United States Patent

Ruderfer

[15] **3,642,339**

[45] **Feb. 15, 1972**

[54] WAREHOUSING STORAGE SYSTEM

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[22] Filed: **May 28, 1970**

[21] Appl. No.: **41,212**

[52] **U.S. Cl.**.....**312/283,** 312/198, 312/211, 52/134, 214/16.4, 211/151

[51] **Int. Cl.**.....**A47b 81/00,** A47b 97/00

[58] **Field of Search**.....312/198, 236, 211, 283, 286; 211/151; 52/79, 134, 263; 214/16.4

[56] **References Cited**

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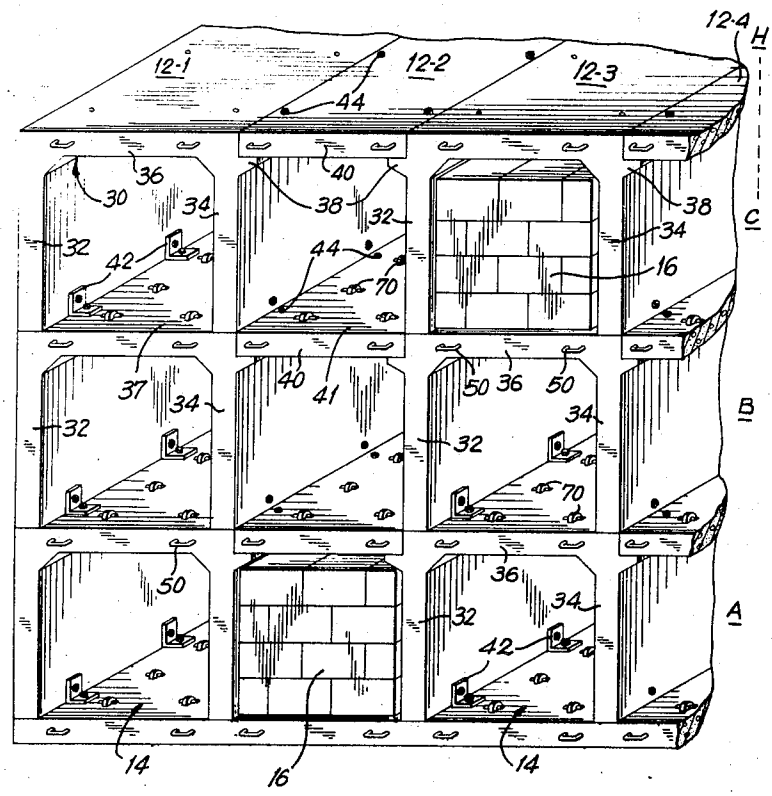
Primary Examiner—James C. Mitchell

Attorney—Stewart J. Fried

[57] **ABSTRACT**

In a warehousing storage system wherein the products are grouped into unit loads, a storage structure is disclosed which includes vertical and horizontal rows of individually isolated compartments, each intended to accommodate a substantial number (e.g., 50) of unit loads along its length. The compartments are preferably constructed from modular elements formed of concrete or other suitable fireproof material to provide a dimensionally stable storage structure compatible with automated order selection arrangements and demonstrating efficient space utilization.

