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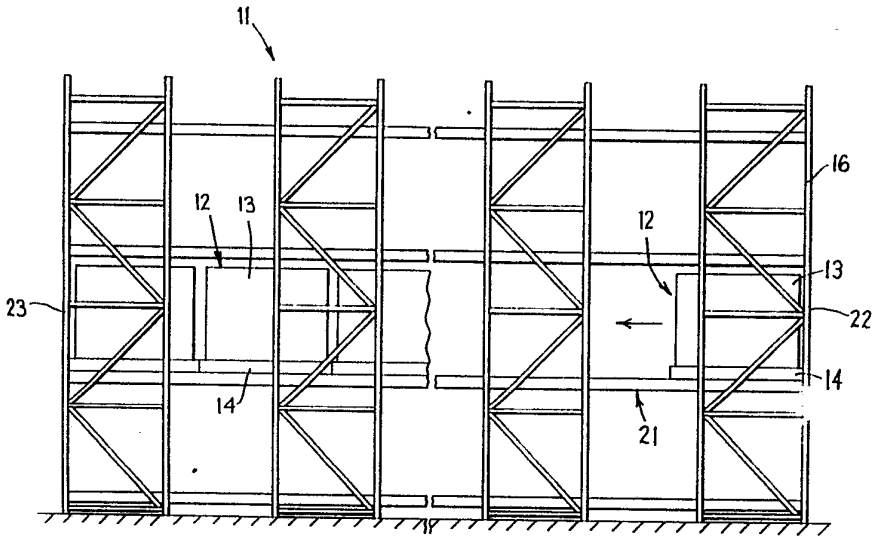
(54) Title: LEVEL GRAVITY CONVEYOR



(57) Abstract

A conveyor arrangement (21), as associated with a storage rack (11), employs a plurality of individual trolleys or cars (45) supported on sloped runways segments (42) which in turn are supported on a pulsating or cyclically-actuated vertical lifting arrangement (56), with the complete arrangement being supported within a rail (26, 27) having upper edges which function as supporting flanges (33) for the loads. When the lifting device (56) is activated to lift the inclined runways (42) and cars (45) upwardly, the loads (12) are lifted away from the supporting flanges (33), whereby the weight of the loads causes the cars (45) to move downwardly by gravity along the sloped runways (42) whereby the loads are forwardly advanced a small amount, until the loads again contact the support flanges (33). When the cars (45) are lowered due to lowering of the lifting arrangement (56), the cars (45) are biased back to a raised position along the upper end of the runway (42) whereby they are again engaged under the load so as to permit a repeat of the cycle.

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LEVEL GRAVITY CONVEYOR

FIELD OF THE INVENTION

This invention relates to a gravity-type transporting or conveying system which is desirable for use as part of a first in-first out storage rack arrangement for storage and transporting of palletized loads and, more particularly, to a system which extends horizontally between input and output ends thereof but permits gravity-induced advancing of loads therealong.

BACKGROUND OF THE INVENTION

My earlier U.S. Patent Nos. 4 205 740, 4 044 876, 4 304 521 and 4 759 676 disclose pulsating gravity-type conveyors which are particularly desirable for conveying palletized loads, and which are also highly desirable for use in storage-rack systems for permitting "first in-first out" storage of palletized loads. In this known conveyor or storage-rack system, the loaded pallets are supported directly on conveyor rollers, which rollers are disposed in longitudinally adjacent relationship and are supported by a carriage or rail structure which enables the rollers to vertically reciprocate in a cyclic or repetitive manner. This arrangement physically causes the palletized loads to be

intermittently lifted and lowered relative to a longitudinally extending stationary brake which extends at a slight decline relative to the horizontal. The pallets are stopped by the brake when the pallets and rollers are in their lowered positions, whereas the slope of the roller arrangement enables limited gravity-induced forward advancing of the pallets when the rollers are in their raised positions.

While the known arrangement described above has proven highly successful and desirable for transporting and storing palletized loads, particularly in storage rack arrangements, nevertheless in some storage racks the spacial or size requirements prevent optimum utilization of such systems in terms of permitting maximum utilization in the number of vertically stacked bays, or use of the system due to the extensive length of the individual bays. For example, with known gravity-type systems of the type described above, the slope of the conveyor as it extends longitudinally along the bay typically involves a vertical drop of about six inches for each ten feet of horizontal conveyor length. Since such conveyors when incorporated into storage racks typically extend from a minimum length of about 40 feet to a maximum length of as much as 200 feet, the vertical drop over such lengths can vary from as little as about two feet to about ten feet. Because of this vertical drop, when several bays each incorporating a conveyor are stacked vertically on top of one other, the number of stacked bays is limited not only by the height limitation of the building, but also by the vertical drop caused by the slope of the conveyor. Thus, optimum utilization of available space, particularly vertical height, cannot always be achieved.

The present invention thus represents an improved gravity-type conveyor which is believed to improve upon known conveyors of this general type by permitting more efficient utilization of vertical height available within a building, and hence permitting utilization of a larger number of vertically stacked bays in a storage rack within the same amount of available vertical space then was previously possible.

