

April 22, 1947

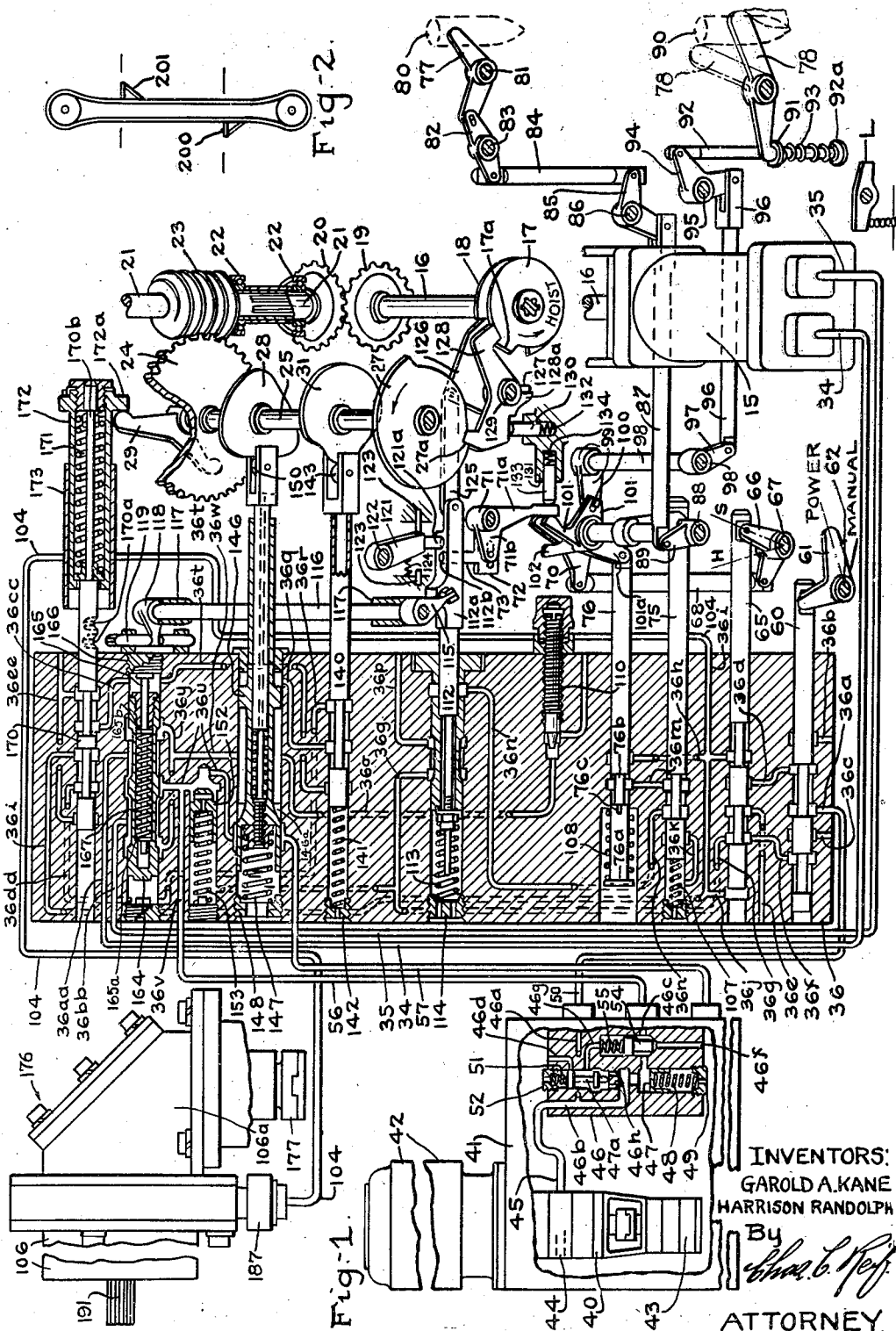
H. RANDOLPH ET AL

2,419,367

CONTROL SYSTEM FOR HYDRAULIC HOIST

Filed May 4, 1940

3 Sheets-Sheet 1



