April 20, 1965 S. T. COMFORT 3,179,274

CONTROL SYSTEM FOR LIFT TRUCK ATTACHMENT

Filed Sept. 28, 1962 3 Sheets-Sheet 1

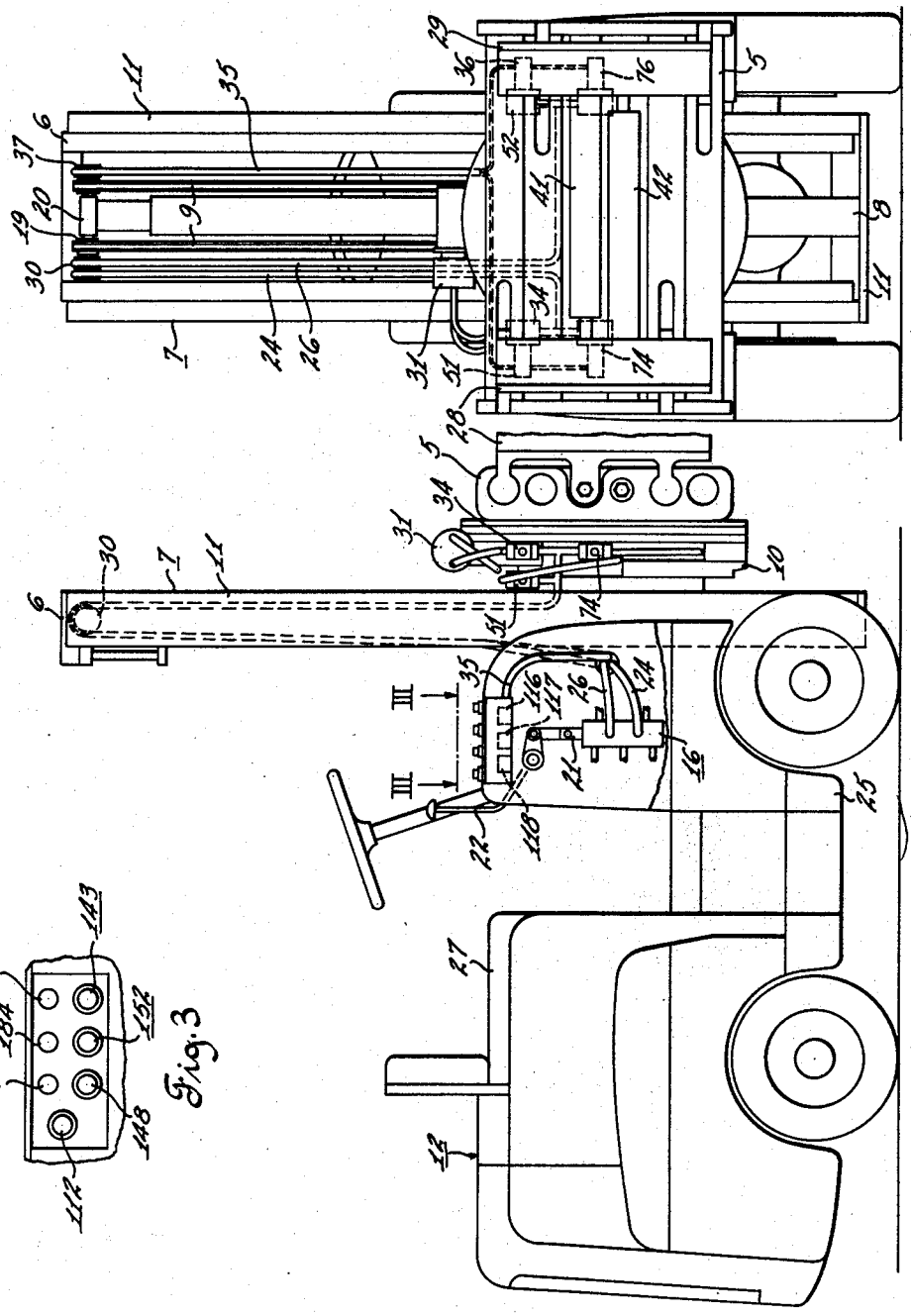


Fig. 2

Fig. 1

Fig. 3

Inventor
Samuel T. Comfort
by Charles L. Schmidt
Attorney

April 20, 1965 S. T. COMFORT 3,179,274

CONTROL SYSTEM FOR LIFT TRUCK ATTACHMENT

Filed Sept. 28, 1962 3 Sheets-Sheet 2

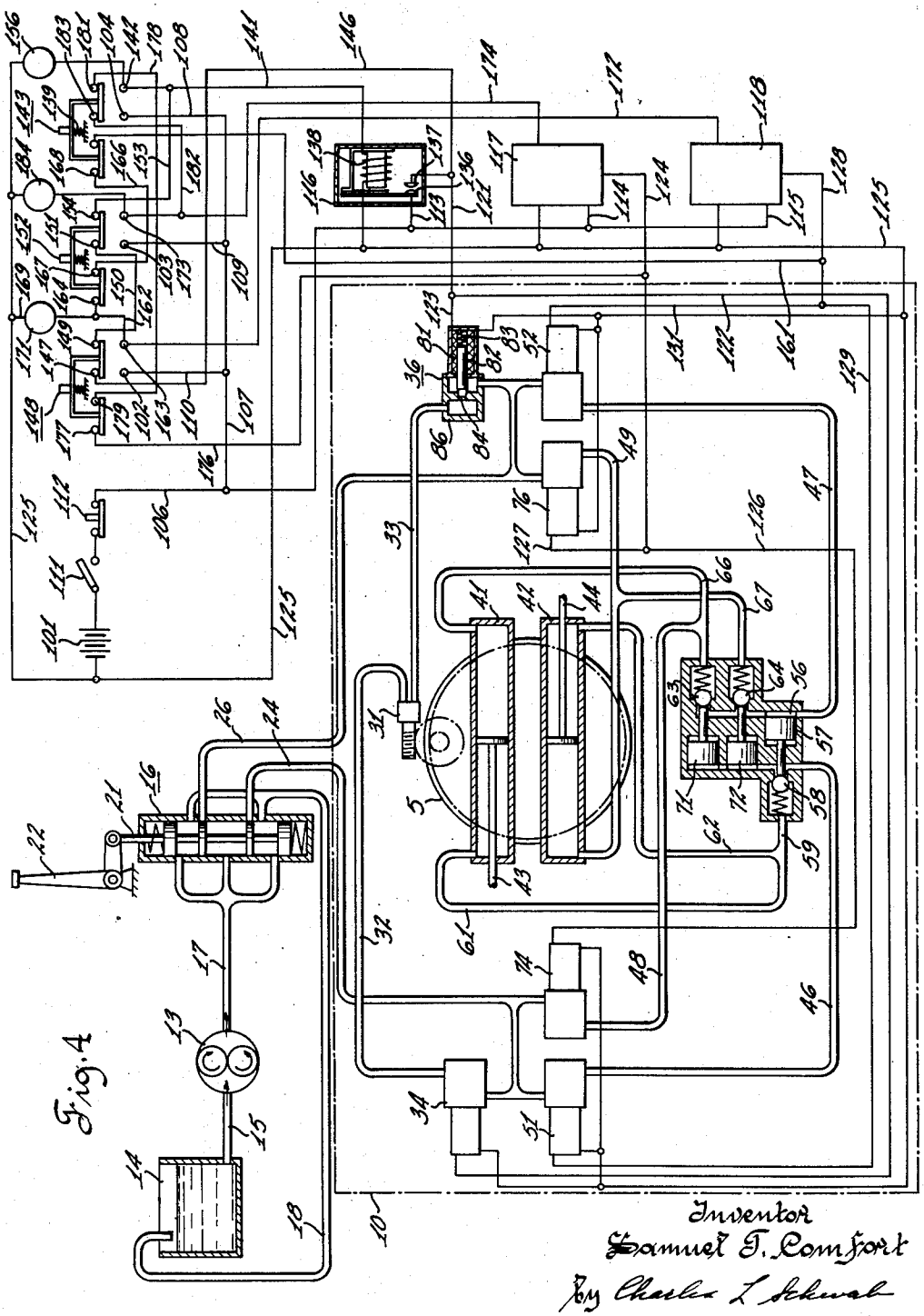


Fig. 4

Inventor
Samuel T. Comfort
By Charles L. Stewart
Attorney

April 20, 1965 S. T. COMFORT 3,179,274

CONTROL SYSTEM FOR LIFT TRUCK ATTACHMENT

Filed Sept. 28, 1962 3 Sheets-Sheet 3

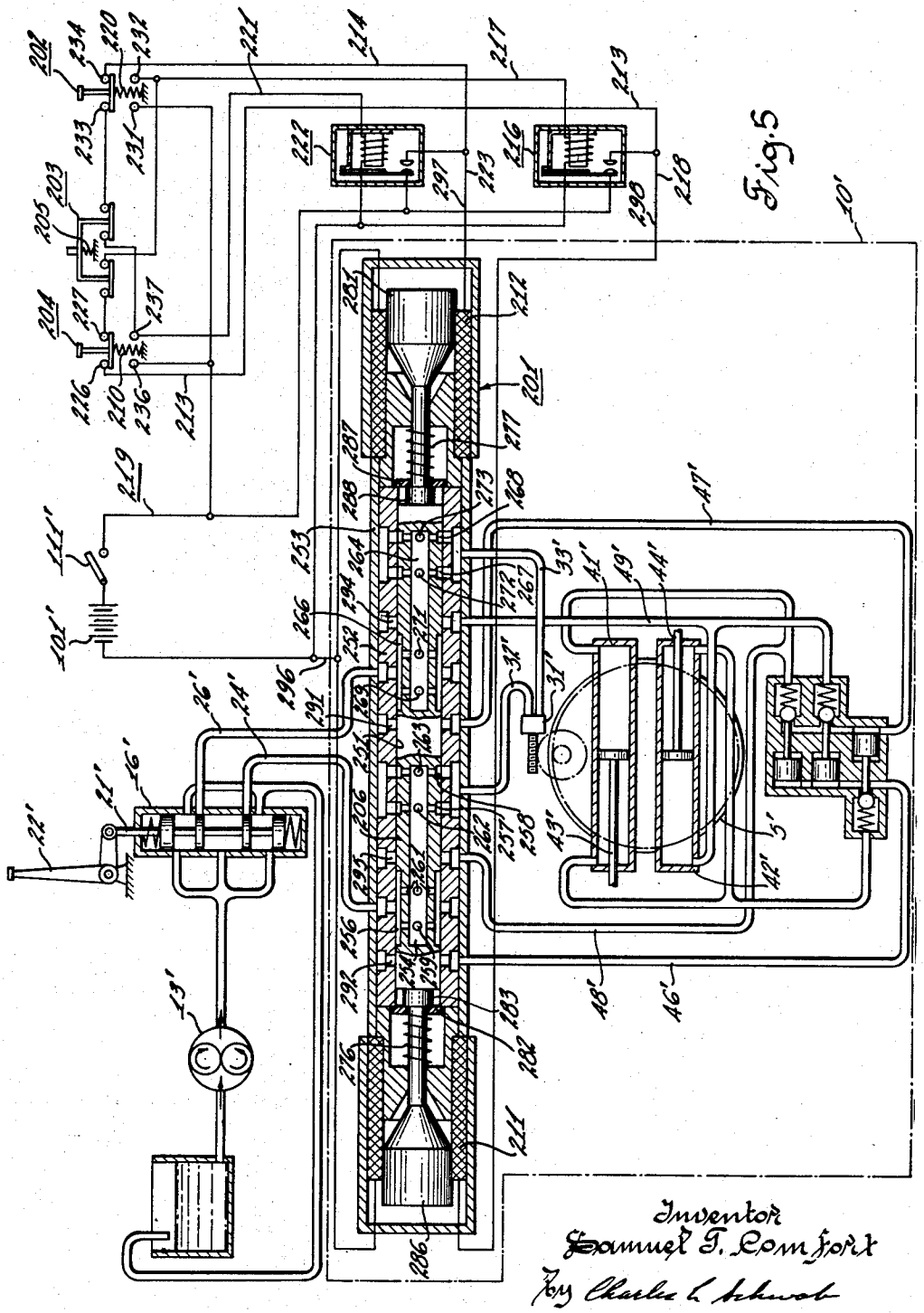


Fig. 5

Inventor
Samuel T. Comfort
By Charles L. Schwab
Attorney

United States Patent Office 3,179,274 Patented Apr. 20, 1965

3,179,274

CONTROL SYSTEM FOR LIFT TRUCK ATTACHMENT

Samuel T. Comfort, Homewood, Ill., assignor to Allis-Chalmers Manufacturing Company, Milwaukee, Wis.

Filed Sept. 28, 1962, Ser. No. 228,216
11 Claims. (Cl. 214—652)

This invention relates to a control system for a lift truck attachment operated by a plurality of hydraulic motors.

In providing lift truck attachments with increased versatility and utility, it has become desirable to provide a plurality of hydraulic motors on the attachment to achieve the desired functions. For instance, it may be desirable to provide a clamp attachment which is capable of being side shifted and rotated as well as possessing its usual clamping function. Such a clamp attachment would normally require three hydraulic motors.