More specifically, with the improved arrangement of the present invention, the gravity-type conveying system is again associated with each bay of a storage rack, which bays are stacked vertically one above the other, with several stacks or columns being disposed horizontally adjacent. The individual inventive conveyor as associated with each bay, however, extends horizontally between input and output ends so that a palletized load as positioned on the conveyor at the input end is at the same elevation as the palletized load stored at the output end. The conveyor, however, incorporates a pulsating load-engaging arrangement which enables the loads to be vertically raised and lowered in a pulsating or cyclic manner, and at the same time enables the individual palletized loads to be gravity-urged forwardly along the conveyor through sequential small distances or steps to effect forward advancing of the loads from the input to the output end of the conveyor.

With this improved arrangement, as described above, the overall available height can be more efficiently utilized since the individual bays do not require additional height at one end to compensate for slope inasmuch as the individual conveyors extend horizontally. This enables a greater number of bays to be vertically stacked within a predetermined

height, and thus enables higher density storage of palletized loads within a particular building volume.

Further, the improved arrangement results in the input ends of the bays being generally lowered than previously possible, and thus facilitates the positioning of loads onto the input ends of the bays. This arrangement also enables the palletized loads to remain horizontal at all times, even during the gravity-urges advancing of the palletized loads along the conveyor. This thus avoids having to tip to tilt the loads, thereby providing greatly improved load stability. This is particularly desirable in situations where the loads are pallets having other objects such as bottles or the like loaded thereon, since the continual horizontal stability of the loads provides greater safety of handling and less tendency for the objects to slip or move off of the pallet.

The improved conveyor arrangement, as associated with the storage rack, employs a plurality of individual trolleys or cars supported on sloped runway segments which in turn are supported on a pulsating or cyclically-actuated vertical lifting arrangement, with the complete arrangement being supported within a rail having upper edges which function as supporting flanges for the palletized loads. When the lifting device is activated to lift the inclined runways and cars upwardly, the pallets are lifted away from the supporting flanges, whereby the weight of the pallets causes the cars to move downwardly by gravity along the sloped runways whereby the loads are forwardly advanced a small amount, until the pallets again contact the support flanges. When the cars are lowered due to lowering of the lifting arrangement, the cars are biased back to a raised position along the upper end of the runway whereby they are again engaged under the pallet so as to permit a repeat of the cycle.

Other objects and purposes of the present invention, including rearrangements of the structure illustrated and described hereinafter, will be apparent to persons familiar with arrangements of this general type upon reading the following specification and inspecting the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a side elevational view of a typical storage rack modified to include the inventive conveyors associated with the individual bays.

Figure 2 is a end elevational view of the storage rack which is diagrammatically illustrated by Figure 1.

Figure 3 is an enlarged fragmentary view which illustrates a conveyor as associated with one bay of the rack, and having a palletized load associated therewith.

Figure 4 is a side elevational view which diagrammatically illustrates, in the longitudinal extent thereof, the improved gravity-type conveyor of the present invention.

Figure 5 is an enlarged, fragmentary sectional view illustrating one of the trolleys associated with the conveyor of this invention.

Figure 6 is an enlarged sectional view which is taken generally along line 6-6 of Figure 4.

Certain terminology will be used in the following description for convenience in reference only, and will not be limiting. For example, the words "upwardly", "downwardly", "rightwardly" and "leftwardly" will refer to directions in the drawings to which reference is made. The word "forwardly" will refer to the normal forward direction of a load along the conveyor, which forward direction is rightwardly in Figures 1, 4 and 5. The words "inwardly" and "outwardly" will refer to directions

toward and away from, respectively, the geometric center of the system and designated parts thereof. Said terminology will include the words specifically mentioned, derivatives thereof, and words of similar import.

DETAILED DESCRIPTION

Figures 1 and 2 illustrate a storing and transporting rack system 11 designed specifically for handling and storing palletized loads 12, which loads in the illustrated embodiment comprise suitable articles or goods 13 stacked on conventional pallets 14. The storing and transporting system 11, in a preferred embodiment, incorporates a rack-type framework 16 which includes a plurality of horizontally adjacent columns 17, each including a plurality of bays or tiers 18 disposed vertically one above the other. Each bay has a gravity-type conveyor or transporter 21 associated therewith and extending longitudinally along the framework from an input end 22 to an output end 23. The conveyor or transport 21 is designed to provide for "first in-first out" storage of palletized loads.

According to the present invention, the conveyor or transporter 21 includes a pair of generally parallel, sidewardly-spaced, horizontally elongate support rails 26 and 27 which extend longitudinally between the input and output ends of the respective bay. These support rails are identical except for being mirror images of one another, and are suitably fixedly secured to and supported on appropriate transverse frame members 28 associated with the framework 16. These support rails 26 and 27 extend horizontally throughout the length thereof between the input end 22 and the output 23. That is, the support rails are not inclined or sloped, and thus the input and output ends 22 and 23 are at the same elevation.

Each support rail 26 and 27 includes a generally upwardly-opening, U-shaped channel defined by a substantially horizontal bottom wall 29 which fixedly and rigidly joins to the bottom edges of a pair of upwardly projecting and sidewardly spaced side walls 31. The channel defines therein a horizontally elongated channellike space 32 which opens upwardly. Each side wall 31 has a flange 33 fixed to the upper edge thereof, which flange extends horizontally along the entire length of the support rail and projects horizontally sidewardly in an outward direction (that is, away from the channellike space 32). The pair of flanges 33 project sidewardly in opposite directions from the upper edges of the channel member, and define thereon upper horizontally-extending surfaces 34 which function as support or brake surfaces for engagement with the underside of the pallets 14. The outermost flange 33, adjacent its outer edge, is also rigidly joined to an edge flange 35 which slopes upwardly at an angle of about 45° as it also projects further outwardly. The pair of edge flanges 35 as defined on the pair of support rails 26 and 27 are hence disposed outermost and function both so sidewardly confine the pallet 14 therebetween, and to effect sideward recentering of the pallet during lowering thereof.

