

[54] **STRADDLE TRUCK FOR CONTAINERS**

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[57] **ABSTRACT**

A straddle truck for containers has two upright lateral frames mounted on respective sets of wheels and held together by transverse beams fixedly connecting the tops of the columns at the front and rear ends of the frames. The columns are vertically extendable to increase the clearance under the transverse beams to more than the combined height of three standard containers, the transverse beams clearing two superimposed containers in the retracted condition of the columns. A lifting frame suspended from the tops of the columns carries standard couplings for engagement with the four top corners of a container. The truck permits containers to be stacked three high without the use of a separate crane, yet it can pass under bridge cranes and the like having a vertical clearance sufficient only for conventional straddle trucks.

**11 Claims, 6 Drawing Figures**

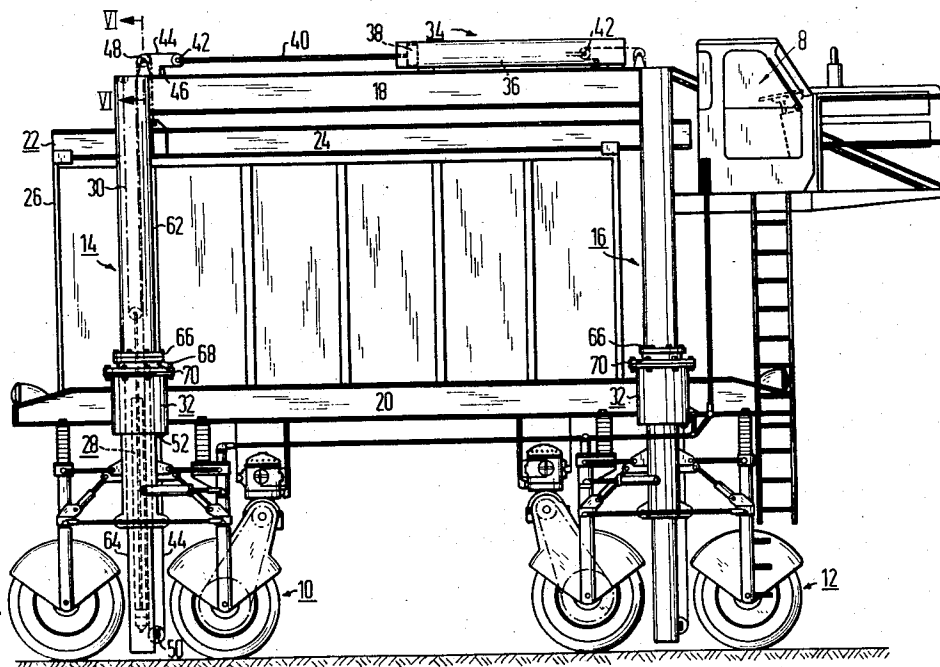
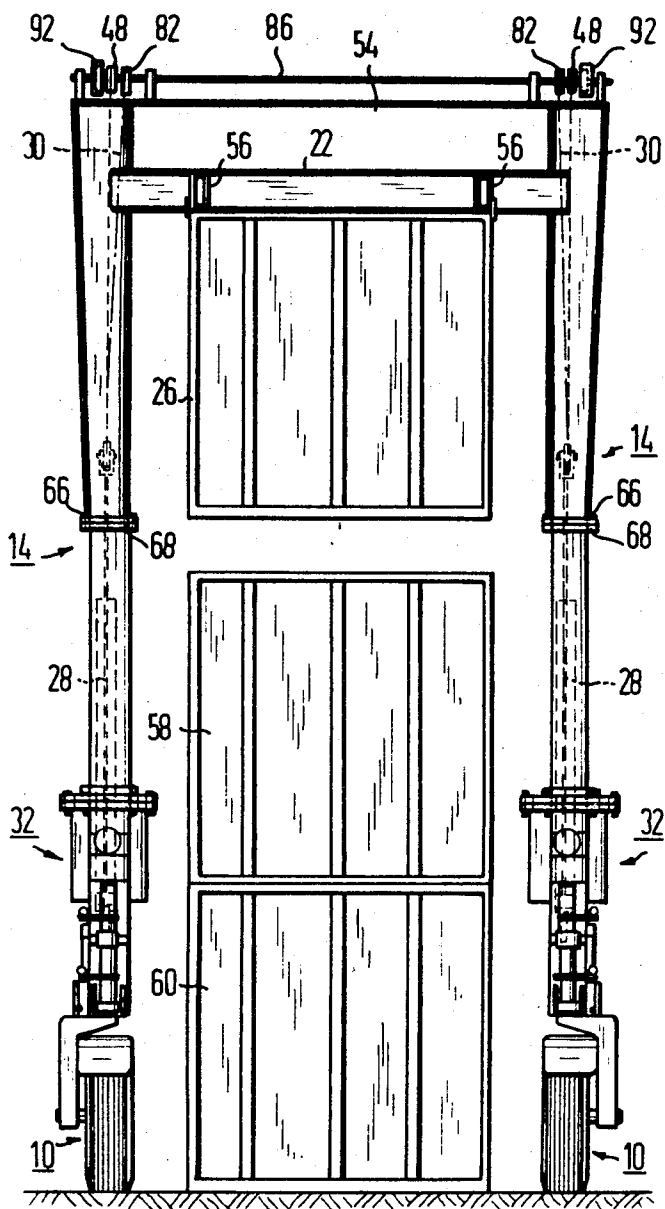
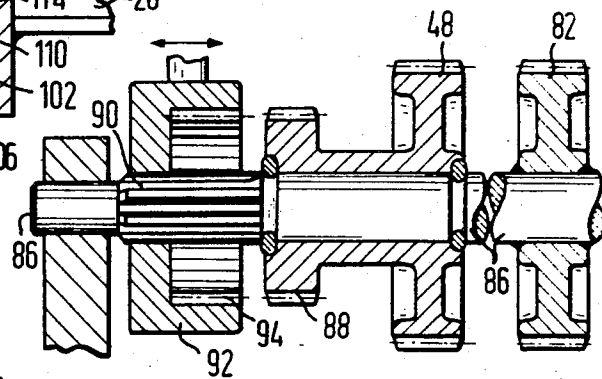
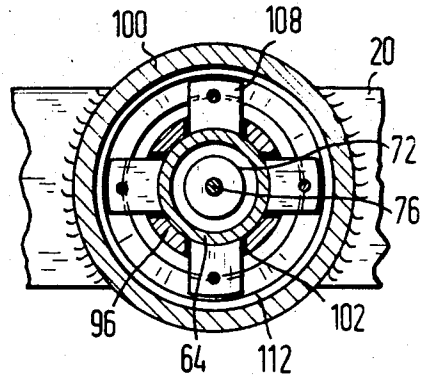
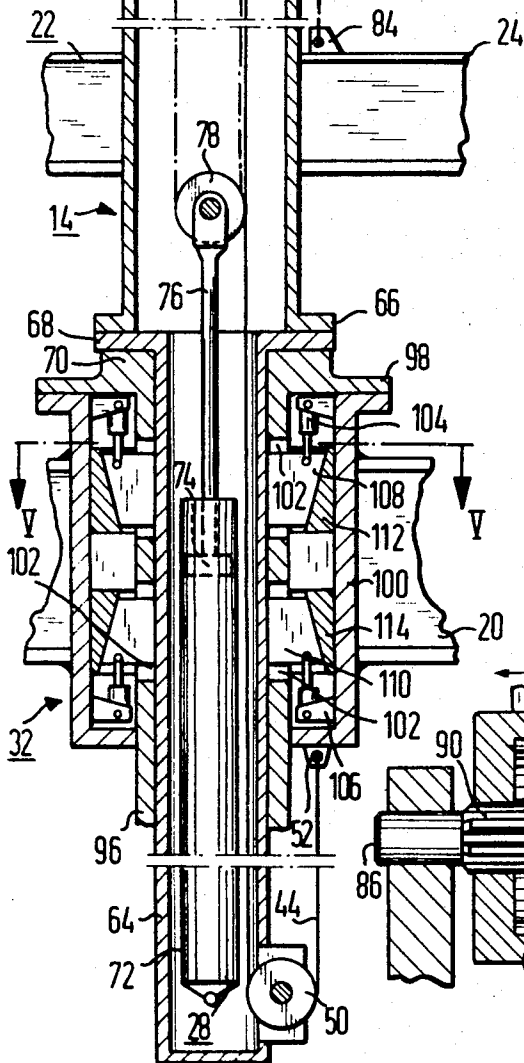
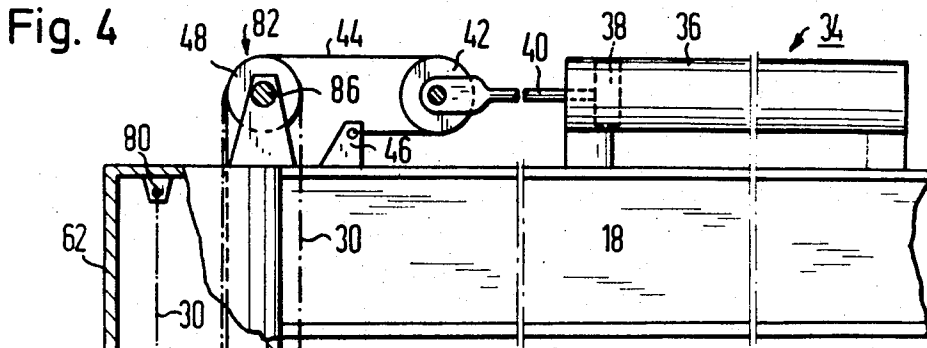