Heretofore, it has been suggested that electrically actuated diverter valves be mounted on the attachment or carriage to which the attachment is mounted, for conveying hydraulic fluid to and from the selected motor on the attachment to achieve the desired attachment function. One such prior device provides push button type controls wherein operation of a particular push button causes a predetermined hydraulic motor of the attachment to be connected to the pressure fluid source and reservoir. In this prior art device the push button must be maintained in its depressed position by the operator so long as he desires the corresponding motor to be operated. This is inconvenient to the operator inasmuch as he simultaneously desires to manually operate the hydraulic control valve with the same hand.

It is an object of this invention to provide an improved control system for a lift truck attachment which is operated by a plurality of hydraulic motors.

It is a further object of this invention to provide a control system for an attachment with a plurality of hydraulic motors which requires the use of only one hand of the operator and wherein a single hydraulic control valve selectively operates the attachment motors.

It is a further object of this invention to provide a control system for a lift truck attachment, wherein only a pair of hydraulic hoses is required between the main body of the lift truck and the carriage to which the attachment is mounted.

It is a further object of this invention to provide a push button control arrangement whereby upon activating a particular push button the hydraulic conduits to a predetermined hydraulic motor are open.

It is a further object of this invention to provide an electric control system for a hydraulically operated attachment of the type hereinbefore described wherein a holding circuit maintains the circuit established by depressing a push button so that it is not necessary to continue to depress the push button in order to continue to have the hydraulic motor associated therewith connected to the hydraulic system.

It is a further object of this invention to provide a control system of the type hereinbefore described wherein a stop switch is employed to deenergize the holding circuits.

It is a further object of this invention to provide signal lights in association with the electrical control system so as to inform the operator which hydraulic circuit is activated.

It is a further object of this invention to provide an electrical control system in combination with a hydraulic control system wherein inexpensive electrical and hydraulic components may be employed, so as to achieve a minimum overall cost for the control system.

It is a further object of this invention to provide a push button type electrical control system for activating one of a plurality of hydraulic motors of a lift truck attachment wherein activation of one push button will deenergize the holding circuits associated with the other push buttons.

It is a further object of this invention to provide a push button operated electric-hydraulic control system for a lift truck attachment wherein a solenoid valve with a plurality of positions is selectively positioned by push button switch operated electric controls including holding circuits.

It is a further object of this invention to provide an electric-hydraulic control system for a multifunction lift truck attachment wherein the attachment functions are selected by operation of manually operated electric switches and wherein operation of one of the function selecting electric switches automatically cancels the previous function selection.