Each of the support rails 26 and 27 mounts therein a load advancing arrangement 37 which extends longitudinally throughout the length of the respective support rail and is adapted to provide for a gravity-induced incremental or steplike forward advancing movement of the loads from the input end 22 toward the output end 23.

This load advancing arrangement 37 includes a declining track or runway structure 38 which is horizontally elongated and extends throughout substantially the entire horizontal length of each of

the support rails 26 and 27. This runway arrangement 38 is positioned within the channellike space 32 and is supported on the respective support rail so as to permit limited vertical displacement therebetween, while being restrained from horizontal movement. This is accomplished, in the illustrated embodiment, by a plurality of pins 39 which are fixed to and extend transversely through the runway structure 38 at longitudinally spaced intervals therealong. The opposite ends of the pins 39 project outwardly beyond the runway and are confined within vertically elongate slots 41 formed in the adjacent side walls 31. These slots 41 normally have closed upper and lower ends to permit only limited vertical displacement of the runway arrangement relative to the support rail.

The runway arrangement 38 is defined by a plurality of ramplike segments 42 which are positioned adjacent and fixedly and rigidly connected together so as to extend throughout the horizontal length of the respective support rail 26, 27. Each ramp segment 42 includes a rearwardly facing shoulder 43 which, at its upper edge, joins to an upper declining surface 44 which slopes downwardly at a small angle as it project forwardly (that is, as it projects toward the output end 23). This declining surface 44 preferably slopes downwardly at a small angle, such as a downward slope in the range of about 2° to about 5° relative to the horizontal, with the lowermost and forwardmost end of this declining surface terminating at the shoulder 43 of the next forwardmost adjacent ramp segment 42.

The elongate declining runway structure 38 is preferably formed in lengths which individually comprise a plurality of ramp segments, with the lengths being suitably rigidly secured together using conventional constructional techniques so that the

overall runway arrangement, as it extends throughout the length of the support rail, effectively functions as a unitary structure. The individual ramp segments 42 themselves, however, are normally of rather short horizontal length, such as in the neighborhood of about 12 inches.

To permit gravity-urged advancement of loads, the load advancing arrangement 37 also includes a plurality of load-engaging units 45 rollingly supported on the declining runway arrangement 38. In fact, preferably at least one such load-engaging unit 45 is associated with each ramp segment 42.

The load-engaging unit 45 functions substantially as and is formed similar to a trolley or car, and includes a top wall 46 which is rigidly joined to a pair of sidewardly-spaced side flanges 47 which project downwardly from the top wall. The side flanges 47 and top wall 46 define a generally inverted channellike structure which is positioned within the channellike space 32 in vertical disposition about the runway arrangement 38. Each trolley frame 46-47 is rollingly supported by front and rear rollers or bearings 48 and 49, respectively. These rollers 48 and 49 are confined between the side flanges 47, and are supported for rotation about respective front and rear axes 51 and 52, whereby the rollers are disposed for rolling engagement with the upper declining surface 44 of the respective ramp segment 42. The front and rear axes 51 and 52 are disposed in parallel relationship, and are horizontally and vertically sidewardly displaced, whereby a line extending perpendicularly between the axes 51 and 52 extends in parallel relationship to the declining surface 44.

Each load-engaging unit or trolley 45 is normally urged or biased toward an uppermost position adjacent the upper end of the respective declining

surface 44, and this is accomplished in the illustrated embodiment by a conventional compression spring 53 which coacts between the respective trolley and the rearward end of the forwardly adjacent ramp segment.

The trolley 45 defines thereon an upper surface 54 which is adapted to directly contact the underside of the load or pallet 14. This upper surface, which is substantially horizontally straight when viewed sidewardly, is preferably of an upwardly convex configuration when viewed sidewardly, as illustrated by Figure 5. This upwardly curved configuration of the upper surface helps to distribute loads, particularly by ensuring that the trolley contacts the load or pallet at a point located somewhere between the front and rear rollers, rather than permitting contact at either the front or rear edge of the trolley.

The load advancing arrangement 37 also includes a reciprocating vertical lifting arrangement 56 which cooperates between the runway arrangement 38 and the respective support rail 26 or 27 so as to effect cyclic raising and lowering of the load advancing arrangement 37. This vertical lifting arrangement 56, in the illustrated embodiment, includes an elongate gas (i.e. air) inflatable hose 57 (such as a fire hose) disposed within the bottom of the respective support rail and extending longitudinally throughout the entire horizontal extent thereof. This inflatable hose 57 is normally supported directly on the bottom wall 29 of the support rail and in turn supports thereon the flat bottom surface 58 of the runway arrangement 38.