10 Claims, 8 Drawing Figures



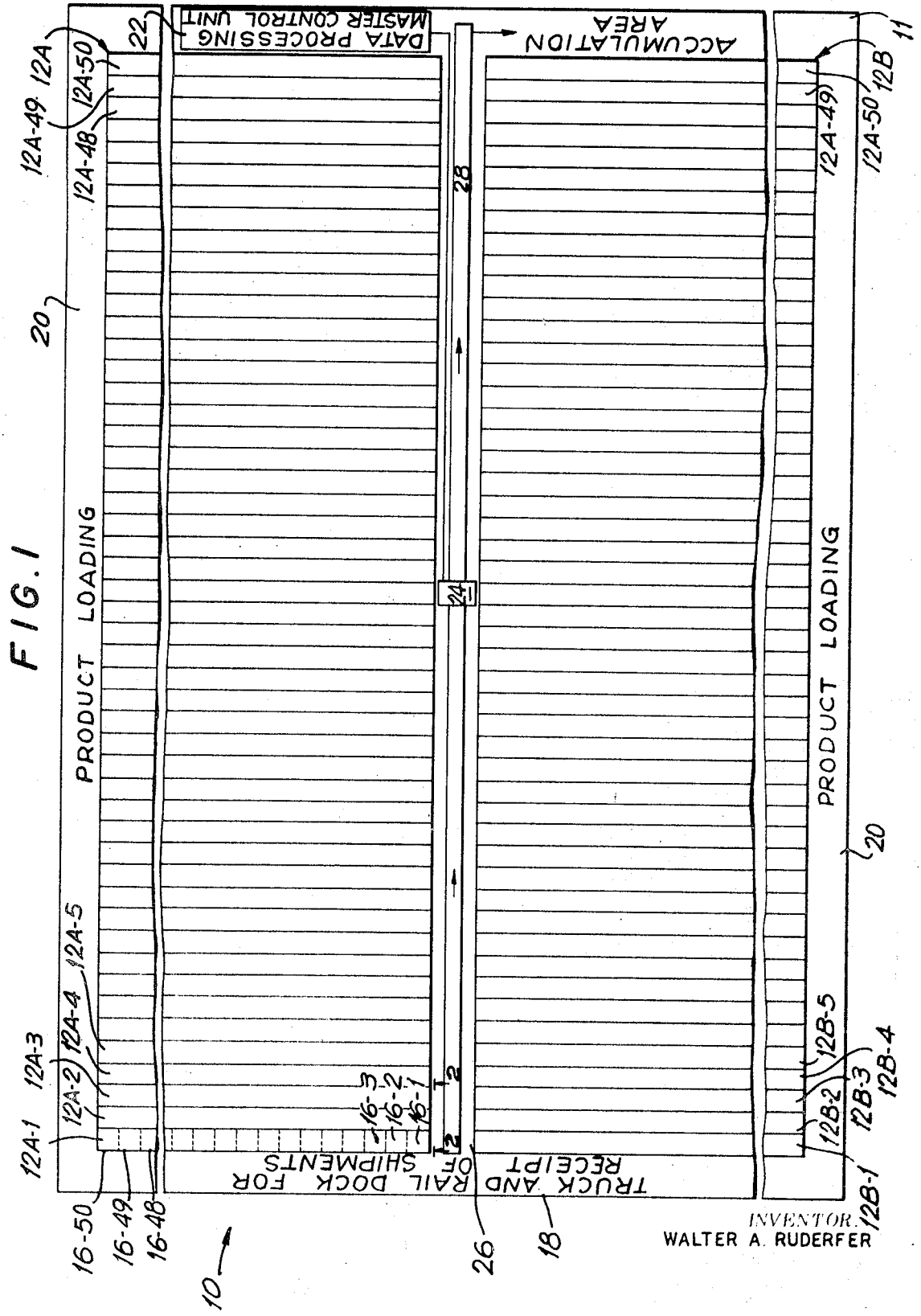


FIG. 1

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FIG. 2

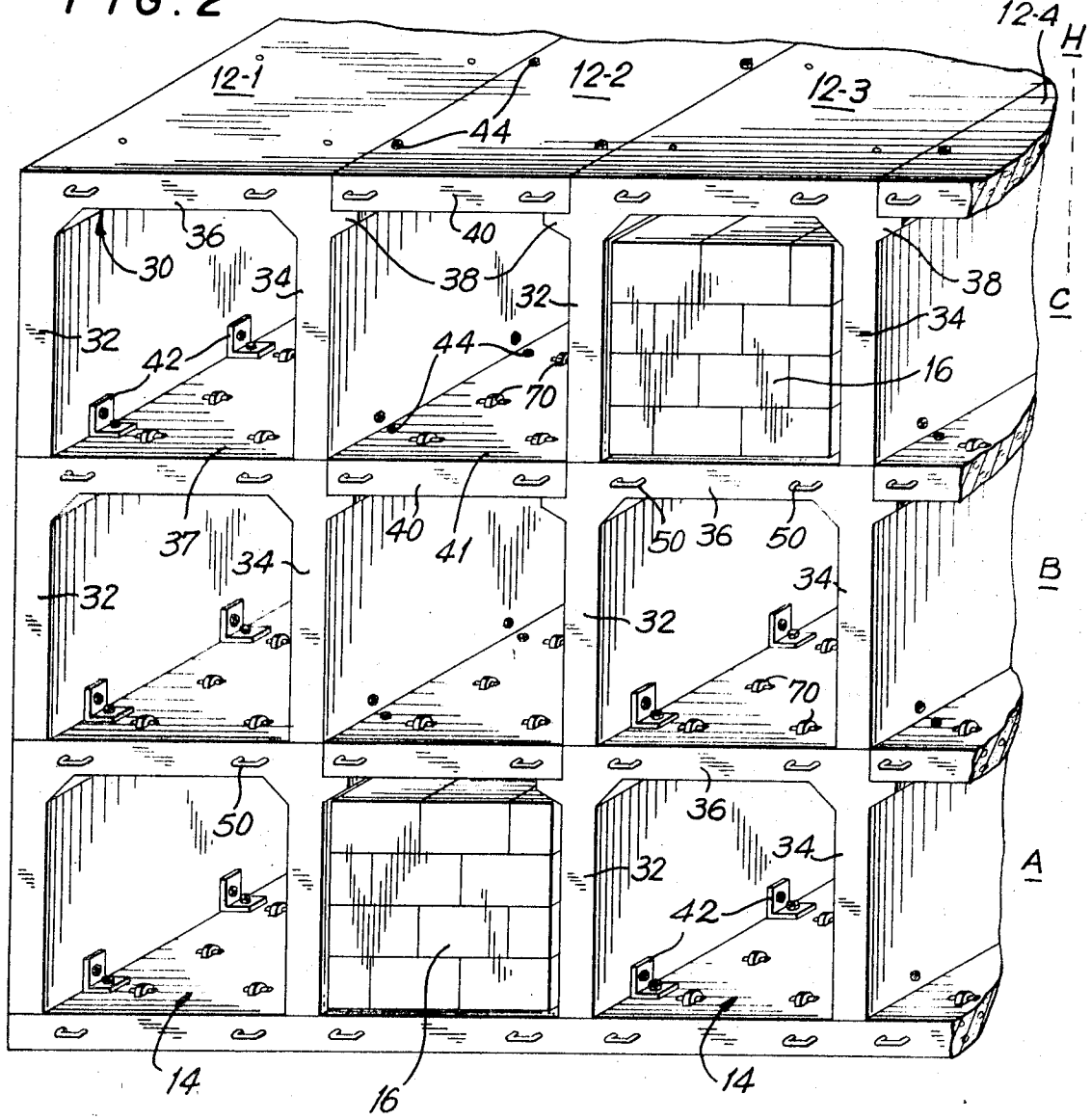
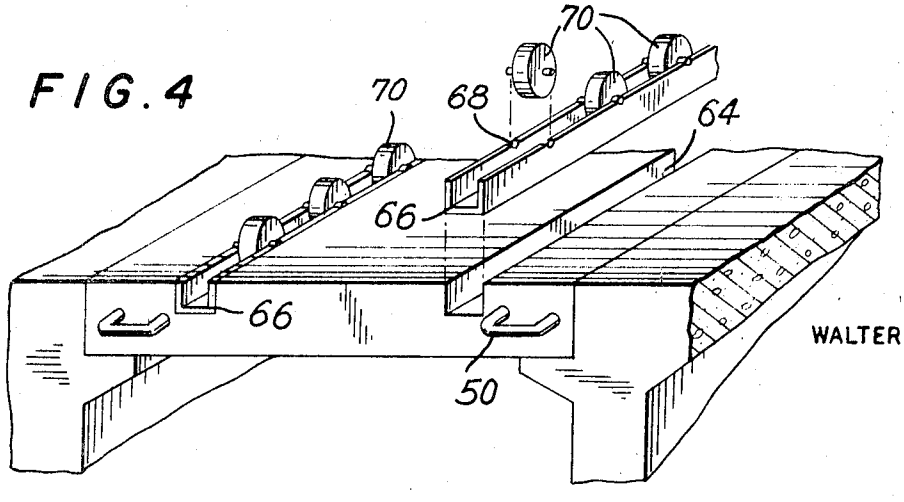


