

Jan. 12, 1960

F. J. SCHENKELBERGER

2,920,775

LOAD CLAMPS FOR AN INDUSTRIAL TRUCK

Filed May 9, 1956

4 Sheets-Sheet 1

FIG. 1

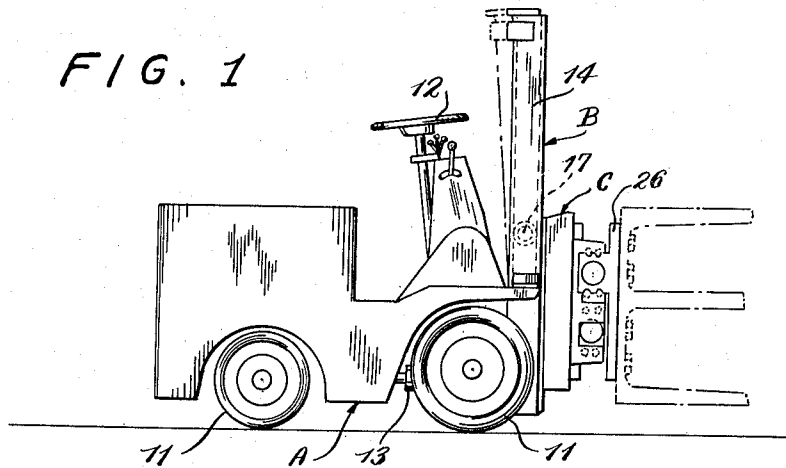
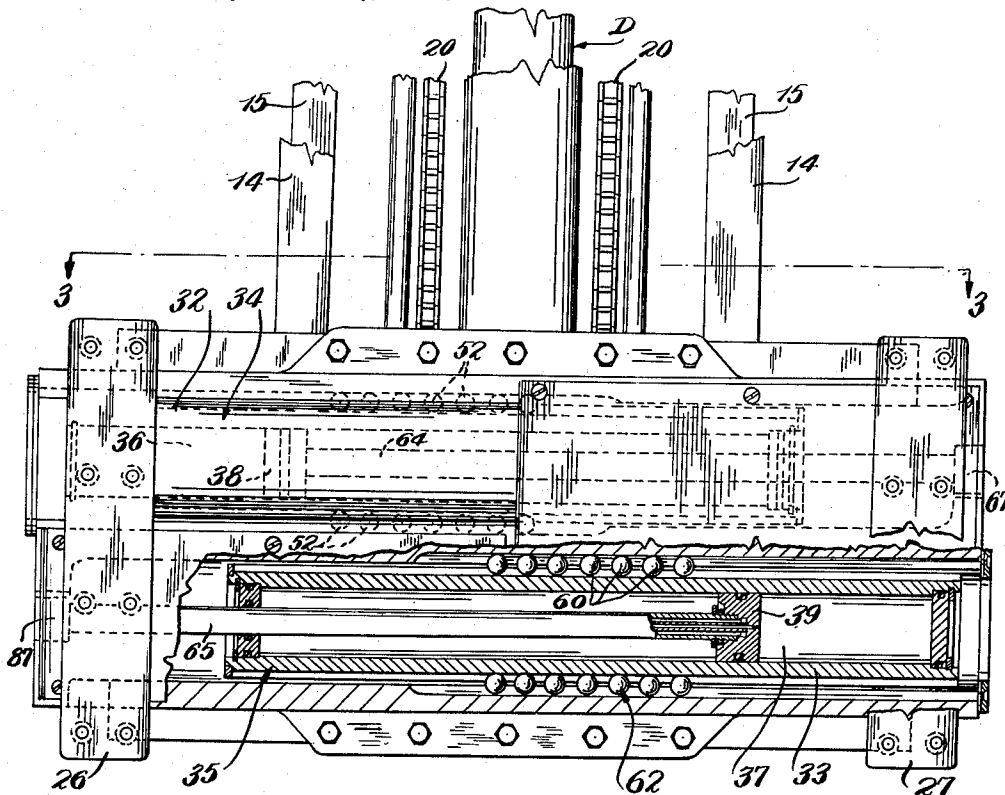