The hose 57 is connected to a suitable power source 61, such as an air compressor, the latter being activated and regulated by a suitable control unit 62, such as a conventional time-control valve,

so that the hose 57 can be cyclicly inflated and deflated in an intermittent yet regulated manner, such as for example approximately 15 to 25 cycles per minute, whereby the load advancing arrangement 37 (that is, the runway arrangement 38 and the load-engaging trolleys 45) are cyclicly raised and lowered in a reciprocating and repetitive manner relative to the support rails 26 and 27 at a rate corresponding to the pulse rate of the hose 57.

In operation, a palletized lo is deposited on the transporter or conveyor 21 a ne input end 22 thereof, such as by a forklift truck. As the hoses 57 of t transporter are cyclicly infla ed and deflated, the advancing arrangements 37 in rails 26 and 7 are also c licly raised and lowered in a rep itive fashi During raisin the trolleys 45 which are engaged with the undersi of the pallet (preferably a minimum of two or three trolleys will be engaged with each pallet) are lifted upwardly so as to lift the pallet upwardly a small distance above the support surfaces 34. The weight of the pallet thus causes the trolleys 45 to roll forwardly by gravity along the downward incline of the declining surfaces 44, thereby forwardly advancing the pallet through a small steplike distance which may be in the order of about three inches to about six inches. The forward advancing of the pallet, due to rolling movement of the trolleys downwardly along the declining surfaces, will continue either until the declining movement of the trolleys causes the pallet to reengage the support surfaces 34, or until the hose 57 is deflated and lowers the pallet back into engagement with the support surfaces 34.

Once the hose 57 is deflated and the pallet 12 repositioned on the support surfaces 34, the continued deflation of the hose 57 tends to effect further lowering of the trolleys 45 away from the underside of the

pallet, whereupon the springs 53 then urge the respective trolleys upwardly along the respective declining surfaces 44 back toward their uppermost position whereby the upper surfaces 54 thereof are again contacted with the underside of the pallet.

The system is then in a position to repeat the cycle in that the hoses are again inflated so that the trolleys again lift the pallet away from the support surfaces and then permit a forward gravity-urged steplike advance of the pallet in the same manner as described above.

Due to this continuous cyclic pulsing of the hoses 57, and the corresponding cyclic actuation of the load advancing arrangements 37, a palletized load can be moved forwardly along the conveyor in a steplike fashion. This forward stepping of the load will continue until the load abuts against a stationary object, such as a front stop or the next forwardly positioned pallet.

For example, if no other pallets are positioned forwardly on the conveyor, then the pallet will be moved forwardly until it contacts a stop disposed at the forward end of the bay. This stop will hold the pallet horizontally stationary, even though the pallet may continue to cycle up and down in response to the pulsing of the inflatable hoses. The pallet is then in a position to be removed when desired, such as by use of a forklift.

On the other hand, if several pallets are arranged in abutting contact rearwardly away from the output end of the conveyor, then pallets which are supplied to the input end will be conveyed forwardly only until they abut the next frontmost stationary pallet. However, when the frontmost pallet as disposed directly at the output end is removed, then continued cyclic movement of the advancing arrangement causes all of the pallets to advance

forwardly in a steplike manner until the leading pallet again contacts the front stop.

With the arrangement of this invention, since the support rails and the conveying structure associated therewith all extend horizontally from the input end to the output end, the pallets themselves remain in a horizontal orientation at all times, even during the lifting and lowering thereof due to the pulsing of the hoses, and also during the forward advance thereof as the trolleys move downwardly along the declining ramps. Thus, the articles or goods supported on the pallets also remain horizontal, and thus are not subjected to tilting or tipping forces induced or created by an inclined orientation of the pallet.

The system for controlling and pulsing the inflatable hoses is conventional, having been extensively utilized on the inclined gravity conveyors shown in Applicant's patents mentioned above, so that further description of such system is believed unnecessary.

While a highly preferred utilization of the improved conveyor or transporter of the present invention is its incorporation into a first in-first out storage rack system employing several bays stacked vertically on top of one another, with each bay employing one of the transporters therein for forwardly advancing and storing loads, nevertheless it will be understood that the improved transporter can also be desirably utilized in nonstorage rack applications, such as more conventional conveying applications.

Although a particular preferred embodiment of the invention has been disclosed in detail for illustrative purposes, it will be recognized that variations or modifications of the disclosed apparatus, including the rearrangement of parts, lie within the scope of the present invention.

Claims:

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A level gravity-type transporting apparatus for transporting loads along a predetermined direction, comprising:

support rail means (26,27) extending longitudinally parallel to the direction of load movement, said rail means extending horizontally from an input end to an output end, said support rail means defining an upwardly facing and substantially longitudinally elongated support surface (34) extending substantially horizontally longitudinally for supportive engagement with loads;

runway means (38) extending horizontally of said support rail means (26,27) and including a plurality of ramplike members (42) which are disposed horizontally in series along the longitudinal extent of said support rail means, each of said ramplike members (42) having an upwardly facing surface (44) which declines as it projects forwardly toward the output end;

a plurality of separate and independently movable load-advancing trolley units (45) movably supported on said runway means (38) at longitudinally spaced intervals therealong, each said trolley unit (45) being movably supported on one of the declining surfaces (44) and having an upwardly facing surface (54) adapted for supportive engagement with an underside of the load, and means (53) for urging the trolley means (45) into an uppermost position along the respective declining surface (44) for engagement with the underside of the load when the load is engaged with the support surface (34), and;

lifting means (56) for causing cyclic raising and lowering of the trolley units (45) relative to

the support rail means (26,27) according to a repetitive pattern to effect lifting of the load away from the support surface (34), following which the load and the trolley units which are engaged therewith are moved forwardly by gravity due to the trolley units moving forwardly and downwardly along the respective declining surfaces (44) to permit a forward steplike advancing movement of the load.

