INDUSTRIAL TRUCK WITH LOAD SUPPORTING MEMBERS
FOR HANDLING A PLURALITY OF STACKED ARTICLES

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INDUSTRIAL TRUCK WITH LOAD SUPPORTING MEMBERS FOR HANDLING A PLURALITY OF STACKED ARTICLES

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This invention relates to an improved truck for handling and moving work pieces, such as boxes of merchandise in a warehouse or the like.

There have heretofore been devised various different types of fork-lift trucks having fork portions adapted to be received beneath a work piece or stack of work pieces, and carry them from place to place in a warehouse. The general object of the present invention is to provide an improved truck of this general type which is able to remove from a stack of work pieces (or insert in such a stack) a single item or series of items located beneath one top of the stack.

Conventionally, such a truck is adapted to remove or insert such intermediate or lower items from a stack, but instead must always remove or replace only an upper work piece or upper group of work pieces. As will be apparent, there are obviously many situations in which it may be desirable to handle selectively one of the lower units in a stack, as for instance where a lower box contains a particular type, size or color of merchandise which is wanted.

The above discussed object is attained by providing the truck with two separate work supporting forks or similar work supporting structures, which structures are adapted to support respectively two different work pieces in a stack. These supporting structures may take the form of two vertically spaced forks projecting horizontally, and adapted to project into and engage in supporting relation two box holding pallets in a stack of palletized cartons. The upper of the two forks or work supporting structures may then hold a top box or top group of boxes, while the lower work supporting structure removes from the stack a lower box or group of boxes. After such removal, the top work supporting structure may lower the upper boxes onto the remaining portion of the stack, and then be withdrawn from engagement with the coating pallet, so that the ultimate overall result is the desired removal of a lower box or boxes from the stack.

To achieve the discussed type of operation, the two forks or work supporting structures are mounted for appropriate movement relative to one another or relative to the truck frame. Preferably, each of the two structures is movable vertically relative to the other structure, and relative to the frame, and at least one of the structures is mounted for horizontal retracting movement, to withdraw the lower box or work piece horizontally from its original position in the stack (or to insert it in the stack if desired). The horizontally retractable work supporting structure may be mounted for its dual type of movement by mounting it for horizontal movement on and relative to an associated vertically movable carrier structure.

The forks or work supporting structures are preferably power actuated, typically by a fluid pressure system or an electric motor system. A control unit controls the operation of the members and may include means for performing automatically a predetermined cycle of operations during a box removing process. More particularly, the control apparatus may be capable, during a box removing cycle, of first automatically moving the two forks upwardly in unison through a short distance, to simultaneously lift all of the boxes or work pieces located above a predetermined point in a stack, and then automatically shifting to an altered condition in which the lower fork is stopped but the upper fork continues its upward movement, so that the box or boxes supported by the lower fork are out of engagement with the upper fork and are therefore free for lateral or horizontal removal from the stack.

The above and other features and objects of the invention will be better understood from the following detailed description of the typical embodiment illustrated in the accompanying drawings, in which:

FIG. 1 is a side view of a fork lift truck constructed in accordance with the invention;
FIG. 2 is a plan view of the FIG. 1 truck;
FIG. 3 is a front view of the truck of FIGS. 1 and 2, taken on line 3—3 of FIG. 1;
FIG. 4 is a representation of the control mechanism and circuit of the truck;
FIG. 5 is an enlarged fragmentary vertical section taken on line 5—5 of FIG. 2;
FIG. 6 is a further enlarged horizontal section taken on line 6—6 of FIG. 5; and
FIGS. 7, 8 and 9 are side views representing the apparatus in three different load handling conditions.

With reference first to FIGS. 1, 2 and 3, it is noted that there is shown at 10 in these figures a vehicle having a body or frame structure represented at 11, mounted by wheels 12 for movement along a floor or support surface 13. The vehicle is driven along surface 13 by a main engine or motor, typically located within a rear portion 14 of the housing, with the front wheels 12 adapted to be turned to steer the vehicle by means of a steering wheel 15 actuable by a driver positioned within a driver's seat 16.