FIG. 2

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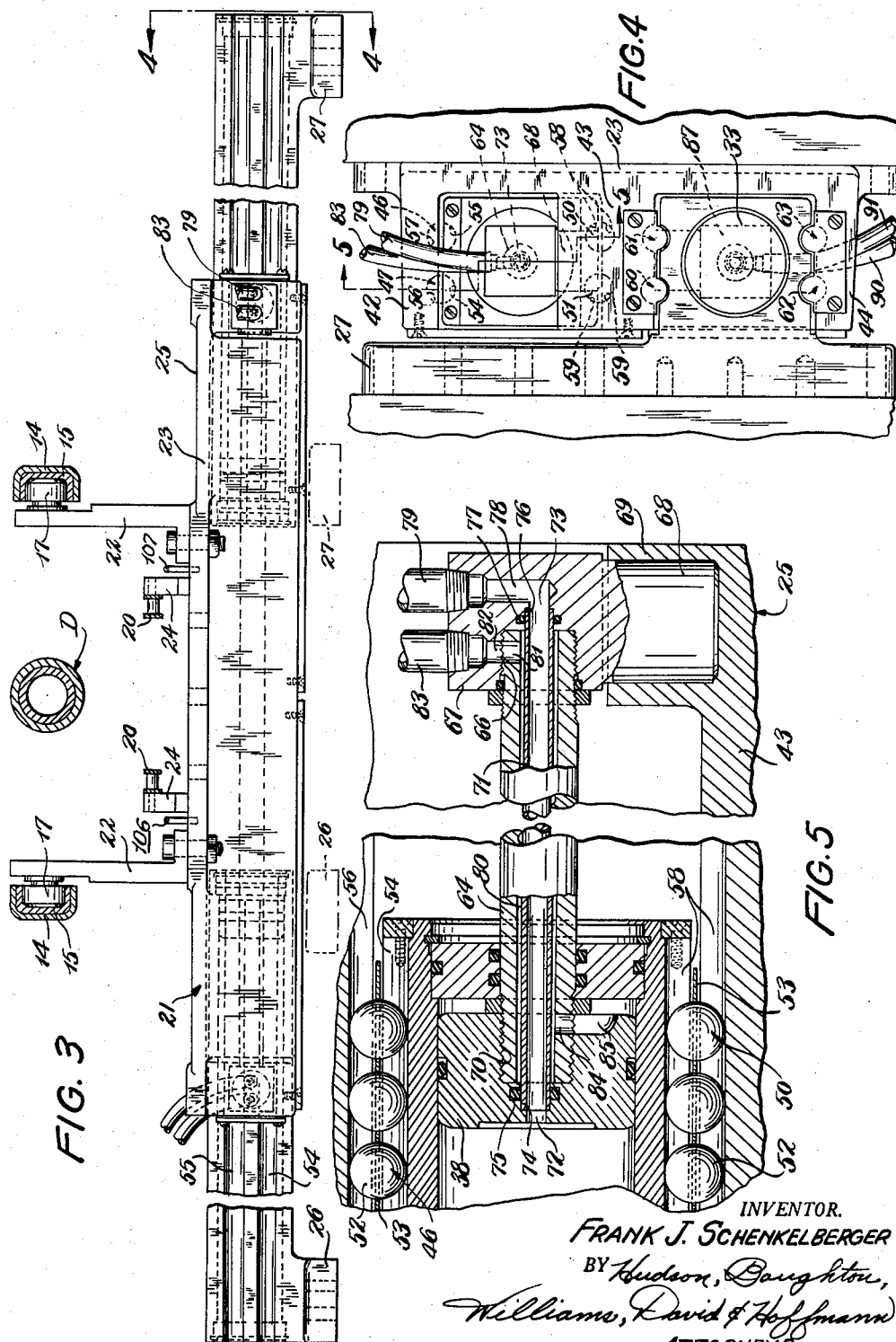
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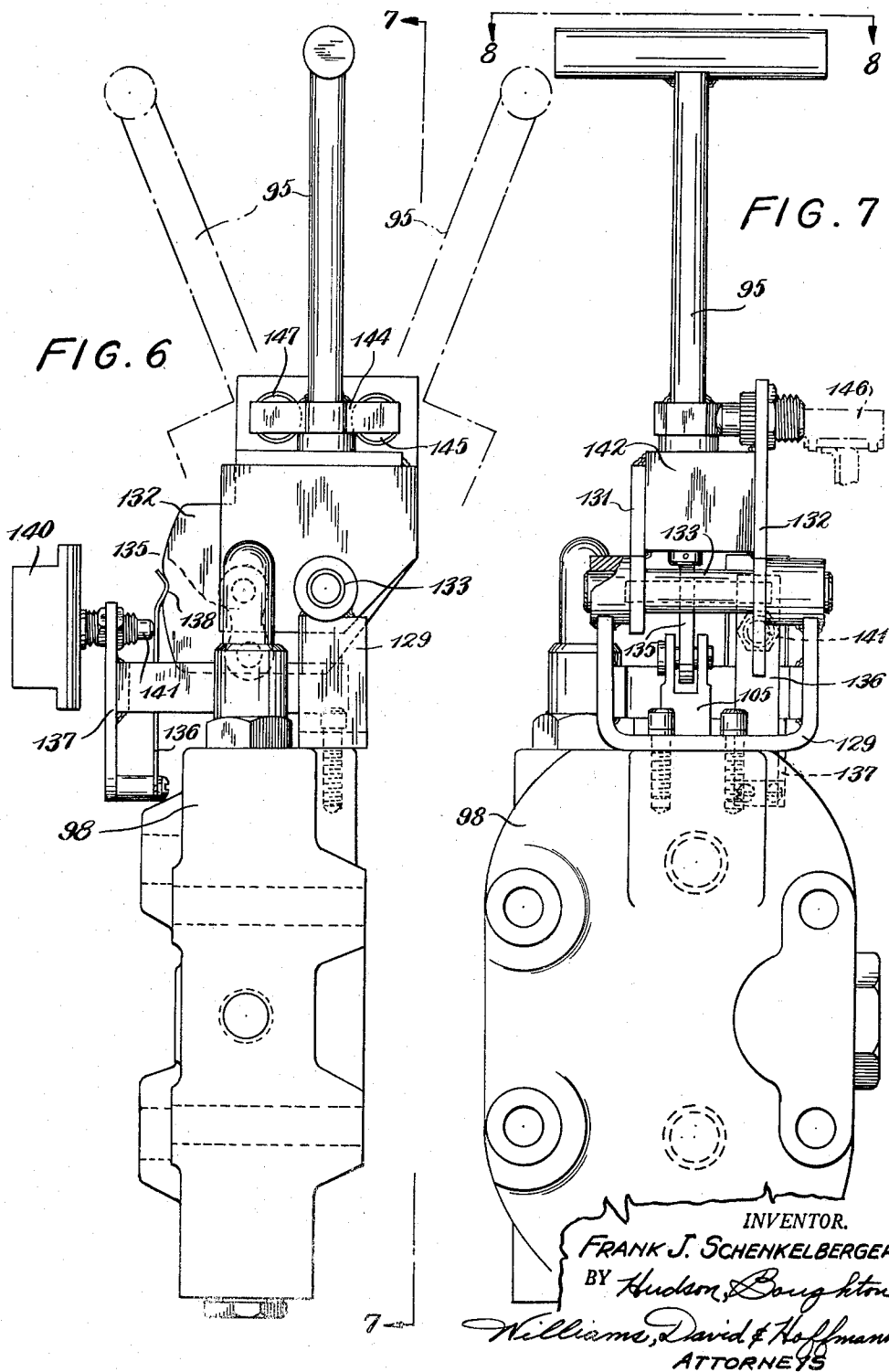
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LOAD CLAMPS FOR AN INDUSTRIAL TRUCK

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Application May 9, 1956, Serial No. 583,709

12 Claims. (Cl. 214—653)

The present invention relates to material-handling apparatus and, more particularly, to material-handling apparatus, especially industrial trucks, having side-shiftable clamp members for handling the load.