2. An apparatus according to Claim 1, wherein said ramplike members (42) are vertically movably relative to said rail means (26,27) and are cyclically vertically raised and lowered by said lifting means (56).

3. A level gravity-type transporting apparatus for transporting loads along a predetermined direction, comprising:

a pair of sidewardly spaced and substantially parallel support rails (26,27) extending longitudinally parallel to the direction of load movement, said rails extending horizontally from an input end to an output end, each said support rail defining thereon an upwardly facing and substantially longitudinally uninterrupted support surface (34) extending substantially horizontally longitudinally for supportive engagement with loads;

vertical lifting means (56) supported on and extending longitudinally of said rails, and control means (62) coupled to said lifting means for causing cyclic raising and lowering of the lifting means relative to the support rail according to a repetitive pattern;

load advancing means (37) coupled with said lifting means (56) for repetitive cyclic raising and lowering thereof;

said load advancing means including horizontally elongate runway means (38) extending horizontally of said support rail (26,27) and movable vertically relative thereto, said runway means being coupled to said lifting means (56) for cyclic raising and lowering thereby relative to said support rails;

said runway means (38) including a plurality of ramplike segments (42) which are disposed horizontally in series throughout the longitudinal extent of said support rail, each of said ramplike segments (42) having an upwardly facing surface (44) which declines as it projects forwardly toward the output end;

said load advancing means (37) including a plurality of separate and independently movable trolley units (45) movably supported on said runway means (38) at longitudinally spaced intervals therealong, each said trolley unit (45) being movably supported on one of the declining surfaces (44) and having an upwardly facing surface (54) adapted for supportive engagement with an underside of the load, and means (53) for urging the trolley unit (45) into an uppermost position along the respective declining surface (44) for engagement with the underside of the load when the lifting means (56) is in a lowered position and the load is engaged with the support surfaces (34);

whereby the lifting means (56) effects raising of the runway means (38) and of the trolley units (45) to effect lifting of the load away from the support surfaces (34), following which the load and the trolley units which are engaged therewith are moved forwardly by gravity due to the trolley units moving forwardly and downwardly along the respective declining surfaces (44) to permit a forward steplike advancing movement of the load.

4. A storage rack system having a framework (16) defining a plurality of adjacent columns (17) each defining a plurality of vertically adjacent bays (18), and a gravity-type transporting apparatus (21) associated with and extending longitudinally along a plurality of said bays for permitting gravity-urged movement of loads (12) from an input end of the respective bay (18) to an output end thereof, said transporting apparatus (21) comprising:

a pair of sidewardly spaced and substantially parallel support rails (26,27) extending longitudinally of said bay (18), said rails extending horizontally between said input and output ends, each said support rail defining thereon an upwardly facing and substantially longitudinally uninterrupted support surface (34) extending substantially horizontally longitudinally of said bay for supportive engagement with the loads;

vertical lifting means (56) supported on and extending longitudinally of said rails, and control means (62) coupled to said lifting means for causing cyclic raising and lowering of the lifting means relative to the support rail according to a repetitive pattern;

load advancing means (37) coupled with said lifting means for repetitive cyclic raising and lowering thereof;

said load advancing means (37) including horizontally elongate runway means (38) extending horizontally of said support rails (26,27) and movable vertically relative thereto, said runway means being coupled to said lifting means for cyclic raising and lowering thereby relative to said support rails;

said runway means (38) including a plurality of ramplike segments (42) which are disposed horizontally in series throughout the longitudinal

extent of said support rails (26,27), each of said ramplike segments having an upwardly facing surface (44) which declines as it projects forwardly toward the output end;

said load advancing means (37) including a plurality of separate and independently movable trolley units (45) movably supported on said runway means (38) at longitudinally spaced intervals therealong, each said trolley unit being movably supported on one of the declining surfaces (44) and having an upwardly facing surface (54) adapted for supportive engagement with an underside of the load, and means (53) for urging the trolley unit (45) into an uppermost position along the respective declining surface (44) for engagement with the underside of the load when the lifting means (56) is in a lowered position and the load is engaged with the support surfaces (34);

whereby the lifting means (56) effects raising of the runway means (38) and of the trolley units (45) to effect lifting of the load away from the support surfaces (34), following which the load and the trolley units which are engaged therewith are moved forwardly by gravity due to the trolley units moving forwardly and downwardly along the respective declining surfaces (44) to permit a forward steplike advancing movement of the load.

