

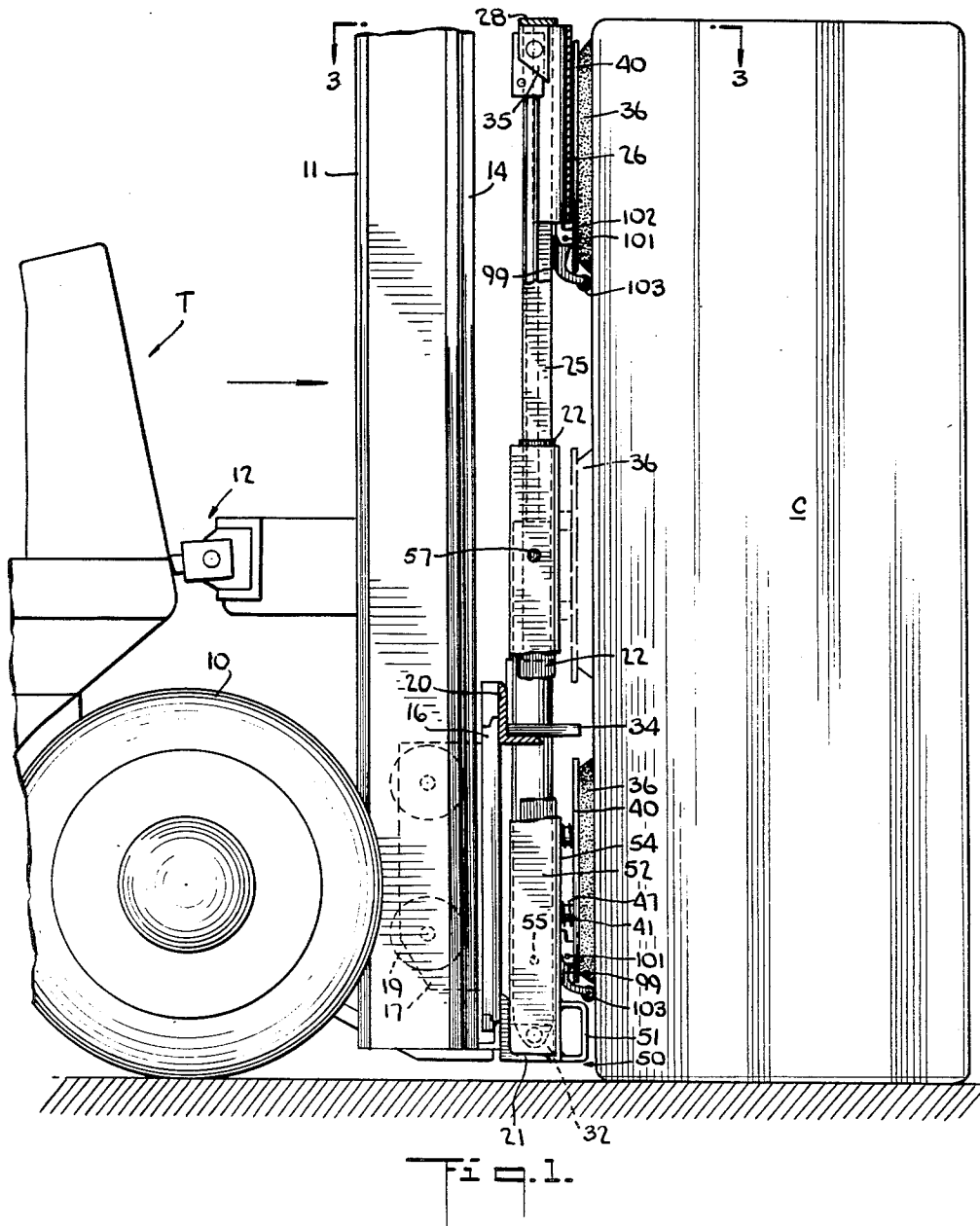
June 28, 1960

E. A. HORTON
VACUUM LIFT DEVICE

2,942,745

Filed Nov. 17, 1958

4 Sheets-Sheet 1



INVENTOR.
EARL A. HORTON

BY