One object of the present invention is the provision of a new and improved material-handling apparatus, particularly an industrial truck having a load carriage comprising spaced load-handling clamp members operatively connected to the movable elements of fluid pressure actuators which are operable to move the members toward, or away from, each other, or to cause movement in the same direction to side-shift the members and a load clamped therebetween.

Another object of the present invention is the provision of a new and improved material-handling apparatus, particularly an industrial truck, having a load carriage comprising a frame and a pair of load-handling clamp members carried thereby and each operatively connected to a movable element of a respective fluid pressure actuator mounted on the frame, the clamp members being supported for movement independently of each other with respect to the load carriage frame by suitable antifriction bearing means whereby the clamp members are readily movable even while under load.

A further object of the present invention is the provision of a new and improved material-handling apparatus, particularly an industrial truck, having a load carriage which includes spaced load-handling clamp members operatively connected to movable elements of fluid pressure actuators, the fluid pressure supplied to the actuators being under the control of a single control lever which is operable to cause the clamp members to move toward, or away from, each other, or to move in the same direction with a load clamped between the members to side-shift the load.

A still further object of the present invention is the provision of a new and improved industrial truck having an elevatable load carriage mounted on the front end thereof which carriage includes opposed clamp members for applying a clamping pressure to a load to be handled and which are movable toward, and away from, each other, or in the same direction to side-shift the load by the operation of fluid pressure actuators to move elements for supporting the clamp members, which elements are connected to the load carriage by antifriction means whereby a load may be readily clamped by the clamp members and side-shifted relative to the chassis of the truck by operation of the fluid pressure actuators.

A still further object of the present invention is the provision of a new and improved industrial truck having spaced load-handling clamp members mounted on movable elements, preferably cylinder elements, of fluid pressure actuators operable to selectively move the clamp members toward and away from each other and to side-shift a load clamped between the clamp members, the movable elements preferably being supported by antifriction means.

The invention resides in certain constructions, combi-

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nations and arrangements of parts and further objects and advantages thereof will be apparent to those skilled in the art to which it relates from the following description of the preferred embodiment described with reference to the accompanying drawings forming a part of this specification, in which

Fig. 1 is a side elevational view of an industrial lift truck embodying the present invention;

Fig. 2 is an enlarged fragmentary front view of the truck of Fig. 1 with portions thereof cut away;

Fig. 3 is a horizontal sectional view taken approximately along line 3—3 of Fig. 2;

Fig. 4 is an end elevational view looking from line 4—4 of Fig. 3;

Fig. 5 is a sectional view taken approximately along line 5—5 of Fig. 4;

Fig. 6 is a detached end elevational view of a control valve and operating mechanism embodied in the truck shown in Fig. 1;

Fig. 7 is a side elevational view of the valve and operating mechanism shown in Fig. 6;

Fig. 8 is a plan view of the valve and operating mechanism shown in Fig. 7 looking from line 8—8; and

Fig. 9 is a diagrammatic view of the hydraulic system for operating the load-handling clamp members of the truck of Fig. 1 and the electrical controls therefor.

Although the present invention is susceptible to various modifications and of embodiment in various types of material-handling apparatus, the preferred embodiment shown in the drawings comprises an industrial lift truck having an elevatable load carriage supported on the front end thereof. The invention is particularly useful in an industrial truck where heavy loads are often handled and where it is often necessary to side-shift the load to align it with the entrance to a place where the load is to be deposited.

Referring to the drawings, the industrial lift truck shown comprises a chassis A supported on front and rear wheels 11. The front wheels are preferably driven by suitable means, such as an electric motor, and the rear wheels are preferably dirigibly connected to the chassis so as to be directable by a steering wheel 12 supported on the chassis adjacent to the operator's position.

The chassis A has a vertically extending mast assembly B mounted on the front end thereof for limited tilting movement about a horizontal axis upon the operation of a hydraulic cylinder 13. The mast assembly B is of conventional construction and will not, therefore, be described in detail. Suffice it to say that the assembly comprises, in the illustrated embodiment, upright, laterally spaced primary guides 14 of channel shape, secondary guides 15, also channel shaped and adapted to telescope, relatively, into the primary guides 14, an elevatable carriage C movable vertically with respect to the guides and having rollers 17 adapted to operate in the channels of the secondary guides, and a vertical hydraulic cylinder assembly D operable to raise and lower the elevatable carriage C relative to the secondary guides 15 through chains 20 connected to a movable member of the cylinder assembly. After a predetermined elevational movement of the carriage C relative to the secondary guides, the cylinder assembly also operates to raise both the secondary guides and the carriage relative to the primary guides 14. Since the mast assembly, per se, for supporting and elevating the load carriage C forms no part of the present invention, it may be of any conventional construction and it is to be understood that other elevating means may be substituted for that shown.

The load carriage C for handling the load comprises, in addition to the rollers 17, a transverse frame 21 to which the rollers 17 are connected by webs 22 extend-

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ing rearwardly from a vertical plate-like member 23 which forms the back side of the frame 21, the webs 22 being bolted to the member 23 at the upper and lower edges thereof. The chains 20 are similarly connected to brackets 24 welded, or otherwise secured, to the lower back side of the member 23.

The frame 21 of the load carriage C has mounted thereon relatively movable clamp members 26, 27 which are adapted to have secured thereto elements or devices for engaging the load and for applying a clamping pressure thereto when the clamp members 26, 27 are moved toward each other. One such load-engaging element is indicated in dot-dash lines in Fig. 1. The clamp members 26, 27 are, respectively, connected to cylinder housings 32, 33 of fluid pressure actuators 34, 35, respectively. The cylinder housings 32, 33 each have a cylindrical bore therein forming cylinder chambers 36, 37, respectively, in which stationary pistons 38, 39 respectively operate.

The frame 21 has an upper horizontally extending portion 42, an intermediate horizontally extending portion 43, and a lower horizontally extending portion 44 spaced from and parallel to each other and extending forwardly from the plate-like member 23, the horizontally extending portions 42-44 being, in the illustrated embodiment, integral with the member 23. The cylinder housings 32, 33, in the preferred embodiment, have a rectangular cross-section and are supported between the horizontal portions of the frame 21. The cylinder housing 32 is supported intermediate the upper horizontal portion 42 and the intermediate horizontal portion 43 of the frame 25, and the cylinder housing 33 is supported between the intermediate horizontal portion 43 and the lower horizontal portion 44 of the frame.