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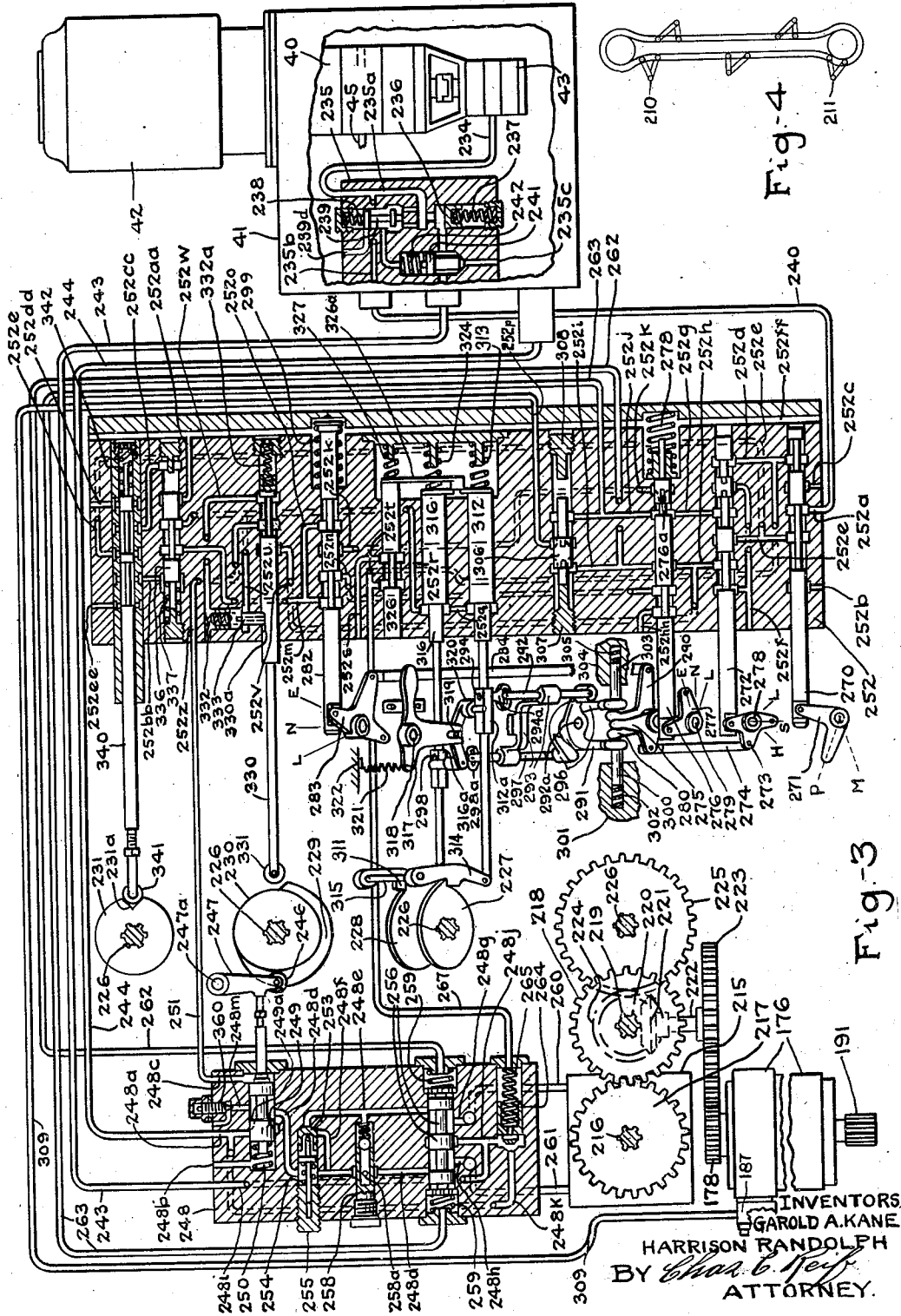
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3 Sheets-Sheet 3

