adapting the motel units **822** to complete finishing at the factory. It has also been found that the partitions **830** and **840** and the walls **842** are adequate to maintain the load bearing walls **826** erect on the prestressed concrete pallets **824** in the finished motel **820**. Additional structure may be provided for maintaining the walls **826** erect during transportation to the construction site, if desired.

Referring now to FIGS. **46** through **51**, there is shown a transportable service module **910** incorporating yet another embodiment of the present invention. The service module **91** comprises a precast concrete pallet including a deck or slab **911** and a plurality of flanges or beams **912** depending therefrom. A plurality of tension members (not shown) extend through the flanges **912** and serve to prestress the concrete pallet. By this means the pallet is adapted for support at spaced points on the flanges **912** to support a load on the upper surface of the slab **911**.

The transportable service module **910** further comprises a hollow framed structure mounted on the slab **911** of the concrete pallet and defined by a plurality of walls **913**. The walls **913** extend along the four edges of the slab **911** and in turn support an overhead structure **914** which cooperates with the walls **913** to enclose the hollow framed structure of the service module **910**. As is best shown in FIG. **6**, the hollow framed structure further includes a plurality of interior walls **917** and **918** formed on the slab **911** to define subenclosures within the hollow framed structure.

The floor plan of the transportable service module **910** is also illustrated in FIG. **51**, it being understood that any desired floor plan can be utilized in the practice of the invention. In the particular floor plan shown, the walls **913** are provided with a plurality of openings O and an entry door ED which extends to an entry area EA. The entry area EA leads to a corridor area CA which in turn leads to a kitchen area KA and a first bathroom **BR1**. One of the openings O provides access to a lavatory and water closet area LWC. A sanitary area SA is disposed between the areas BR1 and LWC to permit suitable service connections to the facilities therein. The transportable service module **910** further comprises a plurality of storage closets SC formed integrally with the walls **917** and **918**.

Referring now to FIGS. **47** through **49**, the transportable service module **910** is adapted for transportation from a factory, wherein the hollow framed structure is formed and the various facilities of the kitchen area KA, the first bathroom area BR1 and the lavatory and water closet area LWC are installed, to the building site by means of a pair of ground engaging wheels W and an axle A extending therebetween. The axle A is connected by suitable shackles to a pair of leaf springs **19**. Each spring **19** extends to a pair of pins **21** which connect the springs to a pair of shackle plates **22**. Each shackle plate **22** is detachably connected to a shackle member **23** which is secured to the concrete pallet by means of reinforcing rods **24** that are molded into the flanges **912** depending from the slab **911**. The members **923** are positioned at points corresponding to the support points of the flanges **912**, and the shackle plates **922** include flanges **926** which extend directly downwardly from the shackle members **923** to receive the pins **921**. By this means the axle A and the ground engaging wheels W are properly positioned to support one end of the concrete pallet and the hollow framed structure formed thereon for transportation to a construction site.

The opposite end of the transportable service module **910** is adapted for connection to a tractor or other towing vehicle. The kingpin KP depends from a load distributing plate P and is adapted for connection to a conventional semitrailer contact plate of the tractor. The plate P is connected to the flanges **912** of the pallet by means of a plurality of bolts **927** which are threadedly engaged with internally threaded members **928**. The members **928** are secured in the flanges **912** by means of reinforcing rods **929** molded therein. The members **928** and the rods **929** are positioned at points corresponding to the support points of the flanges **912** whereby the concrete pallet is properly supported for over-the-road transportation.

Referring now to FIG. **50**, the transportable service module **10** is installed at a construction site by removing the shackle plates **922** to detach the wheels W and the axle A and by removing the bolts **27** to detach the plate P and kingpin KP. The service module **910** is then installed on suitable support by means of a crane or the like. Thereafter a similar service module including a prestressed concrete pallet **930** is installed over the service module **910**. The second module is preferably mounted in spaced relation to the overhead structure **914**, and enclosure panels CP are provided to form a flush outer surface. This forms a service passageway S which may be utilized to provide utility connections between the two service modules.