The cylinder housings 32, 33 are axially movable with respect to the frame 21 and according to one feature of the invention, roller bearings 46, 47 are provided intermediate the upper side of the cylinder housing 32 and the upper horizontal portion 42 of the frame 21, and roller bearings 50, 51 intermediate the lower side of the cylinder housing 32 and the intermediate horizontal portion 43. Each of the roller bearings 46, 47, 50, 51 comprises a row of balls 52 maintained in aligned spaced relationship by a cage 53 for each bearing, the cages 53 having individual openings for the respective balls of the bearing.

The roller bearings 46, 47 operate respectively in spaced axially-extending grooves or lower races 54, 55 in the upper side of the cylinder housing 32 and respectively in spaced parallel grooves or upper races 56, 57 in the underside of the upper horizontal portion 42 of the frame 21. The grooves or races 54, 55 extend from a point adjacent to the right-hand end of the cylinder member 32 to a point short of the left-hand end of the cylinder member, and the grooves or races 54, 55 in the upper horizontal member 42 of the frame 21 extend inwardly from the left-hand end of the upper horizontal member 42. The ball bearings 46, 47 are free to roll in their respective races as the cylinder housing 32 moves relative to the frame 21 and it can be seen that the races are constructed so as to allow the cylinder housing 32 to move from a position where the piston 39 is adjacent to the left-hand end of the cylinder chamber 36 to the left, as viewed in the drawings, to a point where the piston 39 is adjacent the right-hand end of the cylinder chamber. The lengths of the races for the ball bearings 46, 47 are such that the balls are free to roll and the cage to shift with respect thereto as the cylinder housing 32 is moved relative to the frame 21.

The roller bearings 50, 51 engaging the under side of cylinder housing 32 operate in races 58, 59 respectively in the cylinder housing 32 and the intermediate horizontal portion 43 which are constructed and arranged similar to the races for the ball bearings 46, 47 and the description thereof will not therefore be repeated.

Similarly, the cylinder housing 33 is supported for

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movement with respect to the frame 21 from a position where the cylinder member is substantially within the sides of the frame 25 to a position where the cylinder housing extends from the right-hand side of the frame, as viewed in Fig. 2, by ball bearings 60, 61 intermediate the upper side of the cylinder housing 32 and the intermediate portion 43, and ball bearings 62, 63 intermediate the lower side of the cylinder housing 33 and the lower horizontal member 44.

The pistons 38, 39 which operate in the cylinder housings 32, 33, respectively, are stationary pistons and are respectively connected to the frame 21 by piston rods 64, 65. The piston rod 64 extends to the right from piston 38, as viewed in Fig. 2, through the closed right end of the cylinder housing 32 and threads into a counterbore 66 in a block 67 as shown in Fig. 5. The block 67 is formed with a pin 68 depending from its under side, which pin is received in a bore in a vertical flange portion 69 extending upwardly from the right-hand end of the intermediate horizontal portion 43 of the frame 25, as is best shown in Fig. 5.

The piston rod 64 for the piston 38 is a tubular rod which threads into a counterbore 70 in the piston 38. A tubular conduit 71 is positioned coaxially within the piston rod 64 and the opposite ends of the conduit 71 extend beyond the ends of the piston rod 64 and register with coaxially disposed openings 72, 73 in the piston 38 and the block 67, respectively. The opening 72 extends through the piston 38 to the left-hand side thereof to place the conduit 71 in communication with the cylinder chamber on the left-hand side of the piston 38, as the latter is viewed in Figs. 2 and 5. The end of the conduit 71 which registers with the opening 72 is received in a counterbore 74 in the piston 38 which counterbore joins the opening 72 and the counterbore 70 into which the piston rod 64 threads. A suitable packing ring 75 is positioned in an annular groove opening into the side wall of the counterbore 74 for providing a seal between the piston 38 and the conduit 71.

The end portion of the conduit 71 which registers with the opening or passage 73 in the block 67 carried by the frame 21 is likewise received in a bore 76 extending between the counterbore 66 for receiving the piston rod 64 and the opening 73, and a sealing ring 77 provides a fluid-tight connection between the conduit 71 and the counterbore 76 in a manner similar to that of the sealing ring 75. The opening 73 is in communication with a vertical passage 78 opening into the upper side of the block 67 and having a counterbore at its upper end for receiving a conduit 79.

The outside diameter of the conduit 71 is less than the inside diameter of the axial opening in the tubular piston rod 64 thereby providing an annular space 80 between the conduit 71 and the inner circumference of the rod 64. The portion of the piston rod 64 received by the counterbore 66 has a radial port 81 extending between the annular space 80 and the external circumference of the rod. The port 81 registers with a vertical passage 82 in the block 67, which passage has a counterbore at its upper end for receiving a conduit 83 for making a connection to the passage 82.

The portion of the piston rod 64 which is threaded into the counterbore 70 in the piston 38 is similarly provided with a radial port 84 which extends between the annular space 80 and the external circumference of the rod and which registers with a passage 85 in the piston 38. The passage 85 opens into the right-hand side of the piston 38, as viewed in Fig. 5, and places the port 84 in communication with the cylinder chamber on the right-hand side of the piston 38.

It can now be seen that the cylinder chamber on the left-hand side of the piston 38 may be connected to either a source of fluid pressure or to exhaust through the opening 72 in piston 38, the conduit 71, the opening 73 and passage 78 in the block 67, and the conduit

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79, and that the cylinder chamber on the right-hand side of the piston 38 can be placed in communication with exhaust or a source of fluid pressure supply through the passage 85 in the piston 38, the port 84 in the piston rod 64, the annular space 80 between the rod 64 and the conduit 71, the port 81 in the piston rod, the vertical passage 82 in the block 67, and the conduit 83.

