US 20050188632A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2005/0188632 A1**

Rosen (43) **Pub. Date: Sep. 1, 2005**

(54) **MODULAR CORE WALL CONSTRUCTION SYSTEM**

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(21) Appl. No.: **11/067,369**

(22) Filed: **Feb. 25, 2005**

Related U.S. Application Data

(60) Provisional application No. 60/548,457, filed on Feb. 27, 2004.

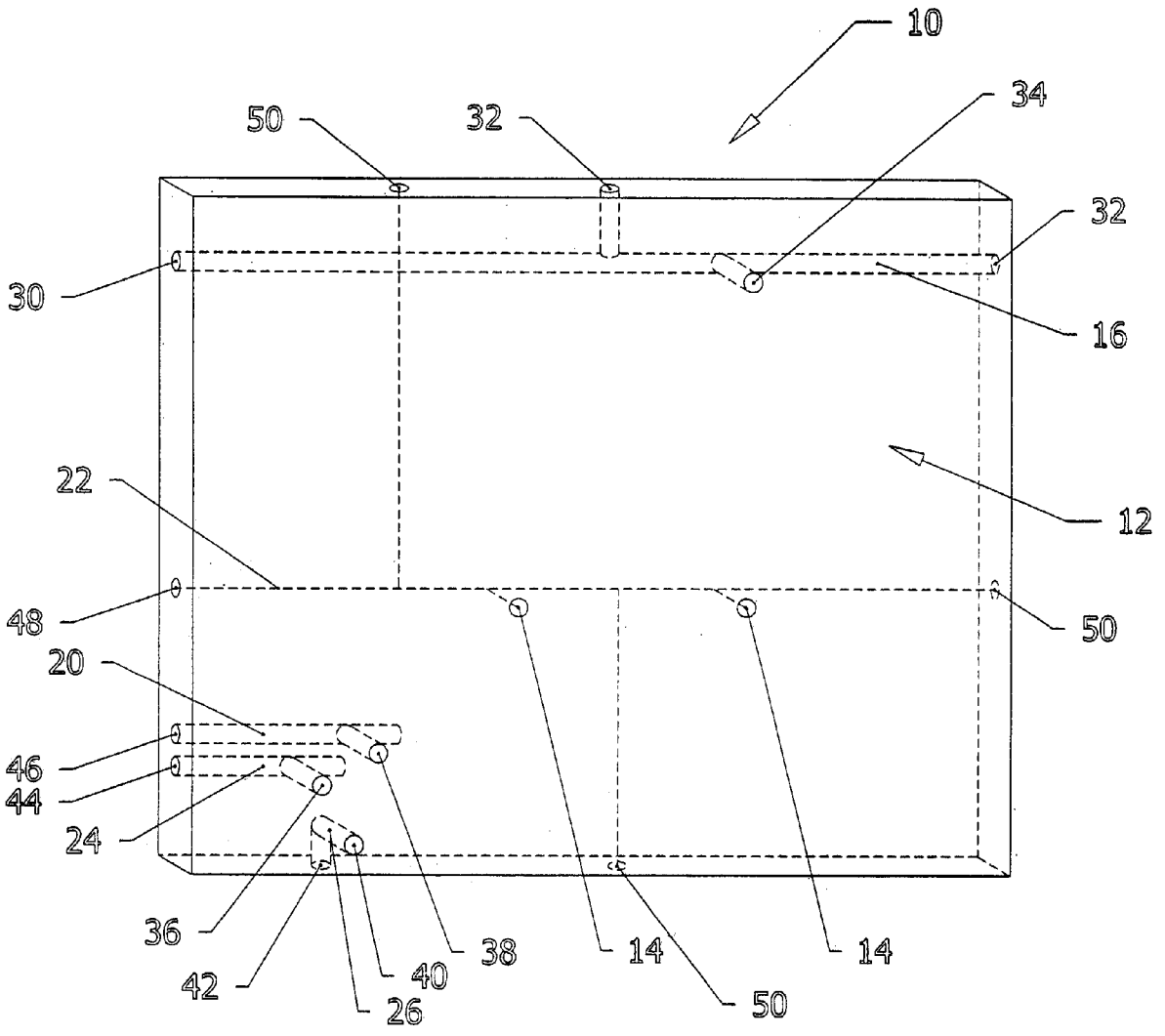
Publication Classification

(51) **Int. Cl.**[7] **E04C 2/52**

(52) **U.S. Cl.** **52/220.2**

(57) **ABSTRACT**

A prefabricated modular building system having a core wall, one or more utility runs that are disposed within the core wall and that have a first connector at one end, one or more panelized partitions attachable to the core wall via a plug-in fastener device, and one or more utility run extensions that are housed within the partition and that have at one end a second connector mateable to the first connector.