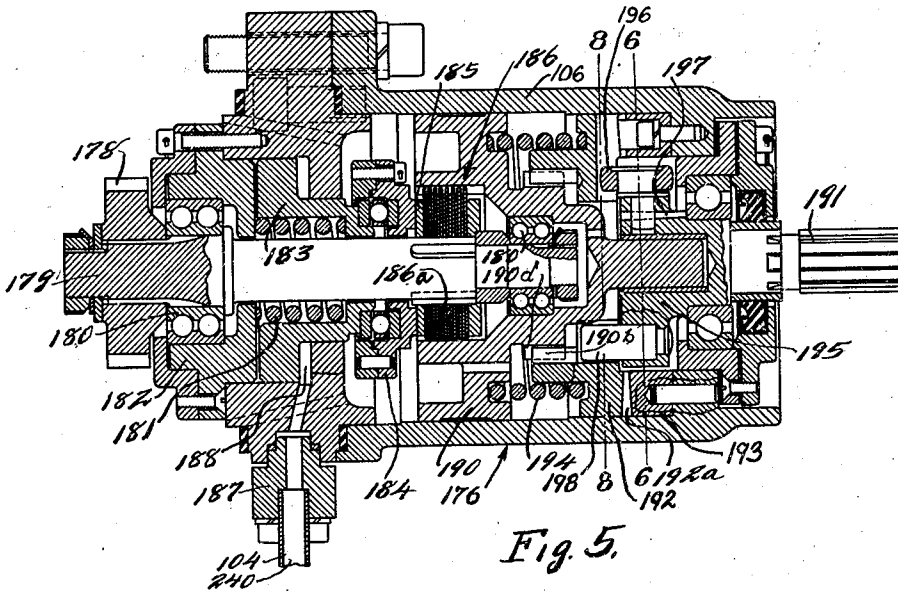


Fig. 5.

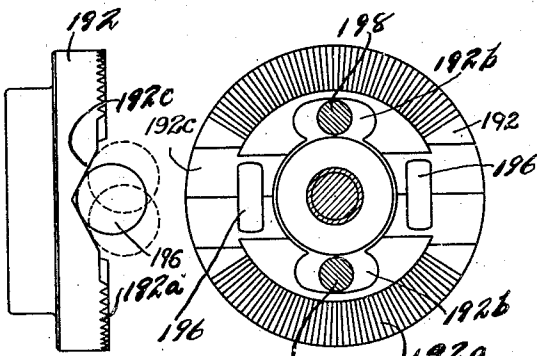
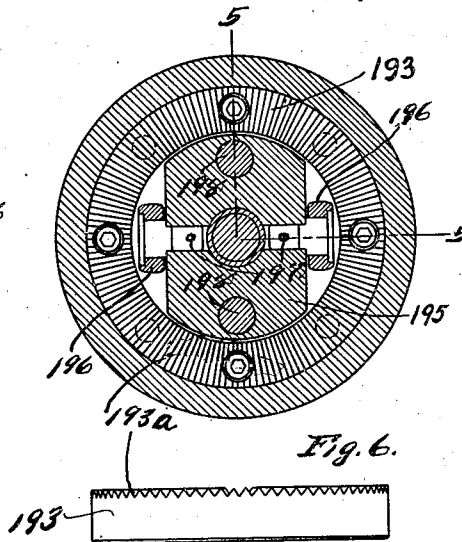


Fig. 9.

Fig. 8.



UNITED STATES PATENT OFFICE

2,419,367

CONTROL SYSTEM FOR HYDRAULIC
HOISTS

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32 Claims. (Cl. 60—53)

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This invention relates to a control system for hoists and particularly to a hydraulic control system for hoists. While the control system might be applicable to various types of hoists, it is illustrated as applied to hoists of the endless conveyor type. One of the specific hoists illustrated with the control is of said endless type having carriers at opposite sides. One carrier is at the top of one side or at the upper flight level, while the other carrier is at the bottom at the opposite side or at the lower flight level. The hoist is alternately driven in opposite directions so that the carrier at one side is raised while the carrier at the other side is lowered.

Another type of hoist illustrated is of the endless conveyor type having a series of carriers thereon adapted to be loaded or unloaded at the same side thereof, said conveyor being adapted to be reversed to raise or lower the material handled.

It is an object of this invention to provide a hydraulic control system for a hoist having two flights movable to upper and lower positions, the control system functioning to initiate a cycle of movement of said hoist under certain conditions of load on the hoist.