It is a further object of this invention to provide an electric-hydraulic control system for a lift truck attachment having a plurality of hydraulic motors which uses a minimum of electric and hydraulic control apparatus.

These and other objects and advantages of this invention will be apparent to persons familiar with the art upon reading the following description in conjunction with the drawings in which:

FIG. 1 is a side view of a lift truck in which this invention is incorporated;

FIG. 2 is a front view of the lift truck shown in FIG. 1;

FIG. 3 is a view of the push button controls and signal lights taken along line III in FIG. 1;

FIG. 4 is a schematic of the control system for the lift truck attachment shown in FIGS. 1 and 2; and

FIG. 5 is a schematic view of a control system for a lift truck attachment in which a second embodiment of this invention is incorporated.

Referring to FIGS. 1 and 2 a rotating side shifting clamp attachment **5** is rotatably mounted in a conventional manner on the lift truck carriage **10** which in turn is reciprocably mounted on the inner section **6** of mast **7**. The carriage and inner section of the mast are raised in a conventional manner by a lift cylinder **8** mounted on the outer section **11** and by chains **9**. The chains are reeved over pulleys **19** mounted on the piston component **20** of the lift cylinder **8**. The outer section **11** of the mast **7** is secured to the main body **25** of the lift truck **12** in a conventional manner as by transverse pivot pins, not shown. An operator's station **27** is provided from which the operator may control the operation of the truck and the attachment.

The rotation of the clamp attachment is effected through a hydraulic motor **31**. The right arm **28** of the clamp attachment is connected to the rod of hydraulic motor **41** and the left arm **29** is connected to the rod of hydraulic motor **42**. The hydraulic motors **41**, **42** effect clamping and side shifting functions as will be hereinafter explained. A single hydraulic control valve **16** is used to control the the three motors **31**, **41**, **42** of the attachment. A manual control element in the form of a control lever **22** is mounted on the main body of the truck at the operator's station. Only two hydraulic conduits **24**, **26** extend between the control valve **16** and the carriage. These conduits **24**, **26** are appropriately reeved over a pulley **30** secured to one of the pulleys **19**. A conduit or hose **35** carries the electrical leads extending between the main body and carriage. Hose **35** is reeved over a pulley **37** secured to the other of pulleys **19**.

Referring to FIG. 4, the electrical and hydraulic control system for the rotating, side shifting clamp attachment **5** is shown. The carriage **10** is indicated by dot-dash lines and the components within these lines are

mounted on the carriage. The other components of the schematic illustration are mounted on the main body 25 of the truck 12. A hydraulic pump 13 is driven by an engine, not shown, of the lift truck through a power train, not shown. A reservoir 14 is mounted on the main body of the truck. The pump 13 draws fluid from the reservoir through conduit 15 and supplies fluid under pressure to the control valve 16 through a conduit 17. The control valve is connected with the reservoir 14 by conduit 18. A spool 21 of hydraulic valve 16 is suitably connected to a control lever 22. Hydraulic supply conduits 24, 26 are connected to the control valve 16 and are the only hydraulic conduits running between the main body of the truck and the carriage. Fluid is supplied to the rotator motor 31 through conduits 32, 33 upon opening of the solenoid control valves 34, 36.

The hydraulic motors of jacks 41, 42 open and close the clamps and also shift the clamps to the right or left. Four fluid pressure lines 46, 47, 48, 49 are required for manipulating motors 41, 42 to achieve the side shifting and clamping functions. When lines 46, 47 are connected to the supply lines 24, 26 by opening the solenoid valves 51, 52, the operator may then open or close the clamps upon manipulation of the hand control lever 22. For instance, if the hand control lever is moved to the right, the pump will deliver pressure fluid to conduit 47 through valve 52 and conduit 46 will be connected to the reservoir. Pressure fluid in conduit 47 will pass to a chamber 56 and move plunger 57 to the left unseating check valve 58, thus permitting fluid flow from conduit 59 to the reservoir. Conduit 59 is connected to the rod end of motor 41 by a conduit 61 and also is connected to the rod end of motor 42 by conduit 62. Presure fluid not only unseats valve 58 through movement of plunger 57, but also passes through check valves 63, 64 thence to the opposite ends of motors 41, 42 through conduits 66, 67, respectively. Thus when pressure fluid is supplied through conduit 47 and conduit 46 is connected to the reservoir, fluid will flow to the right end of motor 41 and the left end of motor 42, thereby moving the rods out of the pistons and opening the clamps.

If the control lever 22 is moved to shift the spool 21 downwardly, the pump will be connected to conduit 24 and assuming solenoid valves 51, 52 have been opened through their being electrically energized, the pressure fluid will flow through the conduit 46, check valve 58, conduits 59, 61 and 62 to the rod end of motors 41, 42, to achieve a closing of the clamp. Fluid will be exhausted from the other ends of the motors 41, 42 through conduits 66, 67 which are connected to conduit 47 by virtue of pistons 71, 72 being moved to the right to unseat check valves 63, 64, respectively, under the fluid pressure supplied by conduit 46.