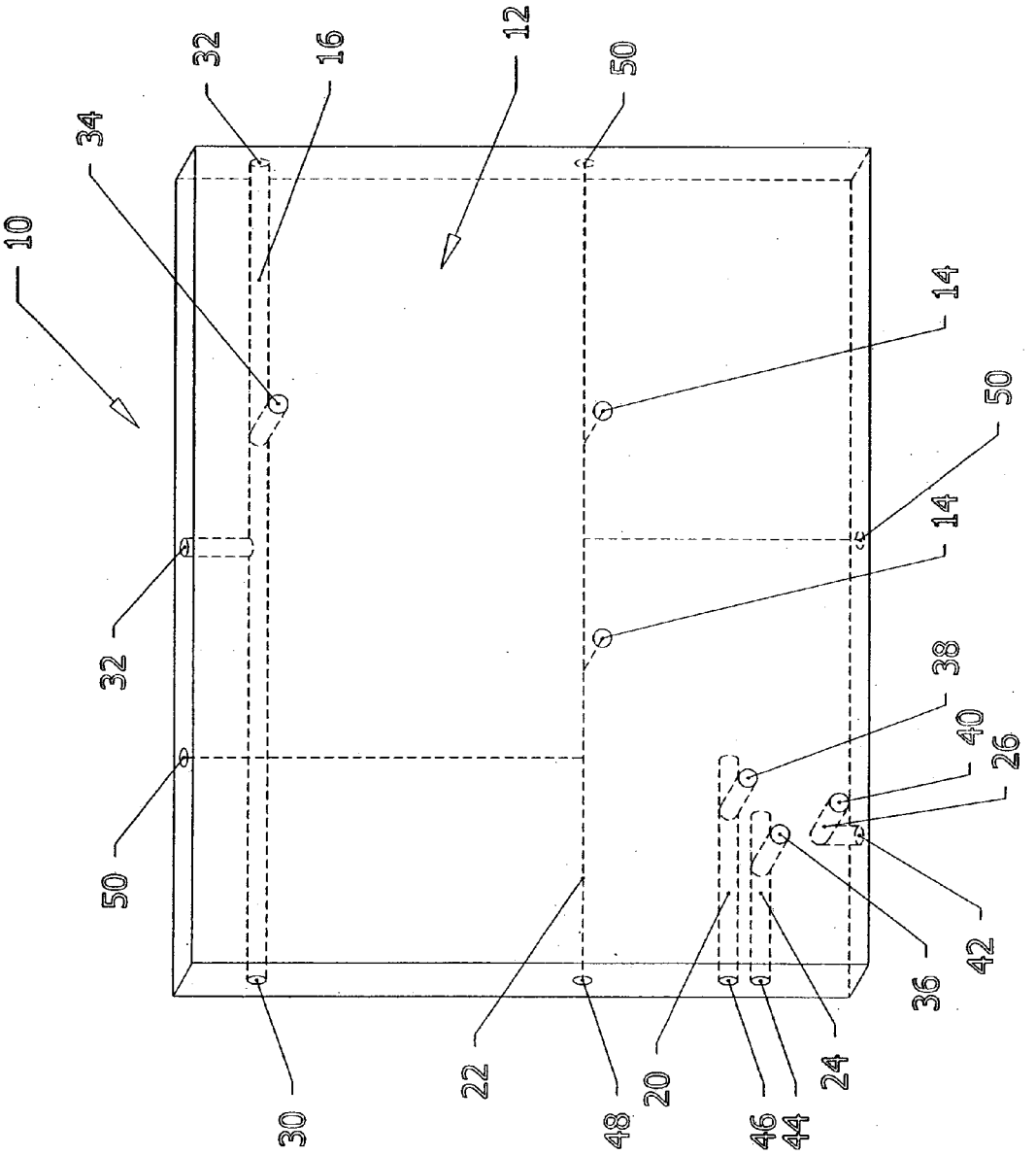


FIGURE 1

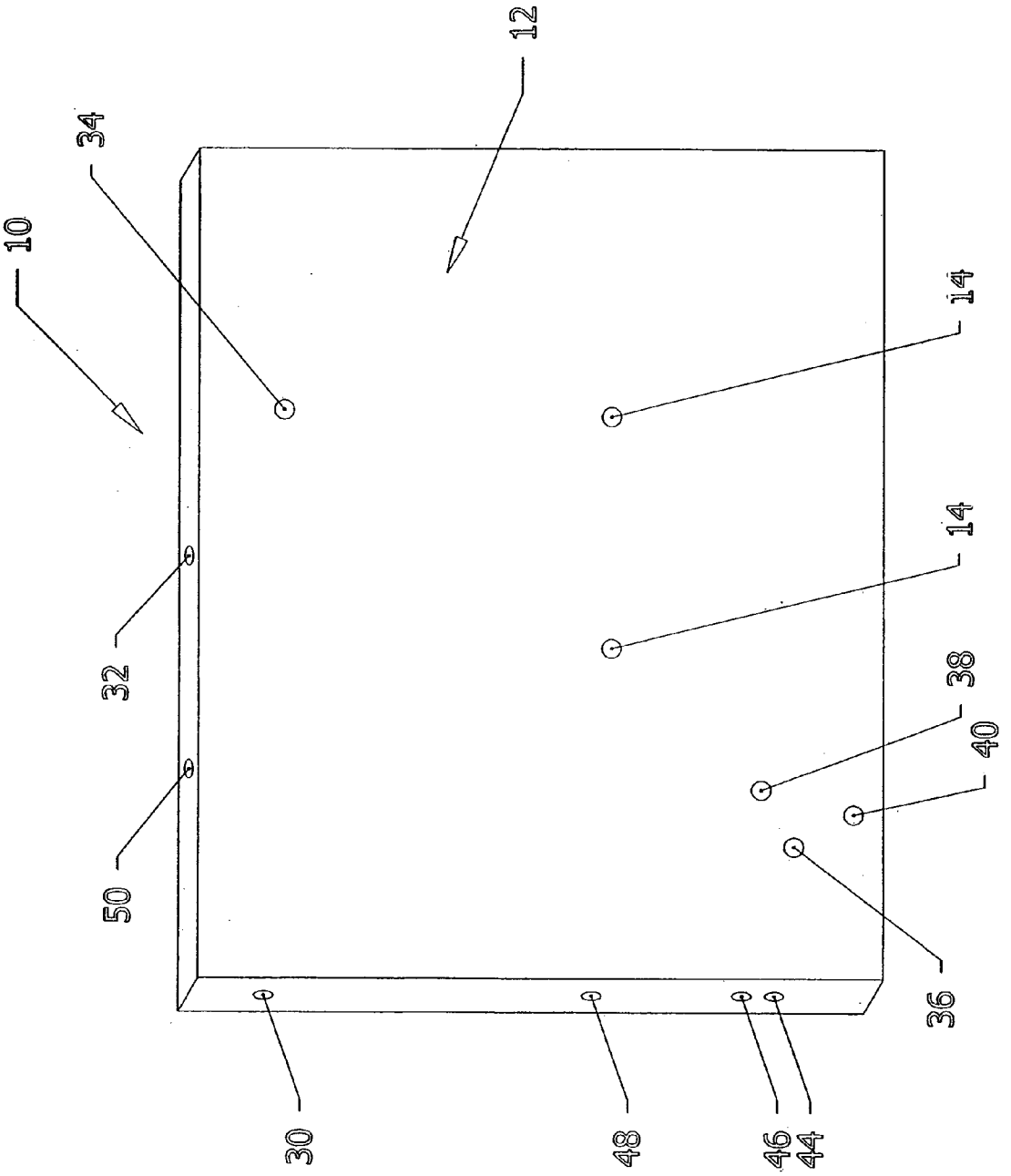


FIGURE 2

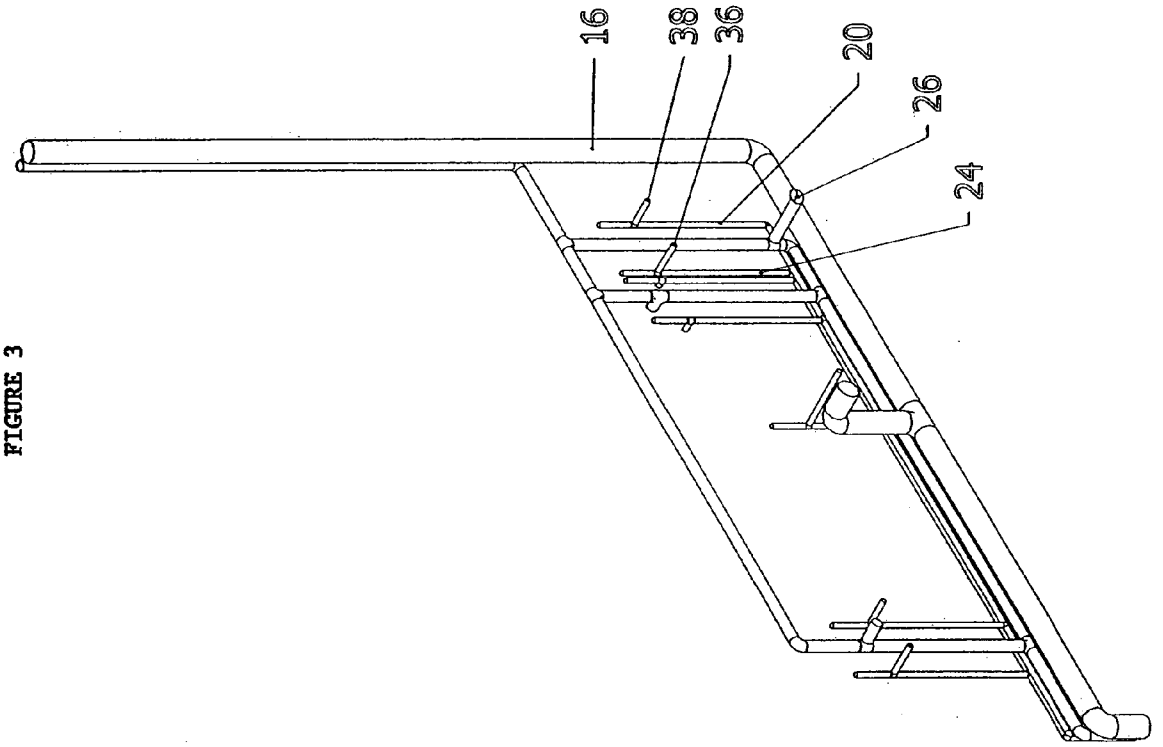


FIGURE 3

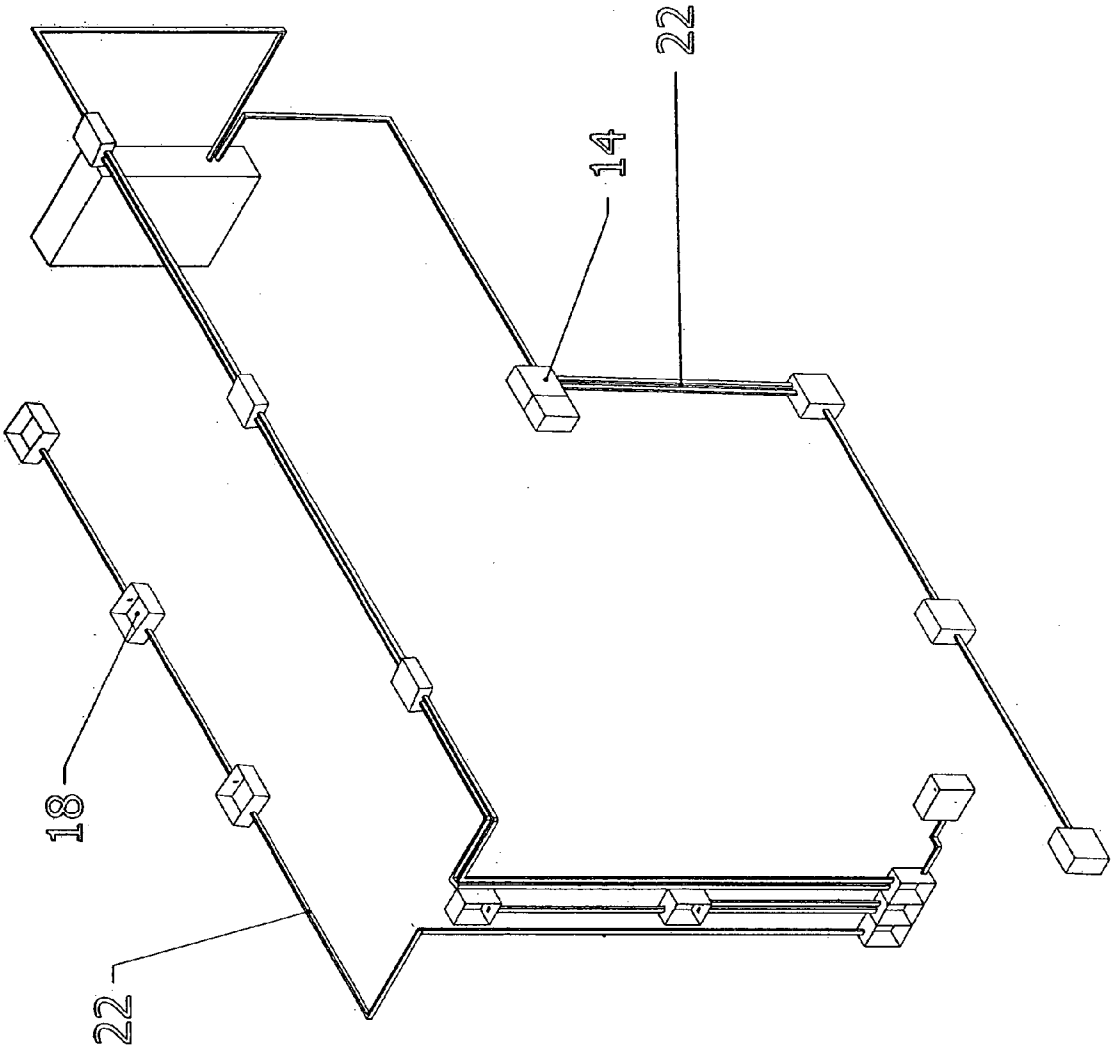


FIGURE 4