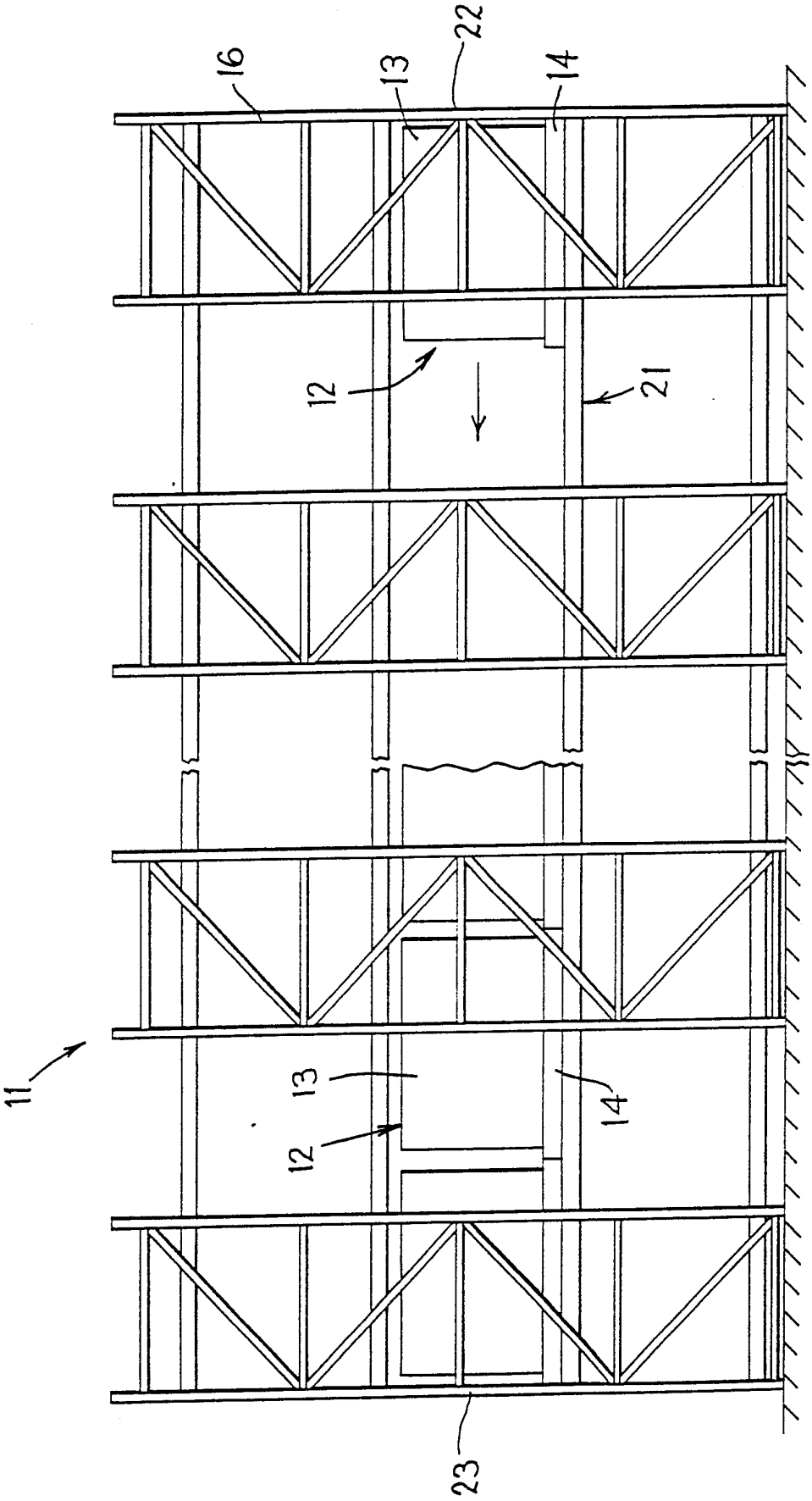

FIG. 1

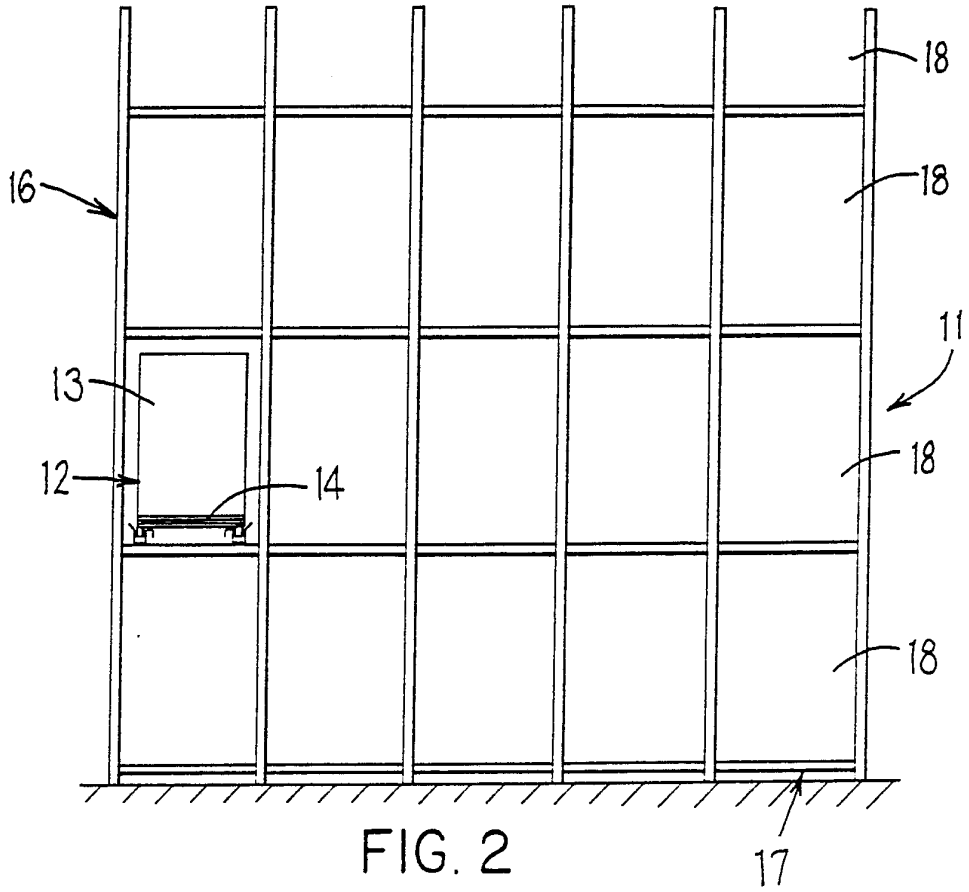
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FIG. 2