The vehicle 10 carries at its forward side a forwardly projecting typically horizontal base member 17, which movably mounts two forwardly projecting work supporting forks 18 and 19. While the arrangement particularly illustrated in the drawings contemplates typically that the work supporting mechanism is mounted at the front end of the vehicle, it will of course be understood that, if desired, similar mechanism may be carried at or projected from a side of the vehicle or its rear, if such positioning would facilitate the operation of the apparatus for a particular use.

In the arrangement illustrated, the platform or base 17 is rigidly secured at its rear end 20 to the front of the vehicle frame 11, to be held in fixed relation thereto, and project forwardly in a horizontal condition. This base 17 is rigid, and may typically be formed of sheet metal, suitably reinforced internally to attain sufficient strength. At a location near the center of platform 17, there is mounted to the platform a hydraulically actuated piston and cylinder mechanism 24 for actuating a carrier part 25 upwardly and downwardly relative to platform 17. In order to increase the range of vertical movement of carrier part 25, the piston and cylinder mechanism 24 may be of a telescopic type, having a piston 26 (see FIG. 7) which is connected to the underside of carrier part 25, and which is actuated by the introduction of fluid pressure into a composite cylinder formed of several telescopic sections 27. As will be apparent, the introduction of pressure fluid into the lower end of the bottom cylinder section 27, through a line 28, causes the various sections 27 to progressively extend upwardly, and to actuate piston 26 upwardly.

The carrier part 25 may take the form of a generally horizontal framework, disposed essentially parallel to but spaced upwardly above bottom platform 17, with the framework of part 25 desirably consisting of a transverse horizontal element 28 carrying two parallel track elements 29 extending in a front-to-rear direction with...
respects to vehicle 10. At their rear ends, tracks 29 carry an upwardly projecting wall or structure 30, which may be engageable at its opposite side edges with two parallel vertical guide plates 31, rigidly carried by the vehicle frame 11, and acting to retain member 25 against swinging movement about the axis of piston and cylinder mechanism 24.

The working support structure 19 may consist of two parallel forwardly projecting horizontal rigid arms 32, having upper horizontal surfaces on which a rectangular box or other work unit may be supported, and having forward tapered portions 33 to facilitate engageability with the arms 31 with the work unit. Structure 19 is mounted for front-to-rear movement relative to vehicle 10 and relative to carrier part 25, by providing the two arms or portions 32 of fork 29 with rollers 34, engageable with tracks 29. The resulting movement of fork 19 along tracks 29 is in a directly horizontal plane, to engage fork 19 with a work piece. This fork has at its rear end an upwardly projecting vertical wall 35, to which there may be attached two horizontally extending cylinders 36, containing pistons having piston rods 37 attached rigidly to upstanding wall 30 of carrier part 25. The axes 38 of the piston and cylinder mechanism 36, 37 is in a horizontal direction, parallel to the tracks 29, and therefore to the axis 39 of front-to-rear movement of fork 19. By controlling the admission of pressure fluid to the opposite ends of cylinders 36, fork 19 may be actuated forwardly and rearwardly relative to carrier part 25.

The second and upper working support fork 18 may be constructed essentially the same as fork 19, having two forwardly projecting parallel arms or portions 40 shaped in correspondence with arms 32 of fork 19, and connected at their rear ends to a vertically extending transverse back wall 41. Fork 18 is mounted by this back wall for vertical movement similar to bottom fork 19, but in the illustrated form of the invention is not free for front-to-rear movement in the manner of bottom fork 19. To support fork 18 for its vertical movement, I provide at one side of the fork a vertically extending mounting column 42, which is rigidly secured at its lower end to platform 17. The outer surface of column 42 may be cylindrical, except that surface is interrupted to provide a toothing vertical rack 43 at one side of the column, and a vertical guideway recess or slot 44 (FIG. 6) at the diametrically opposite side of the column.

About column 42, there is slidably received a rigid cylindrical sleeve 45, which is a close fit on the external cylindrical surface 46 of column 42, and is therefore guided by the column for vertical movement relative thereto. The previously mentioned rear wall 41 of upper fork 18 is rigidly welded or otherwise attached to sleeve 45, to actuate the fork 18 in accordance with upward and downward movement of sleeve 45. Pivotal movement of the fork's structure about the vertical axis 47 of column 42 is prevented by providing sleeve 45 with one or more keys or lugs 48 (FIGS. 5 and 6) which are received within guideway 44 in a manner keying the sleeve 45 against rotary movement while permitting vertical movement of the sleeve.