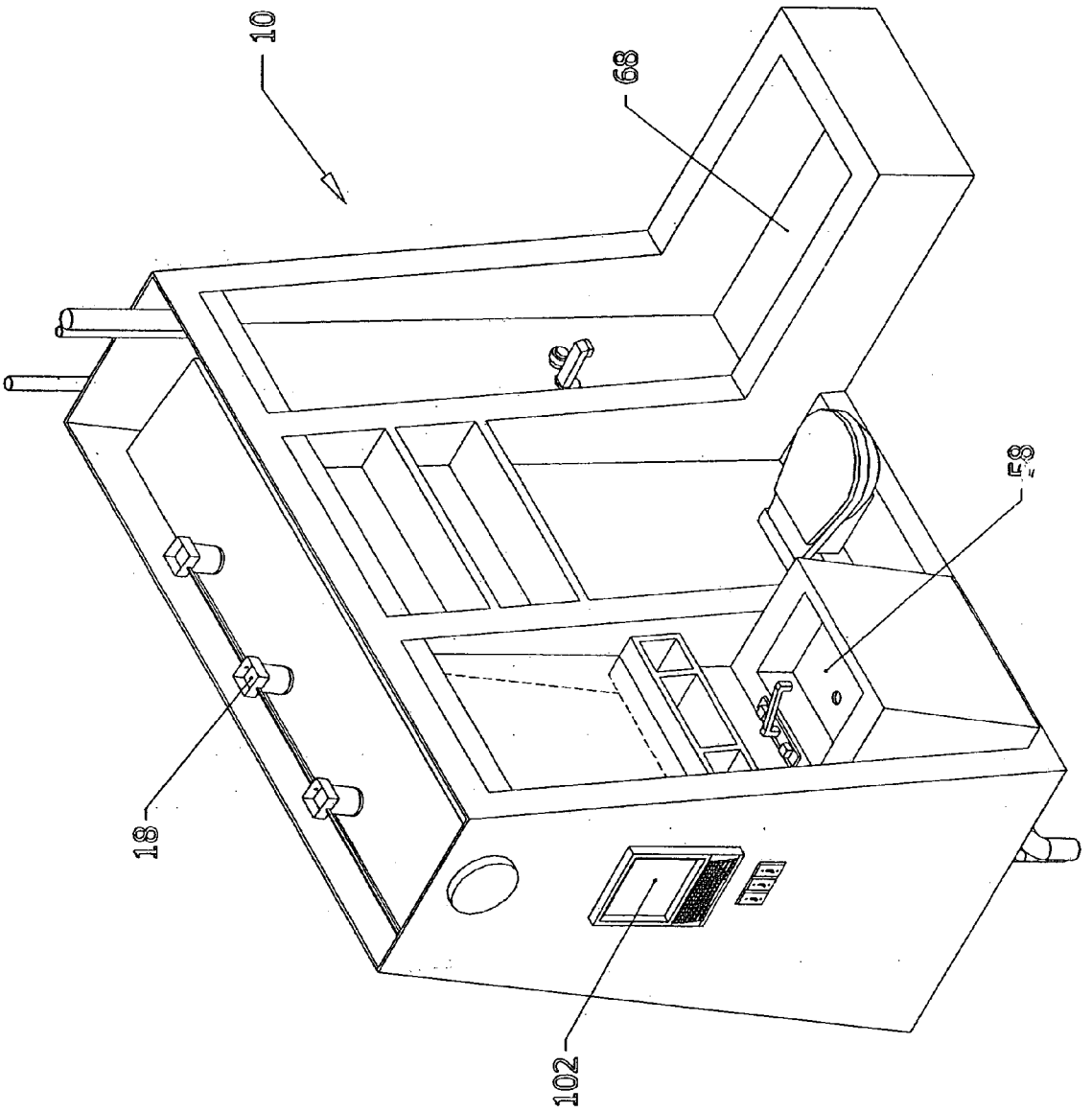


FIGURE 5

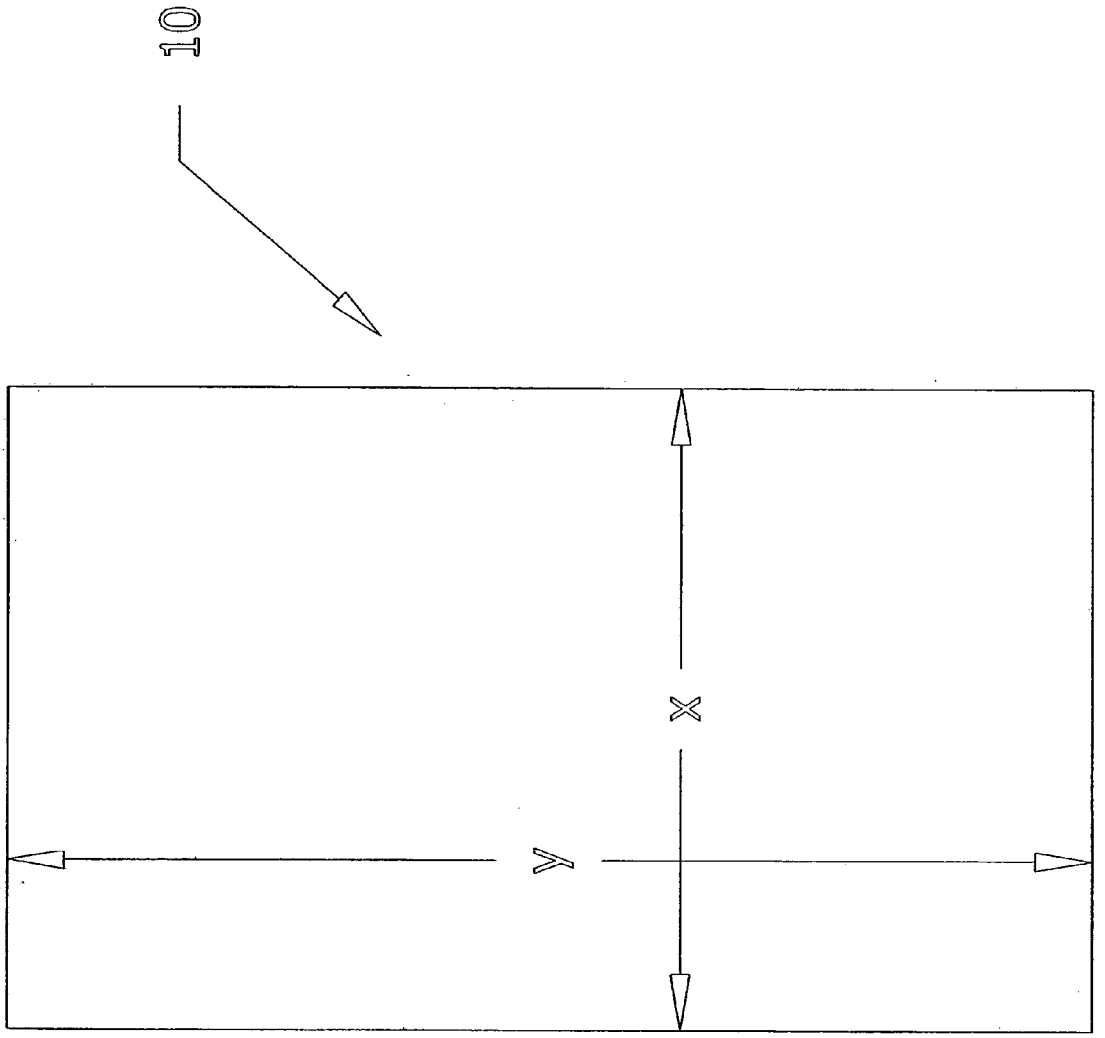


FIGURE 6A

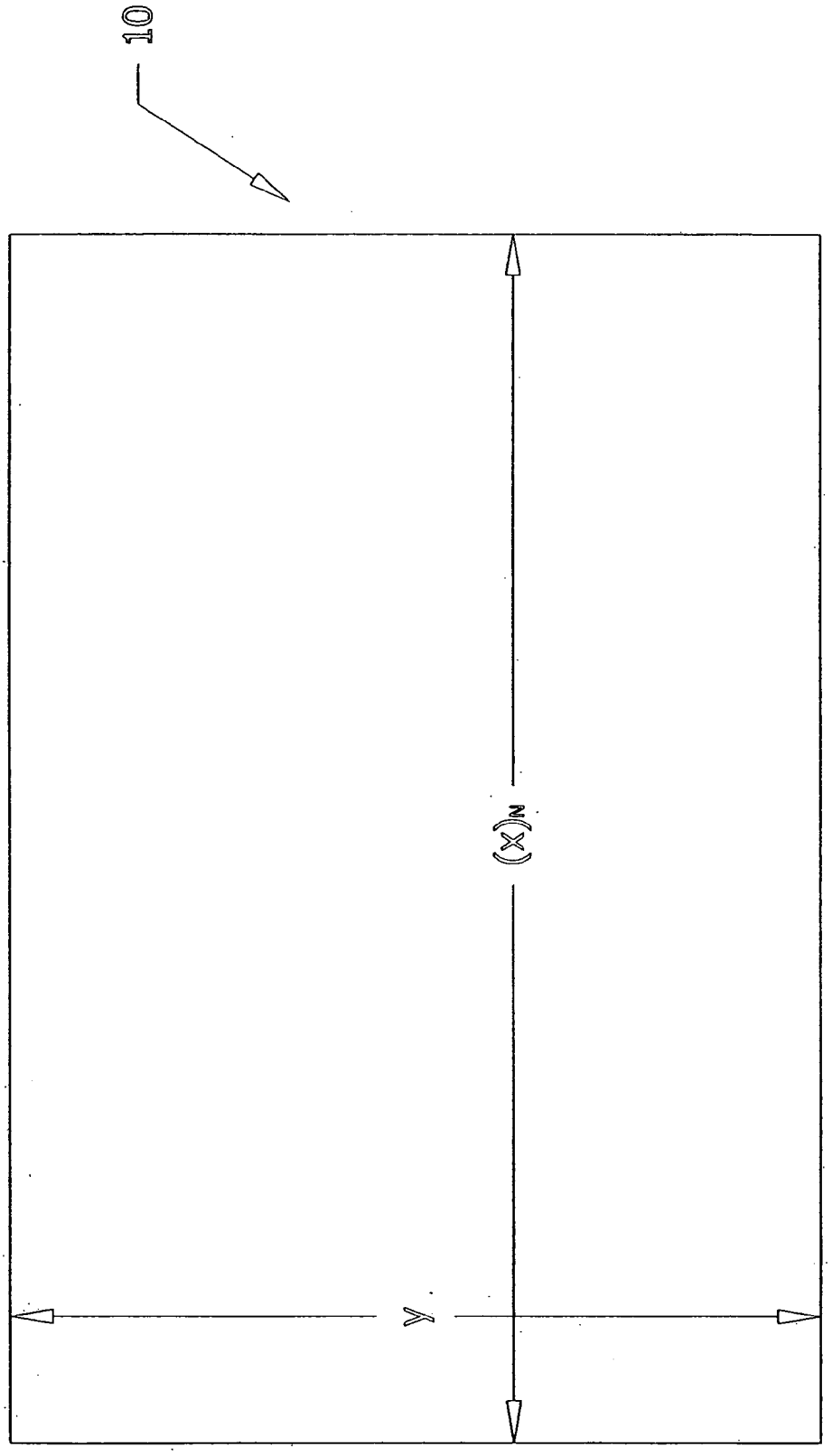


FIGURE 6B

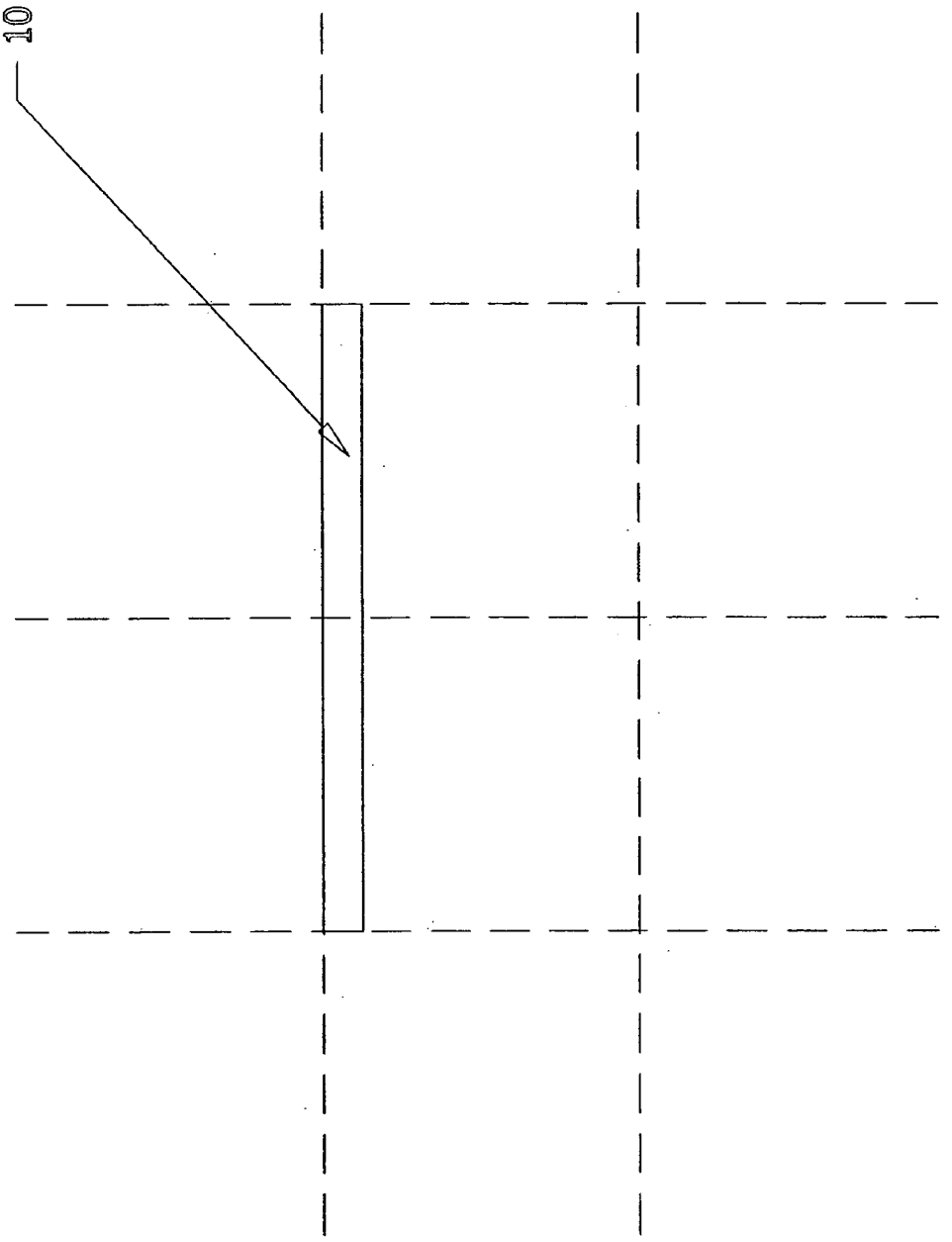


FIGURE 7