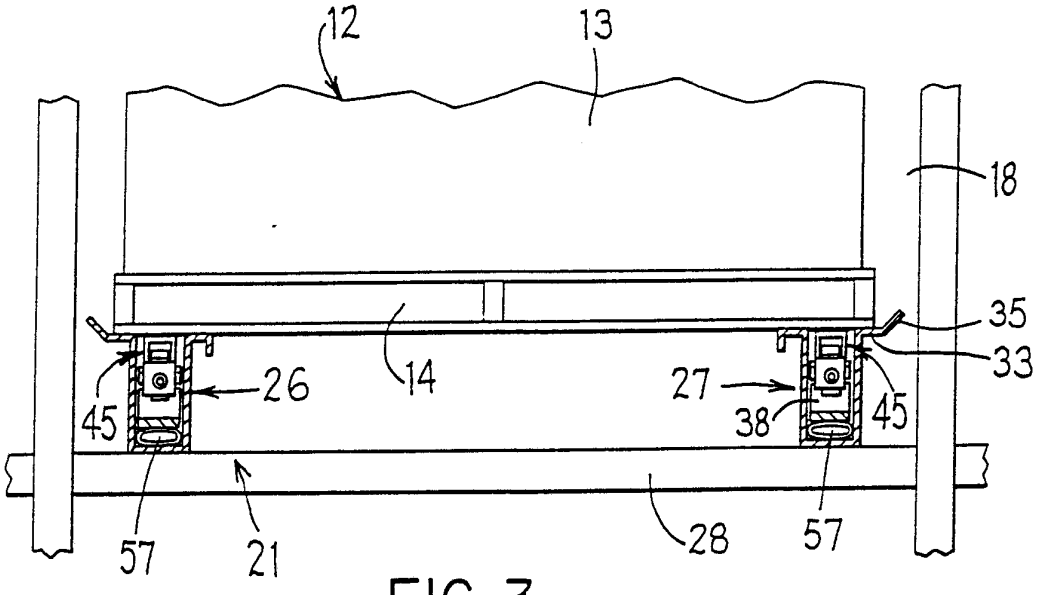
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FIG. 3