The piston rod 65, connected to the piston 39 of the fluid pressure actuator 35, is of a construction similar to the piston rod 64 and is connected at its right-hand end to the piston 39 and at its left-hand end to a block 87, which block is carried by a vertical flange depending from the left-hand side of the intermediate portion 43, as the latter is viewed in Fig. 2. The block 87 is provided with passages similar to the passages 82, 78 of the block 67, which are connected to flexible conduits 90, 91 respectively, for supplying fluid pressure respectively to the cylinder chamber on the right-hand and left-hand sides of the piston 39.

To move the clamp members 26, 27 toward each other, fluid pressure is supplied to the cylinder housing 32 on the right-hand or clamp side of the piston 38 and to the cylinder housing 33 on the left-hand or clamp side of the piston 39. When the clamp members 26, 27 are to be moved apart, the fluid pressure is supplied to the opposite sides of the pistons 38, 39.

The connections of the fluid pressure actuators 34, 35 to source of fluid pressure and to exhaust or return is controlled by the operation of a single control lever 95 located adjacent to the operator's seat on the industrial truck. The control lever 95 is manipulated to control the operation of a motor 96 for driving a pump 97 for supplying fluid pressure to the fluid pressure actuators 34, 35 and for controlling the connection of the fluid pressure actuators to the pump and to reservoir-return or drain.

The control lever 95 is movable to operate a valve 97 having a pressure port connected to the discharge of the pump 97 by a pressure or discharge conduit 99 and a drain or return port connected to the suction side of the pump 97 by a conduit 101. The valve 98 has an axially movable valve core 105 which is shiftable from a neutral position, where all connections to and from the valve 98 are blocked, to a first position where the conduit 99 from the discharge of the pump 97 is connected to a flexible conduit 106 and the conduit 101 to the suction side of the pump is connected to a flexible conduit 107 leading from the control valve 98. When the valve core is shifted in the other direction from its neutral position, the connections between the conduits 99, 101 on the one hand and the conduits 106, 107 on the other hand are reversed and the pressure conduit 99 is connected to the conduit 107, and the suction or return conduit 101 to the conduit 106.

The opposites of the piston of fluid pressure actuator 34 are selectively connectible to the conductors 106, 107 by solenoid valves 110, 111, preferably mounted on the load carriage C. The solenoid valves 110, 111 are each of the type which is open when the solenoid of the valve is energized. The flexible conduit 78 to the left-hand side of piston 38 is connected to the solenoid valve 110 which is, in turn, connected to the conduit 106 while the flexible conduit 83 is connected to the solenoid valve 111 which is, in turn, connected to the conduit 107. When the solenoid valves 110, 111 are open and the conduits 106, 107 are respectively connected to pressure and return, the clamp member 26 will move in its clamping direction and when the conduits 106, 107 are respectively connected to drain and pressure the clamp member 26 will move in the opposite direction which is away from the clamp member 27.

The opposite sides of the piston 39 of the fluid pressure actuator 35 are also selectively connectible to the conduits 106, 107 by solenoid valves 112, 113, respectively.

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The flexible conduit 90 leading to the left-hand side of piston 39 as viewed in Fig. 2 is connected to solenoid valve 112 which in turn is connected to the conduit 107, while the flexible conduit 91 to the right-hand side of piston 39 is connected to the solenoid valve 113 which is, in turn, connected to the conduit 106. It can be seen from the foregoing that when the valve core 105 is in a position where the conduit 106 is connected to the pressure or discharge conduit 99 from the pump 97, and the conduit 107 is connected to the suction or return conduit 101 and the valves 110, 111, 112, 113 are energized to place the conduits 106, 107 in communication with the fluid pressure actuators 34, 35, fluid pressure will be supplied to the left-hand side of the piston 38 and to the right-hand side of the piston 39 causing the clamp members 26, 27 to move away from each other and that the opposite sides of the pistons 38, 39 are connected to conduit 107, which is now a low pressure conduit, to provide a return from the opposite side of the cylinder.

If the valve core 105 is now shifted to interchange the connections from the pump to the conduits 106, 107 so that the conduit 107 becomes the pressure conduit, and the conduit 106 the return conduit, fluid pressure will be supplied to the right-hand side of piston 38 and the left-hand side of piston 39, respectively, and the opposite sides thereof connected to the return conduit, and the clamp members 26, 27 will move toward each other.

According to another feature of the present invention fluid connections and controls are provided to enable one of the clamp members to be moved toward the other clamp member, while a back pressure is maintained on the latter clamp member. The back pressure provided by the latter member is maintained at a lesser magnitude than the pressure applied to the former clamp member, whereby a load may be clamped between the clamp members and the clamp members side-shifted in the direction toward the clamp member having the lesser pressure applied thereto. Provision is made for shifting the clamp members 26, 27 in either direction while a load is clamped therebetween.

To enable the clamp members 26, 27 to be side-shifted, the conduit 90, leading to the left-hand side of piston 39 of the actuator 35, is, in the illustrated embodiment, connected to the inlet side of a pressure relief valve 115 by a conduit 116 which includes a solenoid valve 117 energizable to permit the flow of fluid pressure from the conduit 90 to the valve 115. Similarly, the conduit 83 leading to the right-hand side of the piston 38 of actuator 34 is connected to the inlet of the pressure relief valve 115 by a conduit 118 which includes a solenoid valve 119 energizable to permit flow through the conduit 118. The outlet side of the valve 115 is connected to the conduits 79, 91 leading to the left side of piston 38 and the right-hand side of piston 39, respectively, include check valves 123, 124 which permit flow from the relief valve 115 and block it in the opposite direction. During operation, the solenoid valves 117, 119 are normally energized.

When fluid pressure is supplied to the conduits 83, 90 leading to the clamp sides of piston 38 and 39 respectively, i.e., the right-hand side of the piston 38 and the left-hand side of the piston 39, to cause the clamp members 26, 27 to move in directions toward each other, the pressure applied to the cylinders of the fluid pressure actuators 34, 35 is maintained, when the solenoid valves 117, 119 are open, at a lesser magnitude than the discharge pressure of the pump 97. With the solenoid valves 117, 119 open, the conduits 83, 90 are connected through the pressure relief valve 115 to the conduit 106, which is the return conduit when the members are moved toward each other, and the pressure applied to the fluid pressure actuators 34, 35 is determined by the setting of the relief valve 115 which is set to maintain a pressure

below that of the discharge pressure of the pump 97. The flow from the pressure relief valve 115 to the return conduit 106 is through either the check valve 123 and the conduit 121 to conduit 90 and from there through solenoid valve 110 to conduit 106, or through the check valve 124 and conduit 122 to the conduit 91 and then through the solenoid valve 113 to the conduit 106.