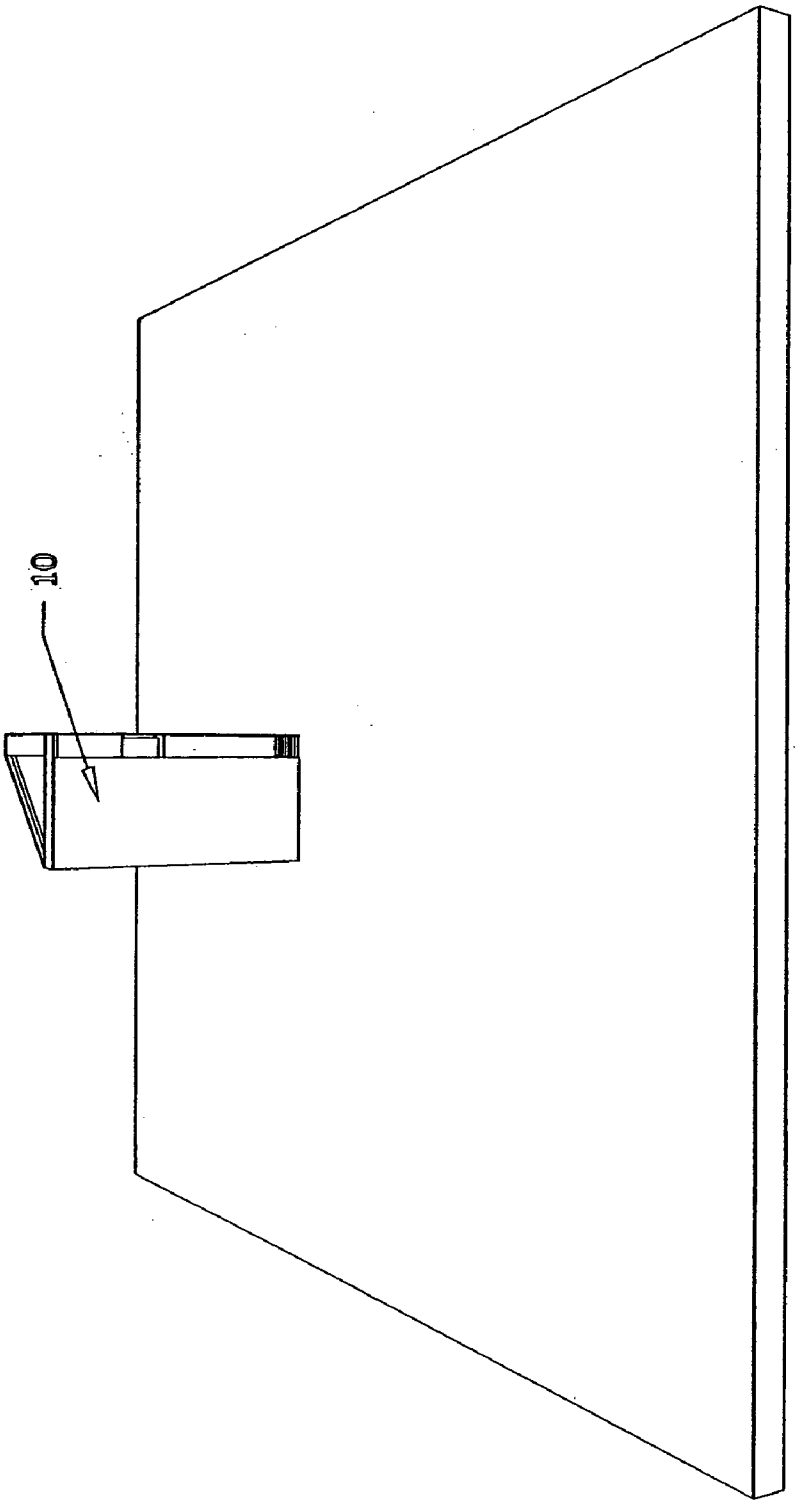


FIGURE 8A

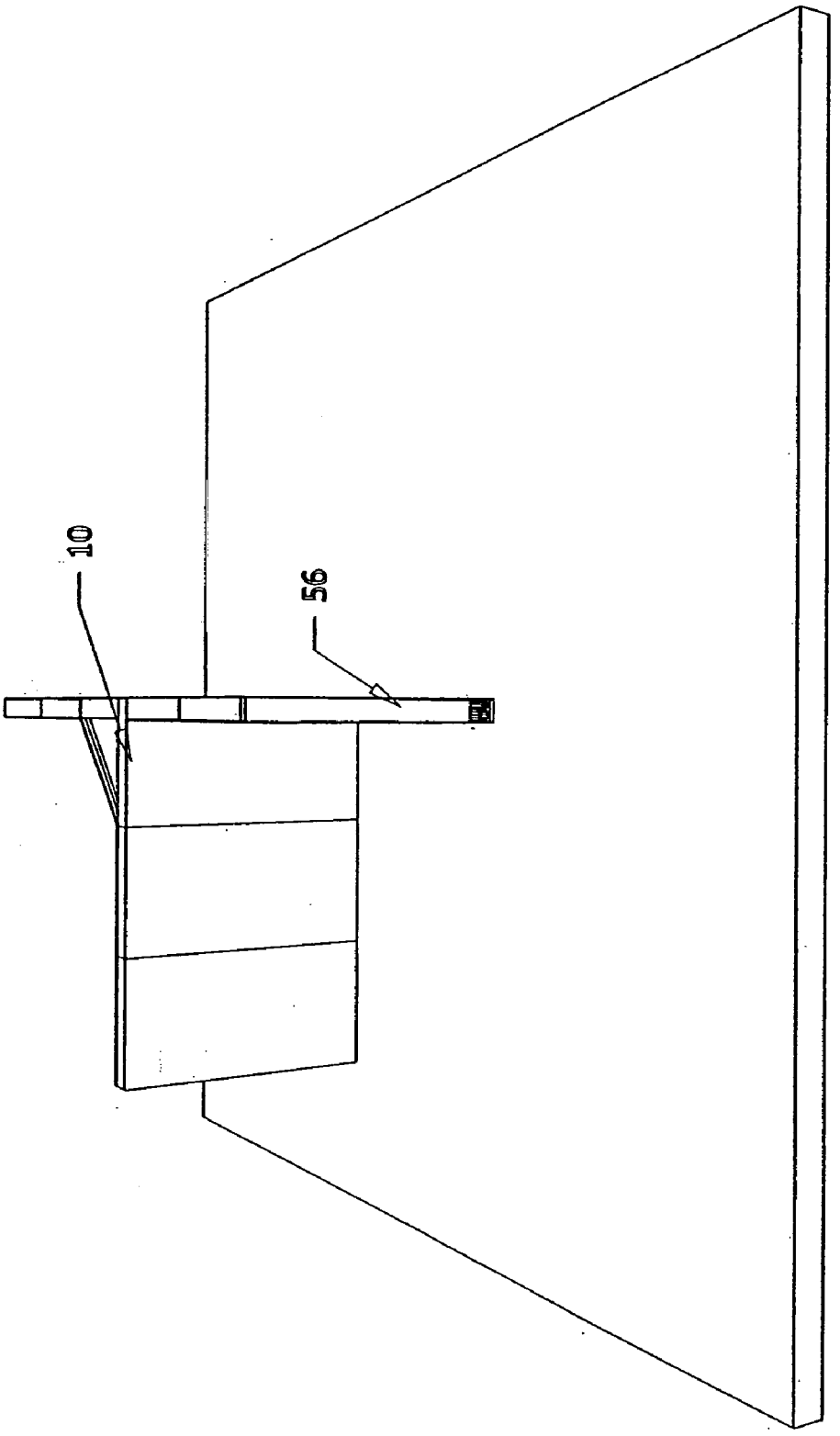


FIGURE 8B

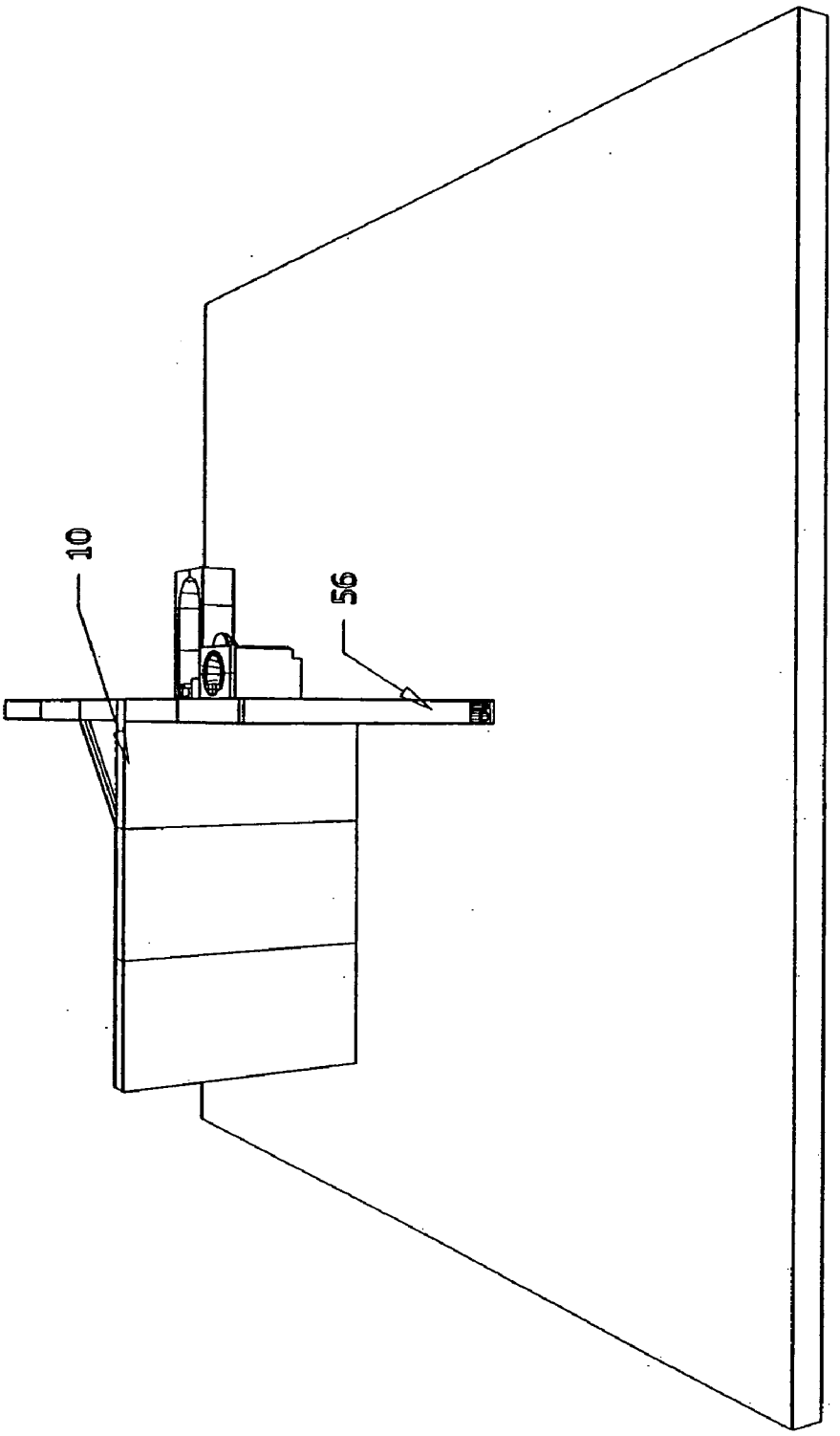


FIGURE 8C

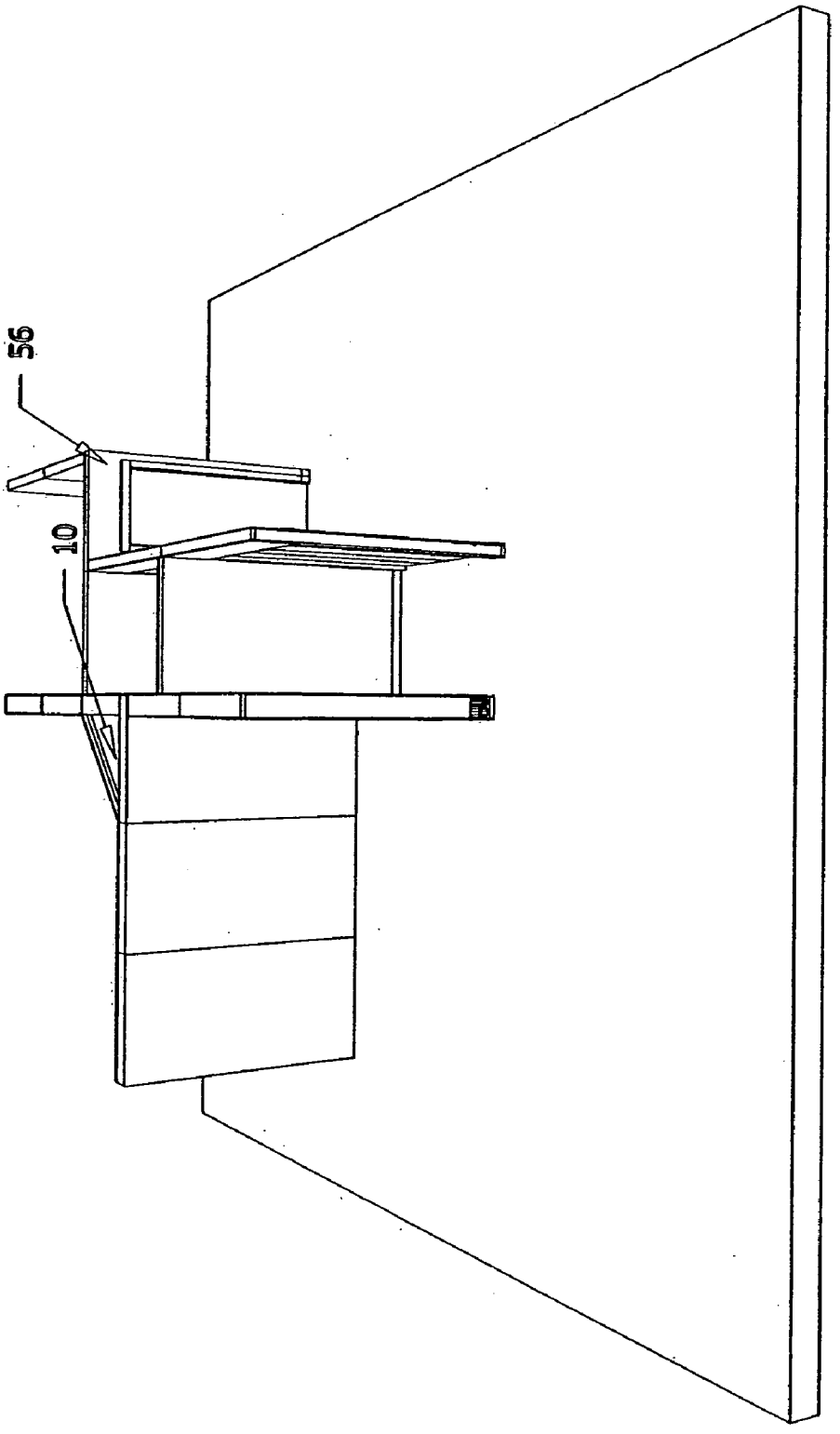


FIGURE 8D

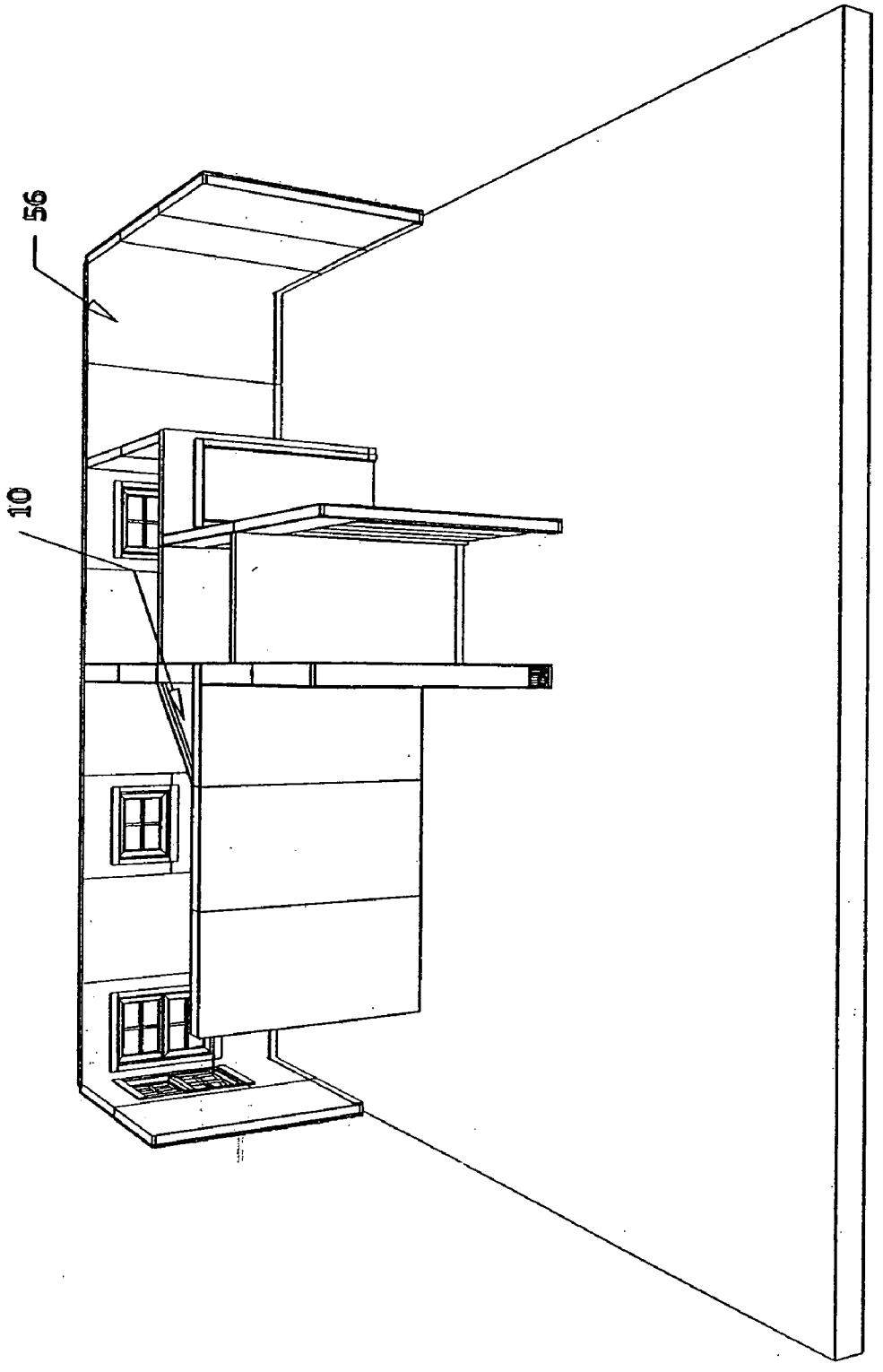