FIG. 4



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FIG. 3

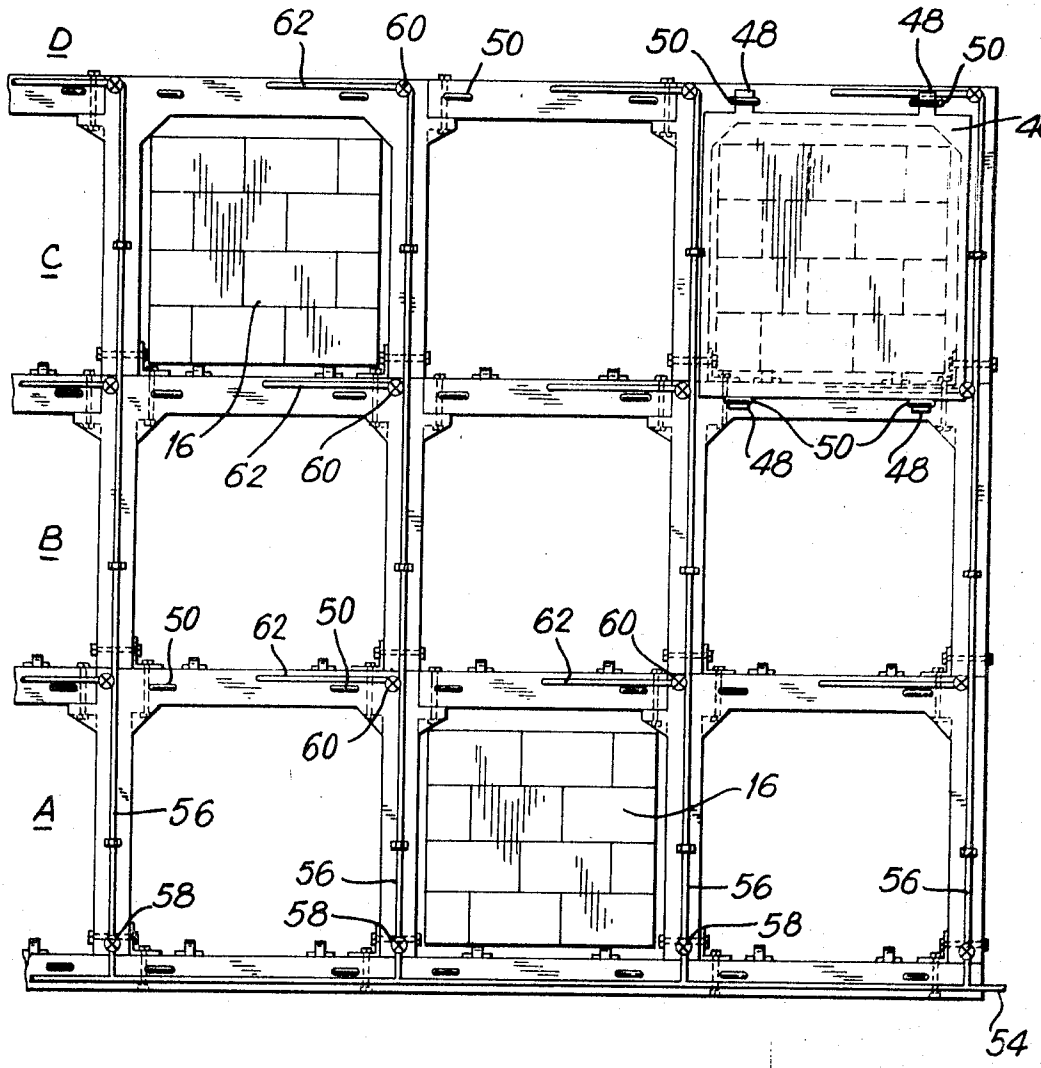
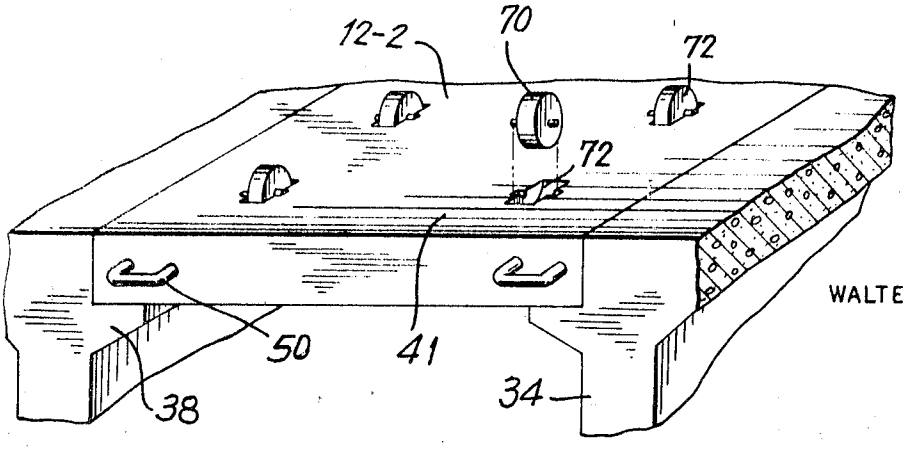