When a load clamped between the clamp members 26, 27 is to be side-shifted the conduit 107 is under pressure so that pressure can be supplied to the clamp side of one of the actuators 34, 35 to move it in its clamping direction and one of the solenoid valves 117, 119 which is connected to the clamp side of the particular actuator is closed. In addition, the solenoid valves between the other fluid pressure actuator and the conduits 106, 107 are closed. When the clamp members 26, 27 are to be shifted to the left, as viewed in Fig. 9, the solenoid valve 117, which is connected to the actuator 35 and controls the flow from the conduit 90 leading to the left-hand or clamp side of the fluid pressure actuator 35, to the relief valve 115 is closed so that the full discharge pressure of the pump can be applied to the clamp side of the fluid pressure actuator 35. In addition, the solenoid valves 110, 111 connecting the fluid pressure actuator 34 to conduits 106, 107 are closed. With the hydraulic circuit in this condition and the control valve 98 shifted to place the conduit 107 under pressure, the full discharge pressure of the pump will be applied to move the clamp member 27 toward the clamp member 26 while no fluid pressure is being supplied to the fluid pressure actuator 34. A back pressure to oppose movement of the clamp member 26 by the clamp member 27 which acts through the load to move the clamp member 26 is maintained on the clamp member 26 by reason of the pressure fluid trapped in the cylinder on the right-hand side of piston 38. This back pressure is maintained at the setting of the relief valve 115 since the solenoid valve 119 is open to connect the right-hand or clamp side of the piston 38 to the relief valve 115 and in turn to the opposite side of the piston 38 through the check valve 123 and conduit 121 or to drain through the check valve 124 and solenoid valve 113. Since the back pressure on the clamp member 26 is less than the discharge pressure of the pump applied to the clamp member 27, the clamp members 26, 27 with the load therebetween will shift to the left as viewed in Fig. 9.

When the clamp members 26, 27 are to be shifted to the right, as viewed in Fig. 9, the solenoid valves 112, 113 for controlling the connections from conduits 106, 107 to the opposite sides of the piston 39 of fluid pressure actuator 35 are closed, as well as the solenoid valve 119 which connects the clamp or right-hand side of piston 38 to return through the pressure relief valve 115. In this condition, the hydraulic circuit will function in the manner described above for side-shifting to the left to maintain a back pressure depending upon the setting of the relief valve 115 on the clamp member 27 and to maintain the full discharge pressure of the pump on the side of the fluid pressure actuator 34 for moving the clamp member 26 in its clamping direction.

The connection of the conduits 106, 107 leading from the control valve 98 to pressure and return, and the energization of the solenoid valves 110, 111, 112, 113, 117, 119 are under the control of the single operating lever 95. The single operating lever 95 is supported for rocking movement about a horizontal axis by a bracket 129 fastened to the top of the housing of the valve 98. The lever 95 is rotatably secured in a block 130 having two vertical plates 131, 132 depending therefrom. The plates have openings for passing a pin 133 supported horizontally between upstanding legs of the bracket 129, which pin supports the lever 95 for movement about a horizontal axis. At a point offset from the pin 133, the plates 131, 132 are connected to the valve core 105 by a link 135 and upon rocking movement of the lever 95

about the pin 133, the valve core 105 is moved in a vertical direction.

The lever 95 is normally maintained in a vertical position and the valve core 105 in its neutral position by a detent spring 136 supported on the housing of the valve 38 by a bracket 137. The detent spring 136 has a reversibly bent end portion adapted to be received in a notch 138 in one edge of the plate 132. The edge of the plate 132 which has the notch 138 therein is curved on either side of the notch 138 to provide a cam surface for the reversibly bent portion of the spring 136. The bracket 137 also mounts an electric switch 140 having a switch operator 141 that bears against the spring 136 so that when the lever 95 is moved in either direction from its vertical position, the switch 140 is operated by the spring 136.

As mentioned above the control lever is supported in the block 130 for rotation about its own axis. The lever 95 carries a transversely extending switch operating member 144 which is rotatable with the lever 95. When the lever 95 is rotated to the right, as viewed in Fig. 6, the switch operating member 144 engages a switch operator 145 for a switch 146 to cause operation thereof. When the lever 95 is rotated in its other direction from the position shown in Fig. 6, the switch operating member 144 engages a switch actuating member 147 to operate a switch 148 to cause the operation thereof. The switches 146, 148 and their operators are supported by a portion of the plate 132 which extends above the block 142 so that the switches move with the lever 95 when rocked about the axis of the pin 133.

The control valve 98 and the lever 95 are positioned adjacent to the operator's seat of the truck shown in Fig. 1 so that the lever 95 can be rocked forwardly and rearwardly about the axis of the pin 133. When the control lever 95 is rocked forwardly or rearwardly, the switch 140 is operated by spring 136 to start the motor 96 for driving the pump 97. Referring to Fig. 9, it will be seen that the switch 140 completes a relay circuit from a battery 150 through a relay coil 151 of a motor relay 152 having normally open contacts 153. The closing of the contacts 153 completes a circuit from the battery 150 to the motor 96. The closing of the switch 140 also connects a wire 155 to one side of the battery 150 to immediately complete circuits to and cause energization of the solenoid valves 110, 111, 112, 113, 117, 119. The circuit for energizing the solenoid valves 110, 111, 117 from the wire 155 includes the switch 144 which is normally closed and which, when operated, causes deenergization of the solenoid valves 110, 111 and 117. The circuit from the wire 155 for energizing the solenoid valves 112, 113, 119 includes the normally closed switch 146 which, when opened, breaks the circuit and deenergizes the valves.