A. A. Golden

ATTORNEY

June 28, 1960

E. A. HORTON
VACUUM LIFT DEVICE

2,942,745

Filed Nov. 17, 1958

4 Sheets-Sheet 2

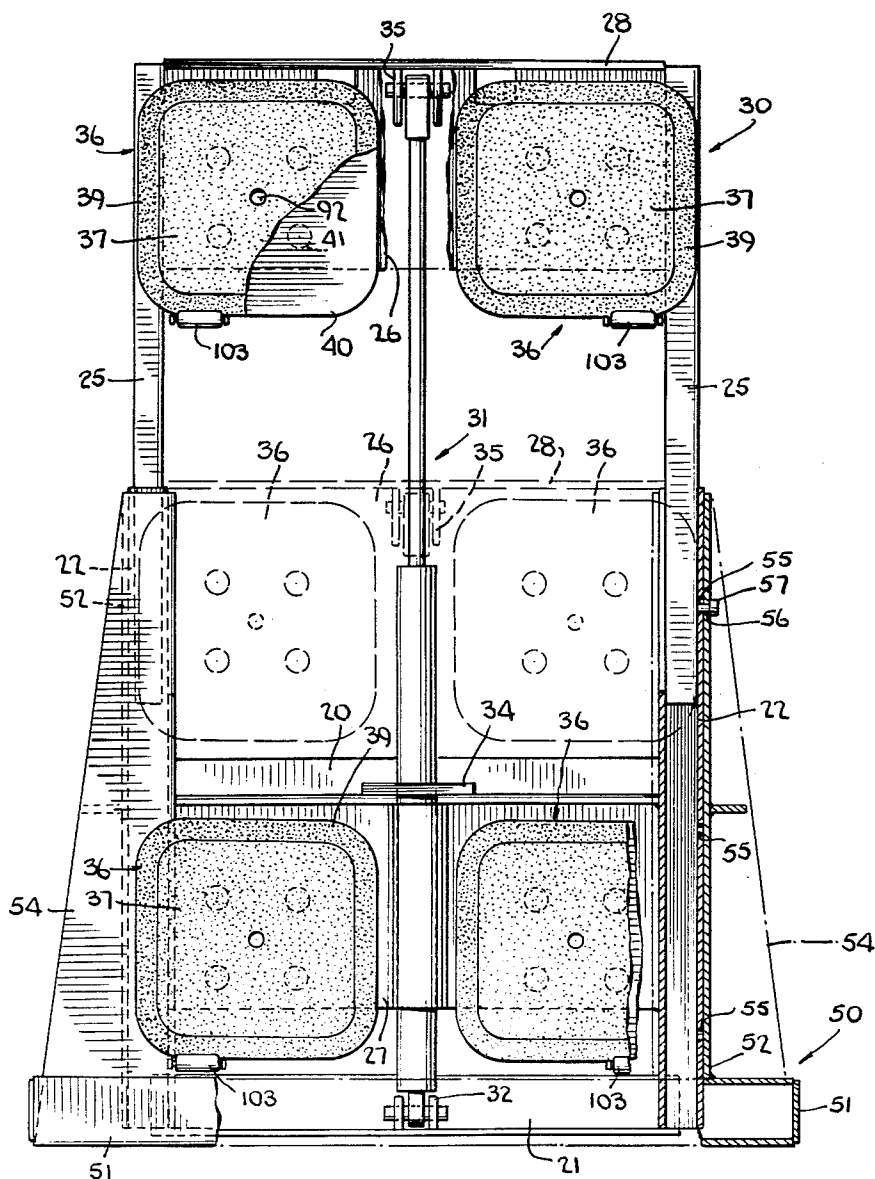


Fig. 2.

