

[54] STORAGE PALLETS AND DRIVE MEANS THEREOF

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[58] Field of Search.....238/122, 123, 137, 138, 281; 287/64, 65, 103; 198/85; 74/464, 465; 214/16.14 D, 16.1, 16.14 C, 16.12

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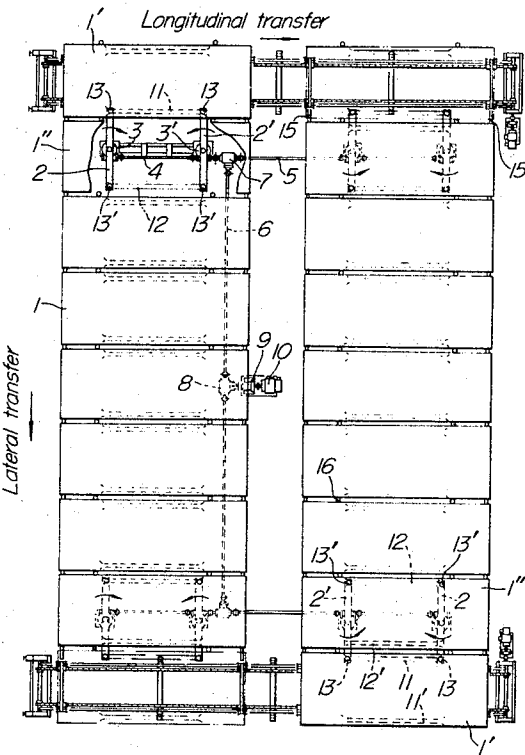
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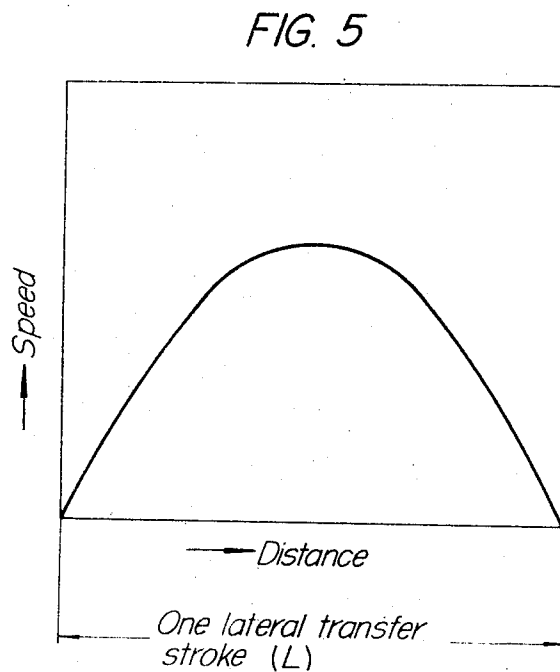
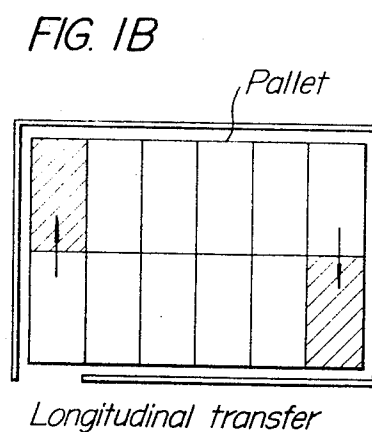
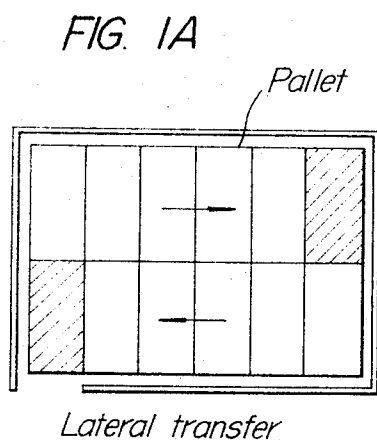
Primary Examiner—Gerald M. Forlenza
Assistant Examiner—R. B. Johnson
Attorney—Craig, Antonelli & Hill

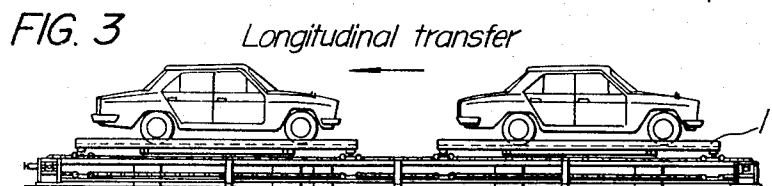
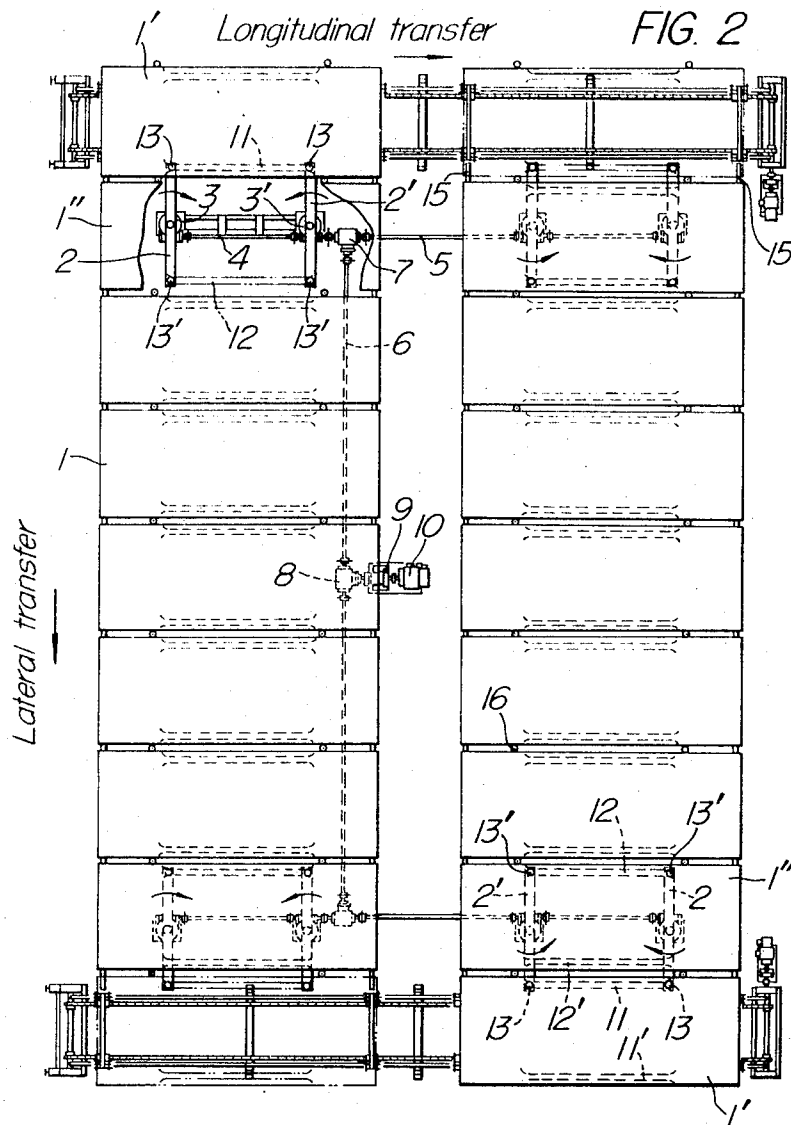
[57] ABSTRACT

A horizontal circulation type of storage equipment having a plurality of horizontal rows of article carrying pallets arranged in a manner to provide a vacancy of pallet at one end of each of the pallet rows so that successive and alternate transfer of pallets can move a desired pallet to a predetermined station. Drive means for successively and alternately transferring the pallets in their longitudinal and lateral directions, plural-storied storage equipment consisting of a stack of the above storage equipments, storage equipment provided with lift means, and coupling means for the pallets are described herein.

3 Claims, 37 Drawing Figures







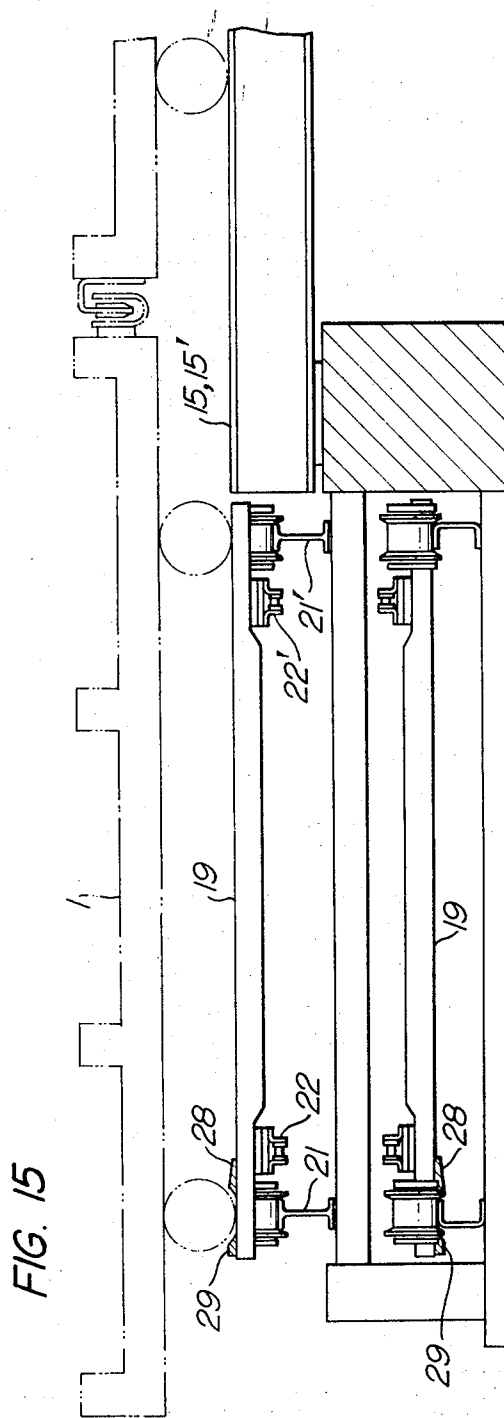
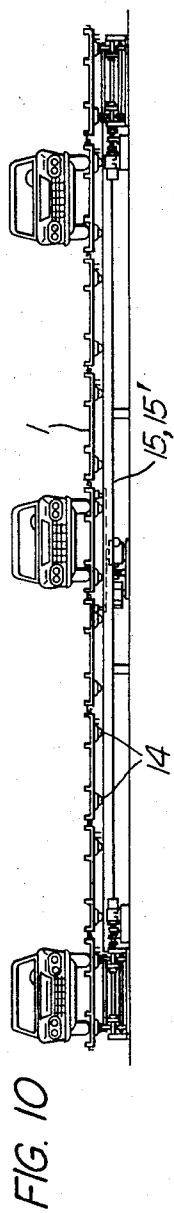
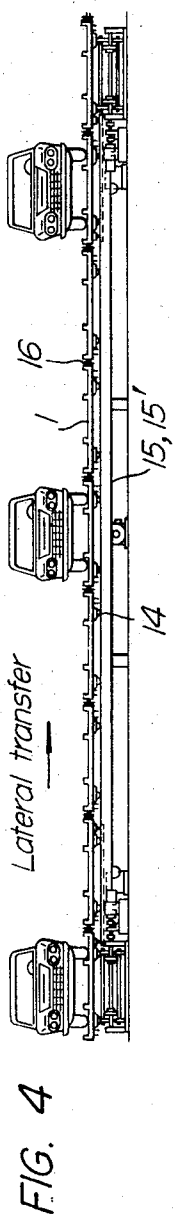