The fork 18 is power actuated upwardly and downwardly by means of a fluid operated rotary motor 49, suitably mounted to sleeve 45, and driving a gear 50 which projects through an aperture 51 in sleeve 45 (see FIG. 5) to engage rack teeth 43 on column 42, and therefore move sleeve 45 and fork 18 upwardly and downwardly in correspondence with the supply of pressure fluid to motor 49. The motor 49 is desirably of a positive displacement liquid actuated type, so that the extent of upward or downward movement of fork 18 may be predetermined for a predetermined amount of fluid flow through motor 49.

Pressurized liquid is supplied to the various actuating motors 24, 36 and 49 by means of a pump represented at 52, which pump may be continuously driven by the main engine 153 for propelling the truck. Pump 52 may take its suction from a reservoir 53 to which fluid returning from the various motors is conducted. The high pressure liquid from the pressure control unit 54 having manually actuated control arms or handles 55, 56, 57 and 58 which are adjacent the driver's seat 16, to be accessible for manual actuation by the driver of the vehicle. Pump 52 may also have a bypass line 59 leading from its discharge side to its suction side, and containing a pressure release valve 60 acting to permit the output fluid from the pump to bypass back to the suction side of the pump in the event of development of an excessive pressure, as when unit 54 is in a condition closing off the delivery of the pressure liquid to all of the various fluid motors 24, 36 and 49.

FIG. 4 represents somewhat diagrammatically a typical valve arrangement for controlling the flow of fluid within control unit 54. This illustrated arrangement includes four valves 61, 62, 63 and 64, which are actuable between different settings by the four previously mentioned handles 55, 56, 57 and 58 respectively. A first of the valves, number 61, is provided for the purpose of shifting the control from the front-to-rear direction, to the automatic condition, and a manually controlled condition. In the first of its settings, the non-automatic setting, valve 61 connects the discharge and suction lines 65 and 66 of the pump and reservoir circuit to a pair of lines 67 and 68 respectively, which are in turn connected to valves 62, 63 and 64, in parallel. When valve 61 is in its second setting, the automatic setting, valve 61 connects lines 65 and 66 to a second pair of lines 69 and 70, respectively. Line 69 has two branches 69' and 69", leading pressure fluid to fluid motor 49 and elevating cylinder 24, while line 70 is a return line through which fluid from motor 49 returns to valve 61, to pass through that valve into line 66 leading back to reservoir 53. Connected into line 69" there is a preferably normally open solenoid valve 71, which when electrically energized by a circuit to be discussed at a later point acts to close line 69", and prevent the admission of further pressure fluid to elevating cylinder 24.

Valve 62 is a three-position selector valve, which in a first position connects pressure fluid line 67 to a line 72 leading to cylinder 24, to actuate the piston of that cylinder, and which in a second position connects line 72 and the cylinder to pump suction line 68, so that fluid may be removed from cylinder 24 and returned to the pump. The third setting of valve 62 is an off position, in which neither of the lines 67 or 68 is connected to line 72.

Valve 63 is a three position reversing valve, having an off position, an elevating position in which lines 67 and 68 are connected through valve 63 to lines 69' and 70 in a manner causing motor 49 to elevate sleeve 45 and fork 18, and a reversed position in which valve 63 connects the motor reversely to lines 67 and 68, to cause the motor to lower sleeve 45 and the connected fork structure. Similarly, valve 64 has three positions, including an off position in which no fluid passes there through, a second setting in which valve 64 connects lines 67 and 68 to a pair of lines 73 and 74 leading to cylinder 36 in a manner causing forward movement of fork 19, and a third setting in which the connections to lines 73 and 74 are reversed to cause rearward movement of fork 19.

Solenoid valve 71 is energized to its closed position by current from a power source represented as a battery 75 in FIG. 4, and under the control of a micro-switch 76 carried by sleeve 45. Referring particularly to FIGS. 5 and 6, this micro-switch 76 may be carried by a vertical plate 77 which is typically welded to and projects outwardly from sleeve 45. Switch 76 is determined for a predetermined amount of fluid flow through motor 49.