INVENTOR.
EARL A. HORTON

BY

A. H. Golden

ATTORNEY

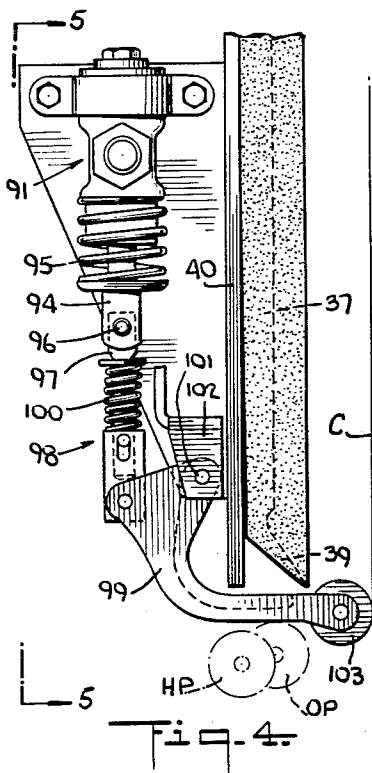
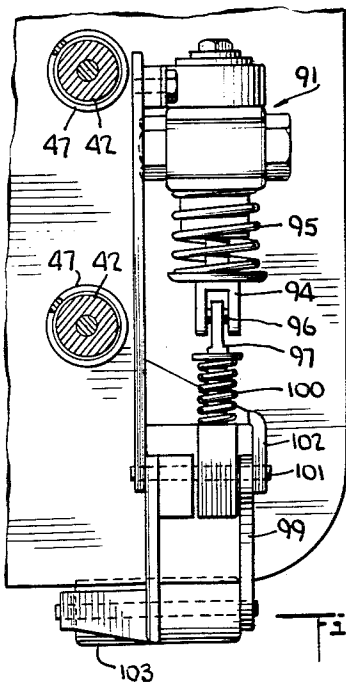
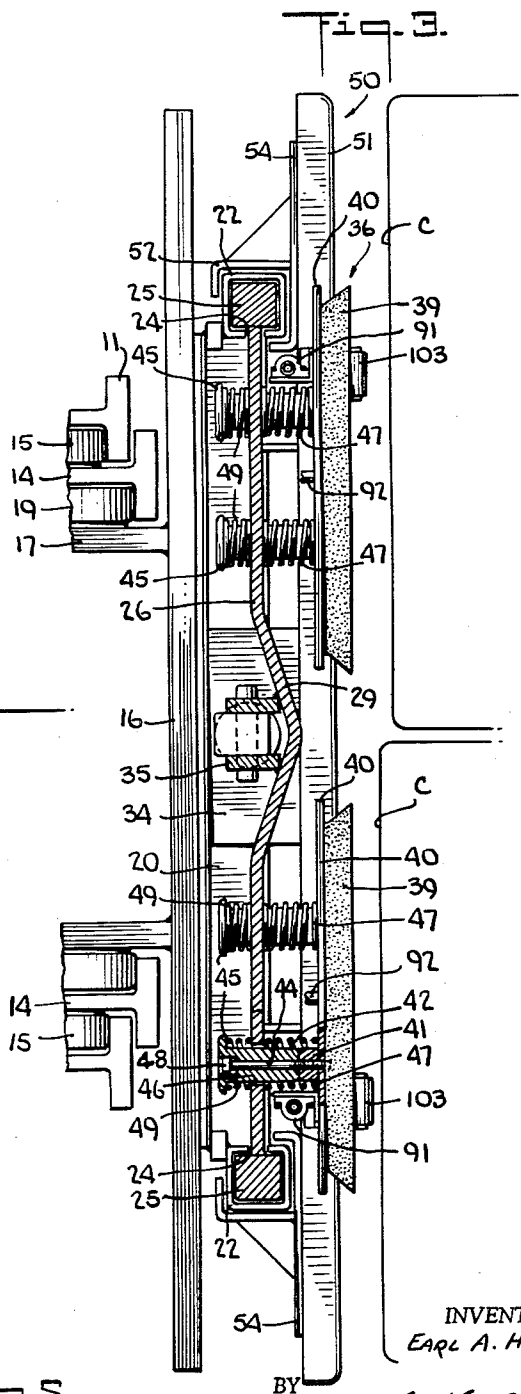
June 28, 1960

E. A. HORTON
VACUUM LIFT DEVICE

2,942,745

Filed Nov. 17, 1958

4 Sheets-Sheet 3



INVENTOR.
EARL A. HORTON

BY

A. Golden

ATTORNEY

1

2,942,745

VACUUM LIFT DEVICE

Earl A. Horton, Philadelphia, Pa., assignor to The Yale and Towne Manufacturing Company, Stamford, Conn., a corporation of Connecticut

Filed Nov. 17, 1958, Ser. No. 774,215

6 Claims. (Cl. 214—650)

This invention relates to an industrial truck, and, more particularly, to an industrial truck equipped with an attachment by which loads may be gripped and lifted through the medium of a vacuum cup or vacuum cups.