It is a further object of the invention to provide a hydraulic control system for a hoist having two flights, said control system being movable to operative position to initiate a hoisting cycle of movement of said hoist when the lower flight of said hoist is loaded and the top flight is empty.

Another object of the invention is to provide a hydraulic control system for a hoist having upper and lower flights, said system so controlling said hoist that said hoist is inoperative with both of said flights empty and is inoperative with both flights loaded.

It is a further object of the invention to provide a control system for a hoist having upper and lower flights, said system including means for controlling the movement of said hoist so that a cycle of lowering movement of said hoist may be initiated with the upper flight of said hoist loaded and the lower flight of said hoist empty.

It is another object of the invention to provide a hydraulic control system for a hoist which is constructed to run in either direction under power operation comprising a manual control lever movable to hoist and stop positions, said control system acting to stop said hoist when running in either direction if said control lever is moved to stop position.

It is also an object of the invention to provide a hydraulic control system for a hoist having upper and lower flights, control elements actuated from said upper and lower flights, a manually operated control lever movable to hoist and stop positions and a member adapted to be moved

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to initiate a hoisting cycle of movement of said hoist which is movable only when said control elements are in certain definite positions and said control lever is in hoist position.

It is still another object of the invention to provide a control system for a hoist having upper and lower flights comprising a hydraulic motor for driving said hoist, a stop means for preventing movement of said hoist, a manually operated control lever movable to hoist and stop positions, a hydraulic control unit including a member movable to power and manual positions, means operated by said hydraulic control unit to release said stop means when said member is in power position and an auxiliary manually operated means for releasing said stop means when said member is in manual position.

It is a further object of the invention to provide a control system for a hoist having an upper flight position and a lower flight position, a hydraulic motor connected to said hoist for driving the same, a stop means preventing movement of said hoist, a manually operated member adapted to release said stop means to initiate a cycle of movement of said hoist and a hydraulic control unit controlling hydraulic means for releasing said stop means to initiate a cycle of movement of said hoist.

It is still another object of the invention to provide a control means for a hoist having upper and lower flight positions, a hydraulic motor connected to said hoist for driving the same, a hydraulic control unit including a manually operated member movable to hoist and stop positions, a driven pump, a fluid power line supplied from said pump for operating said hydraulic motor and means for unloading said power line to stop said hoist whenever said manually operated member is movable to stop position.

These and other objects and advantages of the invention will be fully set forth in the following description made in connection with the accompanying drawings in which like reference characters refer to similar parts throughout the several views and in which:

Fig. 1 is a diagrammatic or schematic view partly in vertical section showing one form of control;

Fig. 2 is a diagrammatic view of the type of hoist to which the control means in Fig. 1 is applied;

Fig. 3 is a diagrammatic or schematic view partly in vertical section of a slightly different form of control means;

Fig. 4 is a diagrammatic view of the type of hoist with which the control means shown in Fig. 3 is used;

Fig. 5 is a sectional view through a hand drive unit used taken substantially on line 5—5 of Fig. 6;

Fig. 6 is a vertical section taken on line 6—6 of Fig. 5;

Fig. 7 is a view in side elevation of a brake ring used;

Fig. 8 is a section taken on line 8—8 of Fig. 1; and

Fig. 9 is a view in side elevation of the parts shown in Fig. 8, some being diagrammatically shown in different positions in dotted lines.

Fig. 10 is a vertical section through a reversing valve, shown on an enlarged scale.

Referring to the drawings, particularly Figs. 1 and 2, a control system for a hoist such as shown in Fig. 2 is illustrated. A hydraulic motor 15 is shown which preferably is of the parallel piston type. Motor 15 has a driven or power output shaft 16 to which is connected a stop cam 17 and a latch cam 18. Shaft 16 has a beveled gear 19 secured thereto meshing with another gear 20 secured to a shaft 21 journaled in suitable bearings 22 shown as of the ball bearing type and shaft 21 is connected directly to the hoist driving mechanism. A worm gear 23 is connected to shaft 21 and meshes with a worm wheel gear 24 secured to a timing shaft 25. Timing shaft 25 has secured thereto a notched timing cam 27, a deceleration cam 28, a snap action valve crank 29 and a deceleration pilot valve cam 31. It will be noted that shaft 16 is driven at much higher speed than shaft 25. Shaft 25 will make something less than one revolution per cycle, depending, of course, on the ratio of reduction gears 23 and 24 and the number of revolutions of shaft 21 required for a cycle of movement of the hoist.