Fig. 3





**STRADDLE TRUCK FOR CONTAINERS**

This invention relates to transporters for moving shipping containers about a storage yard prior to loading on container ships or after unloading, and particularly to a straddle truck for such containers which are of generally rectangular shape and have dimensions of several yards in all directions.

The known straddle trucks have two, parallel, upright frames equipped with respective sets of wheels at least partly driven and/or arranged for pivoting movement about a vertical axis for steering the vehicle. The tops of the lateral frames are connected to define a tunnel open forwardly and rearwardly in the direction of vehicle movement and in a downward direction. An operator's cab, a drive motor, and necessary controls are provided to make the vehicle self-propelled and to drive a hoist which raises or lowers a carrier frame in the tunnel. A container may be suspended from the carrier frame by means of releasable attaching fixtures.

The vertical clearance between a traffic surface which tangentially engages all the wheels of the known trucks and the lifting frame in its topmost position is slightly greater than the combined height of two standard containers, thereby permitting two containers to be stacked on top of each other without the use of a separate crane. When stacks of three containers are to be set up or the topmost container of a stack of three containers is to be removed, a crane must assist the straddle truck.

Vertical clearances under bridge cranes and other machinery normally provided in ports for container ships are chosen to permit passage of conventional straddle trucks, and it would be uneconomical to increase such clearances to permit higher than normal straddle trucks to pass.

A primary object of this invention is the provision of a straddle truck capable of depositing containers in vertical stacks of three, yet not requiring more clearance under bridge cranes and other port structures than is needed by the conventional straddle trucks not capable of such operation.

In its more specific aspects, the invention provides an otherwise basically conventional straddle truck with upright front and rear columns in each of the lateral frames which are movable in guide assemblies relative to the vehicle wheels in a vertical direction. A longitudinal frame member connects the top portions of the front and rear columns in each frame, and transverse beam members fixedly connect the top portions of the front columns and of the rear columns respectively. The carrier frame is secured by its hoist to the column tops for vertical movement with the columns and relative to the columns. An actuating mechanism moves the columns on the associated guide assemblies.