It is old in the art to lift loads by the application of vacuum cups to surfaces of the loads, but so far as I know, it has never been possible to bring about automatically a gripping of a load upon the movement of the truck toward the load. Thus, those skilled in the art will appreciate that industrial trucks must be operated at a very high speed and with a minimum of operator control, particularly during that portion of the cycle when the load is accepted by the truck and that portion of the cycle when the load is deposited by the truck. My invention has for its particular purpose the contribution of means that make possible the acceptance of a load by vacuum cups without exact and complicated maneuvering of the truck relatively to the load, and for automatic deposit of the load or removal of the load from the truck.

My invention is particularly important where a stack of cartons are to be elevated through first being gripped by a series of vacuum cups. Obviously, the application of various vacuum cups to a stack of cartons, and the application of vacuum to the vacuum cups, would in such a situation require considerable manipulation of the truck and considerable manipulation of complicated controls.

As a feature of my invention, I apply to each of one or more vacuum cups a control whereby vacuum is applied to the cup only when the cup is in a position to grip the surface of a load. As a further feature of the invention, the vacuum cup is normally cut off from communication with the vacuum source on the truck, and is automatically placed in communication with the vacuum source only when the control detects the immediate presence of a carton to be gripped. More particularly, the control actuates a valve that opens a path between the cup and the vacuum source as the cup approaches a carton. For this purpose, the control has means for detecting the presence of a carton opposite the cup as the truck is maneuvered towards the carton to be gripped.

As a further control feature of my invention, I apply between the source of vacuum pressure and each of the vacuum cups, a valve which is preferably solenoid operated, and that is normally positioned in a vacuum path between the vacuum cups and controls and the source of vacuum. Naturally, none of the vacuum will be used except when a vacuum cup is applied to a carton to be lifted because of the control at each cup. However, to release the cartons that have been lifted, operation of the solenoid breaks the vacuum path between the cups and the vacuum source, and as a matter of further improvement, places the vacuum cups in communication with the atmosphere, thereby immediately releasing the load. Because of the particular arrangement, it is obvious that all of the cartons gripped by a series of

2

vacuum cups will be released simultaneously. However, each of the cartons will be individually gripped in the order in which it is contacted by its particular vacuum cup, since the vacuum at each cup is controlled by the control mechanism at that cup. Therefore, the lifting is orderly and in sequence as each cup contacts its carton during the part of the load handling cycle when the load is being accepted by the truck. At the same time, the entire load comprising a stack of cartons is released at one time, and this is of extreme importance during the part of the cycle when the load is freed from the truck.

As a still further feature of my invention, I provide a back-up plate that is adjustable vertically and that serves as a bearing surface for the lower part of a carton that has been lifted. Since it is desirable from the point of view of stability to grip the cartons at the highest part thereof that is possible, there will be a tendency for the cartons to rotate relatively to the truck to bring the lower part of the cartons toward the truck and the upper part away from the vacuum cup. To overcome this tendency, the back-up plate is manually adjusted by the operator before he commences to handle a particular group of cartons so that the plate will be in a position to resist the tendency of the cartons to rotate when lifted.

I have thus outlined rather broadly the more important features of my invention in order that the detailed description thereof that follows may be better understood, and in order that my contribution to the art may be better appreciated. There are, of course, additional features of my invention that will be described hereinafter and which will form the subject of the claims appended hereto. Those skilled in the art will appreciate that the conception on which my disclosure is based may readily be utilized as a basis for the designing of other structures for carrying out the several purposes of my invention. It is important, therefore, that the claims be regarded as including such equivalent constructions as do not depart from the spirit and scope of my invention, in order to prevent the appropriation of my invention by those skilled in the art.