FIG. 6

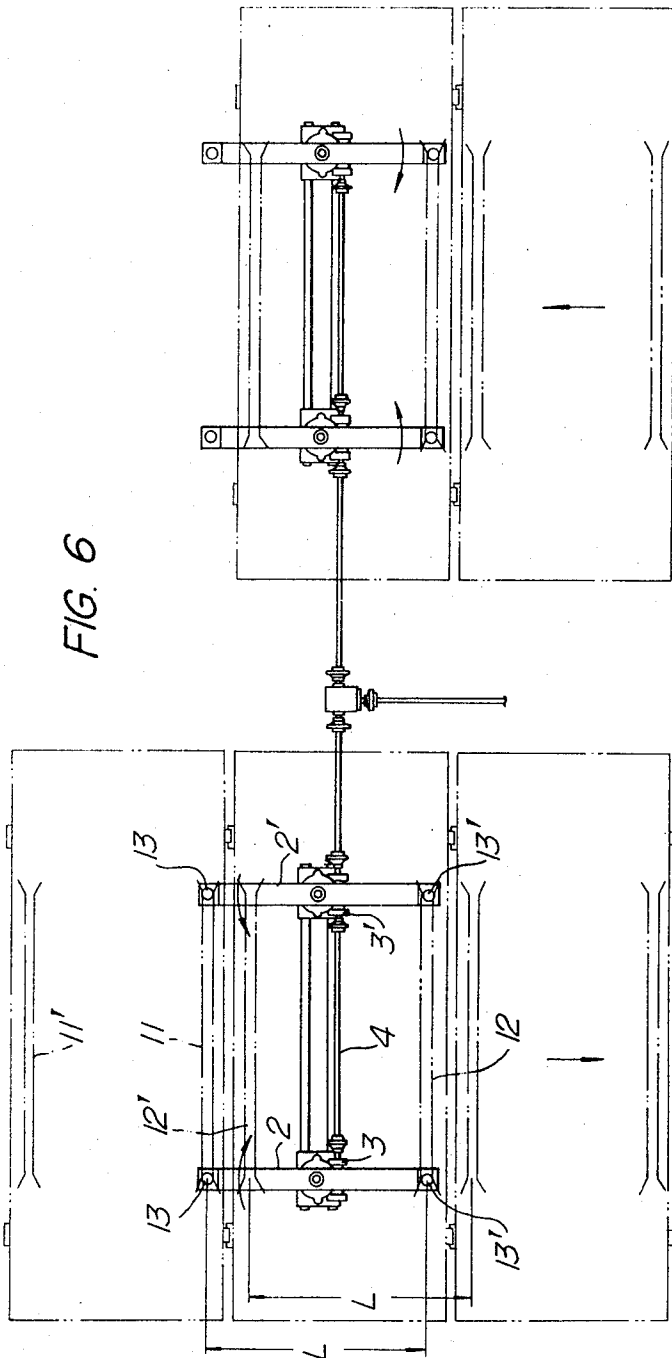
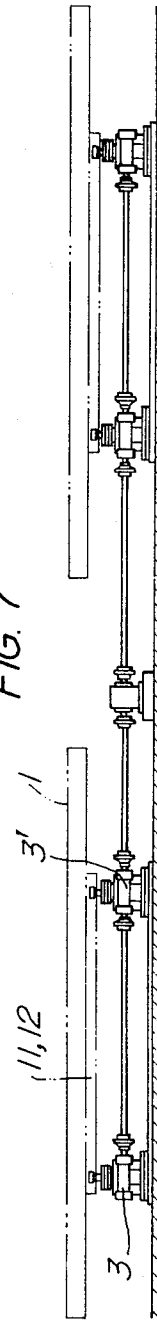


FIG. 7



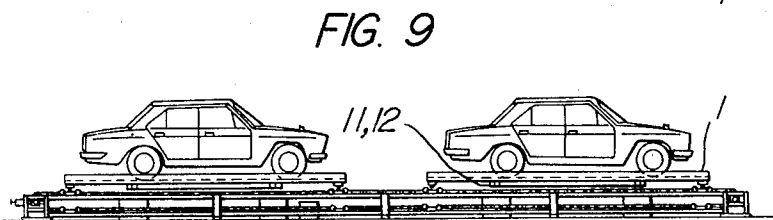
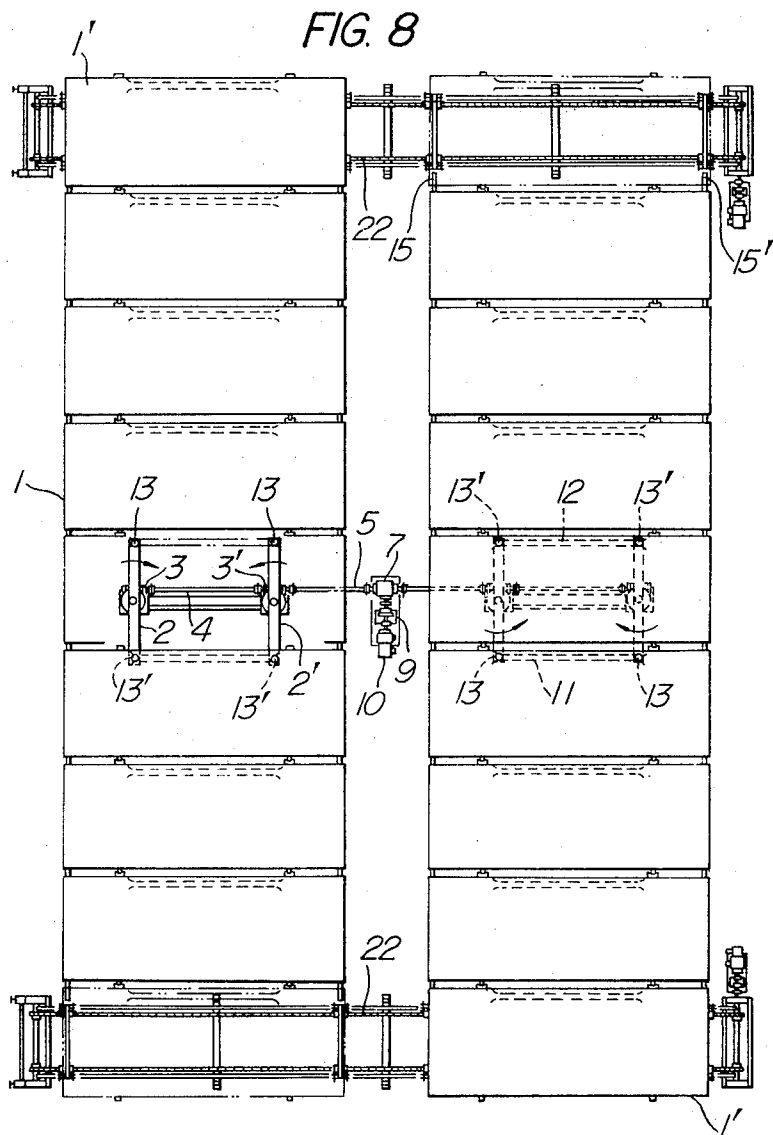