Other features, additional objects, and many of the attendant advantages of this invention will readily be appreciated as the same becomes better understood by reference to the following detailed description of a preferred embodiment when considered in connection with the appended drawing in which:

FIG. 1 shows a straddle truck of the invention in side elevation; and retracted to its minimum height;

FIG. 2 illustrates the rear portion of the truck of FIG. 1 extended to its maximum height;

FIG. 3 shows the truck of FIG. 2 in rear elevation as indicated by the arrow III in FIG. 2;

FIG. 4 shows a portion of the truck of FIG. 1 in enlarged, side-elevation section;

FIG. 5 illustrates the device of FIG. 4 in section on the line V—V; and

FIG. 6 shows a portion of the truck in front elevational enlarged section on the line VI—VI in FIG. 1.

Referring initially to FIG. 1, there is seen a straddle truck for containers according to the invention which is equipped with an operator's cab 8 high on its front end. As is conventional, and not to be described in detail, a diesel engine at the cab drives a pump for hydraulic fluid which is led to other portions of the truck to provide motive power for hydraulic motors. Such motors are associated with the two front wheels 12 and the two rear wheels 10 which are driven and steered hydraulically, the control valves for the hydraulic devices being controlled electrically, and the necessary switches and other control elements, not shown, being arranged in the cab 8.

The truck has two upright side frames of which only one is visible in FIG. 1, the other frame being a mirror image of the structure seen in FIG. 1. The illustrated frame has a rear column 14, a front column 16, and a longitudinal beam 18 which fixedly connects the upper ends of the columns 14, 16. The columns are respectively received in guide assemblies 32 which permit vertical movement of the columns and are fixedly connected by a longitudinal beam 20.

A horizontal, rectangular carrier frame 22 is suspended between the two lateral frames, only a longitudinal side element 24 of the frame 22 being visible in FIG. 1. A container 26 is releasably suspended from the frame 22. The frame 22 may be lowered and raised by means of hydraulic motor or jack 28 arranged in each of the columns 14, 16, as will be described hereinbelow with reference to a rear column 14 and FIG. 4. The motors 28 are connected with the four corners of the rectangular frame 22 by chains 30.

The manner in which the four columns 14, 16 may be adjusted vertically with respect to the associated guide assemblies 32 will now be described with reference to the rear column 14 seen in FIG. 1, but it will be appreciated that the structure described and illustrated in more detail is duplicated for each other column, though not fully shown in the drawing.

The upper longitudinal beam 18 fixedly supports a double-acting hydraulic motor 34 whose cylinder 36 has a horizontal axis and encloses a piston 38. A piston rod 40 attached to the piston 38 extends rearwardly out of the cylinder 36. The pressure lines which permit the compartments in the cylinder 36 on either side of the piston 38 to be supplied with fluid under pressure or to be vented to a sump, and the necessary control valves operated from the cab 8 have been omitted from the drawing since they may be entirely conventional, and are well known in this art.

The free outer end of the piston rod 40 carries an idler sprocket 42. A link chain 44 is trained over the sprocket 42 in an arc of 180°. One end of the chain 44 near the idler 42 is attached to a fixed boss 46 on the upper longitudinal beam 18. The chain 44 is led from the sprocket 42 over another idler 48 mounted on the upper end of the column 14, and passes through the hollow interior of the column 14 to a side opening near the lower end of the column. Another idler sprocket 50

mounted there on the column 14 reverses the direction of the chain 44 which then passes upward outside the column 14 to a fastener 52 which attaches the other end of the chain to the guide assembly 32. When pressure fluid is admitted to the rear compartment of the cylinder 36, the column 14 is lifted from the position shown in FIG. 1.

The vertical movement of the column 14 is limited by the stroke of the piston 38. The difference between the minimum height of the column 14, as measured from the traffic surface tangentially engaged by the wheels 10, 12, and the equally measured maximum height of the column as shown in FIG. 2 is equal to the stroke of the piston 38, and the dimensions of the hydraulic motor 34 are selected accordingly.