A specific embodiment of the invention has been chosen for purposes of illustration and description, and is shown in the accompanying drawings.

In the drawings:

Fig. 1 is a side view, partly broken away, of the load carrying end of an industrial truck equipped with an attachment in accordance with my invention and showing an upper vacuum cup in elevated position in full lines, and in lowered position in broken lines, with the vacuum cups gripping a carton;

Fig. 2 is a front view, partly broken away, of the structure shown in Fig. 1;

Fig. 3 is a cross-sectional view taken along the lines 3—3 of Fig. 1;

Fig. 4 is a side view of a suction cup and its control, the control being illustrated in several positions;

Fig. 5 is a rear view taken along the lines 5—5 of Fig. 4; and

Fig. 6 is a schematic view of an entire vacuum producing and control system, illustrating one vacuum cup about to grip a carton, and one cup already gripping a carton.

Referring now to the drawings, and more particularly to Fig. 1 thereof, there is shown a portion of the main frame of an industrial truck T partly supported on front wheel 10. The truck may be equipped with a pair of primary uprights 11, a tilt device 12 for tilting the uprights forwardly and rearwardly, and secondary uprights 14 in the form of I beams, as best seen in Fig. 3.

In order that the secondary uprights may be movable vertically relatively to the primary uprights, rollers 15 are pivoted on the secondary upright and extend into the

inner channels of the primary uprights to bear against the flanges of these channels for guiding the movement of the secondary uprights.

To support my vacuum lift device for vertical movement relatively to the secondary uprights, I provide a carriage plate 16 that is provided with rearwardly extending brackets 17. These brackets pivotally support rollers 19 that extend into the inner channels of the secondary uprights and bear against the flanges of those uprights to guide the vertical movement of the carriage plate relatively to the secondary uprights.

It is not necessary to show the power means for moving the secondary uprights or the carriage plate since such means are already well known to those persons skilled in the art and constitute on part of the present invention. It will also be appreciated that, if desired, the carriage plate could support a known side shifting or swinging mechanism so that my vacuum lift device could be shifted or swung laterally relatively to the uprights.

As shown in Figs. 1 to 3, I weld to the carriage plate 16, a pair of upper and lower transverse angle members 20 and 21, respectively, and these angle members in turn have welded to their ends complementary, vertically extending tubes 22. These tubes are formed with vertical openings 24 at their inner sides, as shown in Fig. 3.

The tubes 22 serve as guides for vertical bars 25 that I mount within the tubes, and that are connected by a transverse plate 26 the central part of which is bent forwardly as at 29, for a purpose to be later described, and an upper cross piece 28. The plate 26 passes through the vertical openings 24 for connection to the bars 25. I also provide a second transverse plate 27, similar to plate 26 but welded to the tubes 22, as shown in Fig. 2.

From the description thus far, it will be seen that the tubes 22 are integrally connected through the upper and lower angle members 21 and 22 to the carriage plate 16 for vertical movement with the carriage plate. It will also be seen that the bars 25, the plate 26 and the cross piece 28 comprise a frame 30 that is movable vertically under the guidance of the vertical tubes 22, while the plate 27 is integral with the tubes 22.

In order to control movement of the frame 30, I provide a hydraulic ram 31 that is pivotally supported at the center of the lower angle member 21 by a bracket 32. The ram cylinder extends upwardly through the horizontal flange of the upper angle member 20 that is recessed for that purpose, and through a reinforcing plate 34 welded to the angle member 20. As mentioned heretofore, the transverse plates 26 and 27 are bent at their central portions to provide room for the ram to pass behind them. The upper end of the ram piston rod is pivoted to a bracket 35 on the cross piece 28. As the ram is extended, the frame 30 will move upwardly, the bars 25 sliding in tubes 22, and as the ram is retracted, the frame will descend.

I shall now describe the manner in which I mount the vacuum cups 36 on the transverse plates 26 and 27. Since the cups are mounted identically on both plates, I shall only describe the mounting of the cups on the upper plate 26, and for this purpose, I shall refer to Fig. 3.