Switch 76, adapted to swing about an axis 78 (FIG. 6), and actuated by a cam 79 typically having the cross...
section represented in FIG. 5. More particularly, this cam may have a reduced diameter portion 80 which is normally opposite finger 77' of the micro-switch, so that the cam and the normally retracted arm 81 of FIG. 5. This reduced diameter portion 80 may continue about most of the circular extent of the cam, so that finger 77' remains in the full line open switch position of FIG. 5. Until cam 79 turns through almost a complete revolution, in a clockwise direction as viewed in FIG. 5, the switch is eventually returned to a position in which the top of the cam is adjacent to the stack of boxes, the moving arm 81 of the cam with finger 77 of the micro-switch.

Cam 79 is mounted rotatably about a shaft or pin 82, which is rigidly secured to plate 77, and is keyed against rotation relative thereto. There is also mounted about shaft 82 a gear 83 which projects through an aperture 84 in the side of sleeve 45 into engagement with rack teeth 43. Thus, gear 83 turns freely about shaft 82 in correspondence with upward and downward movement of sleeve 45.

Cam 79 is rigidly urged to the position of FIG. 5 by coil spring 185 connected at its opposite ends to shaft 82 and the cam, and is rotatable against the tendency of this spring in a clockwise direction by gear 83. A clutch mechanism is provided between gear 83 and cam 79, typically taking the form of a magnetic clutch including an anular electromagnet 85 secured to plate 77. Gear 83 may be of a magnetic material such as iron, so that the magnetic field from electromagnet 85 is transmitted through gear 83, and acts to pull cam 79 (which is also formed of iron or other magnetic material) into engagement with gear 83. The cam 79 is normally returned axially by spring 185, with the spring acting to yield the magnetically controlled axial movement of cam 79 into engagement with gear 83. When coil 85 is energized, and cam 79 is in engagement with gear 83, the cam is magnetically clutched to the gear to turn the gear about shaft 82. As soon as the circuit to electromagnet coil 85 is broken, however, spring 185 returns cam 79 rotatively to its FIG. 5 position, and axially to its FIG. 6 full line position.

Electromagnet 85 is energized by a suitable power source, represented as a battery 86 in FIG. 4, under the control of a series connected switch 87, which is actuable to close connection by movement of lever 85 forwardly to the position in which lines 65 and 66 are connected to lines 69 and 70, respectively.

In addition to the above discussed micro-switch 76, sleeve 45 carries also a second micro-switch 88, which is actuable by a mechanism which is a duplicate of the cam 79, gear 83, spring 185, electromagnetically clutch element 85, and other associated parts illustrated in FIGS. 5 and 6 in connection with the first mentioned micro-switch 76. The control electromagnet for this micro-switch 88 is designated 85' in FIG. 4, and may be connected in series with electromagnet 85 to be energized in correspondence therewith. Micro-switch 88 controls the energization of a solenoid 89, whose armature is connected to control arm or lever 55, to return that arm rearwardly to its normal non-automatic setting upon energization of solenoid 89.

To now discuss a cycle of operation of the illustrated fork lift truck, reference is first made to FIG. 7, which illustrates a stack of boxes 90, each of which is resting on a pallet 91 having a recess or recesses into which the forks 18 and 19 are adapted to project in a relation for supporting the boxes by means of the forks. Assume in FIG. 7 that it is desired to remove the next to top 90' from the three lower boxes and the uppermost box 90" in the stack. As a first step, the operator drives the truck 10 toward the stack of boxes, preferably to a position in which the two forks 18 and 19 are almost but not quite in engagement with the box stack (say for example to the position illustrated in FIG. 1).
the upper box 90" and its pallet are spaced substantially above intermediate box 90'. At this FIG. 8 position, micro-switch 88 is actuated, to close the circuit to solenoid 89, which pulls handle 55 rearwardly to shift valve 61 to its manually controlled non-automatic condition in which lines 63 and 66 are again connected as in FIG. 7. Since all the valves 62, 63 and 64 were in the closed or off positions prior to actuation of valve 61 to its automatic setting, the return of valve 61 and handles 55 to their non-automatic condition completely stops all motion of the boxes and forks. The operator may then actuate valve 64 to cause cylinders 36 to move fork 19 and its engaged box 99' rearwardly; as to the broken first position of FIG. 8, so that the desired intermediate box 90" is now removed from the stack. The operator may next turn valve 62 to a position for withdrawing fluid from cylinder 24, to thereby lower carrier part 25, fork 19, and the removed box 99' to the FIG. 9 readily accessible position; and may actuate valve 63 to cause motor 49 to rotate sleeve 45 and fork 18 downwardly to the FIG. 9 setting in which the top box 90" and its pallet again rest on the stack. After the apparatus has reached the FIG. 9 condition, the operator backs the truck rearwardly as viewed in FIG. 8, withdraw fork 18 from its engaged position, and leave the stack in its original condition except that the next to top box has been removed. It will of course be apparent that any box or work piece may be removed from the stack in the manner discussed above, or a work piece may be inserted in the stack at an intermediate or lower location by a manually controlled reversal of the discussed process.