As is partly seen in FIG. 3, the tops of the columns 14, 16 are connected by transverse beam members 54 so that the two upper longitudinal beams 18 and the two transverse beam members 54 form a rigid frame from whose four corners the columns 14, 16 depend. As shown in FIG. 3, the carrier frame 22 has been raised sufficiently by the associated chains 30 and motors 28 so that the container 26 suspended from the frame 22 by means of releasable fasteners 56 upwardly clears a stack formed by two identical containers 58, 60, and may be deposited atop the upper container 58 by lowering the frame 22.

For convenience of assembly, and other reasons which will presently become apparent, each column consists of two axial sections 62, 64 coaxially fastened to each other by means of radial flanges 66, 68 and connecting bolts. If at any time the truck of the invention need no longer assembly stacks of three containers, the lower column section 64 may be released, and the upper column section 62 flanged directly to the guide assembly 32, the latter being provided with a seating portion 70 which normally serves as abutment for the connected flanges 66, 68 when the height of the column 14 is at its minimum value.

The afore-described actuating mechanism for shifting the column 14 in the guide assembly 32 and associated elements are best seen in FIG. 4. The hydraulic motor 28 which raises and lowers the carrier frame 22 is arranged in the hollow lower column section 64, the cylinder 72 of the motor being axially fastened in a manner not shown in detail. A piston 74 divides the cavity of the cylinder 72 into two compartments which may be provided with pressure fluid or vented to an oil sump as described above with reference to the motor 34, but not shown explicitly. The piston rod 76 of the motor 28 extends into the upper, wider section 62 of the column 14 in the illustrated condition of the motor 28, and carries an idler sprocket 78. One end of the chain 30 is attached to the inner top wall of the column 14 by a bracket 80, the chain is then trained in an arc of 180° over the sprocket 78, thereafter in another arc of 180° about a sprocket or toothed pulley 82 rotatably mounted on the upper longitudinal beam 18, as is seen in FIG. 3, but obscured in FIG. 4 by the sprocket 48. Ultimately, the end of the chain 30 is attached to a corner of the carrier frame by a lug 84.

Reverting to FIG. 3, the sprockets or toothed pulleys 48, 82 associated with the hydraulic motors 34, 28 respectively, are coaxially mounted on a common shaft 86 which also carries the corresponding sprockets as-

sociated with the other column 14. The chains 30, 44 are trained over the sprockets 82, 48 in such a manner that the column 14 is lifted and the carrier frame 22 is simultaneously lowered when the sprockets 48, 82 turn in the same direction.

As is shown in FIG. 6, the sprocket 82 is fixedly fastened on the shaft 86. The sprocket 48 is axially secured, but freely rotatable on the shaft 86. A gear 88 is integrally connected with the sprocket 48. A cup-shaped coupling sleeve 92 is secured against rotation on the shaft 86 by means of splines 90 which permit axial movement of the sleeve 92 as indicated by a double arrow. The sleeve 92 is shifted axially by a double-acting hydraulic motor, similar to the motors 28, 34, but not explicitly shown.

A circular rim of axial ribs 94 on the sleeve 92 is spaced apart for engagement with the rear teeth on the gear 88. When the sleeve is shifted axially to the right from the position seen in FIG. 6 until the teeth of the gear 88 are locked between the ribs 94 of the coupling sleeve 92, the sprockets 48, 82 are coupled for joint rotation. The two sprockets having the same diameter, the carrier frame 22 and the container 26 suspended therefrom remain on the same level above the ground while the columns 14, 16 are raised or lowered. The hydraulic motor 34 therefore need only provide the energy required for moving the columns.

FIG. 4 also shows details of the guide assembly 32. It includes a guide sleeve 96 which envelops the column section 64 with a sliding fit. A flange 98 on the sleeve 96, integral with the afore-mentioned seating portion 70 connects the sleeve 96 to a cup-shaped casing 100 of the guide assembly 32. The casing 100 is welded to the lower longitudinal beam 20. Four radial openings 102 are provided on each of two axial levels in the sleeve 96, as is also evident from FIG. 5, wedges 108, 110 are retained in the openings 102 in frictional engagement with the column portion 64 and cooperate with two axially offset frustoconical cam faces on the inner circumferences of rings 112, 114 radially aligned with the openings 102 and fixedly secured on the inner face of the casing 100. Small hydraulic jacks 104, 106 mounted on the casing 100 are hinged to the wedges 108, 110 and drive the wedges between the cam rings 112, 114 and the column section 64 when provided with hydraulic fluid firmly to arrest the column 14 in its topmost position or any intermediate position in which the weight of the column and of the load supported thereon is not transmitted to the wheels 10, 12 by abutting engagement of the seating portion 70 by the connected flanges 66, 68.