FIG. 11

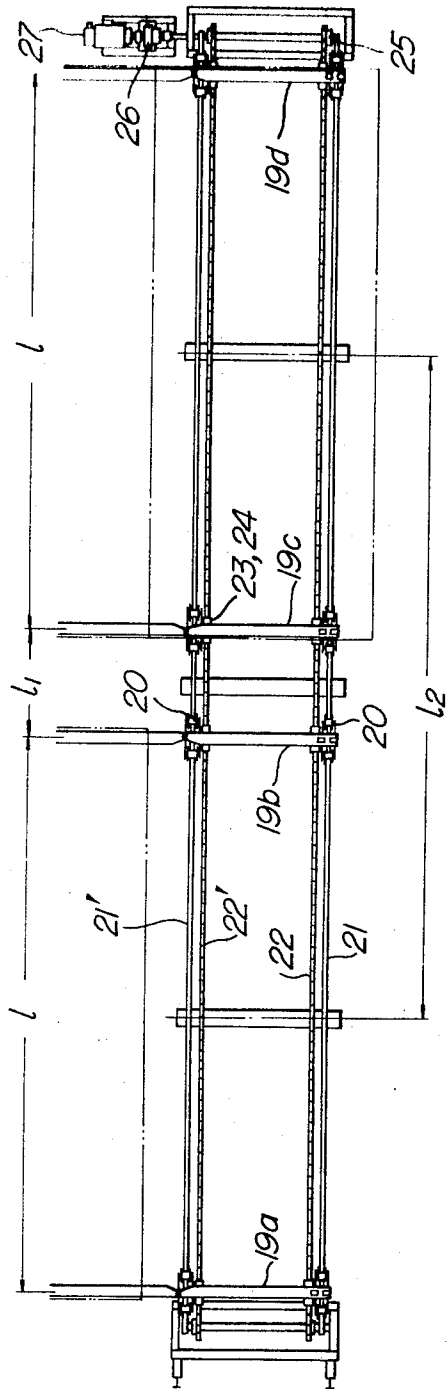


FIG. 12

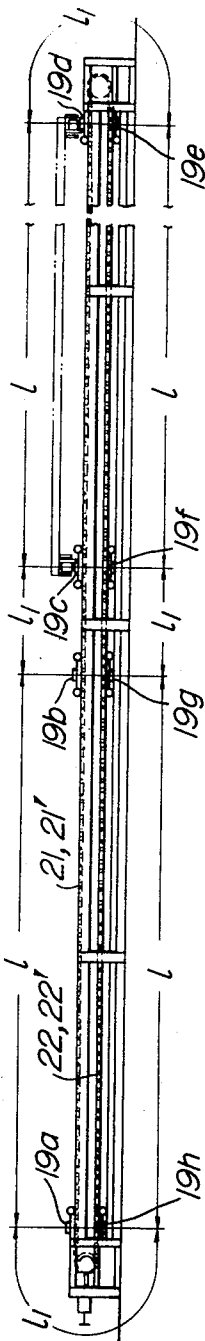


FIG. 13

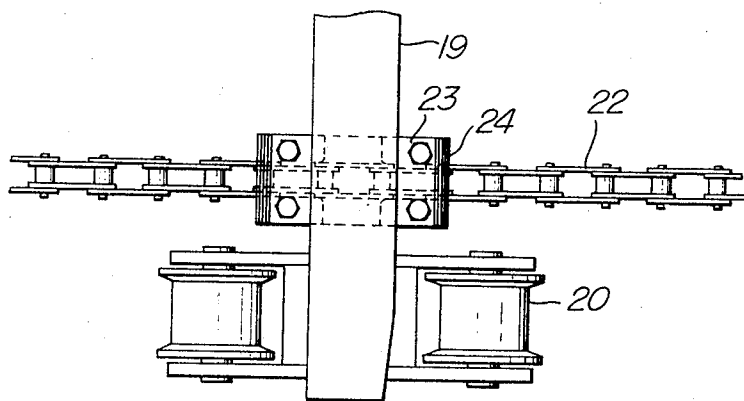


FIG. 14

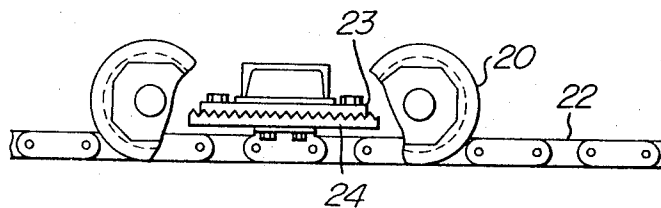


FIG. 16

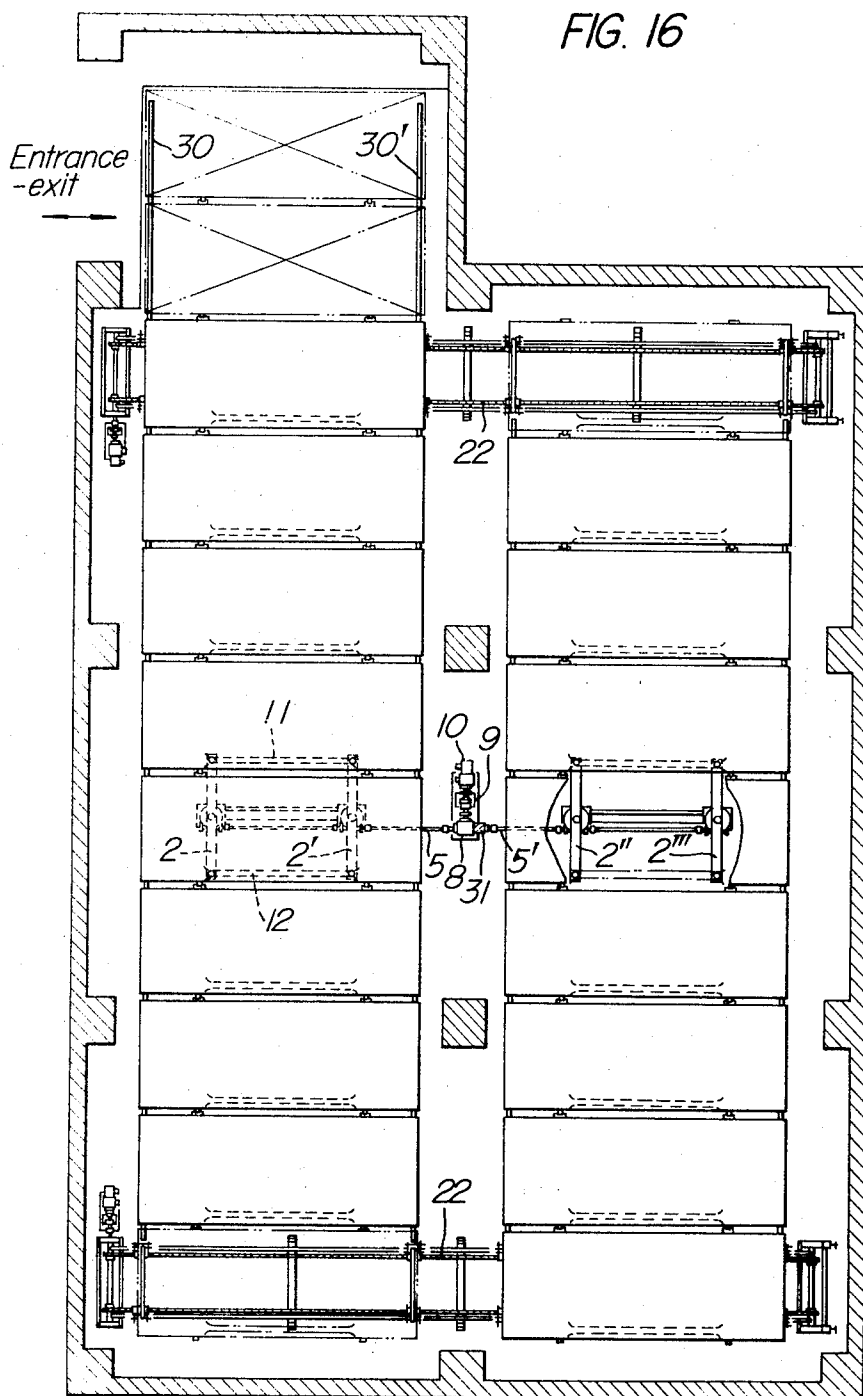


FIG. 17

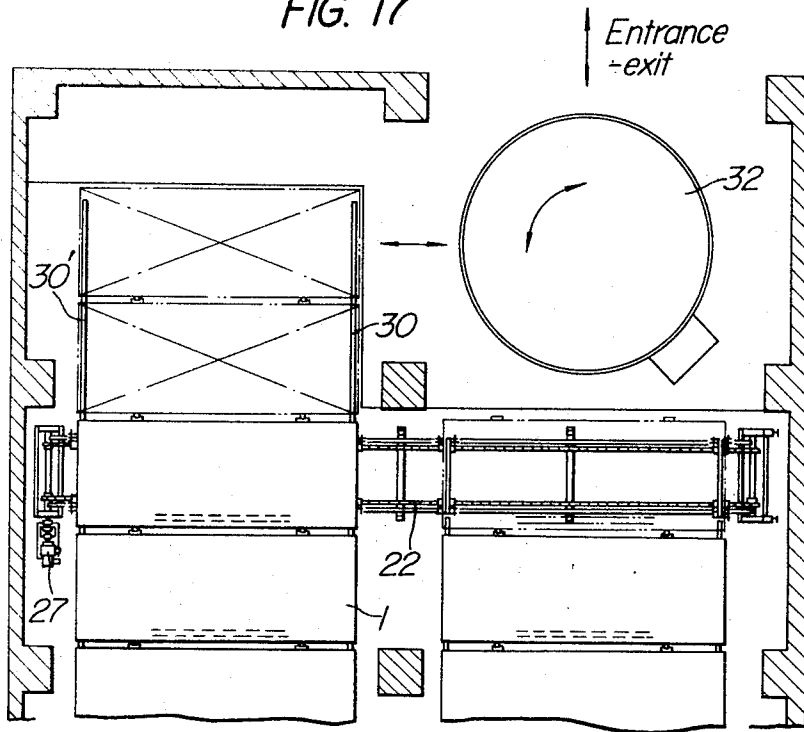
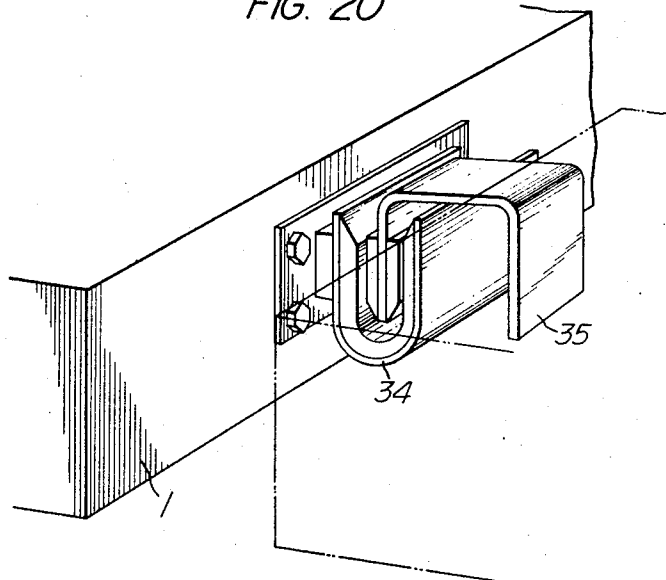


FIG. 20



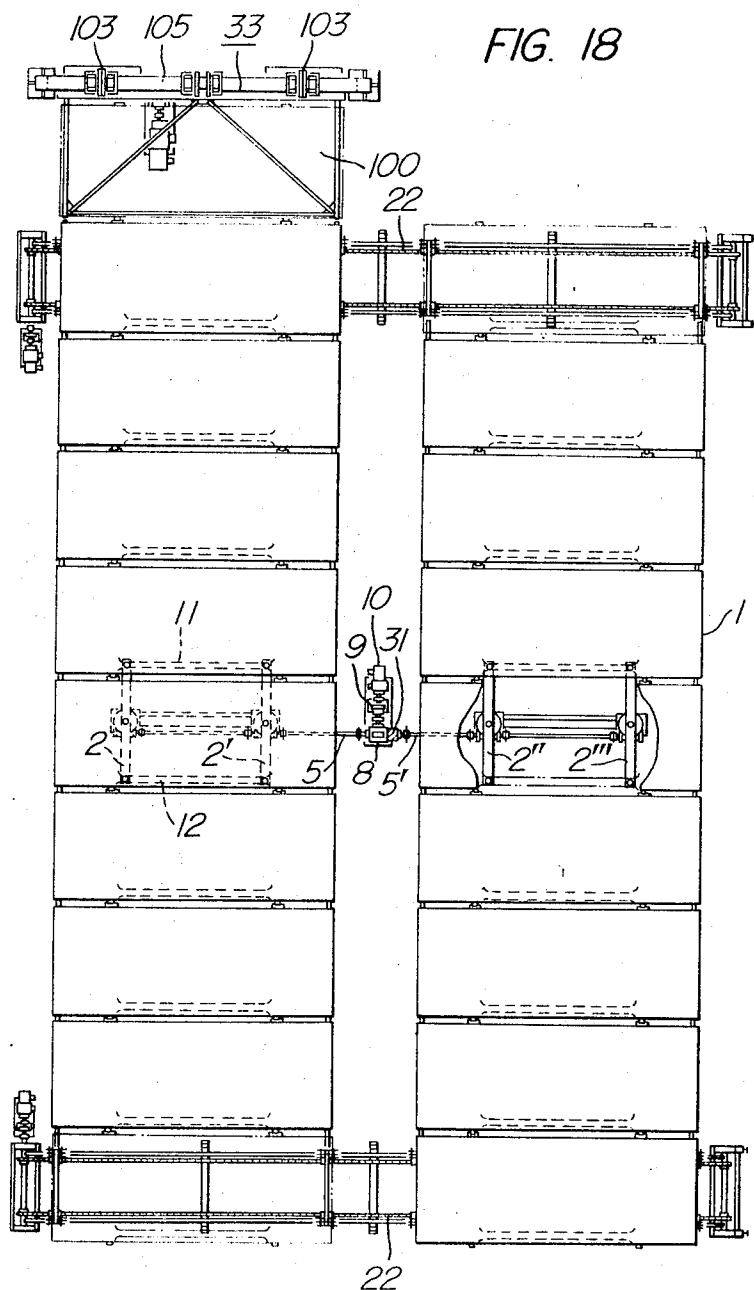
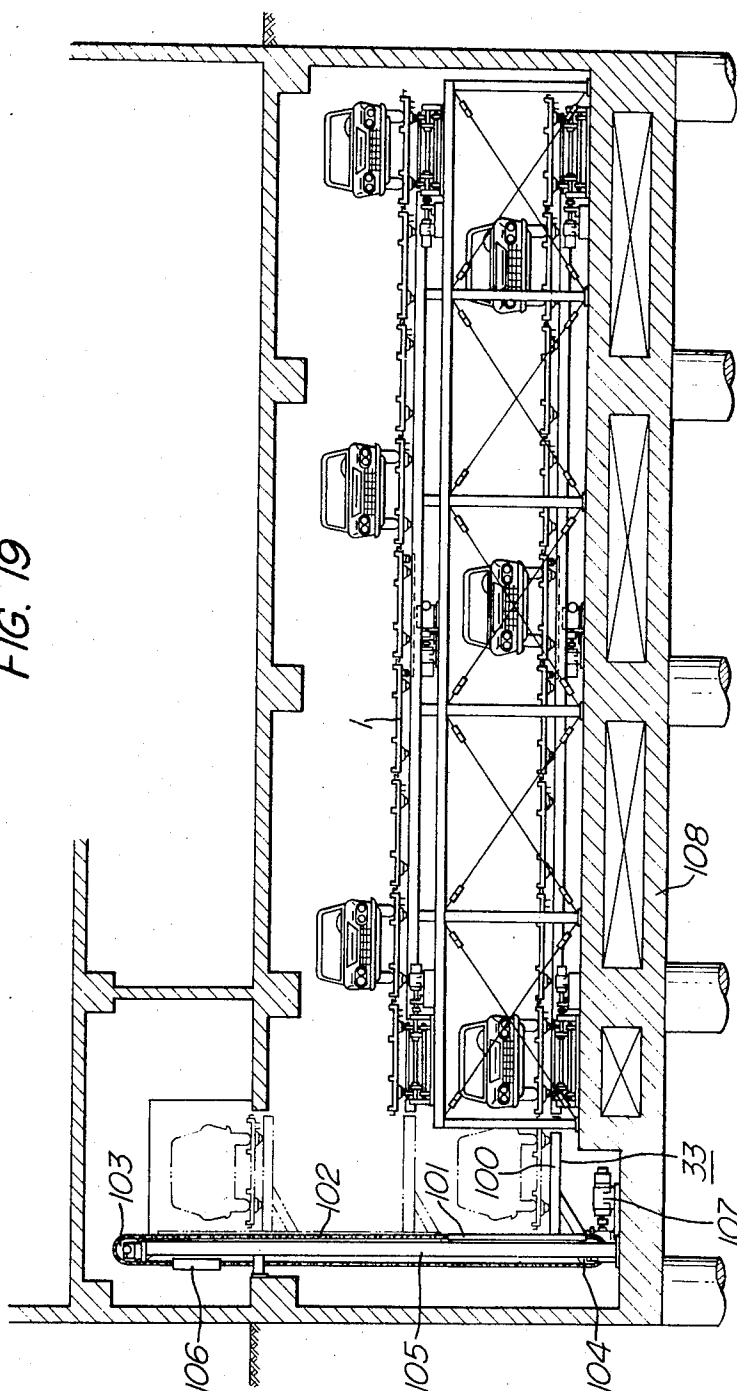