1. A truck for lifting work pieces arranged in a stack, said truck comprising a wheeled vehicle frame, two load supporting structures movably carried by said frame and projecting to positions for supporting respectively two different upper and lower work pieces in said stack, first power operated means for moving a first of said structures and a carried work piece upwardly and downwardly relative to said frame, a carrier structure, second power operated means for actuating said carrier structure upwardly and downwardly relative to the frame, means for actuating said second load supporting structure horizontally relative to said carrier structure between a position generally beneath said first load supporting structure and a horizontally retracted position, and automatic control means for actuating said second load supporting structure horizontally relative to said carrier structure between a position generally beneath said first load supporting structure and a horizontally retracted position, a control system including valves operable to manually control said three fluid pressure actuated means, said control system including a control valve operable to shift said system between a manual condition and an automatic condition and operable in the latter condition to admit fluid to both of said two first mentioned fluid pressure actuated means, to thereby move both fork structures upwardly in unison, two switches operable in sequence upward movement of said first fork structure, a valve operable by a first of said switches to close off the flow of pressure fluid to said second mentioned fluid pressure actuated means, and means operable by said second switch to actuate said control valve from said automatic condition to said manual condition.

2. A truck for lifting work pieces arranged in a stack as recited in claim 1, in which said automatic control means include a first electric switch responsive to upward movement of said load supporting structures in unison through said limited distance, means operable by said switch upon actuation thereof to halt said upward movement of said load supporting structure through a predetermined cycle of operation causing said first and second power operated means to move to said carrier structure and both of said load supporting structures upwardly in unison through a limited distance, and then halt the upward movement of said carrier structure and said second load supporting structure while continuing the upward movement of said first load supporting structure.

3. A truck for lifting work pieces arranged in a stack, said truck comprising a wheeled vehicle frame, two load supporting structures movably carried by said frame and projecting to positions for supporting respectively two different upper and lower work pieces in said stack, first power operated means for moving a first of said structures and a carried work piece upwardly and downwardly relative to said frame, a carrier structure, second power operated means for actuating said carrier structure upwardly and downwardly relative to said frame, and said second load supporting structure horizontally relative to said carrier structure between a position generally beneath said first load supporting structure and a horizontally retracted position, control means for actuating said carrier structure upwardly and downwardly relative to the frame, means for actuating said second load supporting structure horizontally relative to said carrier structure between a position generally beneath said first load supporting structure and said carrier structure, said carrier structure, second switch responsive to continued upward movement of said first load supporting structure, and control means including a control valve operable to shift said system between a manual condition and an automatic condition and operable in the latter condition to admit fluid to both of said two first mentioned fluid pressure actuated means, to thereby move both fork structures upwardly in unison, two switches operable in sequence upward movement of said first fork structure, a valve operable by a first of said switches to close off the flow of pressure fluid to said second mentioned fluid pressure actuated means, and means operable by said second switch to actuate said control valve from said automatic condition to said manual condition.