Motor 15 is supplied with operating fluid, such as oil, by conduits 34 and 35. These conduits lead to certain ports or passages in a control member casing 36 or valve block assembly. The operating fluid, such as oil, for the motor 15 is supplied by a pump 40. This pump is preferably of the positive displacement constant discharge type and may be of the gear type. Pump 40 is located in a fluid supply tank 41 and is driven by a constant speed electric motor 42 illustrated as flange mounted vertically on tank 41. Motor 42 also drives in tandem with pump 40 another pump 43 which is of the same type as pump 40. Pump 40 has an inlet 44 and a discharge conduit 45 which leads to a valve block 46 in which is disposed a valve 47 urged to closed position by a compression coiled spring 48 disposed in a chamber in block 46 and having one end engaging valve 47 and its other end engaging a closing plug 49 for said chamber. A conduit 50 is connected to tank 41 and connects with a passage 46a in block 46 shown as connected to a passage 46b with which discharge conduit 45 connects. A pilot valve 47a is disposed in a cylindrical chamber in block 46 acted on at one end by a compression coiled spring 51. Said chamber has a drain or discharge passage 46h. Member 47a is shown as having spaced lands, one of which is engaged by one end of spring 51 and which controls a vent passage 46d. The other end of said spring 51 engages an apertured closing plug 52 closing one end of the chamber in block 46 which receives member 47a. The other land of valve 47a is disposed in an enlarged chamber in block 46 which is connected by openings with passage 46b. With valve 47a in the position shown, passage 46d is cut off. Pressure at times can build up below the lower land of member 47a and compress spring 51. This will permit venting through passage 46d. Valve 47 is arranged to insure a specific minimum pressure at all times in conduit 50 when motor 42 and

pump 40 are operating. The adjustable spring below valve 47 will be set for a lower pressure than spring 51. This pressure is determined by the setting of spring 48. Conduit 50 is the conduit for supplying operating fluid under pressure for the parts in control casing 36. Also in valve block 46 is a valve 54 acted upon by a compression coiled spring 55 and adapted to control a discharge passage 46f with which connects one of the power discharge conduits 56 leading to pump 40. Valve 54 is later more fully described. Conduit 56 connects with a port and passage in control casing 36. Another power discharge conduit 57 connects with tank 41 and with a passage in control casing 36. The valve 54 is provided to open at a certain pressure as later described so as to maintain the required pressure in the power line to meet the demands of operation and acceleration of the hoist.

Casing 36 is provided with a plurality of valve passages or cylinders in which are disposed a plurality of valves respectively. A valve 60 is movable in casing 36, the same being shown at the bottom of said casing in Fig. 1, said valve being movable to either of two positions determined by an operating lever 61 connected thereto and carried on a shaft 62. Conduit 50 connects with a passage 36a leading to the chamber of valve 60. Valve lever 61 is movable to one position for power control of the hoist and is shown in this position in Fig. 1. Said lever is movable clockwise to another position for manual control of the hoist. Valve 60 is adapted to control venting passages 36b and 36c leading from the chamber thereof. In the power control position in which valve 60 is shown in Fig. 1, it will be seen that conduit 50 is connected through said valve to a passage 36d leading to the valve chamber of a valve 65 shown as located just above valve 60. Valve 65 is arranged to be manually operated by a hand control lever 66 carried on a shaft 67 and said lever 66 is movable to either of two positions, one of which is a position to cause the hoist to move through a cycle and is called the hoist position and to another position for stopping movement of the hoist called the stop position. In Fig. 1 lever 66 is shown in its stop position. Valve 65 controls a venting passage 36e as well as the passage 36d and another passage 36f leading from its chamber to the chamber of valve 60. Valve 65 also controls a passage 36g shown as leading from the upper side thereof and extending to another valve chamber to be later described. Valve 65 also controls another venting passage 36h shown in Fig. 1 as at the top side thereof. Lever 66 has connected thereto a link 68 extending upwardly to one arm of a lever 70. It will be seen that lever 70 is of the bell crank type and has another arm engaging the downwardly extending arm 71a of a bell crank lever 71 having an arm 71b in which is secured a pin projecting into a horizontal slot in a block 72 which has projecting upwardly therefrom a plunger 73 to be referred to later. A pair of valves 75 and 76 are shown disposed in chamber in casing or block 36 above valve 65 and these valves are respectively connected to an upper flight level control member or lever 77 and to a lower flight level controlling member or lever 78. Lever 77 is adapted to be moved in a counterclockwise direction as shown by a projectile or shell 80 carried on the hoist as the hoist and shell reach the upper end or upper flight level in the hoist cycle. Lever 77 is carried on a shaft 81 and is of the bell crank type having its other arm connected to a lever 82 carried on a