FIG. 19



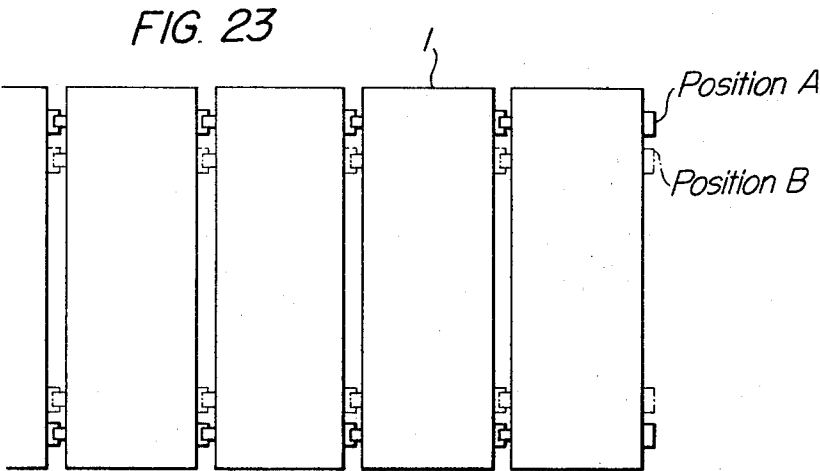
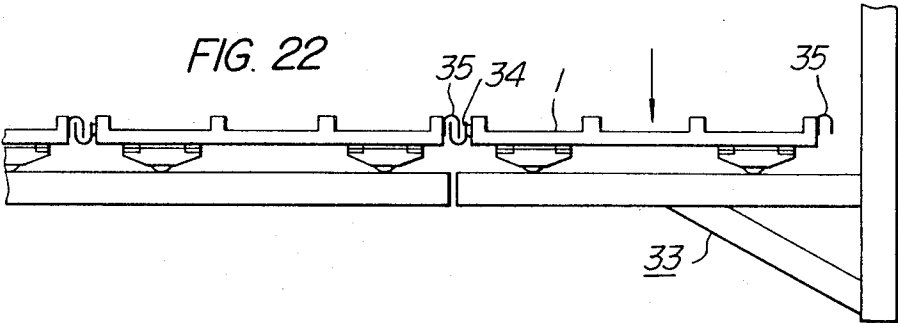
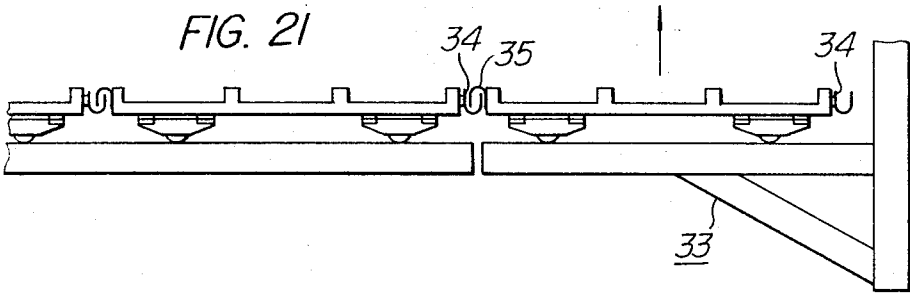
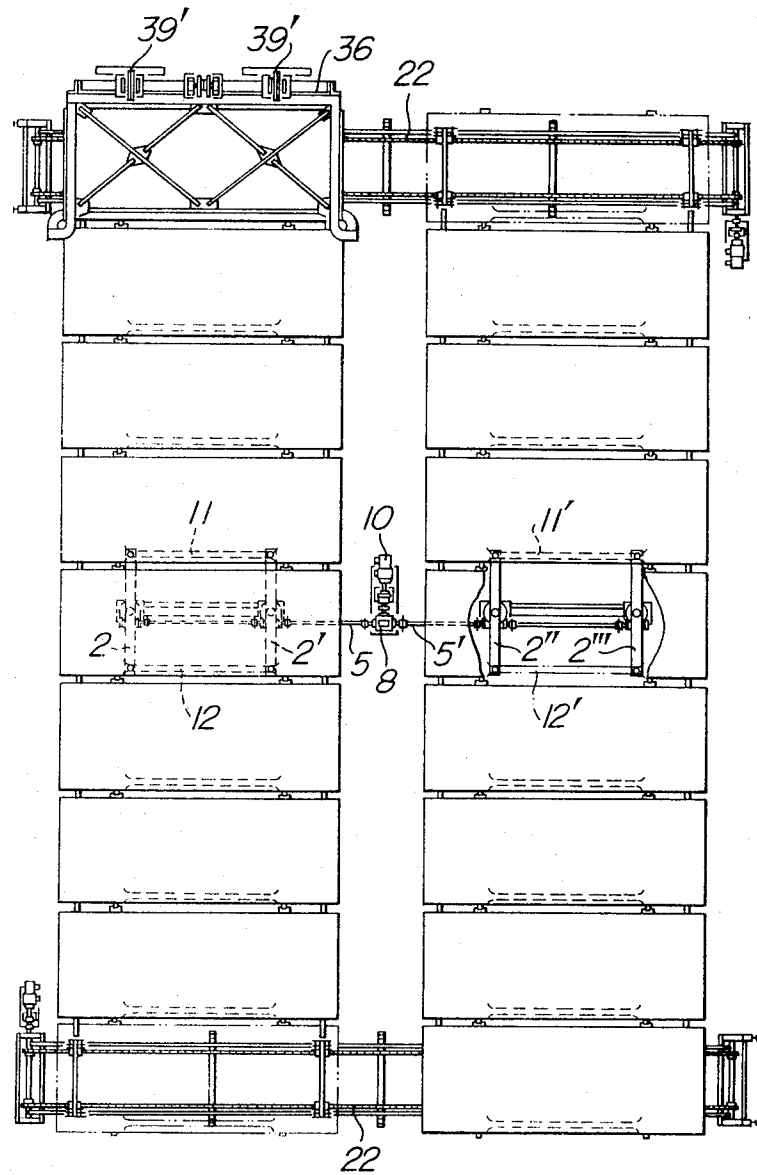