The cups 36 may be formed of any suitable material, such as rubber, and have rear walls 37 and forwardly extending peripheral lips 39. As shown in Fig. 3, the rear walls 37 are bonded to metal plates 40 that are each formed preferably with four rearwardly projecting bosses 41. I then provide a spacer 42 formed with a through bore 44 and an annular flange 45 for each boss. The spacers extend through suitable apertures 46 in the plate 26 and are attached to the bosses 41 by bolts 48 that extend through the bores 44 and are threaded into the bosses. In the course of assembling the cups to the plates 26 and 27, I place a spring 47 around each boss 41 so as to bear against the plates 40 at one end and against the plates 26 and 27 at the other end. I place a second, heavier spring 49 around each spacer 42 to bear against

the rear surface of the plates 26 and 27 at one end, and against the flanges 45 of the spacers at the other end. As I have already stated, when the cups grip cartons and lift them, there will be a tendency for the cartons to rotate relatively to the truck to bring the lower part of the cartons toward the truck and the upper part away from the vacuum cup gripping it. The heavier springs 49 will resist any tendency toward forward movement of the cups due to this rotational effect, and the lighter springs 47 permit the cups to readily seek their own position against the cartons they grip.

In order to provide further assurance that the cartons will not rotate, I provide a vertically adjustable back plate 50 (Figs. 1 to 3). The back plate 50 comprises a cross piece 51 that I weld to the lower ends of a pair of vertically disposed tubes 52. As best shown in Fig. 3, these tubes 52 are generally C-shaped in cross section and are mounted for guided vertical movement about the exterior of tubes 22. Gusset plates 54 are welded to the tubes 52 and cross piece 51 to add rigidity to the back plate. For the purpose of retaining the back plate in various adjusted positions, I provide the tubes 22 with a series of vertically spaced holes 55 (Fig. 2), and I provide a hole 56 in the tube 52. The hole 56 is placed so as to register with one of the holes 55 depending upon the position of the back plate. A pin 57 passes through the hole 56 and its registering hole 55 to retain the back plate in its adjusted position. While I have described means for retaining the back plate in the position to which it has been manually adjusted, it will be understood that my basic concept includes other means of vertical adjustment such as by hydraulic ram, for example.

I shall now describe the vacuum system and control means by which I enable the cups 36 to grip and release a load. For this purpose reference will first be had to Fig. 6. I provide on the truck T a source of electrical power 60 and an electric motor 61 in driven relation to the source. Since I have chosen to represent my power source 60 as an electric battery, I provide a conduit 62 from one terminal of the source 60 to one of the motor terminals. A second conduit 64 extends between the opposed battery terminal and the opposed motor terminal, and this conduit includes the normally open main control switch 65, and a pressure switch 66.

I place a vacuum pump 67 in driven engagement with the motor 61. A vacuum line 69 leading from the pump is connected to a vacuum tank 70 after which it passes through a T connection 71 to a check valve 72. One side of the T connection leads to a vacuum gauge 74 and the pressure switch 66.

After passing the check valve 72, the vacuum line 69 is branched through T connections 75 into a number of secondary vacuum lines 76 equal to the number of vacuum cups to be employed on the particular vacuum lift device.

Since each of the secondary vacuum lines includes the same equipment, I shall confine my description to one only. The secondary line 76 opens into the chamber 77 of an electromagnetically controlled valve 79. A second conduit 80 connects the chamber to atmosphere, and a third conduit 81 leads from the chamber to a vacuum cup control that will later be described. A valve member 82 is slidable within the chamber 77 and has a portion of reduced diameter so disposed that this member normally closes conduit 80 and permits communication between conduits 76 and 81. Upon sliding movement of the valve member 82 to the right as viewed in Fig. 3, under control of an electromagnetic solenoid 84, the conduit 76 is closed and the conduit 81 is vented to atmosphere through the conduit 80. Upon de-energization of the solenoid, a spring 85 returns the valve member to its normal position, as shown. To provide energy for operation of the solenoid 84, I connect an electric conduit 86 between one side of the solenoid 84 and the conduit 64 on the motor side of the main switch 65. The

5

opposite side of the solenoid is connected through electric conduit 87 to conduit 62 or to the same side of source 60 to which conduit 62 is attached. A normally open switch 89 is provided in conduit 86 so that the solenoid is normally inactive.