As described above, when the solenoid valves 110, 111, 117 are deenergized and closed upon the opening of switch 146 and fluid pressure is supplied for moving the clamping elements in a clamping direction, the clamp elements 26, 27 and the load clamped therebetween will side-shift to the left. Likewise, the clamp elements 26, 27 and the load therebetween will side-shift to the right when high pressure is applied to conduit 107 and the solenoid valves 112, 113 and 119 are closed by the opening of switch 148. Therefore, when the lever 95 is rocked rearwardly to supply fluid pressure to the actuators 34, 35 to cause the clamping members 26, 27 to move toward each other, the clamp members and the load therebetween can be side-shifted by rotating the lever 95 about its own axis to open one of the switches 146, 148.

As illustrated in Fig. 9, each of the solenoid valves 110, 111, 112, 113 has a check valve 160 connected in parallel therewith to permit flow toward the conduits 106, 107. These check valves function to eliminate back pressure, which in some cases may be undesirable, on the solenoid valves 110-113.

From the foregoing, it can be seen that the objects here-

tofore enumerated and others have been accomplished and that a new and improved industrial truck having spaced clamp members for engaging and clamping a load therebetween, which members are supported on cylinder elements operable on ball bearings is provided, as well as a new and improved industrial truck where the load may be side-shifted by the operation of a single control lever. Furthermore, a hydraulic system for side-shifting the load is provided wherein a hydraulic back pressure can be maintained on one of the clamping members while a hydraulic pressure of greater magnitude urges the other clamping member in the direction of desired side-shift.

While the preferred form of the present invention has been described in considerable detail, other modifications and constructions and arrangements will be apparent to those skilled in the art and it is hereby my invention to cover all such modifications and constructions and arrangements which fall within the scope of the appended claims.

Having thus described my invention, I claim:

1. In a material handling apparatus, a load carriage comprising a frame, first and second fluid pressure actuators supported on said frame and each having a movable element, first and second clamp members operatively connected to the movable elements of said first and second actuators respectively for movement toward and away from each other upon operation of said actuators, a source of fluid under pressure, means for supplying pressure fluid from said source to first sides of the piston elements of said actuators to provide equal forces for moving said clamp members in respective first directions toward each other and for selectively applying pressure to either of said actuators to urge one clamp member toward the other clamp member with a first force and for selectively maintaining a fluid back pressure on the other actuator to maintain a smaller second force on the other clamp member to oppose movement thereof in a direction opposite its first direction, the last said means including pressure responsive means connectible to the first sides of said piston elements to limit the first sides of the piston elements to a pressure below the pressure of said source.

2. In a material handling apparatus a load carriage, a frame, first and second fluid pressure actuators each comprising cooperating piston and cylinder elements supported on said frame, one of the elements of each of said fluid pressure actuators being movable, first and second clamp members operatively connected to said first and second fluid pressure actuators for movement thereby in directions toward and away from each other, first and second fluid connections to the first sides of said piston elements of said first and second actuators respectively for supplying pressure to move said clamp members in directions toward each other, means for supplying fluid at a predetermined pressure to said fluid connections, pressure responsive means connected to said fluid connections for maintaining the pressure in said fluid connections below said predetermined pressure, and means for selectively effectively disconnecting the last-said means from either of said fluid connections including means for blocking the supply of pressure fluid to the other fluid connection upon the disconnection of the pressure responsive means from one of the fluid connections.

3. In a material handling apparatus a load carriage, a frame, first and second fluid pressure actuators each comprising cooperating piston and cylinder elements supported on said frame, one of the elements of each of said fluid pressure actuators being movable, first and second clamp members operatively connected to said first and second fluid pressure actuators for movement thereby in directions toward and away from each other, a first connection to a first side of each of said piston elements for supplying pressure to move said clamp members in directions toward each other, a second fluid connection to the other side of each of said piston elements for supplying

pressure to said cylinder elements to move said clamp members apart, a first conduit connected to said first fluid connections, a second conduit connected to said second fluid connections, valve means in each of said first and second connections for blocking the flow of pressure fluid therethrough, a pressure limiting valve, means connecting the inlet side of said pressure limiting valve to said first connections between said first conduit and said actuators and including first and second valves operable to effectively disconnect the inlet of the pressure limiting valve from the first fluid connections of said first and second actuators respectively, means connecting the outlet of said pressure limiting valve to said second connections between said second conduits and said actuators and including check valve means permitting fluid from said pressure limiting valve, a control means for operating said valve means to selectively place said conduits and said cylinder elements in communication through said first and second fluid connections and to selectively connect said pressure limiting valve with either of said first fluid connections and simultaneously block the first and second fluid connections to the other fluid pressure actuator, and a control valve operable to selectively connect one of said conduits to a source of pressure and the other to return and to interchange the connection of said conduits to pressure and return.

4. In an industrial truck, a chassis, a load carriage comprising a frame, first and second double acting fluid pressure actuators each comprising a cylinder element and cooperating piston element mounted on said frame, one of the elements of each of said actuators being movable, first and second clamp members operatively connected to the movable elements of said first and second actuators respectively for movement in directions toward each other on application of fluid pressure to first sides of said piston elements and for movement in directions away from each other on application of fluid pressure to the second sides of said piston elements, first and second conduits, fluid connections between said first conduit and said cylinder elements on the first sides of said piston elements therein, fluid connections between said second conduit and said cylinder elements on the second sides of the piston elements therein, control valve means for selectively connecting said first conduit to a source of pressure fluid and said second conduit to return and for selectively reversing the connection of the conduits to pressure and return and having a neutral position blocking the connections between said conduits and said source of pressure fluid, pressure reducing means, first valve means for selectively connecting said pressure reducing means to either or both of said first sides of said pistons, valve means in each of said fluid connections from said conduits to said actuators selectively operable between open and closed positions, a control lever selectively movable in first opposite directions and in second opposite directions, means connecting said lever to shift said control valve in opposite directions from its neutral position upon operation of said lever in said first opposite directions, and means actuated upon movement of said lever in one of its second opposite directions conditioning said first valve means to connect said first actuator to and to effectively disconnect the said second actuator from said pressure reducing means and to block the connection between said first conduit and said first actuator and upon movement in the other of its second opposite directions to effectively disconnect the inlet of said pressure reducing means from said first actuator and to block the connection between said first conduit and said second actuator.