FIG. 24



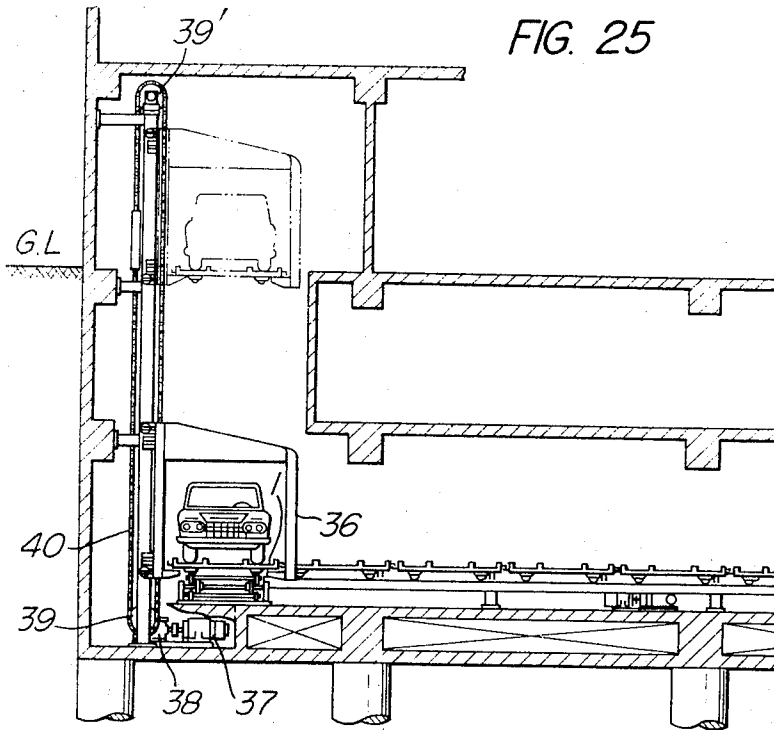


FIG. 26

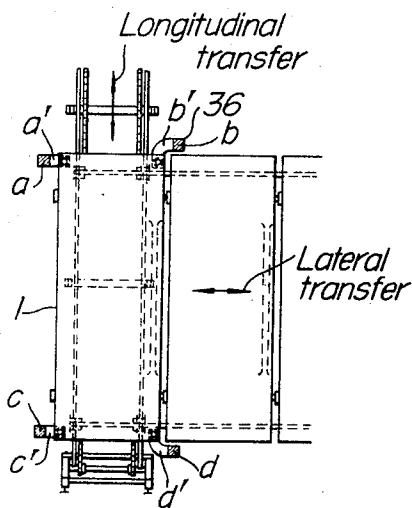


FIG. 27

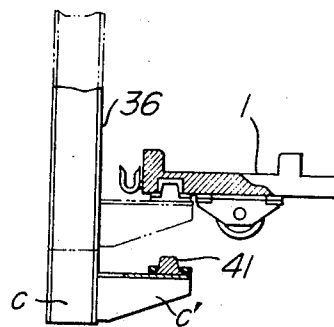


FIG. 28

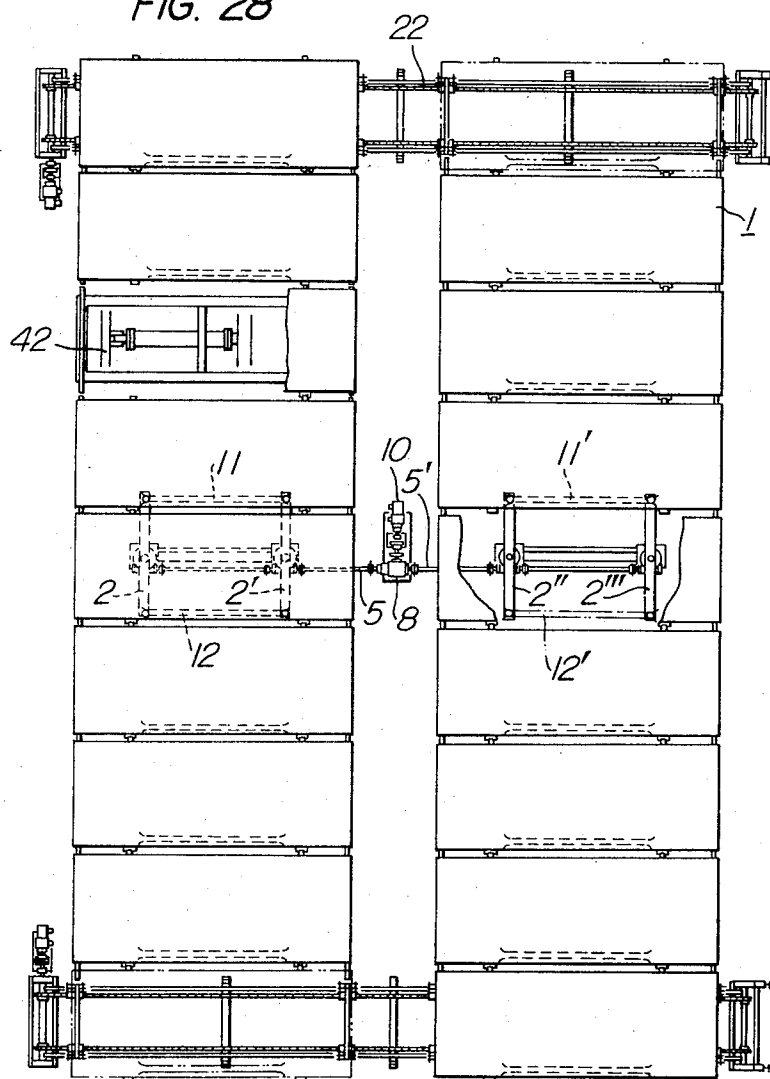


FIG. 29

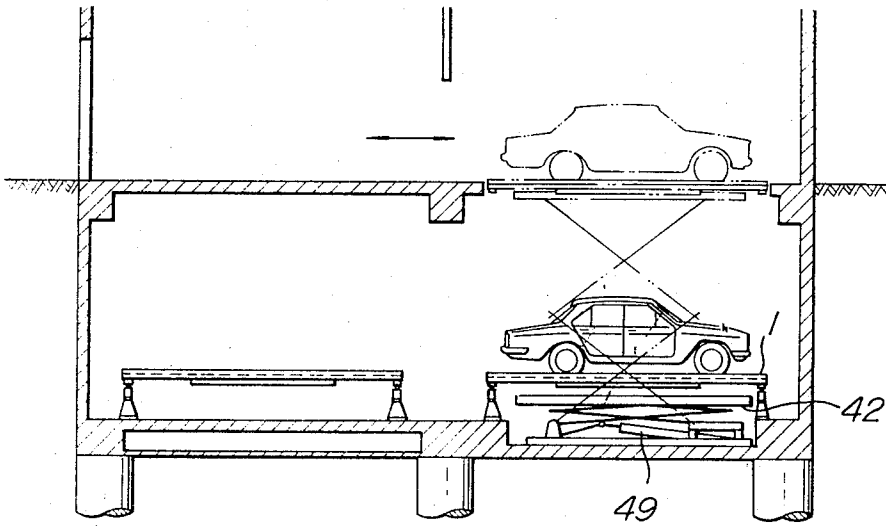


FIG. 30

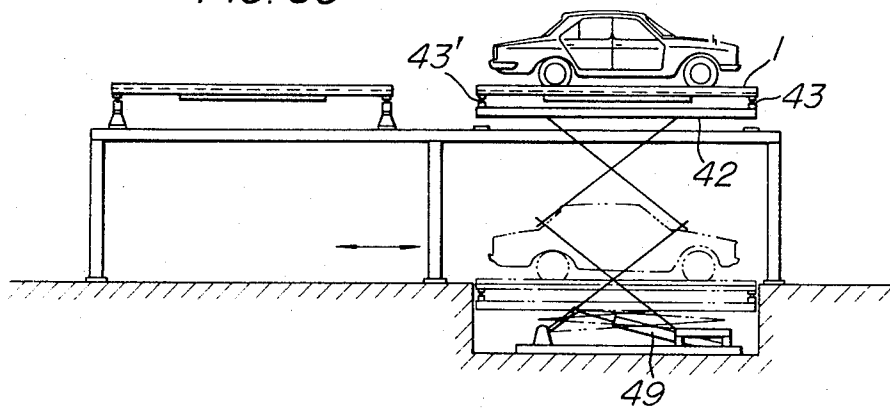


FIG. 31

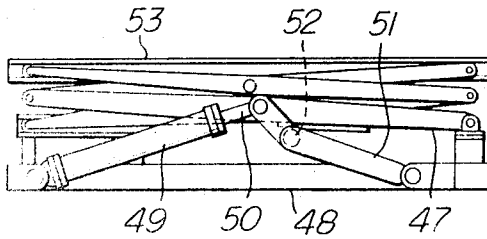


FIG. 36

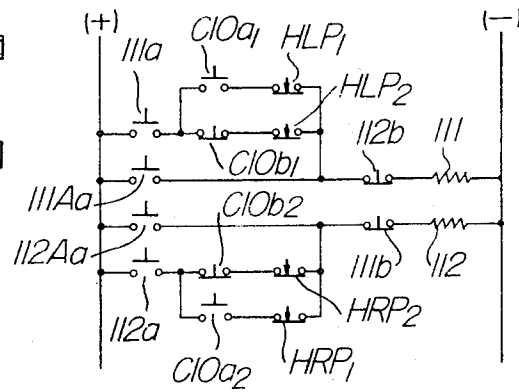


FIG. 32

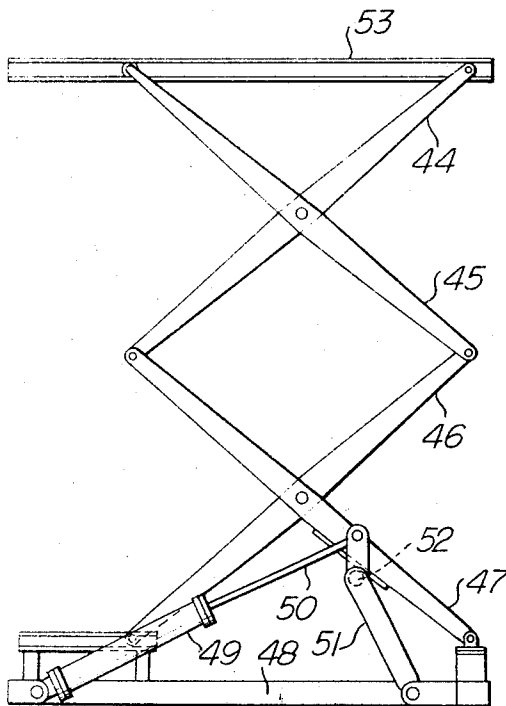


FIG. 33

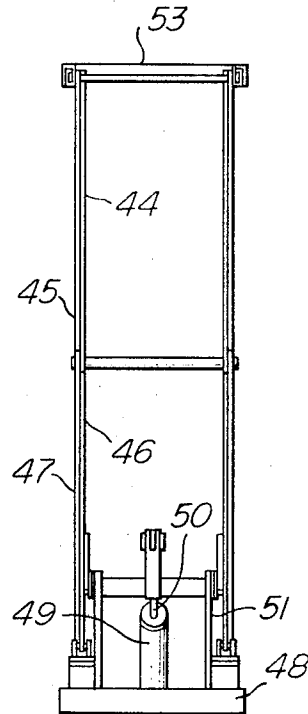


FIG. 35

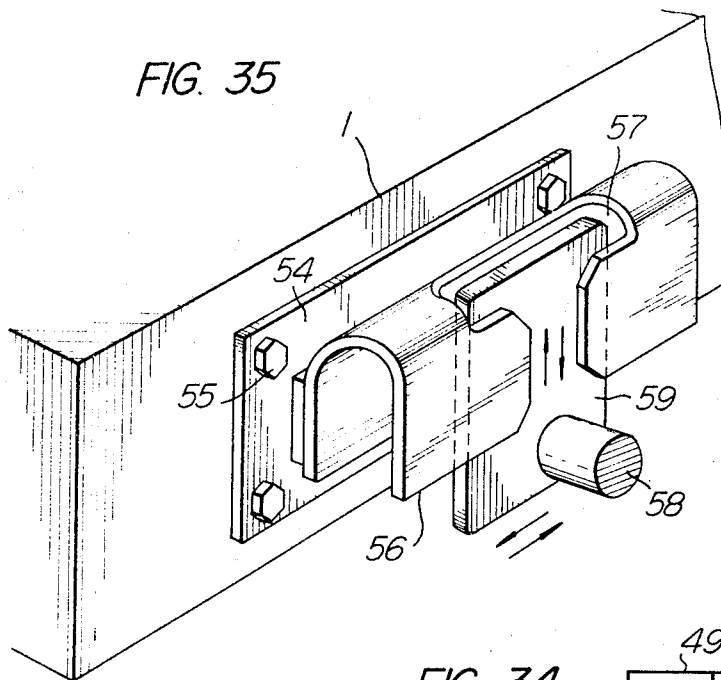
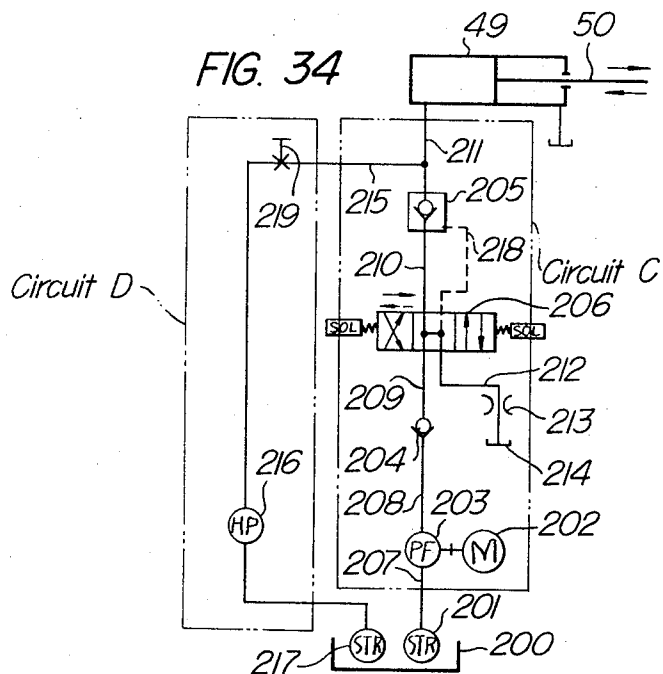


FIG. 34



STORAGE PALLETS AND DRIVE MEANS THEREOF

This invention relates to a horizontal circulation type of storage equipment having a plurality of horizontal rows of pallets for carrying an article, especially an automotive vehicle, on each pallet in which the pallets are arranged in a manner to provide a vacancy, at one end of each of the pallet rows so that successive and alternate transfer of pallets in their longitudinal direction (hereinafter to be referred to as longitudinal transfer) and in their lateral direction (hereinafter to be referred to as lateral transfer) in a manner to fill up such vacancies can move a desired article carrying pallet to a predetermined station. More specifically, this invention relates to a storage equipment of the type described having efficient drive means for causing the longitudinal and lateral transfer of pallets, lift means for use with such equipment, and coupling means for coupling the pallets in the form of a train. This invention further relates to a plural-storied storage equipment comprising a stack of such storage equipments.

Vehicle parking apparatus of merry-go-round type, elevator type, elevator crane type and other types have heretofore been proposed in the art and put into practical use. However, all these prior vehicle parking apparatus have been defective in that they are expensive due to complex structure and have a low degree of space availability, that is, a great deal of dead spaces are involved therein. They have been further defective in that they have a low degree of safety in operation in view of their mechanism and a large power requirement is inevitable with such apparatus.

In an effort to eliminate these and other defects of the prior parking apparatus, a horizontal circulation type of vehicle storage equipment has been recently proposed which has a plurality of horizontal rows of pallets for carrying an automotive vehicle on each pallet and in which the pallets are arranged in a manner to provide a vacancy at one end of each of the pallet rows so that successive and alternate transfer of pallets in their longitudinal and lateral directions, that is, longitudinal and lateral transfer in a manner to fill up the vacancies can move a desired vehicle carrying pallet to a predetermined station. While this horizontal circulation type of storage equipment has had excellent effects of eliminating the defects involved in the prior parking apparatus as described above, it has been still insufficient in its operation and there has been a demand for improvements in the structure and operation of this type of equipment.

It is the primary object of the present invention to provide lateral transfer and longitudinal transfer means preferably used with such horizontal circulation type of storage equipment.

Another object of the invention is to provide pallet shifting means preferably used with a case in which the vehicle entrance is disposed at a position remote from the pallet rows.

A further object of the invention is to provide suitable means for providing communication between floor stages when such horizontal circulation type of storage equipments are stacked up to have a plurality of stories.

Another object of the invention is to provide means for coupling the pallets in the form of a train.