The vacuum conduit 81 connects the chamber 77 of each valve 79 with a chamber 90 of a second valve 91. Each valve 91 is also provided with a vacuum conduit 92 that extends from the chamber 90 through the plate 40 and the vacuum cup 36 to the atmosphere. A valve member 94 in the chamber 90 is normally urged by a spring 95 in a direction to prevent communication between the conduits 81 and 92 so that the vacuum cannot reach the cup 36. As shown in Figs. 4 and 5, the valve member 94 extends beyond the chamber 90 and is connected through a pivot 96 to a link 97 that is connected through a lost motion pin and slotted sleeve connection 98 to a bell crank 99. A light spring 100 urges the slotted sleeve in a direction towards the bell crank. This bell crank is supported by a pivot 101 on a bracket 102 on the rear surface of the plate 40. The free arm of the bell crank 99 extends forwardly past the vacuum cup 36 and has a roller 103 mounted on its extremity.

In operation, assuming that the cartons to be handled are stacked two cartons high, and that the particular vacuum lift device has two upper vacuum cups carried by plate 26 and two lower cups carried by plate 27, the operator first elevates the carriage plate 16 until the lower cups are just below the tops of the lower cartons. He then adjusts the back-up plate 50 downwardly until the cross piece 51 is opposite the lower part of the lower cartons. The upper cups are then elevated relatively to the lower cups by extension of the ram 31 until these cups are just below the tops of the upper cartons.

The switch 65 is closed and the motor 61 operates the vacuum pump 67 to draw a vacuum in the vacuum system. The pressure switch 66 in the motor circuit automatically controls the operation of the motor to maintain the vacuum in the desired range.

When sufficient vacuum is built up, the truck is driven towards the cartons C to be lifted. As the cups 36 approach the cartons, the rollers 103 first make contact causing the bell cranks 99 to rock on pivots 101 in a direction to take up the lost motion in the pin and slotted sleeve connection 98 until the roller reaches opening position, referred to as OP in Fig. 4. At this position valve member 94 is about to open communication between conduits 81 and 92. Further movement of the truck toward the cartons causes the valve member 94 to move in a direction against the force of spring 95 to establish communication between conduits 81 and 92 as shown on the right side of Fig. 6, as viewed. The roller is then in hold position referred to as HP in Fig. 4. In this way, the space in front of each cup 36 facing a carton is placed under vacuum and the carton is gripped by the adjacent cups.

Once all of the cartons to be handled in a particular load are gripped, the carriage plate may be elevated according to the height at which the load is to be deposited.

It will be understood that, due to the weight of the load, and the fact that gripping will usually occur eccentrically of the center of gravity of the load, there will be a tendency for the cartons to rotate in a manner to move their upper portions away from the cups and their lower portions towards the truck. Such tendencies are resisted by the heavy springs 49 behind the plates 26 and 27, and by the back-up plate that provides a surface against which the lower part of the load may bear.

When the load has been transported to the place of deposit and it is desired to release the cartons, the operator closes the switch 89, thereby energizing the solenoids 84 and drawing the valve members toward the right, as viewed in Fig. 6, to close the vacuum conduit 76 and open the conduit 81 to atmosphere through the conduit

6

80. The vacuum in the space in front of the cups will thus be broken and the cartons released.

From the foregoing description, it will be seen that I have contributed to the art means that make possible the acceptance of a load by vacuum cups without exact and complicated maneuvering of the truck relatively to the load, and for automatic deposit of the load or removal of the load from the truck. It will also be seen that by means of my invention, I am able to apply a vacuum automatically only to those cups that are in a position relatively to a load to grip the load.

I believe that the construction and operation of my novel vacuum lift device will now be understood, and that the advantages of my invention will be fully appreciated by those persons skilled in the art.