FIG. 5



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FIG. 7

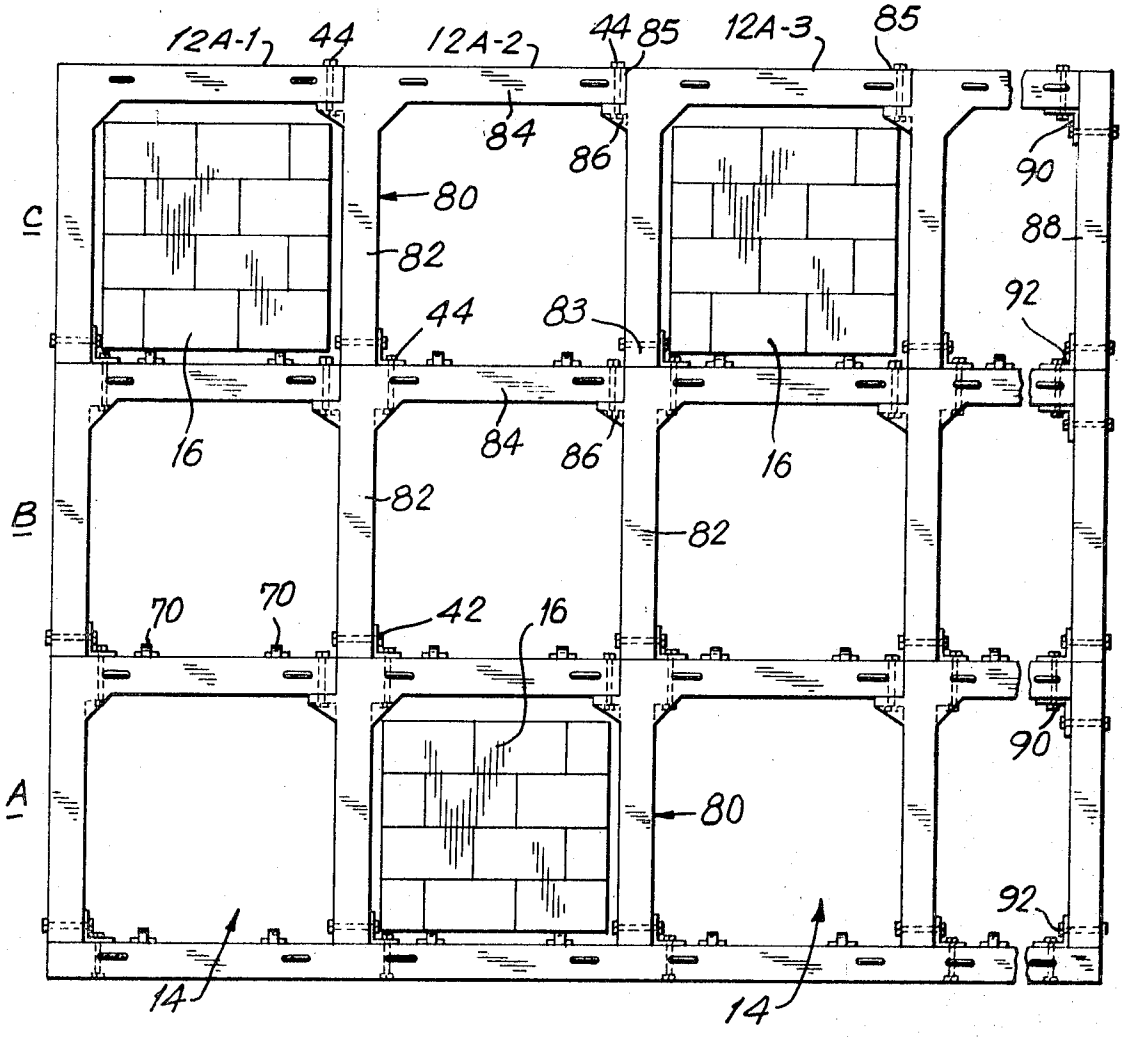
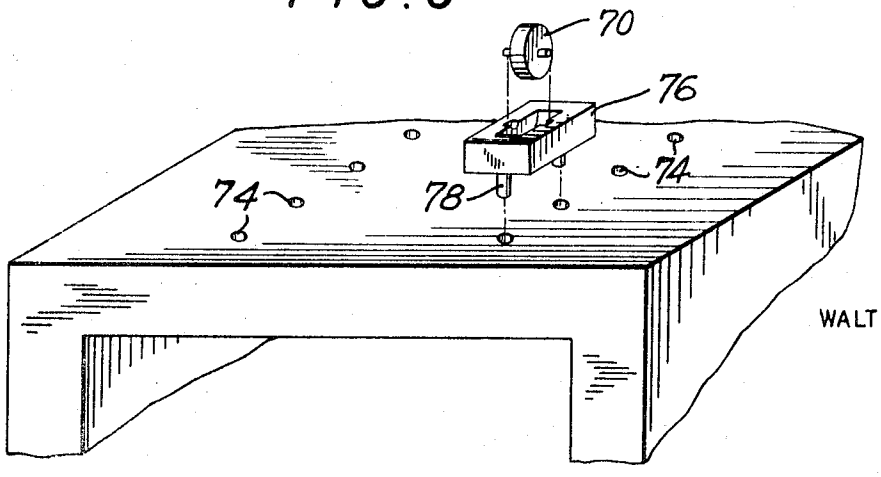
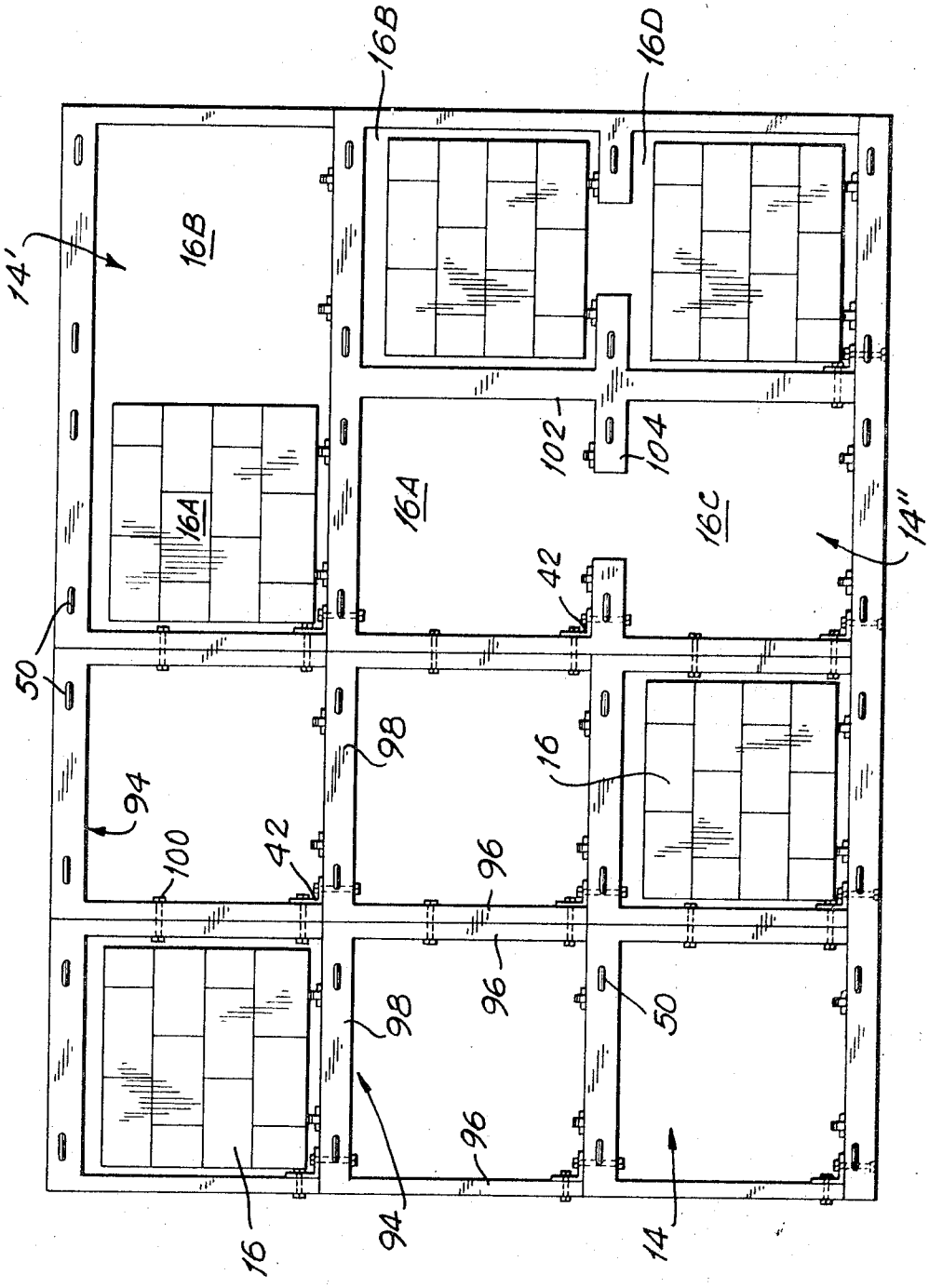