shaft 83 and having oppositely extending arms, the one opposite that connected to lever 77 being connected to a link 84 which is in turn connected to another bell crank lever 85 carried on a shaft 86 connected in turn to a link 87 which is connected to a control shaft 88 through a lever 89. Shaft 88 is connected through a suitable lever to valve 75 so that said valve is moved to the left as shown in Fig. 1 when shaft 88 is moved in the clockwise direction, which latter movement occurs when the shell 80 nears the top of the hoist. Lever 78 is operated by a projectile 90 when the projectile is placed on the hoist at the lower flight or at the bottom thereof. Lever 78 is shown as of the bell crank type having another arm pressing on a collar 91 surrounding and slidable on a link 92 and having a collar 92a at its lower end. A compression coiled spring 93 surrounds link 92 having its ends respectively engaging collars 91 and 92a and thus acting to urge the left hand end of lever 78 upwardly. When a shell 90 is placed on the lower flight of the hoist the right hand end of lever 78 is moved upwardly and spring 93 is compressed. There is a pot (not shown) in the hoist and the operator puts the shell through the door of the hoist and inserts its pointed end into the said pot. The operator then pushes the shell to vertical position. The shell engages the side of lever 78 and cams the same in a counterclockwise direction as indicated in Fig. 1. Link 92 and lever 78 are normally urged to the position shown by spring 108 of valve 76. Spring 93 is provided so that if movement of link 92 is prevented by some extraneous means, such as the door latch L, said spring would be compressed and would act to move link 92 as soon as said means was removed. A door of the hoist might be left open to so position latch L. It is desired to have the hoist inoperative if said door is open. Said door would thus have to be moved to be closed before movement of link 92 could occur. As soon as the said shell leaves the lower flight by movement of the hoist, valve spring 108 raises the left hand end of lever 78. Link 92 is connected to a bell crank lever 94 carried on a shaft 95, the other arm of which lever is connected to a link 96, the other end of link 96 being connected to a lever arm 97. Arm 97 is secured to a shaft 98 to which is also secured a lever arm 99. Lever arm 99 has a pin 100 projecting therefrom disposed in a slot in one arm of a bell crank lever 101, which lever has another arm shown as engaging arm 71a already described. Lever 101 is oscillatable about shaft 88 and has an arm 101a pivotally connected to valve 76. An arm or lever 102 is secured to shaft 88 and is adapted to move toward and from and engage depending arm 71a, said lever 102 thus being connected to valve 75. It will be noted that passage 36n in casing 36 communicates with a passage 36i extending at right angles thereto and transversely of block 36, passage 36i having a passage 36j communicating therewith adjacent one side of casing 36 which is controlled by valve 65. Passage 36i communicates at the opposite side of block 36 with a conduit 104 which extends to a hand drive unit 176 for a purpose to be later described. Passage 36i also extends upward in block 36 to adjacent the top thereof as shown in Fig. 1 and communicates with the chamber of a valve at the top of block 36 to be later described. Valve 75 is engaged by a spring 107 tending to move it to the right as seen in Fig. 1 and said valve controls a passage 36k shown as at the lower side thereof. Valve 75 also controls a passage 36m