These and other objects of the present invention will become apparent from the following description with reference to the accompanying drawings:

FIG. 1 is a diagrammatic plan view showing the basic principle of operation of a horizontal circulation type of storage equipment to which the present invention is directed, FIG. 1A showing the state of lateral transfer and FIG. 1B showing the state of longitudinal transfer.

FIG. 2 is a plan view of a horizontal circulation type of storage equipment equipped with the lateral transfer means and longitudinal transfer means of the present invention and embodying the principle shown in FIG. 1.

FIG. 3 is a side elevational view of FIG. 2.

FIG. 4 is a front elevational view of FIG. 2.

FIG. 5 is a graphic representation of the relation between a speed and a transferred distance in the lateral transfer means of the present invention.

FIG. 6 is an enlarged plan view of the lateral transfer means. FIG. 7 is a side elevational view of FIG. 6.

FIG. 8 is a plan view showing a case in which only one lateral transfer means is provided for each pallet row.

FIG. 9 is a side elevational view of FIG. 8.

FIG. 10 is a front elevational view of FIG. 8.

FIG. 11 is an enlarged plan view of the longitudinal transfer means embodying the present invention.

FIG. 12 is a side elevational view of FIG. 11.

FIG. 13 is an enlarged plan view showing the state of connection between an endless chain and a rail.

FIG. 14 is a partly cut-away side elevational view of FIG. 13.

FIG. 15 is an enlarged front elevational view of the longitudinal transfer means.

FIG. 16 is a plan view of a horizontal circulation type of storage equipment in which the vehicle entrance and exit is disposed at a position remote from the pallet rows.

FIG. 17 is a view similar to FIG. 16, but showing the vehicle entrance and exit disposed at a position different from that of FIG. 16.

FIG. 18 is a plan view of a horizontal circulation type of storage equipment in which lift means is disposed at a position spaced one pallet pitch from the pallet row.

FIG. 19 is a front elevational view showing a two-storied structure of horizontal circulation type of storage equipment.

FIG. 20 is an enlarged perspective view showing the coupled state of adjacent pallets.

FIG. 21 is a front elevational view showing the coupled state of pallets when a pallet is moved upwardly by the lift means.

FIG. 22 is a front elevational view showing the coupled state of pallets when a pallet is moved downwardly by the lift means.

FIG. 23 is a plan view showing the position of the pallet coupling mechanism in each floor in the two-storied structure of storage equipment.

FIG. 24 is a general plan view of the two-storied storage equipment equipped with a different kind of lift means.

FIG. 25 is a sectional front elevational view of part of FIG. 24.

FIG. 26 is a detailed plan view of the lift portion in FIG. 25.

FIG. 27 is a partly sectional detail view showing the engaged state of a pallet and the lift means.

FIG. 28 is a general plan view of the two-storied storage equipment in which a further different kind of lift means is disposed in the pallet row.

FIG. 29 is a sectional side elevational view of FIG. 28 when the vehicle entrance and exit is disposed on the upper floor.

FIG. 30 is a sectional side elevational view of FIG. 28 when the vehicle entrance and exit is disposed on the lower floor.

FIG. 31 is a side elevational view of the lift means shown in FIG. 28.

FIG. 32 is a side elevational view showing the extended state of the lift means in FIG. 31.

FIG. 33 is a front elevational view of FIG. 32.

FIG. 34 is a hydraulic circuit diagram used with the lift means shown in FIG. 31.

FIG. 35 is a detailed perspective view of another form of the pallet coupling mechanism.

FIG. 36 is an electrical circuit diagram of one form of stopping means employed in the present invention.

Referring to FIG. 1, there is shown the basic principle of the horizontal circulation type of vehicle storage equipment in which it will be seen that vacancies corresponding to two pallet are provided at symmetrical ends of two horizontally arranged pallet rows and the pallets are successively and alternately transferred in their lateral direction as shown in FIG. 1A and in their longitudinal direction as shown in FIG. 1B so that a desired pallet can be brought to a predetermined station.

At first, drive means for the lateral transfer will be described with reference to FIGS. 2 to 4. Vehicle carrying pallets 1 are arranged two horizontally parallel rows with eight pallets in each row, for example, as shown in FIGS. 2 to 4 and any two corner positions at symmetrical ends of the two pallet rows are

left vacant. Drive means for causing the lateral transfer of the pallets 1 arranged in the manner as described above is substantially centrally positioned below a pallet 1' being the second one from each end of each pallet row and includes drive gearings 3, 3' having respective links 2, 2' operatively associated therewith. These drive means are simultaneously driven from a drive source 10 through connecting shafts 4, 5, 6, direction changing gearings 7, 8 and a reduction gearing 9.

Driving engagement between the above-described drive system and the pallets 1 is attained by guide grooves 11, 12 provided at the lower part of the pallets in parallel with the length of the pallets and at right angles with respect to the direction of lateral transfer and guide rollers 13, 13' rotatably mounted on opposite ends of the links 2, 2', as shown in FIGS. 6 and 7. More precisely, the guide rollers 13 on one end of the links 2, 2' fit in the guide groove 11 on an end pallet 1', while the guide rollers 13' on the other end of the links 2, 2' fit in the guide groove 12 on an adjacent pallet 1', which guide groove 12 is spaced from the guide groove 11 a distance corresponding to a transfer distance L in one lateral transfer stroke as best shown in FIG. 6. When therefore the links 2, 2' are simultaneously rotated in the directions as shown by arrows, the guide rollers 13 impart to the pallet row a rectilinear movement in the direction of lateral transfer while rolling on the guide faces of the guide grooves 11, and thus 180° rotation of these links 2, 2' can advance the pallets by the distance L of one stroke.

Accordingly, the moving speed of the pallet 1 during one stroke of movement from starting to stopping varies in a sine curve fashion as shown in FIG. 5. It is thus possible to attain an ideal speed control without any provision of special control mechanism on the drive source as with prior apparatus. The fact that the starting and stopping points of the pallet 1 exactly correspond to the dead points in the sine curve provides great advantages of reduction in the abrupt starting load, alleviation of shock during travel of the pallet and freedom from any damage on an automotive vehicle mounted on the pallet 1.

In the prior storage equipment, it has been necessary to provide a large capacity brake means on the drive source to ensure positive stoppage of the pallet 1 at a fixed position at the end of its traveling movement. According to the drive mechanism of the present invention, however, the desired purpose can be attained by provision of a stopping brake means of remarkably small capacity because of the fact that the stopping position corresponds to the dead point of the sine curve as described previously and the load from an automotive vehicle and the pallet 1 carrying the vehicle thereon is almost zero at such point.

Wheels 14 freely rotatable in the direction of lateral transfer may be provided at the lower part of each pallet and arranged to make rolling movement on stationary rails 15, 15' parallelly disposed on the foundation in order to ensure smooth movement of the pallets in their lateral direction.

When it is desired to effect the lateral transfer of the pallets 1 in the directions of arrows or counterclockwise, the links 2 and 2' in each pallet row may be simultaneously rotated in the directions of arrows and the rotation of the links 2 and 2' in the above directions can be easily attained by the operation of the drive system comprising the elements 3 to 9.

The above description has referred to the drive system for the lateral transfer in which the guide rollers 13, 13' on opposite ends of the links 2, 2' are arranged to engage in the guide grooves 11 on the pallets 1' on opposite ends of each pallet row and in the guide grooves 12 on the adjacent pallets 1'', respectively, as shown in FIGS. 2 to 4. Consider one pallet row in the above arrangement, then it will be readily seen that the link pair 2, 2' at one end of the pallet row pulls one pallet while the other link pair at the other end of the pallet row pushes all of the remaining pallets in the row. It is therefore apparent that the pallets need not be bound together by a mechanism such as couplers, and abutments 16, for example, may be provided to transmit power to the adjacent pallets.

However, by coupling the adjacent pallets by coupling means 34 and 35 as shown in FIG. 20, the pallet drive means need not be disposed at such a position at which it engages with the guide grooves at the lower part of the end pallet in each pallet row and at the lower part of the second pallet adjacent to the above end pallet, and such drive means may be disposed at any position in each pallet row. Further, as will be apparent from FIG. 20, the coupling means should have such a structure that they are coupled together in the lateral transfer direction by the lateral transfer operation, while they are not bound in the longitudinal transfer direction by the longitudinal transfer operation being the other circulating movement as will be described later.

It will further be understood that the links 2 and 2' need not be arranged in two pairs in each pallet row and the desired function of lateral transfer can be sufficiently accomplished by merely disposing one pair of such links substantially centrally of each pallet row. The disposition of one pair of links 2 and 2' in each pallet row can simplify the pallet structure in that one of the guide grooves 11 and 12 may be provided at the lower part of each pallet so that it receives therein the guide rollers 13 and 13' at both ends of each of the links 2 and 2'. Further, reduction of the number of the links 2 and 2' to one-half of the previous number can also simplify the overall structure of the drive system which leads to an inexpensive equipment.

An embodiment of such simplified equipment is shown in FIGS. 8 to 10 in which it will be seen that the overall structure of the drive system therefor is substantially similar to that in the embodiment shown in FIGS. 2 to 4 but one pair of links 2, 2' for each pallet row and a guide groove 11 on one pallet and a guide groove 12 on an adjacent pallet suffice although coupling means 34 and 35 as shown in FIG. 20 are required. Like reference numerals are used in FIGS. 8 to 10 to denote like parts of the drive system appearing in FIGS. 2 to 4 and any detailed explanation as to such parts are omitted herein.

Longitudinal transfer indicates such mode of operation in which pallets at opposite ends of each pallet row are transferred in the direction at right angles with respect to the direction of lateral transfer described above. In other words, as will be apparent from the embodiments shown in FIGS. 2 and 8, the longitudinal transfer is a transfer operation by which a pallet at one end of one pallet row is transferred to a vacant portion at one end of the other pallet row.

The longitudinal transfer will now be described in detail with reference to FIGS. 11 to 15. The drive system for the longitudinal transfer includes a plurality of movable rails 19 which are disposed at the position of the end pallet in each pallet row in a manner to lie on the extensions of the stationary rails 15 and 15' on which the wheels 14 at the lower part of each pallet make rolling movement during the lateral transfer of the pallet train. The movable rails 19 lie in the same plane as that of the stationary rails 15 and 15', but are slightly spaced therefrom and have such dimensions that one pallet at the end of each pallet row can sufficiently ride thereonto.

A pair of wheels 20 are provided at the lower part of each end of the movable rail 19 so that these wheels 20 can smoothly roll on guide rails 21 and 21' disposed in the direction of longitudinal transfer. Suppose in FIGS. 11 and 12 that the stationary rails 15 and 15' for each pallet row have a center-to-center distance l and the opposite stationary rails for the adjacent pallet rows have a center-to-center distance l_1 . Then, the movable rails 19a, 19b are arranged to provide an alternate series of dimensions l and l_1 as shown, and where there are two pallet rows, the movable rails are fixed on a pair of endless chains 22 and 22' having such a length as to permit arrangement of eight movable rails in the above series. Where there are more than two pallet rows, the number of movable rails can be determined by the formula, (number of pallet rows $\times 2$) $\times 2$.

Further as shown in FIGS. 13 and 14, the movable rails 19a, 19b are adjustably fixed to the endless chains 22 and 22' by means of adjusting plates 23 and 24 having a plurality of teeth cut at right angles with respect to the direction of longitudinal

transfer so that the movable rails can be accurately fixed with the spacings l and l_1 therebetween. Positive meshing engagement of the adjusting plates 23 and 24 is effective to prevent any displacement of the movable rails 19a, 19h relative to the endless chains 22 and 22' during the longitudinal transfer operation for thereby ensuring the accurate maintenance of the spacings l and l_1 .

The endless chains 22 and 22' having the movable rails 19a, 19h fixedly mounted thereon are driven from a drive source or motor 27 through a reduction gearing 26 and sprocket wheels 25 to move in the direction of longitudinal transfer while the movable rails 19 make advancing movement on the guide rails 21 and 21'.