FIGURE 8E

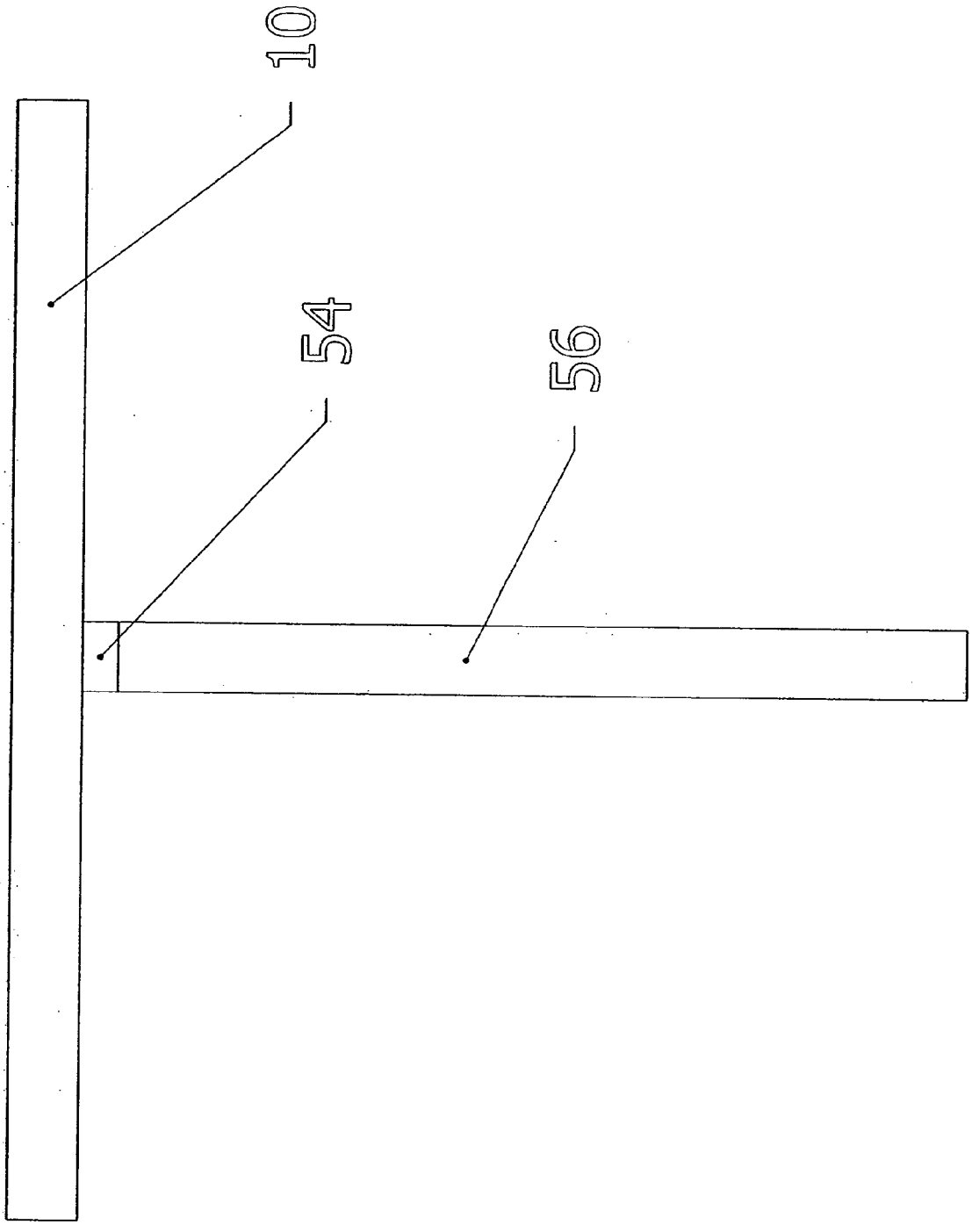


FIGURE 9A

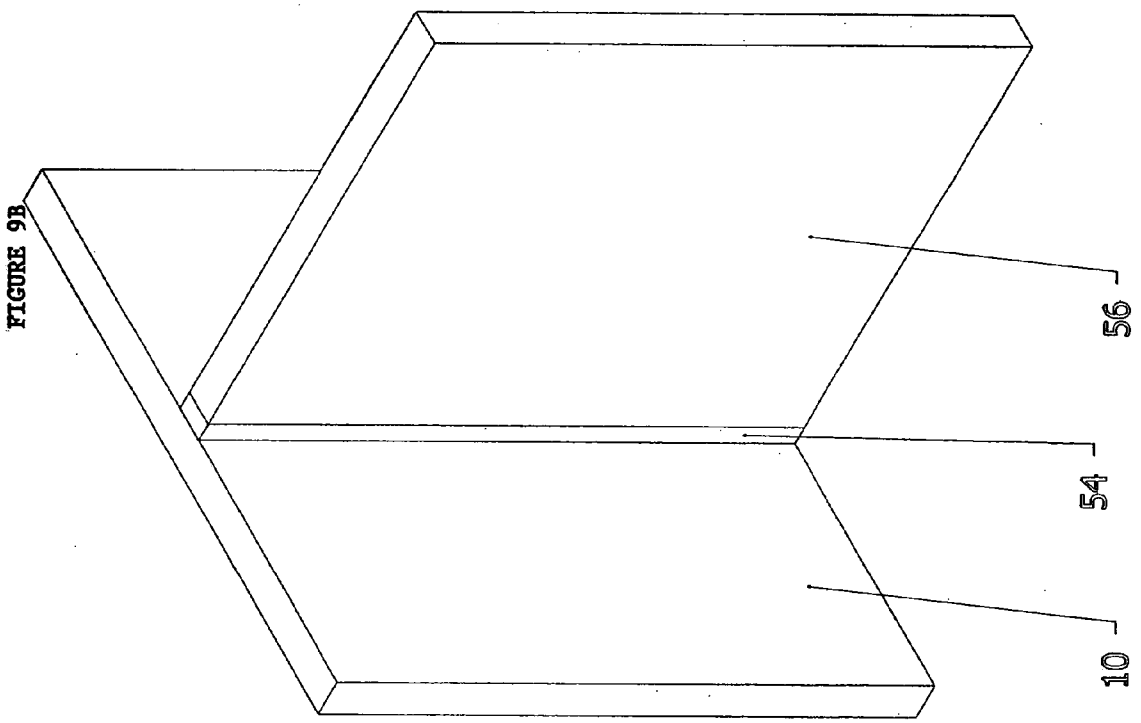


FIGURE 9B

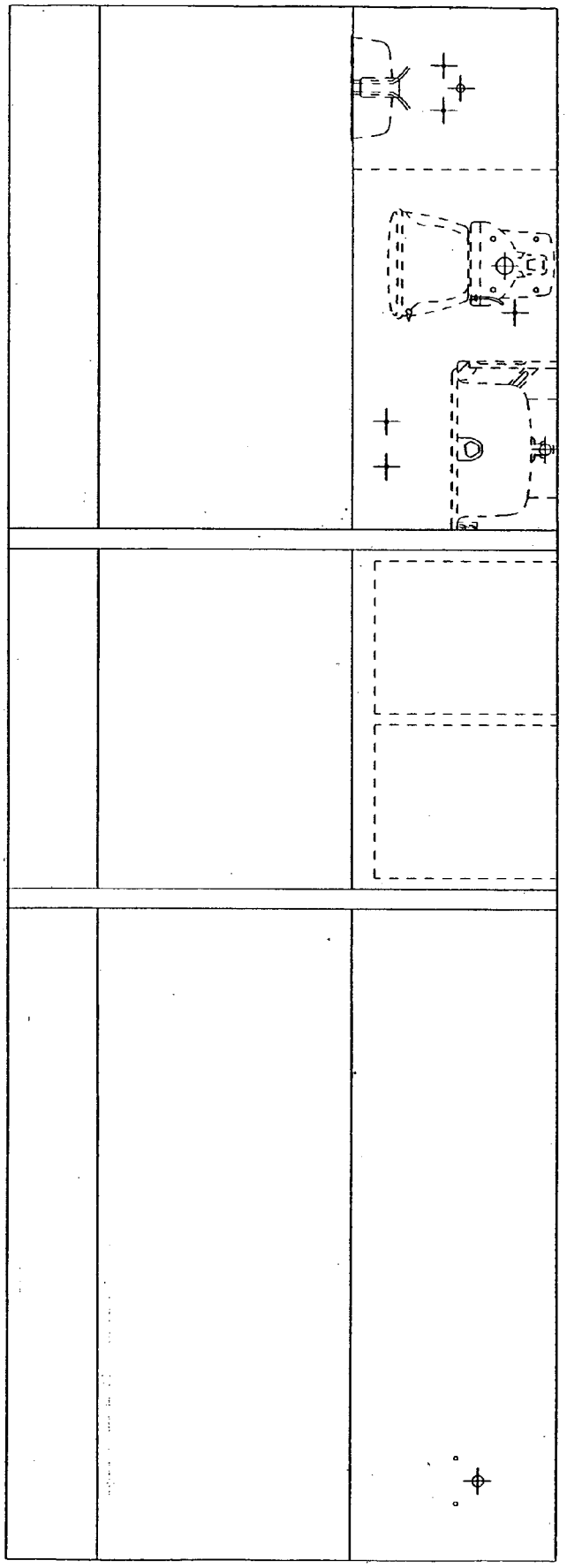


FIGURE 10

FIGURE 11