From the foregoing it will be understood that in accordance with the present invention, dwelling units are formed from prestressed concrete pallets. One of the most important aspects of the invention comprises forming a service core including complete mechanicals for a dwelling unit on a prestressed concrete pallet at a factory by mass production techniques. This substantially reduces the cost of manufacturing a dwelling unit and also substantially reduces the amount of time that is required to finish a dwelling unit following the beginning of construction at the ultimate site of the dwelling. The invention is readily adapted to the construction of the wide variety of dwelling types including garden and low rise apartment buildings, high rise apartment buildings, town house complexes, cluster houses, single fam-

ily residences, vacation houses, trailer homes, motels, etc.

Although preferred embodiments of the invention have been illustrated in the accompanying Drawings and described in the foregoing Detailed Description, it will be understood that the invention is not limited to the embodiments disclosed, but is capable of numerous rearrangements, modifications, and substitutions of parts and elements without departing from the spirit of the invention.

What is claimed is:

1. The dwelling unit comprising:
- a pair of spaced, substantially vertically extending load bearing wall means each formed from prestressed concrete;
- a pair of prestressed concrete pallets supported on the load bearing wall means and positioned adjacent each other to define the floor of a dwelling unit;
- enclosure means formed on one of the pallets and comprising complete mechanicals for the dwelling unit; and
- means forming an electrical conduit extending through at least one of the load bearing wall means from a point adjacent the enclosure means to at least one outlet aligned with the other pallet.

2. The dwelling unit according to claim 1 further including:
- a pair of spaced, substantially vertically extending shear wall means extending between and connected to the load bearing wall means to maintain the load bearing wall means erect; and
- wherein the electrical conduit extends through the load bearing wall means to an outlet positioned adjacent the point of connection of the shear wall means to the load bearing wall means.

3. The dwelling unit according to claim 2 further including means forming an electrical conduit extending from the outlet in the load bearing wall means adjacent the point of connection of the shear wall means thereto along the interior surface of the shear wall means to at least one additional outlet.

4. The dwelling unit according to claim 3 further including paneling mounted on the interior surface of the shear wall means extending over the electrical conduit mounted thereon.

5. A method of constructing a dwelling unit comprising:
- forming an electrical conduit within a prestressed concrete wall;
- forming an enclosure including complete mechanicals for a dwelling unit on a prestressed concrete pallet;
- positioning the enclosure bearing pallet, at least one additional prestressed concrete pallet and the wall to form the floor and one wall of a dwelling unit, respectively, and with the electrical conduit in the wall extending between a point aligned with the enclosure and a point aligned with the additional pallet; and
- extending electrical leads through the conduit in the wall to provide at least one convenience outlet for the dwelling unit.

6. The method of constructing a dwelling unit according to claim 5 wherein the step of forming an electrical conduit within a prestressed concrete wall is carried out by positioning a tubular electrical conduit and then casting concrete around the conduit.

7. The method of constructing a dwelling unit according to claim 5 further comprising positioning a second prestressed concrete wall at one end of the first prestressed concrete wall to form a second wall for the dwelling unit and mounting an electrical conduit structure on the second wall of the dwelling unit and wherein the step of extending electrical leads includes the step of extending leads through the electrical conduit structure on the second wall.

8. The method of constructing a dwelling unit according to claim 7 including the additional step of mounting interior wall paneling members on the second wall of the dwelling unit to enclose the conduit structure thereon.

9. A dwelling unit comprising:
- a pair of spaced, substantially vertically extending prestressed concrete walls each having an electrical conduit structure extending through it to an opening at the end of the wall;
- a third wall extending between the ends of the first two walls and including electrical conduit structure interconnecting the openings at the ends of the electrical conduit structures in the first two walls;
- a prestressed concrete pallet extending to at least one of the walls and having an enclosure formed on it; and
- electrical leads extending from the enclosure on the pallet through the electrical conduit structure of the walls to convenience outlets positioned at spaced points along the electrical conduit structures.

10. The dwelling unit according to claim 9 wherein the electrical conduit structure on the third wall is mounted on the interior surface thereof and further including interior paneling means mounted on the third wall and extending over the electrical conduit structure on the wall.

11. The dwelling unit according to claim 9 wherein the prestressed concrete pallet extends between and is supported by the first two walls and wherein the third wall functions to maintain the first two walls erect.

12. The dwelling unit according to claim 11 wherein the enclosure on the prestressed concrete pallet comprises complete mechanicals for the dwelling unit and electrical risers for supplying electrical power to the dwelling unit and further including means interconnecting the electrical leads in the electrical conduit structures and the electrical risers of the enclosure.

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