When it is desired to side shift the clamps, solenoid valves 74, 76 will be opened and the control lever 22 moved clockwise or counterclockwise to shift the carriage to the left or right. When pressure fluid is supplied to conduit 49 which is connected to conduit 67, the rod 44 will be moved out of the motor 42, and fluid will be displaced from the rod side of motor 42 into the rod side of motor 41 thereby permitting rod 43 to telescope within motor 41. Since the motors are of equal size the movement of rod 43 will be equal to the movement of rod 44. Fluid will be expelled from the right end of motor 41 through conduits 66, 48, 24.

It should be understood that solenoid valves 34, 51, 52, 74, 76 are the same as solenoid valve 36 which is shown in section. When electrical current is passed to the coil 81 plunger 82 is moved to the right against biasing spring 83, thereby permitting fluid to flow through port 84 in the valve body 86. Thus fluid is permitted to flow from supply conduit 26 to the rotor motor supply conduit 33.

The electrical system for actuating selected pairs of the solenoid valves will now be described. A battery 101

is connected to terminals 102, 103, 104 through lead 106, branch leads 107, 108, 109 and 110 when ignition switch 111 is closed and relay deenergizing switch 112 is closed. Electrical lead 106 branches into three parallel leads 113, 114, 115 which are connected to relay switches 116, 117, 118, respectively. When relay switch 116 is closed, current will flow through lead 121 to the solenoid windings of solenoid valves 34, 36 through lead wires 122 and 123. A ground lead 125 is provided to return the current flow to the battery. When relay switch 117 is closed electricity will flow through lead 114 then to lead 124 which branches into parallel leads 126, 127 leading to solenoid valves 74 and 76, respectively.

When the electrical relay switch 118 is closed, electricity will flow from lead 115 through the switch to lead 128 which branches into parallel leads 129, 131 connected to solenoid valves 51, 52. Relay switch 116 is shown in detail and it will be seen that lead 113 is connected to contact 136 and lead 121 is connected to contact 137. One end of the switch energizing coil 138 is connected to the ground lead 125 and the other end is connected to a lead 141 which in turn is connected to a terminal 142 of a push button switch 143. The push button switch 143 is biased by spring means 139 to the position illustrated wherein terminals 104 and 142 are not bridged. Other spring means bias the other push button switches 112, 148, 152 in a like manner. When the push button 143 is depressed, electricity will flow from lead 108 to lead 141 to close the relay switch 116 thereby supplying current to solenoid valves 34, 36. This results in valves 34 and 36 being opened permitting the operator to rotate the attachment upon manipulation of the manual control lever 22.

The switch 143 need only be held depressed momentarily inasmuch as a holding circuit will keep the relay switch in a closed position. The holding circuit includes lead 146 connected to terminal 147 of switch 148, a jumper lead 150 connected to terminal 149 of push button switch 148 and the terminal 151 of push button switch 152 and a jumper lead 153 connected to the terminal 154 of switch 152 and lead 141. Current flowing through the holding circuit will pass through a light 156 and thence to ground lead 125. Thus it will be seen that when push button switches 148 and 152 are not depressed, a holding circuit is provided to maintain current flow through the coil of the relay switch 116 once contact has been made. So long as current is flowing through the signal light 156, it will be known that current is flowing through the solenoid of the relay switch 116 thereby holding the relay switch 116 in a closed position. Accordingly, when the signal light 156 is on, the operator will be informed that the rotator solenoid valves 34, 36 are open and that movement of the manual control lever 22 will effect rotation of the attachment. The holding circuit will continue to keep the relay switch 116 closed until deenergized through pressing push button switch 112 or push button switches 148 or 152.

If for instance push button switch 148 is depressed the current will no longer flow through lead 146 since there will be no connection between the terminals 147 and 149. Thus when push button switch 148 is depressed the holding circuit for any other switch will be deenergized, and the holding circuit for relay switch 118 will be energized through the electricity being permitted to flow through lead 161, lead 162 extending between terminal 163 of push button switch 148 and terminal 164 of push button switch 152. The holding circuit for relay switch 118 further consists of a lead 166 extending between terminal 167 of push button switch 152 and terminal 168 of push button switch 143 and a lead 169 connecting terminal 163 and light 171 to ground lead 125. When push button switch 148 is depressed electricity flows through lead 107 to lead 172 through the coil of switch 118, then to ground lead 125. When relay switch 118 is energized the solenoid valves 51, 52 will

be opened thereby permitting the operator to open and close the arms of the clamp attachment. Once the operator punches push button switch **148** any other holding circuit which may have been in operation will be automatically deenergized, the light **171** will light to indicate that the clamping function of the attachment is now obtainable through operation of the manual control lever **22**, and the holding circuit brought into operation by the initial closing of the relay switch **118** will continue to energize the coil of switch **118** until such time as the holding circuit deenergizing button **112** is depressed or either of the other push button switches **152** or **143** is depressed.

If it is desired to side shift the clamps the operator will depress push button switch **152** thereby bridging terminals **103** and **173**. Thus the electricity will flow through lead **109** to lead **174** thence through the coil of relay switch **117** to ground lead **125**. The switch **117** will be closed upon being energized to permit current flow from lead **114** to lead **124** thereby opening solenoid valves **74**, **76** to permit side shifting to the right or left upon proper manipulation of the manual control lever **22**.