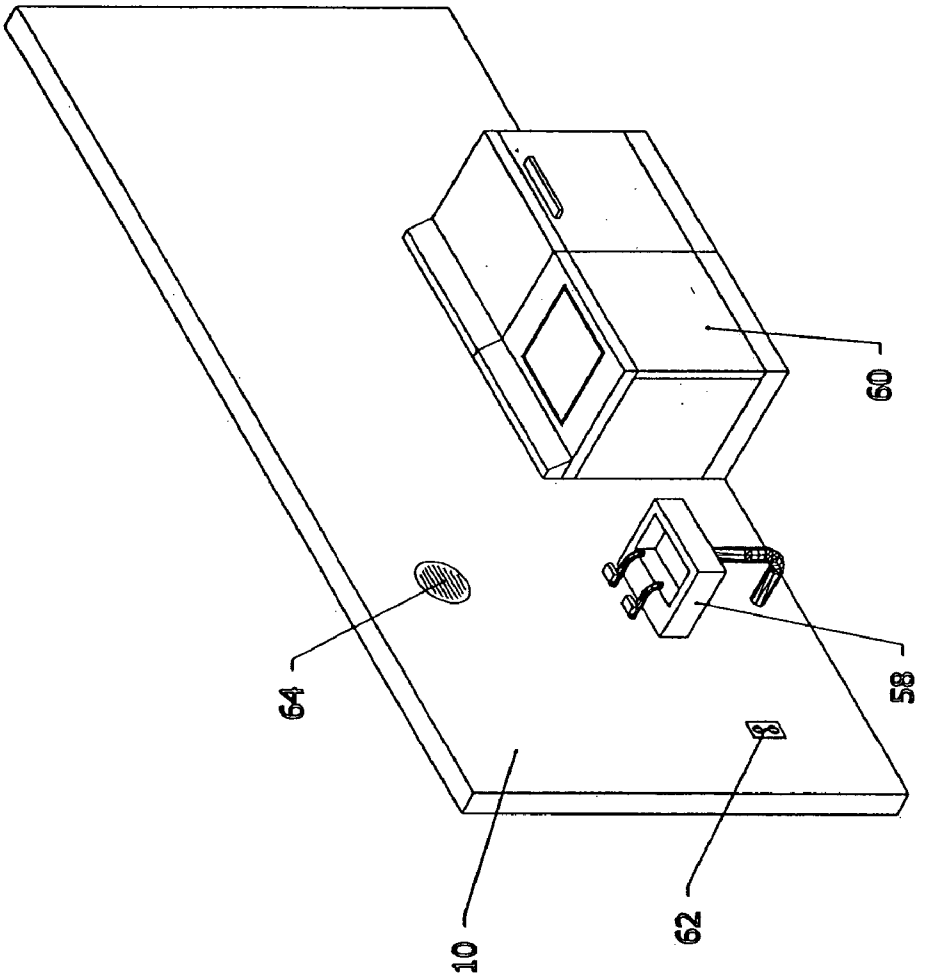
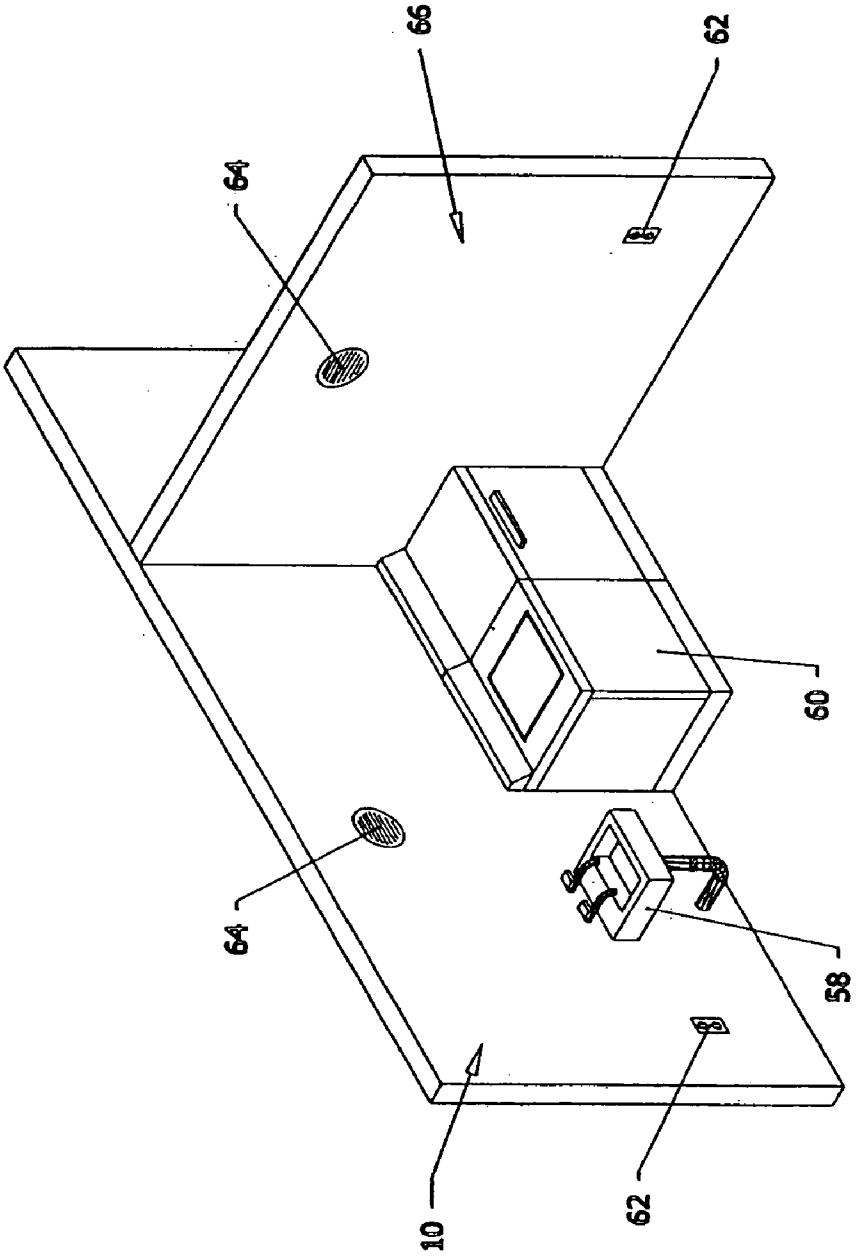


FIGURE 12A



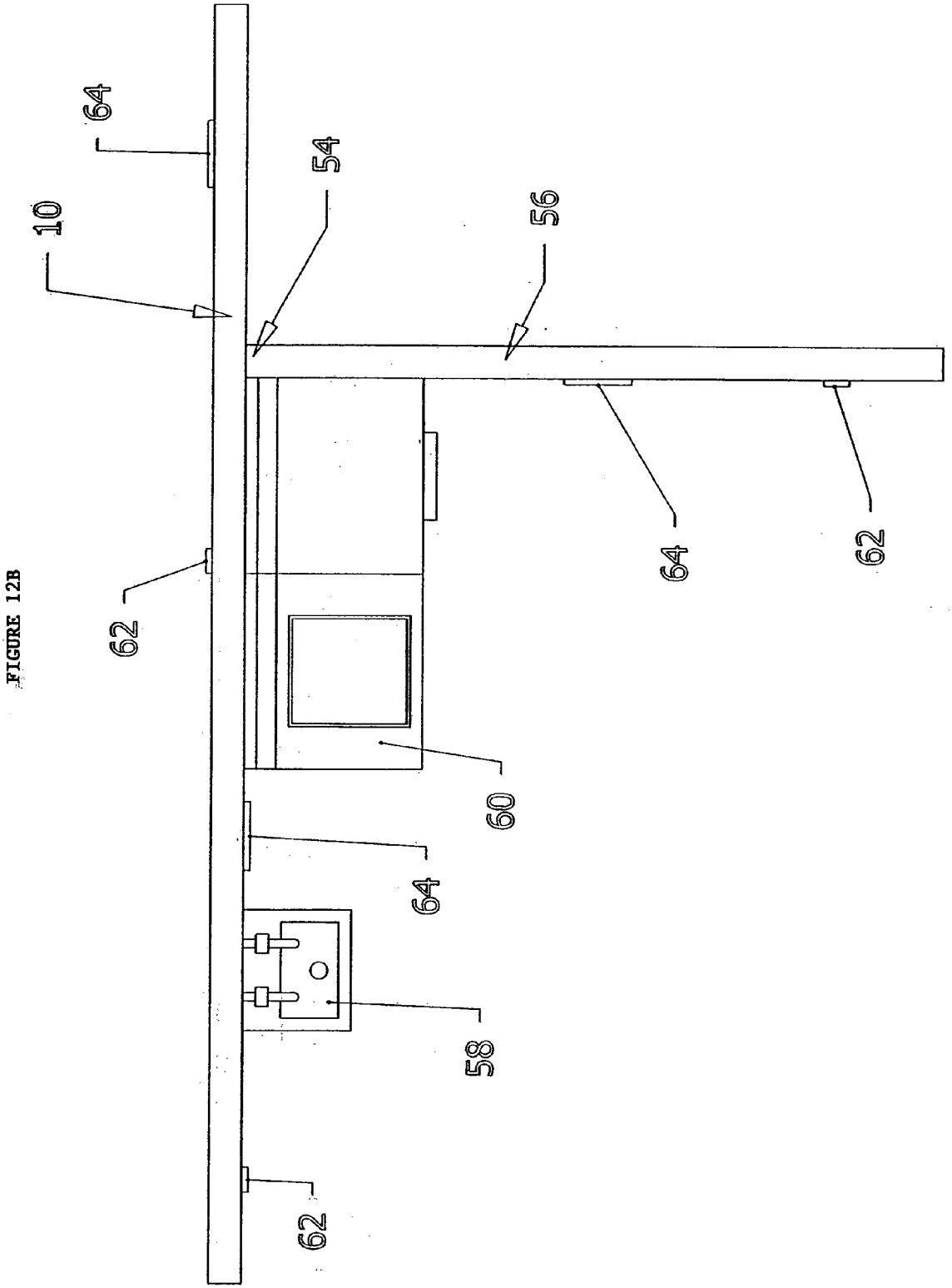


FIGURE 12B

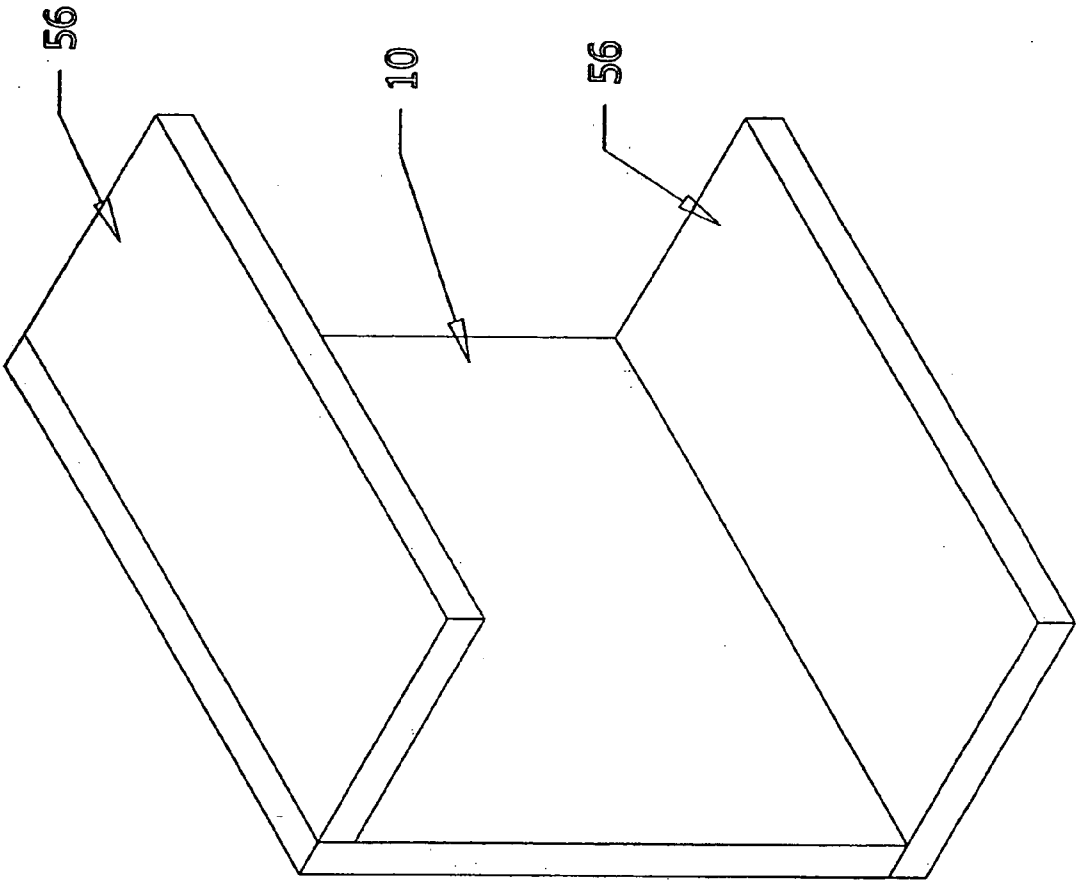
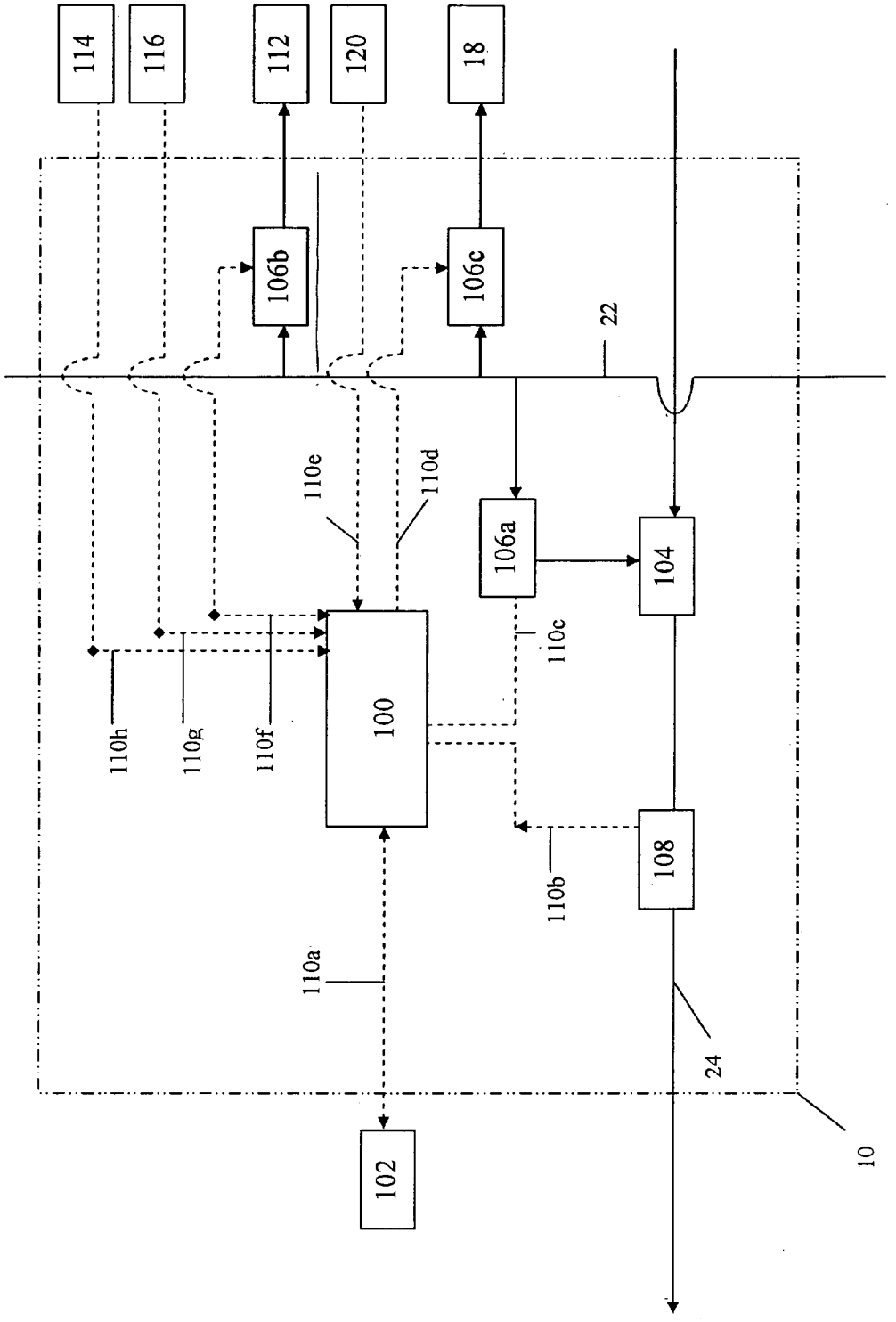