I now claim:

1. In a truck of the class described, a carriage mounted for vertical lifting movement, a series of vacuum cups mounted on said carriage, a vacuum source on said truck communicating with all of said vacuum cups, separate means for each vacuum cup for normally closing communication between each vacuum cup and said vacuum source, separate control means carried by said carriage adjacent each vacuum cup movable by physical contact with a particular surface to be gripped by a vacuum cup upon movement of said truck toward a plurality of such surfaces to operate said means and establish communication between its respective vacuum cup and said vacuum source whereby each vacuum cup grips its particular surface in sequence as said cups contact said surfaces, and means for breaking simultaneously the communication between said vacuum source and all of said cups.

2. In a truck of the class described, a carriage mounted for vertical lifting movement, a series of vacuum cups mounted on said carriage, a vacuum source on said truck communicating with all of said vacuum cups, separate means for each vacuum cup for normally closing communication between each vacuum cup and said vacuum source, separate control means carried by said carriage adjacent each vacuum cup movable by physical contact with a particular surface to be gripped by a vacuum cup upon movement of said truck toward a plurality of such surfaces, means whereby each control means upon such movement establishes communication between its respective vacuum cup and said vacuum source whereby each vacuum cup grips its particular surface in sequence as said cups contact said surfaces, and means for breaking simultaneously the communication between said vacuum source and all of said cups.

3. In a truck of the class described, a carriage mounted for vertical lifting movement, a series of vacuum cups mounted on said carriage, a vacuum source on said truck communicating with all of said vacuum cups, a separate valve for each vacuum cup normally closing communication between each vacuum cup and said vacuum source, separate control means for each vacuum cup movable by physical contact with a particular surface to be gripped by said vacuum cup upon movement of said truck toward a plurality of such surfaces, means whereby each control means upon such movement operates one of said valves to establish communication between its respective vacuum cup and said vacuum source whereby each vacuum cup grips its particular surface in sequence as said cups contact said surfaces, and means for breaking simultaneously the communication between said vacuum source and all of said cups.

4. In a truck of the class described, a carriage mounted for vertical lifting movement, a series of vacuum cups mounted on said carriage, a vacuum source on said truck communicating with all of said vacuum cups, a separate valve for each vacuum cup normally closing communication between each vacuum cup and said vacuum source, separate control means for each vacuum cup being movable by physical contact with a particular surface to be gripped by said vacuum cup upon movement of said

7

truck toward a plurality of such surfaces, means whereby each control means upon such movement operates one of said valves to establish communication between its respective vacuum cup and said vacuum source whereby each vacuum cup grips its particular surface in sequence as said cups contact said surfaces, and electromagnetic valve means for simultaneously closing communication between said vacuum source and all of said cups and venting said cups to atmosphere.

5 5. In a truck of the class described, a carriage mounted for vertical lifting movement, a series of vacuum cups mounted in vertically spaced relation on said carriage, a vacuum source on said truck communicating with all of said vacuum cups, separate means for each vacuum cup for normally closing communication between each vacuum cup and said vacuum source, separate control means carried by said carriage movable by physical contact with a particular surface to be gripped by each vacuum cup upon movement of said truck toward a plu- 10 rality of such surfaces, means whereby each control means, upon such movement, establishes communication between its respective vacuum cup and said vacuum source whereby each vacuum cup grips its particular surface in sequence as said cups contact said surfaces, means for breaking simultaneously the communication between said vacuum source and all of said cups, and means adjust-

8

able vertically below the lowest of said vacuum cups to provide a bearing for the lower portion of said surfaces to be gripped by said lowest vacuum cups for accepting forces tending to rotate said surfaces.

5 6. In a truck of the class described, a carriage mounted for vertical lifting movement, a series of vacuum cups mounted on said carriage, a vacuum source on said truck communicating with all of said vacuum cups, separate means for each vacuum cup for normally closing communication between each vacuum cup and said vacuum source, separate control means carried by said carriage adjacent each vacuum cup and movable by physical contact with a particular surface to be gripped by said vacuum cup to operate said means and established communication between the vacuum cup associated therewith and said vacuum source whereby vacuum is applied to a particular vacuum cup only when a surface to be gripped is brought into close proximity to said particular vacuum cup.

References Cited in the file of this patent

UNITED STATES PATENTS

2,049,850	Lytle et al. -----	Aug. 4, 1936
2,675,153	Weimer -----	Apr. 13, 1954
25 2,708,046	Cusham -----	May 10, 1955