Upon the push button switch **152** being depressed and relay switch **117** energized, the holding circuit is energized which includes lead **176** connected to terminal **177** of switch **148** and a lead **178** connected to terminal **179** of switch **148** and connected to a terminal **181** of switch **143**. Also, the holding circuit for relay switch **148** includes a lead **182** connected to terminal **183** of switch **143** which connects to lead **174**. So long as the relay **117** remains energized, the signal light **184** will be lit to inform the operator of the fact that upon moving control lever **22** he will effect side shifting of the attachment.

The push button controls and signal lights therefor, the relay switches, the control valve, pump and the reservoir are all mounted on the main body of the truck. The adjacent position of the push button controls and signal lights is shown in FIG. 3.

The single conduit **35** contains four leads, namely, leads **121**, **124**, **128** and the ground lead **125**. The four electrical leads contained in hose **35** are handled in the same manner as a hydraulic hose in its positioning between the main body of the truck and the carriage.

Referring to FIG. 5, the second illustrated embodiment of this invention employs electrically operated valve means in the form of a double solenoid valve **201** which permits reduction of electrical control apparatus over that required in the embodiment illustrated in FIGS. 1 through 4. The electrical control means for selectively positioning the valve means on the attachment includes manually operable selector switches **202**, **203** and **204** which, when operated, position the fluid directing element or spool **206** in side shifting, rotating and clamping positions. In the condition shown in FIG. 5 the valve spool **206** is in rotating position wherein operation of the manual control valve **16'** delivers fluid from pump **13'** to one of conduits **24'**, **26'** thereby effecting rotation of double acting motor **31'** connected to valve **201** by branch conduits **32'**, **33'**. The valve spool **206** will assume the illustrated fluid directing position, which is the rotating position, when the ignition switch **111'** is opened thereby cutting off current to solenoids **211**, **212** associated with opposite ends of the valve spool **206**; however, during normal operation of the lift truck such position will be selected by the operator by manually depressing push button switch **203**. Moving push button switch **203** against the biasing action of spring **205** interrupts the holding circuits **213**, **214** for relay switches **216**, **222** should either happen to be energized.

When the operator wishes to side shift the clamp arms, which are connected to rods **43'**, **44'** of double acting motors **41'**, **42'**, he will depress push button switch **202** against the biasing action of spring **220** to bridge terminals **231**, **232** thereby closing relay switch **216** through energization of relay switch operating circuit **217**. Closing of relay switch **216** energizes solenoid **211** by virtue of current flow through branch control circuit **218** of the main control circuit **219**. When the manually operated switch **202** is operated, the electrical connection between terminals **233**, **234** is broken. Thus the holding circuit **214** for relay switch **222** is interrupted thereby deenergizing the relay operating circuit **221** and deenergizing solenoid **212**, if in fact the valve was just previously in a clamping position.

When the operator wishes to clamp or disengage from a load, he pushes the clamping button **204** against the biasing action of spring **210** to bridge terminals **236**, **237**, thereby energizing relay operating circuit **221**, which closes the relay switch **222** to effect flow of current through branch control circuit **223** and energization of solenoid **212**. Depressing switch **204** interrupts holding circuit **213** thereby deenergizing solenoid **211**, if energized at the time. When flow of current between terminals **226**, **227** of push button switch **204** is interrupted current will not flow through relay switch operating circuit **217** by way of the holding circuit **213**, and the switch **216** will assume the open position in which illustrated. Branch control circuit **223** is electrically in parallel with branch control circuit **218** and is also a part of main control circuit **219**.

Referring to the solenoid valve **201**, the valve spool **206** reciprocates in a bore **251** formed in a sleeve part **252** of the valve housing **253**. Internal axial passage **254** connects annular recess **256** with annular recesses **257**, **258** by way of circumferentially spaced radial bores **259**, **261**, **262**, **263**. Likewise an internal axial passage **264** connects annular recesses **266**, **267**, **268** in fluid communication with one another through circumferentially spaced radial bores **269**, **271**, **272**, **273**. In the illustrated position of the valve, the rotating position, the centering springs **276**, **277** bias the valve spool **206** against movement in either axial direction.

When push button **204** is moved from its illustrated off position to its on position, solenoid **212** is energized causing its plunger **281** to move valve spool **206** to the left against the biasing action of spring **276**, which acts against the left end of the valve spool **206** through washer **282** and head portion **283** of plunger **286**. Upon movement of the valve spool **206** to the left, recess **266** registers with port **291** thereby placing conduit **26'** in fluid communication with branch conduit **47'**, and recess **256** registers with port **292** thereby placing conduit **24'** in fluid communication with branch conduit **46'**, thus permitting the operator to clamp a load upon movement of control valve spool **21'** downwardly and to release a load upon movement of valve spool **21'** upwardly.

The side shifting position of the valve spool **206** is effected by depressing push button switch **202** to its on position to energize solenoid **211** thereby causing its plunger **286** to move valve spool **206** to the right against the biasing action of spring **277** acting against the right end of the valve spool **206** through washer **287** and head portion **288** of plunger **281**. Movement of spool **206** to the right causes recess **266** to register with port **294** and recess **256** to register with port **295**, thus placing conduits **24'**, **26'** in fluid communication with branch conduits **48'**, **49'**, respectively. By appropriate movement of manually operable control valve spool **21'** through hand lever **22'**, the operator can side shift the load to the right or to the left.