FIG. 6



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FIG. 8



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WAREHOUSING STORAGE SYSTEM

The present invention relates to a warehousing system, and more particularly, to a storage structure consisting of an interconnected plurality of tunnellike enclosed compartments, each adapted to contain a substantial quantity of unit loads.

In warehouses operated by distribution organizations, a variety of products are received in large quantities, which are usually grouped in unit loads, which may typically be of the type capable of being handled by conventional pallet handling equipment. These unit loads are then stored in individual stalls which are typically arranged in adjacent horizontal and vertical rows. In the filling of an order for a particular outlet, an order selector must remove the desired products from their respective compartments, and then combine the selected products. With the advent of larger distribution requirements, rising labor and building costs and the increasing use of frozen foods, warehousing systems are becoming increasingly automated. Up to now, the introduction of automatic or semiautomatic order selection systems has been done in conjunction with conventional racking structures. Such racking structures have various deficiencies, relating to the economies of construction and maintenance and the methods of order selection. The present invention provides an improved storage structure which is easier and less costly to construct, and has certain operating advantages.

One type of storage system presently practiced in conjunction with conventional manually operated forklift equipment is known as floor-loading. This consists of stocking one unit load above the other, usually in depth. The height of stacking is limited by the ability of the lower loads to withstand crushing from the weight of the other unit loads. In addition, the close proximity of all the unit loads poses a serious fire hazard, usually requiring sprinkler equipment. Even with such equipment, a fire is apt to spread to and damage a substantial volume of stored merchandise. Also, should some product spillage occur in one unit load, this can spread to and contaminate many other unit loads.

In order to alleviate the crushing problem and provide for a greater variety of products within a given volume, various racking systems have been constructed of a lattice work of horizontal and vertical steel beams, dividing the space into cubicles. Such racking systems are typically shown in my prior U.S. Pat. No. 3,351,219 and U.S. Pat. Nos. 3,119,501 and 3,033,392. Such racking systems are essentially of an openwork construction, thereby failing to alleviate the aforementioned problems of fire and spillage isolation. Also, such racks have been limited in depth, in order to minimize shifting of the rack, thereby requiring additional aisle space, creating additional erection problems and costs since each facing is physically separated from the other facings.