The illustrated truck has been found capable of carrying heavy loads in any one of the vertical positions of its columns 14, 16 without loss of rigidity because of the rigid, welded connections between the beams 18, transverse beam members 54, and columns 14, 16, and the fastening effect of the wedges 108, 110.

While transporting a container, the truck of the invention is normally retracted to the condition seen in FIG. 1 in which the minimum height of the columns is defined by the seating portion 70 and the cooperating flanges 66, 68 on the columns. The vehicle readily clears cranes and other port structures designed for conventional straddle trucks. When reaching a stack of two containers on which the carried container is to be

superimposed, the columns 14, 16 are extended to their maximum height, and the truck is driven over the lower stack until the position seen in FIG. 3 is reached. The frame 22 is then lowered to set the container 26 on the container 58, whereupon the fasteners 56 are released by remote control from the operator's cab in the usual manner.

Because the guide assemblies 32 for the columns 14, 16 are mounted on longitudinally terminal parts of the lower, longitudinal beams 20, the probability of jamming the columns in the guide assemblies is reduced to a minimum. Jamming would be more likely if the guide assemblies were arranged higher on the columns, and not at the point which is the lowest possible, as is evident from FIG. 2. The weight of the superstructure and of the supported load is transmitted to the fixed vehicle structure including mainly the beams 20, guide assemblies 32, and wheels 10, 12 at a low level, thereby further contributing to the stability of the vehicle during its travel with a suspended load.

It is preferred to associate two hydraulic motors 28, 34 with each column 14, 16. However, the truck may be operated with motors arranged on only two diagonally opposite columns, and the motor which hoists the carrier frame 22 need not be mounted on a column which may be raised and lowered by means of a motor 34. Even fewer or differently arranged motors may be employed when multiple tension members are driven by the same motor, or when systems of counterweights are resorted to, as may be practical under certain conditions.

It should be understood, therefore, that the foregoing disclosure relates only to a preferred embodiment of the invention, and that it is intended to cover all changes and modifications of the example of the invention herein chosen for the purpose of the disclosure which do not constitute departures from the spirit and scope of the invention set forth in the appended claims.

What is claimed is:

1. In a straddle truck for containers including two upright lateral frames, driving and steering wheels on said frames for supporting the truck on a traffic surface simultaneously engaging said wheels, each lateral frame including a front column, a rear column, an upper horizontally extending frame member connecting respective upper portions of said columns, and a lower horizontally extending frame member connecting respective lower portions of said columns, transverse connecting means connecting said lateral frames, a horizontally extending carrier frame arranged between said lateral frames, hoist means on said upper portions and connected to said carrier frame for raising and lowering the same, the improvement which comprises:

- a. guide means mounted on said wheels and respectively receiving said lower portions of said columns for vertical movement;
- b. said upper frame member being fixedly secured to said upper portions of the columns in each lateral frame;
- c. said transverse connecting means fixedly connecting said upper frame member and the columns of each lateral frame to the upper frame member and the columns of the other lateral frame;

d. actuating means for vertically moving one of said columns relative to the associated guide means; and

e. coupling means for coupling said hoist means and said actuating means for lowering said carrier frame relative to said upper portions when said columns are moved vertically upward by said actuating means.

2. In a truck as set forth in claim 1, limiting means for limiting said movement of each column to an overall maximum height and minimum height of the column as measured from said traffic surface, said maximum height being approximately fifty percent greater than said minimum height.

3. In a truck as set forth in claim 1, said guide means being secured on respective terminal parts of said lower frame members.