The drive means having a structure as described above are disposed on opposite ends of the pallet rows and are actuated so that a pallet 1' fed onto the movable rails 19c and 19d at one end of one pallet row by the previously described lateral transfer can be transferred to the vacant portion at one end of the other pallet row by a distance corresponding to the center-to-center distance l_2 of the adjacent pallet rows. The above operation is simultaneously performed at opposite ends of the pallet rows, but the direction of longitudinal transfer at one end of the pallet rows is opposite to that at the other end as shown in FIG. 2. Since the movable rails 19a, 19h on the endless chains 22 and 22' are arranged to have alternate spacings of l and l_1 , the succeeding movable rails 19e and 19f come to a position at which they register with the stationary rails 15 and 15' at the end portion of the pallet row from which the pallet is removed by the longitudinal transfer. Thus the movable rails 19e and 19f are ready to receive thereon a pallet to be transferred by the lateral transfer. It will thus be understood that two operations, lateral transfer and longitudinal transfer, can be alternately and continuously effected by disposing the movable rails 19a, 19h in the manner as described above.

During the longitudinal transfer, the pallet 1' moves away from the pallet row to which it formerly belongs. However, as shown in FIG. 2, the longitudinal movement of the pallet 1' is guided by the guide groove 11 at the lower part thereof and the guide rollers 13 at one end of the links 2 and 2' of the drive means for lateral transfer. Therefore the pallet 1' can be successfully transferred without disengaging from the movable rails 19c and 19d.

On the other hand, in case the drive means for lateral transfer is disposed at the center of each pallet row, the end pallet 1' is disconnected from an adjacent pallet 1'' due to the longitudinal transfer of the former and the pallet 1' on the movable rails 19c and 19d is free to move in the direction of lateral transfer and may fall off from the movable rails 19c and 19d because there is no means for restricting such objectionable movement of the pallet 1'. The above problem can be easily solved by providing simple stoppers on the moveable rails 19a, 19h. One form of such stopper means is illustrated in FIG. 15, in which it will be seen that wedge-like stoppers 28 and 29 are provided to ensure positive transfer in the lateral transfer operation of the pallet 1' onto the movable rails.

In the horizontal circulation type of vehicle storage equipment described above, the parking equipment in FIGS. 2 and 8 can be used in its existing form where the vehicle entrance is located at either end or an intermediate portion of the pallet rows so that an automotive vehicle can directly ride onto one of the pallets. When however the vehicle entrance is located at a position remote from the pallet rows in the parking equipment or when the vehicle entrance is so directed that an automotive vehicle can not directly ride onto one of the pallets, it has heretofore been necessary with prior parking apparatus to provide special transfer means independently of transfer means in the parking apparatus so as to guide the pallet from the vehicle entrance into the parking apparatus. According to the present invention, the purpose can be easily attained by mere affixing of simple means as will be described later to part of the drive system in the parking equipment.

A few forms of the equipment suitable for use with such situation are illustrated in FIGS. 16 and 17. Suppose that the vehicle entrance is spaced several pallet widths (two pallet widths in the case of FIG. 16) from one end of one pallet row. To effectively deal with such a case, stationary rails 30 and 31' extending to the vehicle entrance may be provided to transfer the pallets to the vehicle entrance and the pallet row on the vehicle entrance side may be continuously moved through several strokes in the direction of lateral transfer. However, operation of the lateral transfer means in their previously described state is undesirable because that pallet row which has no relation with the vehicle entrance is simultaneously driven and the pallets in that row will drop off from the rails due to the fact that a plurality of pallet rows are simultaneously driven by a single drive source.

In order to prevent such drop-off, the pallet row on the vehicle entrance side may be solely driven. To do this, releasably connecting means 31 such as clutch means or gear means may be provided between a direction changing gearing 8 and a drive shaft 5' for links 2'' and 2''' driving that pallet row which has no relation with the vehicle entrance. More precisely, when the drive system is driven with the means 31 held in its released state, power from a drive source 10 is transmitted to a drive shaft 5 through a reduction gearing 9 and direction changing gearing 8 to cause rotation solely of links 2 and 2' so that the pallet row on the vehicle entrance side is solely driven. On the other hand, the pallet row having no relation with the vehicle entrance is not driven and there is no drop-off of the pallets from the rails because the links 2'' and 2''' are prevented from rotating.

In connection with the above operation, some difficulty arises from the use of stopping means for a case in which one of the pallet rows is solely driven since the stopping means is primarily adapted for use in the case of simultaneous drive of both the pallet rows. In such a case, since the load on the drive source or motor 10 for the lateral transfer is reduced to one-half of the normal load, the stopped position differs from that when both the pallet rows are simultaneously driven and such poor accuracy of the stopped position gives rise to a trouble in the succeeding operation. Further it is easily inferable from the above description that difficulty is encountered in the adjustment in an effort to obtain accuracy of the stopped position for both the case in which one of the pallet rows is solely driven and the case in which both the pallet rows are simultaneously driven.

The above difficulty can be solved by providing a stopping means on the drive means 2, 2', 5, 8, 9 and 10 (hereinafter to be referred to as first drive means) for the lateral transfer of one of the pallet rows so that this stopping means can stop the first drive means and by providing a stopping means on the drive means 2'', 2''', 5', 8, 9 and 10 (hereinafter to be referred to as second drive means) so that these stopping means cooperate to stop the first and second drive means when both the pallet rows are simultaneously driven for the lateral transfer. It will be understood, however, that the effect similar to above can be obtained by providing a stopping means for use in the simultaneous drive of both the drive means. Such stopping means may be provided independently of the stopping means on each drive means as described above. By the provision of the above stopping means, it is possible to ensure accuracy of stopping in the lateral transfer and facilitate the adjustment in both of the case in which the first drive means is solely placed in operation and the case in which both the first and second drive means are placed in operation.

An embodiment of such stopping means will be described in detail with reference to FIG. 36. A circuit shown in FIG. 36 includes a dc power supply (+), (-), a left-hand rotation relay 111 for a lateral transfer drive motor and a right-hand rotation relay 112 for a lateral transfer drive motor. A contact 111Aa of left-hand rotation command relay (not shown) energizes the relay 111 and opens after energization of the relay 111. Contacts C10_{a1} and C10_{a2} are arranged to close when the

releasable connecting means 31 such as clutch means or gear means is in its actuated state, that is, when both the first and second drive means are in operation, and open when the releasable connecting means 31 is in its released state, that is, when the first drive means is solely in operation. Contacts C10_{b1} and C10_{b2} are arranged to open when the releasable connecting means 31 is in its actuated state and close when the means 31 is in its released state. HLP₁ and HRP₁ are contacts of limit switches provided on the second drive means and these contacts are arranged to open when the second drive means makes its left-hand rotation or right-hand rotation to transfer the pallets in the lateral direction to the predetermined position. HLP₂ and HRP₂ are contacts of limit switches provided on the first drive means and these contacts are arranged to open when the first drive means makes its left-hand or right-hand rotation to transfer the pallets in the lateral direction to the predetermined position. By the opening of these contacts, the relays 111 and 112 are deenergized to stop rotation of the lateral transfer drive motor. Those contacts having suffix *a* represent make or normally open contacts of corresponding relays, while those contacts having suffix *b* represent break or normally closed contacts of corresponding relays.

The stopping means operates in the following manner: When both the first and second drive means are placed in operation for right-hand rotation, the contact 112Aa of right-hand rotation command relay is closed to complete a circuit (+) - 112Aa - 111b - 112 - (-) whereby the right-hand rotation relay 112 for lateral transfer motor is energized. The relay 112 is urged to its self-holding state by the contact 112a thereof through a circuit (+) - 112a - C10_{a2} - HRP₁ - 111b - 112 - (-) whereby the motor starts its rotation. When the pallets are moved to the predetermined position, the contact HRP₁ is opened to deenergize the relay 112 so that the motor 10 is stopped. It will be understood that the stopping position can be easily adjusted by adjusting the limit switch HRP₁.

When the first drive means is solely driven for right-hand rotation, the contact 112Aa of right-hand rotation command relay is closed to complete a circuit (+) - 112Aa - 111b - 112 - (-) whereby the right-hand rotation relay 112 for lateral transfer motor is energized. The relay 112 is urged to its self-holding state by the contact 112b thereof through a circuit (+) - 112a - C10_{b2} - HRP₂ - 111b - 112 - (-) whereby the motor starts its rotation. When the pallets are moved to the predetermined position, the contact HRP₂ is opened to deenergize the relay 112 so that the motor 10 is stopped. It will be understood that the stopping position can be easily adjusted by adjusting the limit switch HRP₂ and this adjustment can be done independently of the adjustment of the limit switch HRP₁ described previously. Thus the lateral transfer motor 10 can be stopped by the limit switch HRP₁ when both the first and second drive means are placed in operation and by the limit switch HRP₂ when the first drive means is solely placed in operation. It is therefore possible to improve the accuracy of stopping through adjustment depending on load conditions for each drive means and this adjustment can be easily done. In left-hand rotation, the limit switches HLP₁ and HLP₂ are operated to attain an effect similar to the case of right-hand rotation.

Circulating movement of the pallets in the parking equipment can be effected by urging the means 31 to its actuated state. Thus the releasable connecting means 31 such as clutch means or gear means may merely be urged to its actuated or released state to effect circulating movement of the pallets or transfer of the pallets to the vehicle entrance, and such operations may be automatically done if so required.

In FIG. 16 description has been given with regard to the case in which the drive means for lateral transfer is located at the center of each pallet row. However it will be readily understood that the above manner of operation is applicable to the equipment having the drive means for lateral transfer located adjacent to opposite ends of each pallet row as shown in FIGS. 2 to 4, in which case a releasable connecting means

similar to that shown in FIG. 16 may be used to connect the drive means for the pallet rows and arrangement of the drive shafts may be slightly varied to attain the similar effect.

Where the vehicle entrance is disposed at such a position that an automotive vehicle coming therein can not directly ride onto a pallet, direction changing means 32 such as a turntable may be additionally provided adjacent to the pallet to provide an efficient parking equipment, as seen in FIG. 17.

The foregoing description has referred to a one-storied parking equipment of horizontal circulation type, but a space which can accommodate automotive vehicles in a plurality of stories in a three-dimensional fashion is usually available under the ground level or above the highest floor of a building.

The following description will be directed to a plural-storied parking equipment comprising horizontal circulation type of vehicle storage equipment stacked in tiers of more than two stories and having lift means affixed thereto.

When the horizontal circulation type of storage equipments are stacked in tiers of more than two stories, a problem arises as to how the storage equipments may be interrelated with lift means which carries pallets to a vehicle entrance and exit. For example, when the lift means is disposed at one end or at an intermediate position of a pallet row, storage equipments at other stories will become a hindrance with the result that vertical movement of the lift means becomes impossible. Therefore the lift means must be located for vertical movement at a position outside of the pallet rows.

In an embodiment as shown in FIGS. 18 and 19, lift means 33 may be disposed at a position displaced at least one pallet width from one end of a pallet row so that a pallet on the lift 33 is free to make vertical movement with the lift 33 without contacting the storage equipment at the other story. A drive system similar to that described previously may be employed to transfer a pallet from the storage equipment onto the lift 33. More precisely, clutch means or gear means 31 similar to that shown in FIG. 16 may merely be interposed between a direction changing gearing 8 and a drive shaft 5' for driving a pair of links 2'' and 2''' so that the pallet row on the lift side can be solely driven and transfer of pallets onto the lift 33 can be easily realized. Since further the circulating movement of pallets in the storage equipment and transfer movement of pallets onto the lift 33 can be continuously and automatically effected, vertical movement of the lift 33 may be arranged to occur in interengaging relation with the above movement so that transfer of pallets from the vehicle entrance and exit into the storage equipment and vice versa can be fully automatically done.