Another racking system, which permits increased depth of storage is drive-in rack. This racking structure subdivides the vertical space into cubicles, but disadvantageously requires the emptying of the lower vertical levels before the forklift equipment may be driven in to handle the inner depth of the upper levels. While the latter disadvantage may be alleviated by gravity flow or power-driven racks, the structure is still subject to fire and spillage problems.

A further disadvantage of the various prior art storage racking systems is that they are not self-sustaining. Thus, they require a building, satisfying various structural requirements, which adds to the cost of the warehousing system. Also, since such racking structures are openwork lattices within the volume enclosed by the supporting building, the entire contents will be at the same temperature. Hence, if only some of the stored commodities need be maintained at a certain temperature, the entire building had to be kept at such temperature.

These various limitations of the prior art are eliminated by the present warehousing storage structure composed of an interconnected array of individually isolated tunnellike compartments. Each of the compartments is, enclosed by solid fireproof walls (e.g., concrete) which serve to isolate any fire or spillage to that particular compartment. The compartments

are of sufficient width and height to accommodate a unit load, which is typically on a pallet, and of a length to contain a substantial number (e.g., 50) of such unit loads, one behind the other. The compartments are preferably formed of modular prefabricated concrete members which may be readily interconnected to provide the basic storage structure. Such a storage structure is rigid and requires a minimum of structural requirements for the associated building—essentially just an enclosure is needed since the interconnected modules are self-sustaining and provide their own outer walls.

The unit loads stored within the compartments are progressively fed forward by either an intermittently activated power drive or gravity feed. Where a gravity feed is used, recesses may be provided in the concrete floor of the compartment for the reception of roller assemblies, which preferably include control braking wheels (such as the type available from Control Flow Systems, Lancaster Pa.) to suitably slow down the forward movement of the unit loads within the compartment. The compartments have an appropriate angle of slope, with the rear being higher than the front, to promote such gravity feed.

In accordance with another aspect of the present invention, the isolation of compartments not only inhibits the spreading of fires, but permits the suffocation of such fires by sealing up the ends of the compartments. This avoids the need for expensive sprinkler equipment, previously one of the drawbacks to high-rise warehousing structures. Also, such compartmentalization permits individual temperature control within the storage volume. Thus, where automatic order selection is used, the building need not be heated, with those products which must be maintained at certain temperatures being located within temperature-controlled compartments.

As another advantageous feature of the present invention, in the event a problem occurs in one of the compartments (e.g., spillage) which requires human assistance, the compartments have a floor which may be walked on, while preventing damage to the products stored at lower levels. This is particularly important where such tunnels may be 30 to 50 feet above the floor.

Another advantage of the present storage structure is its dimensional stability. This is particularly important in conjunction with multilevel computer-controlled order selection where any shifting of the cubicles will adversely effect the accuracy of order selection.

It is therefore a primary object of the present invention to provide an improved warehousing structure, providing increased construction and operating efficiencies.

Another object is to provide such an improved warehousing structure, including a honeycomb of fireproof tunnellike compartments arranged in adjacent vertical and horizontal rows, each compartment having a length adapted to receive a substantial number of unit loads, one behind the other.

A further object is to provide such a warehousing structure in which the compartments are formed of an interconnected assembly of prefabricated modular members, which provide the outer walls of a self-sustaining building enclosure.

These as well as other objects and advantages of the present invention will become apparent upon a consideration of the following description and accompanying drawings in which:

FIG. 1 is a simplified diagrammatic view of a typical warehouse layout incorporating a pair of novel storage structures in accordance with the present invention.

FIG. 2 is a partial frontal perspective view of the storage volume, as seen from along the order selection aisle, and shown by the arrows 2—2 of FIG. 1.

FIG. 3 is a partial rear view of the storage structure, showing heating conduits for individual compartment temperature control and the compartment end cover which may be used for fire control

FIG. 4 is a perspective view showing a gravity drive for moving the unit loads forward.

FIG. 5 and 6 show alternative gravity feed arrangements.

FIG. 7 shows another embodiment of modular prefabricated elements for constructing the storage unit.

FIG. 8 shows still various other arrangements for constructing the storage unit of modular prefabricated elements, some of which compartments may, if desired, have a cross section to accommodate more than one unit load.

Referring to the drawings in detail and initially to FIG. 1 and 2 thereof, a warehousing system **10** is illustratively shown contained within a building enclosure **11**. As will be henceforth discussed in detail, since the storage structure within building **10** is a self-sustaining multistoried unit, the building enclosure **11** primarily serves as a covering and not as a structural support. Hence, such a building may be constructed in a simpler and less expensive manner than other warehouse buildings, and may typically be formed of prefabricated wall sections.

Warehouse **10** includes a pair of storage structures **12A, 12B**, each similarly constructed in accordance with the present invention. The particular layout of storage structures **12** and warehouse **10**, is only one of numerous such systems which may be constructed in accordance with the general concept of the present invention, and accordingly is not intended as a limitation of its application. Storage structure **12** includes a plurality of horizontal and vertical rows of individual compartments **14**. In a typical such storage structure, 50 horizontal rows may be provided, (indicated by **12-1, 12-2, 12-3 . . . 12-49, 12-50**) and eight vertical rows (indicated by A, B, C . . . H). Each of the compartments **14** is of an appreciable length, typically able to accommodate 50 unit loads, **16**, of stored products, which may be conventional size unit loads (e.g., 48 inches side, 72 inches high, and 40 inches deep). The unit loads are located within the compartment, one immediately behind the other, as indicated by **16-1, 16-2, 16-3 . . . 16-49, 16-50**. Thus, each of the storage structures **12** can accommodate up to 20,000 unit loads with a minimum of nonusable space. It should be appreciated that with such a substantial volume of merchandise, the spread of fire or product spillage is a formidable problem.