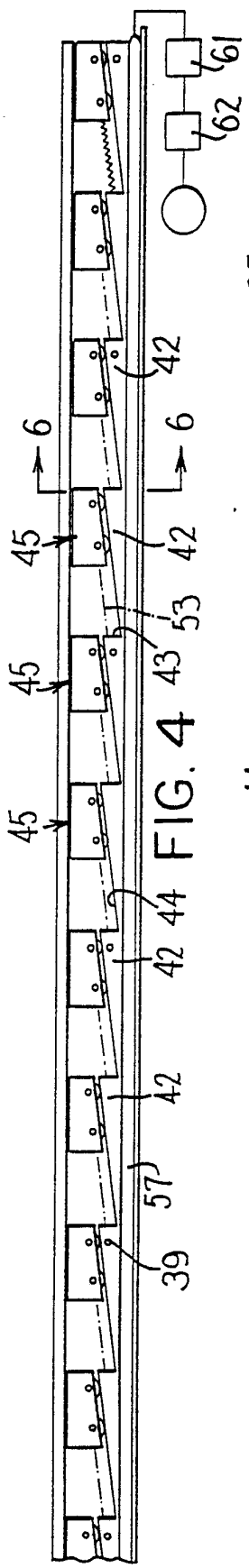

FIG. 4

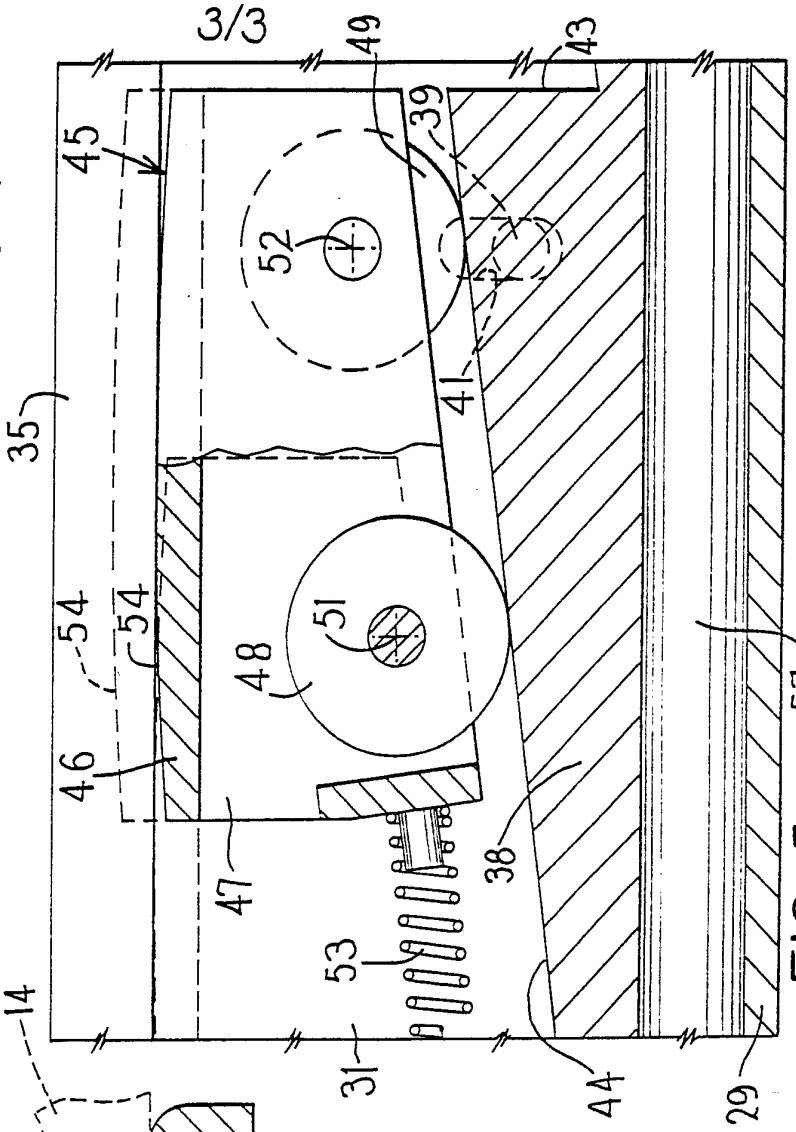

FIG. 5

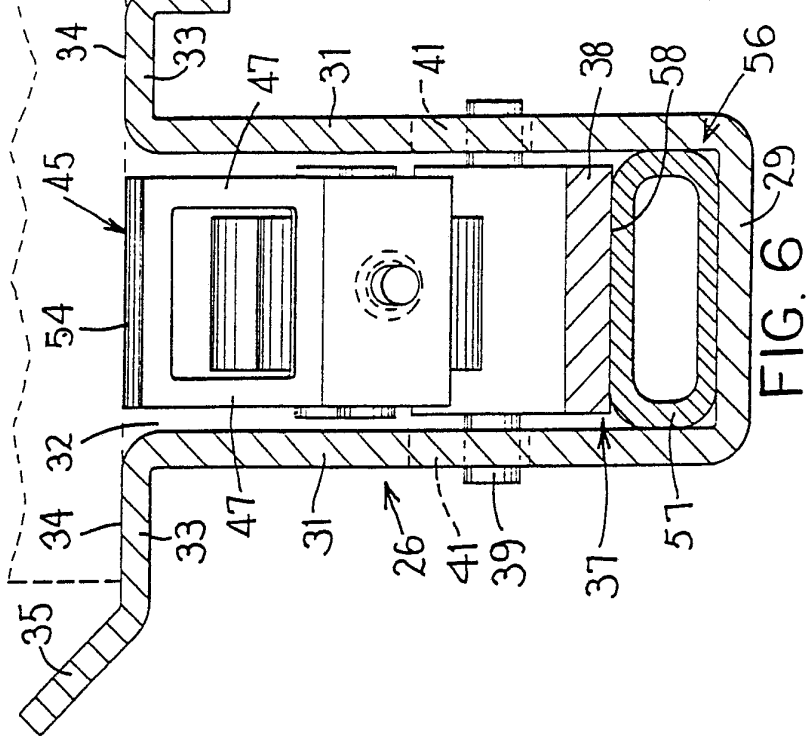

FIG. 6

INTERNATIONAL SEARCH REPORT

International Application No. PCT/US92/01209

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC (5): B65G 1/06
U.S.Cl.: 414/267

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
U.S.	414/267,276,286; 198/774.2,774.2,774.4

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category *	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
A	US, A, 3,451,532 (MANTERFIELD) 24 June 1969	
A	US, A, 3,658,171 (FUKADA) 25 April 1972	
A	US, A, 4,044,876 (HAMMOND) 30 August 1977	
A	US, A, 4,205,740 (HAMMOND) 03 June 1980	
A	US, A, 4,304,521 (HAMMOND) 08 December 1981	
A	US, A, 4,673,326 (HALONEN ET AL.) 16 June 1987	
A	US, A, 4,723,909 (ROUVET) 09 February 1988	
A	US, A, 4,759,676 (HAMMOND) 26 July 1958	
A	US, A, 4,787,803 (VAN ELTEN ET AL.) 29 November 1988	

* Special categories of cited documents: [10]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
04 May 1992	11 JUN 1992
International Searching Authority	**Signature of Authorized Officer**
ISA/US	David A. Bucci

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