5. In a material handling apparatus, a load carriage including a frame, first and second double acting fluid pressure actuators supported by said frame, first and second clamp members operatively connected to said first and second actuators respectively for movement in direc-

tions toward and away from each other, first fluid connections for supplying pressure fluid from a source of fluid pressure to respective ones of said actuators on one side thereof to move said clamp members toward each other, second fluid connections to the opposite sides of said actuators for connecting said actuators to the return for the fluid pressure, pressure reducing means having its inlet connected to each of said first fluid connections for maintaining the pressure fluid supplied to said actuator at a pressure below the available pressure from the source of pressure fluid, and control means for effectively disconnecting the inlet of said pressure reducing means from said first fluid connection of a selected one of said actuators and for blocking the flow of pressure fluid from the source of pressure fluid through the first fluid connection of the other actuator.

6. In a material handling apparatus, a load carriage including a frame, first and second double acting fluid pressure actuators supported by said frame, first and second clamp members operatively connected to said first and second actuators respectively for movement in directions toward and away from each other, first fluid connections for supplying pressure fluid from a source of fluid pressure to respective ones of said actuators on first sides thereof to move said clamp members toward each other, second fluid connections to the opposite sides of said actuators for connecting the opposite sides to the return for the pressure fluid, pressure reducing means having its inlet connected to each of said first fluid connections for maintaining the pressure fluid supplied to said actuators at a pressure below the available pressure from the source of pressure fluid and the outlet thereof in communication with said second fluid connections, and control means for effectively disconnecting the inlet of said pressure reducing means from said first fluid connection of a selected one of said actuators and for blocking the flow of pressure fluid from the source through the first fluid connection to the other actuator.

7. In a material handling apparatus, a load carriage including a frame, first and second double acting fluid pressure actuators each comprising a cylinder element and a piston element, means mounting said actuators on said frame including antifriction means comprising a plurality of rotatable bearing elements disposed between one of said elements of each actuator and said frame and supporting said one of said elements of each actuator for movement relative to said frame and means fixedly connecting the other of said elements of each of said actuators to said frame, a clamp member carried by each of the movable elements of said actuators, and means for supplying fluid pressure to said cylinder elements for selectively moving said members toward and away from each other.

8. In a material handling apparatus, a load carriage comprising a frame, first and second double acting fluid pressure actuators supported on said frame and each having a movable cylinder element, first and second clamp members carried by said cylinder elements of said first and second actuators respectively for movement toward and away from each other upon operation of said actuators, a source of fluid under pressure, means for supplying pressure fluid from said source to said actuators to provide equal fluid pressure forces for moving said clamp members in respective first directions toward each other and for selectively applying fluid pressure to said actuators to urge said clamp members toward each other with different fluid pressure forces whereby said clamp members shift in the direction of the clamp member having the smaller force applied thereto.

9. In a material handling apparatus, a load carriage including a frame, first and second double acting fluid pressure actuators each comprising a cylinder element and a piston element, antifriction means supporting said cylinder elements on said frame for axial movement

along generally parallel lines, a clamp member carried by each of said cylinder elements, means fixedly connecting said piston element to said frame, and means for supplying fluid pressure to said cylinder elements for selectively moving said clamp members toward and away from each other.

10. In a material-handling apparatus, a load carriage comprising a frame, first and second fluid pressure actuators supported on said frame and each having a piston element and a cylinder element, one of said elements of each of said actuators being movable, first and second clamp members operatively connected to the movable elements of said first and second actuators respectively for actuation thereby to selectively move said clamp members toward and away from each other and for movement in the same direction as a unit upon operation of said actuators, said clamp members being urged toward each other when pressure fluid is supplied to respective first sides of the piston elements of said actuators, fluid circuit means for maintaining pressure fluid at first and second pressures selectively on a first side of the piston element of each of said actuators to urge said clamp members in their respective first directions toward each other, said elements being urged toward each other with equal force when said first pressures are maintained on said first sides, said fluid circuit means including means for selectively maintaining said first pressures on said first sides and means for selectively maintaining the respective said first pressure on the first side of either of said actuators and for simultaneously maintaining the respective second pressure on the first side of the piston element of the other actuator, and means for connecting the other sides of said piston elements to drain.

11. In a material-handling apparatus, a load carriage comprising a frame, first and second fluid pressure actuators supported on said frame and each having piston and cylinder elements, one of said elements of each of said actuators being movable, first and second clamp members operatively connected to the movable elements of said first and second actuators respectively for movement toward and away from each other upon operation of said actuators, said clamp members being urged toward each other when fluid pressure is supplied to first sides of the piston elements of said actuators, a fluid pressure system for supplying pressure fluid to said first sides of the piston elements of said actuators and for maintaining fluid pressure thereon comprising first valve means operable to selectively maintain fluid pressure on said first side of the piston element of the first actuator at first and second pressures to selectively provide first and second forces tending to move said first clamp member toward said second clamp member, second valve means operable to selectively maintain fluid pressure on said first side of the piston element of the second actuator at first and second pressures to selectively provide first and second forces tending to move said second clamp member toward said first clamp member, the said first forces of said actuators being equal and said second forces differing in the same direction from said first forces, and control means for selectively operating said valve means to selectively supply fluid at said first pressure to the first sides of the piston elements of said actuators or fluid at said first pressure to the first side of a piston element of a selected one of said actuators and fluid at said second pressure to said first side of the piston element of the other of said actuators.

12. In a material handling apparatus, a load carriage comprising a frame, first and second clamp members adapted to support load engaging devices, first and second double acting piston and cylinder actuators respectively connected to said first and second clamp members respectively and to said frame for moving the clamp members relative to said frame, antifriction means comprising a plurality of rotatable bearing elements sup-

porting said clamp members for movement with respect to said frame in directions toward and away from each other, a source of fluid under pressure, means for selectively supplying pressure fluid from said source to said first and second piston and cylinder actuators to provide equal forces for moving said clamp members in respective first directions toward each other and means for selectively supplying fluid pressure to said actuators to urge said clamp members toward each other with different fluid pressure forces whereby said clamp members will shift as a unit in the direction of the clamp member having the smaller force applied thereto while maintaining a clamping force on a load disposed therebetween.

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