In accordance with general warehousing practice, the products received at the dock **18** are grouped into unit loads suitable for movement by fork lift equipment. Such unit loads are then transferred to the storage structure loading areas **20**. The unit loads are then moved into the desired compartments **14** for the particular commodity. The correlation of such movement may be governed by an appropriate data processing system, generally shown as **22**, which may be of the type shown in U.S. Pat. Nos. 3,119,501, or 3,480,162. **The data processing equipment 22 automatically directs the loading of merchandise to a partially filled compartment 14 intended for that commodity, or to the next available compartment location, should the previous compartment containing that commodity have its full capacity of unit loads, or the warehouse is depleted of that commodity. In selecting a compartment, the data processing equipment preferably stores the temperature requirement of each commodity so as to permit different segments of the storage unit to have different temperatures. Through appropriate equipment control and system handling, the compartments may include unit loads of intermixed commodities which require the same storage temperatures. The compartment locations of the various types of merchandise are stored within the memory portion of the data processing system 22. The order selection means 24, which moves along a single common aisle 26 may be of the pallet removal type shown in U.S. Pat. No. 3,119,501**, or an individual article removal type shown in U.S. Pat. No. 3,351,219. Order selection means **24** is automatically dispatched to the compartment locations of the desired articles for filling a particular customer's order on a first-in, first-out basis. When positioned at the desired compartment, the order selection means **24** removes the desired number of articles and then may typically transfer same to a conveyor **28**, the terminus of which leads to an accumulation area.

The individual compartments **14**, are completely self-enclosed (except for their loading and dispensing ends) and are, in accordance with the present invention formed of a solid mass of fireproof material. This material is preferably concrete with the entire storage unit **12** being formed of an interconnected array of prefabricated members. As shown in FIG. **2**, these members may be of a first and second type, **30** and **40** respectively. The first type of prefabricated concrete member **30** is substantially U-shaped, and includes a pair of spaced vertical walls **32, 34**, and an interconnecting horizontal wall **36**, extending inward between the vertical walls at one end thereof. A horizontal ledge **38** extends outward of each of the vertical walls (except, if desired, those forming the end walls of compartments **12A-1, 12A-50, 12B-1** and **12B-50**), at the top region thereof, and downwardly displaced from the top surface of the horizontal wall **36**. The second type of prefabricated concrete member **40** is a planar member having a thickness corresponding to the downward displacement of the ledge **38**, and preferably corresponding to the thickness of wall **36**. With the first and second members alternately arranged, as shown in FIG. **2**, enclosed compartments are formed with the vertical walls **32, 34** providing the common sidewall of adjacent compartments within the same horizontal row, and the horizontal walls **36, 40** providing the common top and bottom walls of adjacent compartments within the same vertical row. The members are advantageously secured together by spaced recessed angle brackets **42**, bolted to threaded inserts within the prefabricated members, and bolts **44** extending through aligned openings in ledge **38** and the sides of slab member **40**. Thus, the storage units **12A, 12B**, in addition to being self-sustaining structures, have a high degree of dimensional stability, thereby improving the accuracy of positioning the automatic order selector **24**.

By virtue of compartment isolation, any fire occuring in a compartment will be inhibited from spreading to other compartments. Further, such fires may be suffocated by the provision of a simple cover **46** (e.g., steel) which may be inserted at the opposed ends of the particular compartment where a fire has occurred. These covers include projecting members **48**, which are inserted into U-shaped extensions **50**. This effective method of fire control avoids the expense and complications of sprinkler systems. Isolation of the compartments also serves to localize any spillage that may occur, preventing the spillage from physically upsetting other unit loads beneath, as would occur in open framework racks, and permits improved vermin control.

Further, since the compartments are isolated by substantial concrete walls, they may have individual temperature control. This is illustratively shown in FIG. **3**, where main hot air conduit **54** is connected to an individual riser, **56**, at those sections of the storage unit which are to be heated. A separate shutoff valve **58** may be provided for each riser, and if desirable, a separate shutoff valve **60** for each compartment. The individual compartment conduits **62** then enter an opening along one of the walls, which wall includes an internal passageway with spaced openings in the compartment. Alternatively, a blower may be positioned at the end of the compartment. Similarly, where desired, other compartments, or sections of the storage unit, may be kept at a suitable temperature for maintaining frozen foods. It should thus be recognized that by not heating or cooling an entire building substantial operating cost reductions are obtained.

As a particular unit load is depleted, the next unit load may be automatically moved forward to the selection aisle **26** by an appropriate power-driven conveyor, unit-load gravity feed conveyor, or gravity feed slat conveyors as discussed in my previous U.S. Pat. No. 3,351,219. Advantageously, one of the gravity feed arrangements as shown in FIGS. **4–6** may be provided along the suitably canted bottom of the compartment. Referring to FIG. **4**, the bottom surface **37** (or **41**) includes a pair of longitudinal grooves **64** which receive U-shaped tracks **66**. Tracks **66** include axial support recesses **68** for locating skate wheel assemblies **70**. As shown in FIG. **5**, recesses **72** are provided along the surfaces **37** or **41** for directly mounting the axle and wheel assemblies **70**. In FIG. **6**, the axle and wheel assemblies **70** are mounted in recesses **74** via an intermediate mounting block **76** having complementary projections **78**. In addition control braking wheel assemblies (not shown) may

be included to govern the speed of unit load movement within the compartment.