FIGURE 13

Figure 14


114
116
112
120
18
106b
106c
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110e
110d
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104
110c
110h
110g
110f
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108
110b
110a
24
102
10

MODULAR CORE WALL CONSTRUCTION SYSTEM

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority benefit to U.S. Provisional Application No. 60/548,457, filed on Feb. 27, 2004, which is incorporated herein by reference.

FIELD OF INVENTION

[0002] The present invention relates to a modular building system wherein a building's utilities are distributed from a prefabricated core wall that is equipped with a computer-based controller for managing the utilities.

BACKGROUND

[0003] The US housing construction industry is one the largest sectors of the economy. This sector includes building additions or alterations to existing homes, construction of custom homes, and on-site assembly of modular and prefabricated houses. The types of businesses servicing this sector include custom builders, general contractors, design builders, engineer-constructors, joint-venture contractors, turnkey contractors, and construction management firms. These different businesses face considerable competition, especially relating to construction costs and job scheduling.

[0004] One method to reduce cost and shorten construction schedules is to use prefabricated units or modules. This approach not only reduces the total amount of labor involved, but allows for relatively unskilled laborers to operate on-site while skilled laborers (i.e. plumbers, electricians, etc.) are concentrated at central locations, such as manufacturing and assembly facilities. The use of prefabricated modules also reduces or eliminates the need to coordinate the schedules of electricians, plumbers, and others skilled in their craft with the schedule of the general contractor.

[0005] The use of prefabricated modular units for construction of residential buildings, such as houses and apartments, is known in the art. Some of these modular units, including those described in U.S. Pat. No. 2,712,863 (Busch), U.S. Pat. No. 3,110,907 (King), and U.S. Pat. No. 4,470,227 (Bigelow), are designed as complete preassembled rooms. Transportation of these prefabricated "boxes of air" from the fabrication site to the installation site is difficult and uneconomical because the units are not compact.

[0006] Other modular units are built as core walls, for example U.S. Pat. No. 4,221,441 (Bain) (showing a prefabricated kitchen/bath/utility system that is built as three separate modules) and U.S. Pat. No. 3,590,393 (Hollander) (showing a prefabricated bathroom component built to accommodate a specific appliance). These modular units typically incorporate utilities such as plumbing (hot/cold water, sewage, etc.) and/or electrical wiring, within one or more wall structures to which conventional home appliances can be attached. Although these modular units can be incorporated into the structure of a residential building's interior layout, they are inflexible with respect to their spatial arrangement and are not designed with consideration of the building's interior layout as a whole. Thus, they are not adaptable to a variety of architectural layouts or features of the building and are principally designed to service only rooms adjacent to the modular unit. Due to their limited flexibility, modular units known in the art ineffectively utilize the space available within the building. In addition, these modular units are not readily adaptable to the wide variety of spatial arrangements that are required to maximize the utility and effectiveness of the interior space of both new construction and renovated residential buildings.

[0007] Computer-based control systems have also been developed to manage the mechanical and other systems of a building, such as ventilation, audio/video entertainment, and security systems. Conventionally, these control systems are located remotely with respect to the building utilities that they manage. For example, conventional control systems may reside on a personal computer or other type of electrical equipment box that is placed in an office, closet, basement, etc. However, controlling the building utilities remotely incurs an extra and needless degree of complexity and cost.

[0008] The present invention solves these and other problems associated with the modular units known in the art.

SUMMARY OF INVENTION

[0009] Applicants have discovered a novel system for building construction in which prefabricated modules having an integrated control system are used to distribute, at least in part, the building's utilities. This system brings together concepts of modular construction with efficient mechanical planning and integrated computer-based controllers to create a unique system for residential construction. Integration of a controller directly into a core wall that houses a utility distribution system increases building efficiency, flexibility, and cost effectiveness over conventional building techniques. Moreover, these modules are readily adaptable to a wide variety of spatial arrangements and, therefore, can be used to optimize the building's interior layout. In addition, unlike other modular approaches in which a complete prefabricated room is shipped, the present invention provides for a compact, easily transportable package of an essentially flat core wall with all essential services preinstalled and attachable prefabricated panelized partitions.

[0010] Accordingly, one aspect of the present invention is a prefabricated modular building system having a core wall that houses a central utility distribution system and a computer-based control system located within the core wall that is capable of integrating and managing the building utilities. In a particularly preferred embodiment of this aspect of the intention, the building system also has one or more panelized partitions attachable to the core wall via a plug-in fastener device and one or more utility run extension located within the partition wherein the utilities of the utility distribution system and the utility run extensions located in the panelized partitions are mateable via complimentary connectors.

[0011] Another aspect of the present invention is a method of constructing a building comprising the steps of providing a prefabricated core wall in which one or more utility runs are disposed; providing a computer-based control system located within said core wall; and integrating the control system with the utility runs to manage the utilities.

BRIEF DESCRIPTION OF DRAWINGS

[0012] **FIG. 1** shows an embodiment of a core wall.

[0013] **FIG. 2** shows entrance and egress points of a core wall embodiment.

[0014] **FIG. 3** shows an assembled plumbing utility distribution system within a core wall embodiment.

[0015] **FIG. 4** shows an assembled electrical utility distribution system within a core wall embodiment.

[0016] **FIG. 5** shows a core wall embodiment directly integrated with appliances.

[0017] **FIGS. 6A** & B depict the vertical heights and horizontal lengths of a core wall embodiment.

[0018] **FIG. 7** shows a core wall embodiment on an architectural planning grid.

[0019] FIGS. **8**A-E show different embodiments of a core wall and panelized partitions on an architectural planning grid.

[0020] **FIGS. 9A** & B show a core wall attached to a panelized partition.

[0021] **FIG. 10** shows a panelized partition embodiment.

[0022] **FIG. 11** shows conventional appliances and utility user interfaces with a core wall.

[0023] **FIG. 12A** & B show conventional appliances and utility user interfaces with a core wall and panelized partition.

[0024] **FIG. 13** shows panelized partition attached to a core wall, wherein the panelized partitions function as a ceiling or a floor.

[0025] **FIG. 14** shows a schematic diagram of an integrated controller managing certain utilities in a core wall.

DETAILED DESCRIPTION OF THE INVENTION

[0026] The present invention is directed to flexible systems for building construction wherein a building's utilities are distributed from a prefabricated core wall and are managed by a computer-based controller that is located in the core wall. The core wall modules are self-contained and include plumbing, wiring, ventilation, etc., thereby providing a flexible spatial layout of both utility intensive rooms, such as kitchen and bathroom, and other rooms of a building. Moreover, the system's flexibility allows for the building's interior layout to expand or contact around the core wall as required by a particular architectural plan. The prefabricated core wall and panelized partitions of the present invention are suitable for use in modular or conventional construction, can be produced in a variety of finishes or unfinished, and can be manufactured and shipped with or without common residential appliances and fixtures, such as sinks, tubs, toilets, cabinets, etc. The most common use for the invention is in residential buildings, such as single family homes, duplexes, condominiums, town homes, apartment complexes, assisted living communities, hotels, mobile homes, and the like. However, those skilled in the art will appreciate that the invention may be adapted for other applications as well, including office buildings, hospitals, and the like.

[0027] Thus, in one aspect, the system comprises a prefabricated modular core wall that houses a central utility distribution system and a computer-based control system that is disposed within the core wall and that is capable of integrating and managing the utility distribution system.

[0028] According to the present invention, the core wall serves as a central utility distribution source. An example of an embodiment of a central utility distribution system in a core wall is illustrated in **FIG. 1**, wherein a core wall **10** houses utility runs including HVAC **16**, 120V electricity **22**, hot water **24**, cold water **20**, and sewage **26**. While the embodiment shown in **FIG. 1** includes five utilities, it is understood that the core wall may house any utility. Examples of other such utilities include, but are not limited to, natural gas, radiator hot water, radiator steam, telecommunication lines (including automation of building utilities), coaxial data cables, 240V electricity, water deionization, water purification, air purification, security cameras, motion detectors, smoke and dangerous gas detectors, telecommunications, electronic data transmission and reception, and audio and video entertainment. Also, the utility run layouts shown in **FIG. 1** is only exemplary. Examples of other utility run layouts include the plumbing runs shown in **FIG. 3**, and the electrical runs shown in **FIG. 4**. The core wall of the present invention can accommodate any utility run layout that would be practically feasible.

[0029] The present invention utilizes a computer-based control system embedded in the core wall to manage one or more of the building's utilities housed therein. In certain preferred embodiments, the controller manages all of the building utility system. The controller comprises a central processing unit, an operating system, and input/output data ports that are in communication with input and/or input/output devices such as solenoid valves, electropneumatic and electric-motor actuators, variable speed drives, thermostats, home entertainment centers, touch screen displays, digital data ports, and the like. The controller and ancillary control components may be of any type that are feasible for use for controlling building utilities. Operating systems for such controllers are commercially available from vendors such as Homeseer Technologies and Microsoft.

[0030] Referring to **FIG. 14**, shown is an embodiment of a core wall **10** (depicted, for clarity, as a dash-dotted line) having an integrated computer-based controller **100** which manages all of the shown building utilities, including hot water **24**, electricity **22**, security system **112**/**114**, smoke detector **112**/**116**, and lighting **18**/**120**. For example when hot water is desired, a user opens a hot water valve (not shown) at a use point, such as a sink (not shown). Opening the valve starts the flow of water through the hot water line **24** and the water flow and corresponding temperature is measured by a pressure transducer/thermometer **108**. The pressure transducer/thermometer sends a signal to the controller via channel **110***b* (indicated by a dashed-line). Channels to and from the controller may be of any suitable form, but are preferably electrical or wireless. When the controller receives a signal that hot water is in demand, it sends a signal to electrical switch **106***a* along channel **110***c* so that electricity from the electrical line **22** will be provided to an electrical heater **104**.

[0031] Other building utilities are controlled in a similar manner. For example, when the security motion detector **114**

senses motion, a signal is sent to the controller along channel **110***h*. The controller, in turn, sends a single along **106***f* to electrical switch **106***b* which activates an alarm siren **112**. When the smoke detector **116** senses smoke, a signal is sent to the controller along channel **110***g* and the controller again responds by sending a signal along channel **110***f* to activate the alarm siren **112**. The controller manages the buildings lighting, in part, by signals received along channel **110***e* from a light-level detector **120** and by signals sent along channel **110***d* to dimmer switch **106***c* which activates/deactivates the lighting fixture **18**. An operator can send and receive data to and from the controller along channel **1110***a* via an operator interface, such as a video display **102**.