4. In a truck as set forth in claim 1, said actuating means including a hydraulic motor secured to said one column for movement therewith, and a tension member having respective terminal portions secured to said hydraulic motor and said guide means.

5. In a truck as set forth in claim 4, said one column being hollow, said tension member passing from said hydraulic motor downward through the hollow interior of said one column, and deflecting means deflecting said tension member upwardly from the lower portion of said one column, said lower portion being formed with an opening for passage of said tension member.

6. In a truck as set forth in claim 1, one of said columns being hollow, said hoist means including motor means mounted in the hollow interior of said one column and a tension member connected to said motor means and to said carrier frame.

7. In a truck as set forth in claim 6, said actuating means including a hydraulic motor secured to one of said columns for movement therewith, and a tension member having respective terminal portions secured to said hydraulic motor and said guide means, said coupling means including two pulley members, said tension members being respectively trained over said pulley members, and means for securing said pulley members to each other for joint rotation.

8. In a straddle truck for containers including two upright lateral frames, driving and steering wheels on said frames for supporting the truck on a traffic surface simultaneously engaging said wheels, each lateral frame including a front column, a rear column, an upper horizontally extending frame member connecting respective upper portions of said columns, and a lower horizontally extending frame member connecting respective lower portions of said columns, transverse connecting means connecting said lateral frames, a horizontally extending carrier frame arranged between said lateral frames, hoist means on said upper portions and connected to said carrier frame for raising and lowering the same, the improvement which comprises:

- a. guide means mounted on said wheels and respectively receiving said lower portions of said columns for vertical movement;
- b. said upper frame member being fixedly secured to said upper portions of the columns in each lateral frame;

- c. said transverse connecting means fixedly connecting said upper frame member and the columns of each lateral frame to the upper frame member and the columns of the other lateral frame;
- d. actuating means for vertically moving one of said columns relative to the associated guide means; and
- e. arresting means for arresting said columns in each of a plurality of vertically spaced positions,
  - 1. said guide means being mounted on said lower frame member and including a sleeve member slidably receiving the lower portion of one of said columns and formed with apertures, and
  - 2. said arresting means including
    - i. a plurality of wedge-shaped clamping members movably mounted on said lower frame member,
    - ii. operating means for moving said clamping members into engagement with said one column through the apertures of said sleeve member, and
    - iii. cam means on said lower frame member engaging said clamping members during said moving thereof by said operating means.
- 9. In a truck as set forth in claim 8, a casing fixedly fastened to said lower frame member, the apertured portion of said sleeve member, said clamping member, and said operating means being mounted in said casing.
- 10. In a truck as set forth in claim 9, said operating means including a hydraulic motor.
- 11. In a straddle truck for containers including two upright lateral frames, driving and steering wheels on said frames for supporting the truck on a traffic surface simultaneously engaging said wheels, each lateral frame including a front column, a rear column, an upper horizontally extending frame member connect-

- ing respective upper portions of said columns, and a lower horizontally extending frame member connecting respective lower portions of said columns, transverse connecting means connecting said lateral frames, a horizontally extending carrier frame arranged between said lateral frames, hoist means on said upper portions and connected to said carrier frame for raising and lowering the same, the improvement which comprises:
  - a. guide means mounted on said wheels and respectively receiving said lower portions of said columns for vertical movement;
  - b. said upper frame member being fixedly secured to said upper portions of the columns in each lateral frame;
  - c. said transverse connecting means fixedly connecting said upper frame member and the columns of each lateral frame to the upper frame member and the columns of the other lateral frame;
  - d. actuating means for vertically moving one of said columns relative to the associated guide means;
  - e. a first radial flange on the upper end of the lower portion of each column above the associated guide means;
  - f. a second radial flange on the lower end of the upper portion of each column and releasably fastened to the associated first flange; and
  - g. seating means on the associated guide means abuttingly engaging said first flange during downward vertical movement of the same and thereby limiting said downward movement,
    - 1. said seating means being dimensioned for direct seating engagement with said second flange when said lower portion is released from said upper portion and from said guide means.

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