Reference is now made to FIG. 7, which shows an alternative configuration of prefabricated concrete members **80** for forming the storage modules **12A**, **12B**. The interconnected concrete members **80** are L-shaped, and include a vertical wall **82** and horizontal wall **84**. A downwardly displaced horizontal ledge **86** extends outward of the L, for seating the free end **85** of the adjacent member **80**. However, those modules forming the outer walls of compartments **12A-1** and **12B-1** may have this ledge omitted. The free ends **85** are appropriately secured to the ledge **86**, as by the bolts **44**, and the free ends **83** of the vertical walls are secured to the top of the downwardly preceding compartment (forming the bottom of the next upward compartments) as by angle brackets **42**, in the same manner as shown in FIG. **2**. To complete the endmost compartment of rows **12A-50** and **12B-50**, a planar member **88** is secured in place, as by bolted angle brackets **90** and **92**.

FIG. **8** shows still another configuration of prefabricated members **94** which are all U-shaped, and include sidewalls **96** and an interconnecting horizontal wall **98**. These members are placed one next to another and one on top of each other. Dependent on loading and materials selected, walls **96** may be of lesser thickness than wall **98**. Adjacent horizontal units may be interconnected by bolts **100**. Brackets **42** may be used to connect vertically adjacent units. If desired, some of the compartments, such as **14'**, may be wider to accommodate a pair of side-by-side unit loads **16A**, **16B**, or a wider unit load, such unit loads extending in depth along the length of the compartment. Also, a compartment, such as **14''**, may have an inner divider wall **102** and horizontal ledges **104**, so as to provide a cross section which accommodates four unit loads **16A**, **16B**, **16C** and **16D**. While the compartments **14'** and **14''** do not provide the extent of fire spillage retardation isolation of the single-unit load compartment **14**, they still provide an appreciable improvement over the openwork rack of the prior art, and simplify the warehouse fabrication.

It should naturally be understood that numerous other modifications and variations can be made from the embodiments of the invention disclosed herein without departing from the spirit and scope of the invention. Accordingly, it is to be understood that the invention is not limited by such specific embodiments, but is defined in the appended claims.

I claim:

1. In a warehousing storage and product selection system in which the stored products are grouped in unit loads, a storage structure comprising:

an interconnected plurality of horizontally and vertically successive modular elements forming a self-sustaining structure defining individual compartments adjacently disposed within a plurality of horizontally and vertically successive rows;

each of said compartments being of sufficient width and height to accommodate at least one unit load, and having a length corresponding to a substantial multiple of unit-load depths, such that each compartment may contain a series of successively adjacent unit loads along the length thereof;

each of said compartments including a first end whereat the unit loads of products to be stored therein are received, and a second end whereat the products stored therein are dispensed to an order selector;

said dispensing ends lying within a common vertical plane;

the modular elements defining each of said compartments providing continuous top, bottom and side walls formed of a solid mass of material and void of any openings between adjacent compartments, and said continuous modular element walls enclosing their respective compartments completely along the length thereof, and isolating each compartment from its adjacently disposed compartment.

2. In a warehousing storage and product selection system as set forth in claim **1**, said compartment walls being formed of a fireproof material.

3. In a warehousing storage and product selection system as set forth in claim **2**, said compartments walls being formed of a plurality of interconnected solid prefabricated members.

4. In a warehousing storage and product selection system as set forth in claim **3**, said solid prefabricated members including a first and second type, each of a length corresponding to the compartment length:

said first type being U-shaped and including a pair of spaced vertical walls, an interconnecting horizontal wall extending inward between said vertical walls at one end thereof, and a horizontal ledge extending outwardly of each of said vertical walls, at the top region thereof, and downwardly displaced from the top surface of said horizontal wall;

said second type being a planar member of a thickness corresponding to the downward displacement of said horizontal ledge, and of a width corresponding to the compartment width;

a horizontal row including alternate first and second members, with the lower edges of said second members seated on the horizontal ledges of the first members at either side thereof;

said vertical walls providing the sidewalls of said compartments and said horizontal walls and planar member alternately providing the top walls of said compartments and the bottom walls of the compartments in the vertically successive horizontal row.

5. In a warehousing storage and product selection system as set forth in claim **3**, said solid prefabricated members including a plurality of L-shaped members;

each of said L-shaped members being of a length corresponding to the compartment length and including:

a vertical wall of an extent corresponding to the compartment height;

a horizontal wall extending from one end of said vertical wall, in a first horizontal direction, and of an extent corresponding to the compartment width;

a horizontal ledge extending from said one end, in a second horizontal direction, appreciably less than the extent of said horizontal wall, and downwardly displaced from the top surface of said horizontal wall an amount corresponding to the thickness of such wall;

a horizontal row including successive L-shaped members with the free end of each horizontal wall seated on the horizontal ledge of the next adjacent L-shaped member,

said vertical walls providing the sidewalls of said compartments, and said horizontal walls providing the top walls of said compartments, and the bottom walls of the compartments in the vertically successive horizontal row.

6. In a warehousing storage and product selection system, as set forth in claim **3**, said solid prefabricated members being self-supporting, and forming outer walls of the warehousing building enclosure.

7. In a warehousing storage and product selection system, as set forth in claim **1**, said compartment walls being formed of fireproof material and further including a fire-retarding cover means for sealing the first and second ends of individual compartments.

8. In a warehousing storage and product selection system as set forth in claim **1**, further including temperature control means for controlling the temperature of individual compartments.

9. In a warehousing storage and product selection system as set forth in claim **1**, further including means for feeding successive ones of said unit loads towards said second end, as the preceding unit loads are removed from the compartment.

10. In a warehousing storage and product selection system, as set forth in claim **3**, further including means for feeding successive ones of said unit loads towards said second end, as the preceding unit loads are removed from the compartment, said

feeding means including a plurality of rollers seated within complementary recesses along the compartment floor.

* * * * *