[**0032**] Utilities that are distributed via the core wall **10** are channeled through utility runs constructed of conventional materials such as insulated copper wire or conduit suitable for electrical wiring, copper tubing or CPVC for hot and cold water, PVC for sewage, and iron piping or flexible metal tubing with plastic coating for natural gas and synthetic propane, and the like. The core wall and associated utility runs are built off-site, but can easily be installed on-site without need for skilled labor.

[**0033**] Each utility run disposed within the core wall has an entrance point and optionally one or more egress points. That is, each utility run within the core wall has an entrance point for receiving the utility from a point of origin and has one or more egress points for connecting the utility either to subsequent distribution runs via a utility run extension interface or to a point of use via a termination interface, or to both. In general, the terminal interfaces are located along the front **12** of the core wall. The utility run extension interface comprises conventional mateable connectors that enable the utility run to be quickly and easily connected to a complimentary connector on an extension of the utility run. As will be described in more detail below, these utility run extensions are disposed within panelized partitions which are attachable to the core wall, thus providing, in part, the means for a simple and flexible system of building construction.

[**0034**] In the embodiment depicted in **FIGS. 1 and 2**, the HVAC run **16** has an HVAC entrance point **30** which can be, for example, flexible, sound-dampening supply tubes, an HVAC extension interface **32** comprising a mateable connector, which can be, for example, "T"-connectors, and an HVAC end terminal interface **34**, which can be, for example, a ventilation register or grill. Also depicted in **FIG. 1**, the 120V electrical run **22** has an entrance point **48** which can be for example 12 gage insulated copper wire, an electrical extension interface **50** comprising a mateably connector, which can be, for example, Marrette connector, and a terminal interface **14** which can be, for example, a standard 2- or 3-prong electrical outlet. **FIG. 1** further depicts hot and cold water entrance points **44** & **46**, respectively, and extension interfaces **36** and **38**, respectively, and sewer entrance point **40** and exit point **42** comprising mateable connectors, which can be, for example, male/female compression fittings, male/female screw fittings, and the like. Alternatively, terminal interfaces of the present invention can be rough-ins for appliances such as electric ranges, gas dryers, and the like. In certain preferred embodiments, all of the utility interfaces are located above the floor level so as to allow for installation of the core wall onto an existing foundation, such a poured concrete foundation.

[**0035**] In certain other embodiments, the core module concept incorporates a simplified coordinated plumbing riser system including waste lines, vents, and supply lines which can be made in quantity and delivered to the point of assembly as a complete unit, i.e. including all fittings required for fixture and appliance hook ups as well as mateable connectors for tying into the sewer system and for extension of the vent pipes to the roof. Similarly, an electrical wiring harness can be fabricated which drops into the core unit, supplying power and switching to outlets, appliances, and lighting systems. In addition, the house electrical panel can be incorporated into this wiring harness and supplied as part of the total core module.

[**0036**] **FIGS. 11 and 12**A-B show a core wall **10** to which conventional residential appliances such as a sink **58** and a washer/dryer unit **60** are attached. Also attached to the core wall is a standard household 120V electrical outlet **62** and a ventilation louver **64**. **FIG. 12A** shows the utility runs being extended from the core wall **10** through another architectural feature of the building's interior, such as an existing wall **66**. **FIG. 12B** further shows another embodiment of the present invention, wherein terminal interfaces of a utility run (i.e. electrical outlets **62** and ventilation louvers **64**) appear on both sides of the core wall **10**. Yet another embodiment of the present invention is shown in **FIG. 5**, wherein the core wall **10** is integrated directly with appliances such as a sink **58**, a tub **68**, and recessed lighting **18**.

[**0037**] In certain preferred embodiment, the utility runs disposed in the core wall are encased in a filler, preferably synthetic polymer insulation such as foam insulation packed in oriented strand board. Preferably, the utility runs are assembled within the core wall or assembled separately and then placed within the core wall prior to adding the filler. In certain other embodiments, the core wall itself is formed by assembling the utility runs and then encasing the utility runs in the filler. In this later embodiment, the filler provides, at least in part, the structural support for the core wall. In still other embodiments, the filler may be added during the installation process at the construction site. Specific types of filler that can be used with the present invention include, but are not limited to, expanded polystyrene, rigid insulation, closed-cell foams, polyisocyanurate, and the like.

[**0038**] In certain embodiments, the core wall includes conventional structural building materials such as wood, galvanized steel, etc. These materials can provide the core wall and the utilities disposed therein with structural support. In certain other embodiments, the structural support of the core wall is derived from the inside and outside skin of oriented strand board (OSB) separated by foam insulation encasing the utility runs. Preferably, the face of the core wall is adapted to receive interior wall construction materials such as sheet rock. In certain embodiments, the core wall functions as a load-bearing wall of the building. In still other embodiments, the core wall includes provisions for integrating with conventional construction, such as plaster flanges, that can be predrilled to easily accommodate wood or metal studs of adjoining conventional walls.

[**0039**] The core wall of the present invention is also adaptable to different dimensions. Referring to **FIG. 6A**, a preferred embodiment of the core wall **10** is shown wherein the core wall has a horizontal dimension, X, and a vertical dimension, Y. Y is preferably any conventional height of an

interior room of a residential building, such as 8 feet, 10 feet, or 12 feet. In particularly preferred embodiments, the value of X is approximately 4 feet. Another preferred embodiment of the present invention is shown in **FIG. 6B** wherein the horizontal dimension X is some multiple n of approximately 4 feet, wherein n is an integer from about 1 to about 25. For example, where X is 4 feet, the horizontal length of the core wall can be 1X (four feet), 2X (8 feet), 3X (12 feet), 4X (16 feet), and the like.

[**0040**] A core wall with a horizontal length of approximately 4 feet, or some whole multiple thereof, combined with a system of plug-in interior and exterior panelized partitions creates a complete system that allows for simple and uncomplicated integration into an architectural plan. That is, core walls that have a horizontal length of approximately four feet or some whole multiple thereof can easily be represented in a 4×4 architectural planning grid, which is commonly used to design the spatial layout of a building's interior.

[**0041**] Referring to **FIGS. 7 and 8**A-8E, shown are core walls represented on a 4×4 architectural planning grid, wherein the core wall has a horizontal length of 4 feet or some multiple thereof. For example, **FIG. 8A** shows a core wall having a horizontal length of four feet and **FIGS. 8B-8E** show core walls having a horizontal length of 16 feet.

[**0042**] As shown in **FIGS. 9A and 9B**, in certain preferred embodiments, the core wall **10** is attachable to one or more prefabricated panelized partitions **56** by means of a plug-in fastening device **54**. The attaching device **54** can be any practical attachment device known in the art, including studs (metal or wood), metal cabling, prefabricated metal or extruded plastic, nails, screws, bolts and nuts, prefabricated interlocking connectors, and the like. A panelized partition according to the present invention may also be attachable to other panelized partitions by a similar means. Attachment of a panelized partition to the core wall is not limited to vertical attachments. As shown in **FIG. 13**, a panelized partition **56** may be attachable to the top or bottom edge of the core wall **10** so as to form a ceiling or floor, respectively.

[**0043**] A panelized partition **56**, as shown in **FIG. 10**, can be constructed of conventional framing materials, such as wood and galvanized steel, and covered with conventional surfacing materials, such as sheet rock or other similar products, with sheet metal products or carpeted products, or with metal or plastic lath, or with plaster or similar material. In certain other preferred embodiments, the prefabricated panelized partitions are adapted to house utility run extensions. The utility run extensions of the panelized partitions have at least one end equipped with a connector that is mateable with the connector of that utility run disposed in the core wall. Preferably, the prefabricated core wall and panelized partitions are manufactured and shipped unattached depending on the application. When the core wall and panelized partition arrive at the construction site, they are quickly and easily assembled and their respective utilities connected by unskilled labor.

[**0044**] Referring again to **FIGS. 8B-8E**, panelized partitions, in certain preferred embodiments have a horizontal length of approximately 4 feet or some whole multiple thereof, so that they are readily represented in a 4×4 architectural planning grid. The modularity and interconnectivity of the core wall and panelized partitions allows an architect or other person skilled in the art to easily design the spatial layout of a building's interior so as to maximize the effectiveness and functionality of the building's room(s).

[**0045**] According to another aspect of the present invention, provided are methods of constructing a building having the steps of providing a prefabricated core wall in which one or more utility runs are disposed; providing a computer-based control system disposed within the core wall; and integrating the control system with the utility runs so as to manage the utilities. In certain preferred embodiments, the method further comprises the steps of providing one or more panelized partitions in which one or more utility run extensions are disposed; attaching, via a plug-in fastener device, the partition to the core wall; and connecting, via a mateable connector, at least one of the utility runs disposed within the core wall with its complimentary utility run extension disposed within the partition. In certain other preferred embodiments, methods of the present invention further include the step of attaching at least one partition to another partition via a plug-in fastener device.

[**0046**] In certain other preferred embodiments of this aspect of the invention, the core wall and the partition are sized to comply with a four-foot architectural planning grid and are interconnectable to form one or more rooms. These rooms may be sized and arranged so as to maximize the utility and effectiveness of the spatial layout of the building's interior.

[**0047**] Having thus described a few particular embodiments of the invention, various alterations, modifications, and improvements will readily occur to those skilled in the art. Such alterations, modifications, and improvements, as are made obvious by this disclosure, are intended to be part of this description though not expressly stated herein, and are intended to be within the spirit and scope of the invention. Accordingly, the foregoing description is by way of example only, and not limiting. The invention is limited only as defined in the following claims and equivalents thereto.

What is claimed is:

1. A prefabricated modular building system comprising:

(a) a core wall housing a central utility distribution system; and

(b) a computer-based control system disposed within said core wall, wherein said control system is capable of integrating and managing said utility distribution system.

2. The building system of claim 1, wherein said utility distribution system comprises one or more utility systems selected from potable water, hot water, water deionization, water purification, sewage, ventilation, air purification, heating and air conditioning, electrical power, security cameras, motion detectors, smoke and dangerous gas detectors, telecommunications, electronic data transmission and reception, and audio and video entertainment.

3. The building system of claim 1, wherein said control system manages all of the utilities of the building.

4. The building system of claim 1, wherein said utility distribution system is encased in a filler.

5. The building system of claim 1, wherein said core wall is a load-bearing wall.

6. The building system of claim 1, further comprising:

(c) one or more utility runs disposed within said core wall having, at one end, a first connector that is mateable to a second connector;

(d) one or more panelized partitions attachable to said core wall via a plug-in fastener device;

(e) one or more utility run extensions disposed within said partition having, at one end, said second connector.

7. The prefabricated modular building system of claim 6, wherein said utility run comprises:

an entrance point, and

one or more egress points, wherein each egress point comprises a terminal interface or a utility run extension interface.

8. The prefabricated modular building system of claim 7, wherein said entrance and egress points are located above floor-level.

9. The prefabricated modular building system of claim 6, wherein said plug-in fastener device is selected from metal studs, wood studs, metal cabling, prefabricated metal or extruded plastic, nails, screws, bolts and nuts, and prefabricated interlocking connectors.

10. The prefabricated modular building system of claim 6, wherein said partition is one of a wall, ceiling, and floor.

11. The prefabricated modular building system of claim 6, wherein said core wall and said partition are sized to comply with an architectural planning grid.

12. The prefabricated modular building system of claim 11, wherein said core wall and said partition have a width that is approximately a whole multiple of four feet.

13. The prefabricated modular building system of claim 12, wherein said core wall and said partition have, independently of each other, a width of 4 feet, 8 feet, 12 feet, 16 feet, 20 feet, 24 feet, 28 feet, or 32 feet.

14. The prefabricated modular building system of claim 6, comprising one or more panelized partitions attachable to other partitions via said plug-in fastener device.

15. A method of constructing a building comprising the steps of:

(a) providing a prefabricated core wall in which one or more utility runs are disposed;

(b) providing a computer-based control system disposed within said core wall;

(c) integrating said control system with said utility runs to manage said utilities.

16. The method of claim 15, wherein said utility runs comprises one or more utility systems selected from potable water, hot water, water deionization, water purification, sewage, ventilation, air purification, heating and air conditioning, electrical power, security cameras, motion detectors, smoke and dangerous gas detectors, telecommunications, electronic data transmission and reception, and audio and video entertainment.

17. The method of claim 15, wherein said control system manages all of the building utilities.

18. The method of claim 15, further comprising the steps of:

(d) providing one or more panelized partitions in which one or more utility run extensions are disposed;

(e) attaching said partition to said core wall via a plug-in fastener device; and

(f) connecting at least one utility run disposed within said core wall with at least one utility run extension disposed within said partition via mateable connectors.

19. The method of claim 18 further comprising the step of:

(g) attaching at least one partition to another partition via plug-in fastener device.

20. The method of claim 18, wherein said core wall and partitions are interconnected to form one or more rooms.

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