4. A truck for lifting work pieces arranged in a stack as recited in claim 3, in which said automatic control means include a first electric switch responsive to upward movement of said load supporting structures movably carried by said frame and projecting to vertically spaced positions for supporting respectively two different upper and lower work pieces in said stack, fluid pressure actuated means for moving a first of said fork structures and a carried work piece upwardly and downwardly relative to said frame, a carrier structure, fluid pressure actuated means for actuating said carrier structure upwardly and downwardly relative to the frame, means for actuating said second load supporting structure horizontally relative to said carrier structure between a position generally beneath said first load supporting structure and a horizontally retracted position, and automatic control means for actuating said second load supporting structure horizontally relative to said carrier structure between a position generally beneath said first load supporting structure and said carrier structure, said carrier structure, second switch responsive to continued upward movement of said first load supporting structure, and control system including a control valve operable to shift said system between a manual condition and an automatic condition and operable in the latter condition to admit fluid to both of said two first mentioned fluid pressure actuated means, to thereby move both fork structures upwardly in unison, two switches operable in sequence upward movement of said first fork structure, a valve operable by a first of said switches to close off the flow of pressure fluid to said second mentioned fluid pressure actuated means, and means operable by said second switch to actuate said control valve from said automatic condition to said manual condition.

5. A truck for lifting work pieces arranged in a stack as recited in claim 3, in which said automatic control means include a first electric switch responsive to upward movement of said load supporting structures movably carried by said frame and projecting to vertically spaced positions for supporting respectively two different upper and lower work pieces in said stack, fluid pressure actuated means for moving a first of said fork structures and a carried work piece upwardly and downwardly relative to said frame, a carrier structure, fluid pressure actuated means for actuating said carrier structure upwardly and downwardly relative to the frame, means for actuating said second load supporting structure horizontally relative to said carrier structure between a position generally beneath said first load supporting structure and said carrier structure, said carrier structure, second switch responsive to continued upward movement of said first load supporting structure, and control system including a control valve operable to shift said system between a manual condition and an automatic condition and operable in the latter condition to admit fluid to both of said two first mentioned fluid pressure actuated means, to thereby move both fork structures upwardly in unison, two switches operable in sequence upward movement of said first fork structure, a valve operable by a first of said switches to close off the flow of pressure fluid to said second mentioned fluid pressure actuated means, and means operable by said second switch to actuate said control valve from said automatic condition to said manual condition.
9 and said upper workpiece supported independently on said upper structure, and between an active position in which said lower structure and work piece are generally beneath said upper structure and a retracted position in which said lower structure is withdrawn horizontally from beneath the upper structure, and power operated means for actuating both of said load supporting structures upwardly and downwardly relative to said frame and one relative to the other, said last mentioned means including means operable to move said upper load supporting structure, with said upper work piece supported thereon, generally vertically when said lower load supporting structure is in said active position and also when it is in said retracted position.

7. A truck for lifting work pieces arranged in a stack, said truck comprising a wheeled vehicle frame, two upper and lower load supporting structures both carried movably by said frame and projecting generally horizontally to positions for supporting respectively two different upper and lower work pieces in said stack, a carrier structure mounted to said frame for essentially vertical movement and movably carrying said lower load supporting structure, means for shifting said lower load supporting structure generally horizontally relative to said carrier structure and said upper supporting structure, with said upper and lower work pieces supported by said two supporting structures respectively, and between an active position in which said lower structure and work piece are generally beneath said upper structure and a retracted position in which said lower structure is withdrawn horizontally from beneath said upper structure, second power actuated motor means for actuating said carrier part and thereby said carried lower supporting structure upwardly and downwardly relative to said frame, and third power actuated motor means for moving said upper load supporting structure, with said upper work piece supported thereon, generally vertically relative to said frame and relative to said lower load supporting structure when said lower load supporting structure is in said active position and also when it is in said retracted position.

10. A truck for lifting work pieces arranged in a stack, said truck comprising a wheeled vehicle frame, two load supporting structures both carried movably by said frame and projecting to positions for supporting respectively two different upper and lower work pieces in said stack, power operated drives for actuating said two structures respectively generally vertically relative to the frame and operable to move said structures generally vertically relative to one another, and automatic control means for said drives operable through a predetermined cycle of operation to first actuate both drives to move said two structures and carry work pieces upwardly in unison, and to then automatically advance an upper one of said structures and said upper work piece upwardly farther relative to the other structure and lower work piece, said automatic control means including a first control element responsive to limited upward movement of said two structures in unison through a predetermined distance to halt the upward movement of said lower structure after said limited movement while continuing the upward movement of said upper structure, and a second control element responsive to said continued upward movement of said upper structure to halt that movement after a predetermined travel.

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