The structure enclosed by dot-dash lines **10'** is included on the carriage mounting attachment **5'** and thus it is seen that only a single common ground lead **296** and two solenoid leads **297**, **298** are required between the attachment and the lift truck main body where the push button switches **202**, **203**, **204**, relay switches **216**, **222**, ignition switch **111'** and battery **101'** are located. The leads **296**, **297**, **298** are preferably placed within a single hose, conduit, or other suitable flexible covering to permit reeving

over a single sheave in much the same manner as conduit 35 is reeved over sheave 37 as shown in FIG. 2. Only two hydraulic conduits 24', 26' are required between the main body of the lift truck and the multifunction attachment 5'. Thus wiring and hose space requirements on the mast are minimized and the operator need only momentarily operate one of the push button switches 202, 203, 204 to select the attachment function achieved by operation of manually operable control valve 16'.

From the foregoing it is obvious that a novel control system has been provided for a lift truck attachment having a plurality of hydraulic motors for performing desired attachment functions. By providing relay switches and holding circuits, the operator may preselect the function of the attachment desired by merely depressing the proper push button momentarily. This permits the operator to hold the push button for a very short time and then use the same hand to manually manipulate the hydraulic control valve lever 22. It is obvious that this will permit the operator to use his other hand for steering or other functions. Also, the relay and holding circuits are so organized that the operator will deenergize the holding circuit associated with the other push button switch or switches when a particular push button switch is actuated. The signal lights inform the operator which attachment function is keyed in with the hydraulic control valve 16. This will help to avoid human errors in handling attachment loads. The relays, solenoid valves, switches and signal lights are individually of conventional design, thereby permitting the control system to be manufactured at a low cost.

This application is a continuation in part of my previous application Serial No. 105,413 filed April 25, 1961, now abandoned.

Although only two embodiments of this invention have been illustrated and described, it is not intended to limit the invention except as necessitated by the scope of the appended claims.

What is claimed is:

1. In combination with a lift truck having an operator's station and a material handling attachment mounted on a carriage which in turn is mounted for vertical movement on a mast, a plurality of double acting hydraulic motors on said carriage which upon being actuated effect a plurality of attachment functions, a source of pressure fluid on said truck, a manually operable hydraulic control valve on said truck at the operator's station, a pair of conduits having corresponding ends connected to said control valve and having the opposite ends terminating on said carriage, electrically operated valve means on said carriage connected in fluid communication with said pair of conduits, branch conduits extending between said valve means and said motors, and electrical control means for selectively conditioning said valve means to predetermined positions whereby said motors effect said attachment functions upon manual operation of said control valve, said control means including a pair of manually operable selector switches at the operator's station for selecting two of said attachment functions, control circuits between each of said selector switches and said electrically operated valve means, said selector switches being biased to an off position, and a holding circuit for each of said selector switches for maintaining the control circuit of the associated selector switch activated after the latter is released, said holding circuits being connected, respectively, to normally bridged terminals of the selector switches whereby actuation of one of said selector switches interrupts the holding circuit for the other of said selector switches.

2. The structure set forth in claim 1 and further comprising a signal light adjacent each selector switch and connected to the holding circuit thereof to light when the holding circuit is energized.

3. In a lift truck having a main body, an operator's station on the main body, a mast connected to the main body, a carriage mounted for vertical movement on the mast, and a material handling attachment mounted on the carriage, the combination comprising: a plurality of double acting hydraulic motors on said carriage which upon being actuated effect a plurality of attachment functions, a source of pressure fluid on said truck, a hydraulic control system for said motors including a hydraulic control valve on said main body, a manual control element connected to said control valve and located at the operator's station, a pair of conduits having corresponding ends connected to said control valve and having their other ends terminating on said carriage, branch conduits extending between said other ends of said conduits and said motors, electrically operated valve means on said carriage between said pair of conduits and said motors for selectively placing said motors in fluid communication with said pair of conduits, an electrical system for said truck including electrical control means for conditioning said valve means to predetermined positions whereby said motors effect said attachment functions upon operation of said control valve, said control means including a main control circuit having a pair of branch circuits connected to said valve means, a relay switch in each branch circuit, a relay switch operating circuit connected to each relay switch, a push button switch at the operator's station in each relay switch operating circuit, a holding circuit for each relay switch for maintaining the latter in a closed condition, said holding circuit being connected to the associated relay switch operating circuit between the associated relay switch and the push button switch in the other relay switch operating circuit and to the associated branch circuit intermediate the relay switch and valve means associated therewith, and a push button switch at the operator's station for interrupting current flow in said holding circuits.

4. In a lift truck having an operator's station on its main body and a material handling attachment mounted on a carriage which in turn is mounted for vertical movement on a mast connected to the main body, the combination comprising; a plurality of double acting hydraulic motors on said carriage which upon being actuated effect a plurality of attachment functions, a hydraulic control system for said motors including a hydraulic control valve on said main body, a manual control element at said operator's station connected to said control valve, a pair of conduits having corresponding ends connected to said control valve and having their other ends terminating on said carriage, branch conduits extending between said other ends of said conduits and said motors, electrically operated valve means on said carriage intermediate said pair of conduits and said motors for selectively placing said motors in fluid communication with said pair of conduits, and electrical control means for selectively conditioning said valve means to predetermined positions whereby said motors effect said attachment functions upon manual operation of said control valve, said control means including a main control circuit having a pair of branch circuits connected to said valve means, a relay switch in each branch circuit, a relay switch operating circuit connected to each relay switch, a push button switch in each relay switch operating circuit biased toward an open position in which the associated relay switch operating circuit is open, a holding circuit for each relay switch for maintaining the latter in a closed condition, each of said holding circuits being connected to the associated relay operating circuit and to the associated branch circuit intermediate the relay switch and valve means associated therewith and each holding circuit connecting in series the push button switch for the other relay switch whereby when one push button switch is manually closed to energize and close the relay switch associated therewith, the holding circuit for the other relay switch will be deenergized.