The lift means 33 will be described in detail with reference to FIGS. 18 and 19. The lift means 33 comprises sprocket wheels 103 and 104 supported at opposite ends of a support column 105, a chain 102 trained about each pair of sprocket wheels 103 and 104, a frame member 101 having opposite ends of the chains 102 fixed thereto, and a pallet carriage 100 secured to the frame member 101. The lower sprocket wheels 104 are arranged to be driven by a motor 107 so that the frame member 101 and pallet carriage 100 can be vertically moved by the chains 102 as shown by two-dot chain lines for thereby bringing a pallet to a desired position. Reference numeral 106 denotes a counterweight for reducing the driving power of the motor 107, and numeral 108 denotes walls of building structure.

In connection with the above storage equipment, it is necessary that coupling means between pallets has such a structure that pallets can be coupled with each other in their lateral transfer direction while they are free to move in their longitudinal transfer as well as vertical transfer direction. One form of such coupling means is illustrated in FIG. 20 in which it will be seen that one or two U-shaped coupling members 34 are provided at one end of each pallet and one or two inverted U-shaped coupling members 35 are provided at the opposite end of the pallet so that, when they are engaged with each other, a train of pallets can be coupled in the direction of lateral transfer while these pallets are free to move in the direction of longitudinal transfer.

Vertical movement of pallets may be discussed in two cases, that is, a case in which the vehicle entrance and exit is positioned at the uppermost part of a plural-storied parking equipment and a case in which it is positioned at the lowermost part of such equipment. Where the vehicle entrance and exit is disposed at the uppermost part, the coupling member 35 for coupling with the coupling member 34 on an adjacent pallet may have an inverted U-shape as shown in FIG. 21, while where the vehicle entrance and exit is disposed at the lowermost part, the coupling member 34 for coupling with the coupling member 35 on an adjacent pallet may have a U-shape as shown in FIG. 22.

Further if the coupling members 34 and 35 on the pallets are mounted at the same positions for all of the pallets on every stories, vertical movement of the lift 33 carrying a pallet thereon will result in collision of the coupling members on such pallet with the coupling members on pallets on other stories and thus gives rise to a trouble in lift operation. Therefore it is advisable that the position of the coupling members on the pallets on one story relative to the position of the coupling members on the pallets on another story should be displaced as shown by A and B in FIG. 23.

When it is desired to provide a one-story vehicle storage equipment under the ground level of a building or on the top of a building and to carry automotive vehicles to the vehicle entrance and exit by lift means, provision of the lift means outside of the parking equipment as shown in FIG. 18 will result in a small number of vehicles that can be accommodated and thus in poor space utility. It is therefore advantageous to dispose the lift means at one end or at an intermediate position of a pallet row in case such one-story vehicle storage equipment is under consideration. Description will first be given with regard to a case in which the lift means is disposed at one end of a pallet row and vehicle storage equipment is disposed underground with the vehicle entrance and exit positioned thereabove.

In FIGS. 24 to 27 there is shown an embodiment of such vehicle storage equipment. Lift means in this case comprises a lift cage 36 consisting of four columns *a*, *b*, *c* and *d* and drive means therefor. The four columns *a*, *b*, *c* and *d* forming the lift cage 36 are disposed outside of a pallet 1 as will be apparent from FIG. 25 and have respective arms *a'*, *b'*, *c'* and *d'* inwardly extending from the lower ends thereof in a manner to underlie the lower face of the pallet 1 in every direction. By virtue of the above structure, movement of the pallet 1 in the direction of lateral as well as longitudinal transfer does not give rise to contact between the pallet 1 and the lift cage 36 so that circulating movement of the pallets can be unobstructedly repeated.

In lift operation of the pallet 1, the pallet 1 is brought to stop at the position of the lift cage 36. A drive source 37 for driving the lift cage 36 is then placed in operation to drive the lift cage 36 together with the pallet 1 through a reduction gearing 38, sprocket wheels 39 and 39' and endless chains 40. As shown in FIG. 27, a projection 41 is provided on each arm and is arranged to fit in a corresponding recess on the lower face of the pallet 1 to prevent the pallet 1 from dropping off from the lift cage 36.

Although description has been given with respect to the embodiment having the lift cage 36 disposed at one end of a pallet row, lift means similar to the above may be disposed at an intermediate position of such pallet row. Such lift means may, for example, comprise support columns erected in close proximity to opposite ends of a pallet, endless chains mounted on these columns, pallet engaging lugs provided on these chains, and drive means for causing vertical movement of the chains so that the four corners of a pallet can be engaged by the engaging lugs and the pallet can thereby be moved upwardly. However, it is to be understood that this arrangement is solely applicable to a one-story storage equipment.

Various other kinds of lift means may be used for the operation, but the lift means described above has great advantages in that it has a simple structure and its traveling distance can be freely selected by merely varying the length of the chain 40.

In FIGS. 28 to 33, there is shown an embodiment which is preferred for use with a case in which lift means is disposed at an intermediate position of a pallet row. Where the vehicle entrance and exit is disposed above vehicle storage equipment as shown in FIG. 29, lift means 42 may merely be provided at the flat of the storage equipment, but where the vehicle entrance and exit is disposed below vehicle storage equipment as shown in FIG. 30, stationary rails for the lateral transfer should be cut off at that portion corresponding to the position of lift means 42 so as to avoid contact of the lift means 42 and the pallet 1 during lift operation and rails 43 and 43' may be provided on the lift 42 so that circulating movement of the pallets in the storage equipment can be carried out without any trouble.

There are various kinds of lift means, but description will be herein given with regard to the vehicle storage equipment when it is combined with a hydraulic lift which has a simple structure. As shown in FIGS. 31, 32 and 33, a hydraulic lift 42 herein employed comprises links 44, 45, 46 and 47 assembled in a pantagraph-like fashion to support thereon a carriage 53, a frame 48 supporting the linkage, a hydraulic cylinder 49 swingably mounted on the frame 48, a lift lever 51 having one end thereof connected to the end of a piston rod 50 of the hydraulic cylinder 49 and having the other end thereof pivotally connected to the frame 48, and a roller 52 mounted on the lever 51 so as to make rolling movement along the lower face of the link 47. Advancing movement of the piston rod 50 urges the lift lever 51 and causes rolling movement of the roller 52 mounted on the lever 51 along the lower face of the link 47 to force the links 44, 45, 46 and 47 upwardly.

By virtue of the above structure, a shallow depth of a pit required for installation of the lift means suffices and a long lift stroke can be obtained in spite of a short piston stroke. A further advantage is derivable from the fact that the power required for the cylinder is substantially constant and the cylinder suitable for the purpose can be easily selected, thus giving an improved efficiency.

A simple hydraulic circuit C as shown in FIG. 34 can be sufficiently used for the operation of the hydraulic lift described above, but a hydraulic circuit D is provided in addition to the circuit C to deal with interruption of electric supply and failure of hydraulic equipment so that automotive vehicles can be carried outwardly by means of a hand pump.

In the hydraulic circuit C, a pump 203 is driven by a motor 202 to take suction of hydraulic fluid from a fluid reservoir 200 by way of a strainer 201 and a conduit 207, and the hydraulic fluid under pressure is forced by way of a conduit 208, check valve 204, conduit 209, changeover valve 206 (which is urged in a direction of dotted line by an electromagnet SOL), conduit 210, check valve 205 and conduit 211 into the cylinder 49 to urge the piston rod 50 in the right-hand or advancing direction. By this movement of the piston rod 50, the carriage 53 is forced upwardly by the afore-described linkage for thereby bringing the pallet 1 upwardly.

In pallet lowering operation, the change-over valve 206 is urged in a direction of solid line to permit flow of hydraulic fluid under pressure from the conduit 209 into a conduit 218 to urge open the check valve 205. By the opening of the check valve 205, the hydraulic fluid under pressure in the cylinder 49 flows back into a reservoir 214 by way of the change-over valve 206, conduit 212 and flow restriction valve 213 for thereby causing lowering movement of the carriage 53. The speed of downward movement of the carriage 53 can be adjusted by suitable manipulation of the flow restriction valve 213.

In the hydraulic circuit D, a manual valve 219 may be opened and a hand pump 216 may be driven to force the hydraulic fluid in the reservoir 200 through a strainer 217 and conduits 215 and 211 into the cylinder 49 for thereby causing upward movement of the carriage 53. The carriage 53 can be lowered by merely turning the hand pump 216 in the opposite direction.

The hydraulic lift described above may be disposed at one end of a pallet row, in which case the lift may be disposed

below the longitudinal transfer means so as to engage the lower face of a pallet to lift it upwardly. This arrangement, however, has a limitation in its distance of lift and therefore it is impossible to take a long lift stroke.

When the lift is disposed at an intermediate position of a pallet row, coupling means between adjacent pallets becomes more complex than when the lift is disposed at one end of the pallet row. More precisely, in case the lift is disposed at one end or outside of a pallet row, relative positions of the coupling members 34 and 35 of the shapes as shown in FIG. 20 may merely be varied because a pallet on the lift is coupled to an adjacent pallet only at one side thereof. However, the coupling members 34 and 35 of such shapes can not be used when the lift is disposed at the intermediate position of the pallet row since a pallet on the lift is coupled to adjacent pallets on opposite sides thereof.

Coupling means shown in FIG. 35 is devised to solve the above problem. More precisely, as shown in FIG. 35, a plate 54 is fastened to one side of a pallet 1 by bolts 55 and an inverted U-shaped frame 56 is secured to this plate 54 by welding. This frame 56 is provided with a cut-out 57 in which a plate-like frame 59 secured to an adjacent pallet (not shown) by a rod 58 makes vertical movement to release the coupling between the pallets. Therefore the adjacent pallets can move in unitary relation for lateral transfer but are disconnected from each other in case of longitudinal or vertical transfer.

We claim:

1. A horizontal circulation type of storage equipment having a plurality of rows of pallets each capable of carrying an article, said pallets being arranged to provide a vacant space at one end of each of the pallet rows so that successive and alternate transfer of pallets in their longitudinal direction and in their lateral direction in a manner to fill up such vacancies will effect movement of the article carrying pallets to a predetermined station, comprising longitudinal transfer means positioned at each end of the pallet rows for effecting the transfer of said pallets from one row to an adjacent row, and lateral transfer means including a guide groove provided on the lower face of each pallet at right angles to the direction of lateral travel and a pair of pivot arms in each pallet row pivotable at the center thereof about a respective pivot point and having guide rollers mounted on the respective ends thereof for en-

gagement in said guide grooves, and drive means for imparting unidirectional rotary movement to said pivot arms so as to cause direct transfer of said pallets by one lateral transfer pitch of the pallet in the lateral direction by 180° rotation of said pivot arms, said guide rollers being mounted to make movement in said guide grooves in response to the rotary movement of said pivot arms to convert the circular movement of said pivot arms into linear movement in the lateral direction, said drive means including means for selectively effecting simultaneous rotation of said first and second pivot arms in opposite directions to progressively advance said pallets in the lateral direction with continued rotation of said pivot arms, each pair of pivot arms including first and second pivot arms pivotable at the center thereof with the guide rollers mounted on the corresponding ends of the respective first and second pivot arms engaging in a common guide groove, said pivot arms each having a length equal to the width of a pallet so that said lateral transfer pitch is equal to one pallet width, thereby providing for engagement by the rollers on respective ends of a pivot arm simultaneously with guide grooves on adjacent pallets.

2. A horizontal circulation type of storage equipment according to claim 1, wherein said longitudinal transfer means includes endless chains in meshing engagement with a pair of sprocket wheels, drive means connected to one of said sprocket wheels for driving said endless chains, and a plurality of movable rails fixedly mounted on said endless chains and having a length capable of carrying one of said pallets, and guide roller means including guide rollers secured to said movable rails for supporting said pallets on said endless chains, in which wedge-shaped stoppers are provided on the end of said movable rails to prevent drop-off of said pallets during the longitudinal transfer.

3. A horizontal circulation type of storage equipment according to claim 1, including coupling means for coupling one pallet to another pallet disposed adjacent thereto, said coupling means comprising a U-shaped frame provided on one side of said pallet and a plate-like frame provided on the other pallet for engaging in said U-shaped frame, said U-shaped frame being provided with a cut-out for releasing the coupling therebetween when said plate-like frame is operated to make a vertical movement.

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