5. The structure set forth in claim 4 wherein said electrical control means further comprises a push button

switch for interrupting electric current flow through said holding circuits.

6. The structure set forth in claim 4 in which said relay switches are mounted on said main body of said truck and the number of electrical leads between said main body and carriage equals the number of relay switches plus one.

7. In a lift truck having an operator's station on the main body and a material handling attachment mounted on a carriage which in turn is mounted for vertical movement on a mast attached to the main body, the combination comprising: a plurality of double acting hydraulic motors on said carriage which upon being actuated effect the plurality of attachment functions, a hydraulic control system for said motors including a manually operable hydraulic control valve on said main body, a pair of conduits having corresponding ends connected to said control valve and having their other ends terminating on said carriage, branch conduits on said carriage connected to said motors, electrically operated valve means on said carriage connected to said other ends of said pair of conduits and to said branch conduits for selectively placing said motors in fluid communication with said pair of conduits, and electrical control means for conditioning said valve means to predetermined positions whereby said motors effect said attachment functions upon operation of said control valve, said control means including a main control circuit having a pair of branch circuits connected to said valve means, a relay switch in each branch circuit, a relay switch operating circuit connected to each relay switch, a push button switch at the operator's station in each relay switch operating circuit, and a holding circuit for each relay switch for maintaining the latter in a closed condition, said holding circuit being connected to the associated relay switch operating circuit and to the associated branch circuit intermediate the relay switch and valve means associated therewith, the holding circuit for one relay switch being connected to the push button switch in the relay switch operating circuit for the other relay switch whereby depressing one push button switch closes one relay switch and interrupts the holding circuit for the other relay switch.

8. The structure set forth in claim 7 wherein said relay switches are mounted on the main body of said truck.

9. The structure set forth in claim 7 wherein said electrically operated valve means is a double acting solenoid valve having a pair of solenoids connected to be energized by said branch circuits, respectively.

10. The structure set forth in claim 9 and further comprising a third push button switch at the operator's station connected to said holding circuits and operable to interrupt both of said holding circuits.

11. In a lift truck having an operator's station on its main body and a material handling attachment mounted on a carriage which in turn is mounted for vertical movement on a mast connected to the main body, the combination comprising: a plurality of double acting hydraulic motors on said carriage which upon being actuated effect a plurality of attachment functions, a hydraulic control system for said motors including a hydraulic control valve on said main body, a manual control element at said operator's station connected to said control valve, a pair of conduits having corresponding ends connected to said control valve and having their other ends terminating on said carriage, a double acting solenoid valve mounted on said carriage and connected to said other ends of said pair of conduits, a movable flow control element in said solenoid valve movable between three fluid directing positions corresponding to three attachment functions, branch conduits connected to said solenoid valve and said motors whereby said motors are selectively placed in fluid communication with said pair of conduits by said solenoid valve, and electrical control means for selectively adjusting said flow control element to its fluid directing positions whereby said motors effect the selected attachment function upon manual operation of said control valve, said control means including a main control circuit having a pair of branch circuits connected to said solenoid valve, a relay switch in each branch circuit, a relay switch operating circuit connected to each relay switch, first and second push button switches in said relay switch operating circuits, respectively, biased toward an open position in which the associated relay switch operating circuit is open, a holding circuit for each relay switch for maintaining the latter in a closed condition, each of said holding circuits being connected to the associated relay operating circuit and to the associated branch circuit intermediate the relay switch thereof and said valve means, a third push button switch operable to interrupt said holding circuits, each holding circuit connecting said third push button switch and the push button switch for the other relay switch in series, said holding circuit for one of said relay switches being interrupted when the push button switch in the operating circuit for the other of said relay switches is closed.

References Cited by the Examiner

UNITED STATES PATENTS

2,287,559	6/42	Nye	51—34
2,449,269	9/48	Austin.	
2,484,879	10/49	Earnest et al.	
2,611,246	9/52	Ackerman	60—52
2,638,232	5/53	Perkin	212—38
2,643,515	6/53	Harsch	60—52
2,754,018	7/56	Schroeder	214—653
2,821,172	1/58	Randall	121—40
2,920,775	1/60	Schenkelberger	214—653
2,968,927	1/61	Quayle	60—97
2,977,769	4/61	Troche	60—97
2,984,985	5/61	MacMillin	60—97
3,026,892	3/62	Tsiew	251—30
3,036,433	5/62	Loup.	
3,065,145	11/62	Molander et al.	137—625.64

FOREIGN PATENTS

1,122,619	9/56	France.
837,114	6/60	Great Britain.

HUGO O. SCHULZ, *Primary Examiner.*

MORRIS TEMIN, *Examiner.*