extending to the chamber of valve 76 and it controls another passage 36n shown as extending to another valve in block 36 to be later described. Valve 76 has a collar 76a at its inner end of smaller diameter than the chamber in which it is disposed, which chamber is open at the side of block 36. It will be understood that block 36 will be contained in an oil-containing casing. Collar 76a is engaged by a compression coiled spring 108, the other end of which engages the inner end of said chamber. Valve 76 has an intermediate reduced portion 76b at the inner end of which are a plurality of radially extending slots 76c. Fluid can thus pass from about portion 76b through slots 76c to the chamber containing spring 108 and collar 76a. A by-pass creeper valve 110 is shown in block 36 above valve 76, the same being adapted to be adjusted to control the rate of flow of oil through a passage 36o which extends upwardly to the chamber of a decelerator valve to be later described. A valve 112 is disposed in a chamber in block 36, the same being normally urged to the right as shown by a coiled compression spring 113 engaging the inner end of said valve and engaging an apertured closing plug 114 in the end of said valve chamber. Valve 112 has an extension 112a shown as projecting at the right of block 36 and illustrated for the most part as a bar rectangular in cross section. Extension 112a has a vertically extending aperture 112b therethrough into which plunger 73 is adapted to enter at certain times. Extension 112a also has a slot in the top in which is disposed the lower end of a lever arm 115 secured to a shaft 116 journaled in suitable bearings 117, which shaft extends upward and has secured to its upper end a lever arm 118 which has its end disposed in a slot intermediate the ends of a pin or plunger 119. Plunger 119 is adapted to cooperate with a snap action valve in the upper end of block 36 to be later described. A lever arm 121 is shown as mounted on a shaft 22 and moving between stops 123 and as being acted upon at one side by a light spring 124. Lever 121 also has an extension 121a movable along the top of extension 112a over aperture 112b. Stops 123 are provided so that lever 121 will not be moved sufficiently to place excessive drag on pin 73 or to move valve 112 so that its inner end will engage plug 114. Lever 121 is an auxiliary hand lever adapted to initiate a cycle, or in other words to start the hoist in a cycle of movement when it is under manual control. Extension 112a has connected to its outer end a link 125, the other end of which is pivotally connected to a starting latch 126. Starting latch 126 has a tooth or dog at one end adapted to ride upon the latch cam 18 and to engage against a shoulder on said cam. The stop cam 17 is engaged by a stop latch or dog 128 oscillatable about the axis of shaft 129 on which it is carried. Stop latch 128 has a tooth or dog at one end adapted to ride upon cam 17 and to engage the shoulder of a projection 17a thereon. Latch 128 also has a tooth or dog adapted to ride upon the periphery of cam 27 and to engage a shoulder 27a on said cam. Latch 128 is moved toward cam 27 by a plunger 130 carried in a casing 131 and urged toward latch 128 by a compression coiled spring 132. Another plunger 133 in casing 131 engages the side of arm 71a tending to move it in a clockwise direction or in a direction to move plunger 73 upward. Plunger 133 is engaged by a compression coiled spring 134 disposed in casing 131. Valve 112 controls a vent passage 36p and passage 36g already described which extends to valve 65.

Valve 112 also is controlled by the flow or pressure of fluid in passage 36n already described which extends to valve 75.

Another valve 140 is disposed in block 36 above valve 112, the same being engaged at its inner end by a compression coiled spring 141 which also engages an apertured plug 142 in the end of the valve chamber of valve 140. Valve 140 projects at the right of block 36 and has a fork at its outer end carrying a roller 143 which engages the decelerating pilot valve cam 31. Valve 140 controls a passage 36q which extends upwardly to the decelerating valve chamber to be later described. Valve 140 also controls a passage 36r which extends from one side of its chamber upwardly to the chamber of a power reversing valve to be later described. Valve 140 also controls a passage 36t which extends upwardly to the power reversing valve to be later described.

A decelerating valve 146 is disposed in block 36 above valve 140, the same being urged to the right as shown in Fig. 1 by a coiled compression spring 147 which engages the inner end of said valve and a plug 148 in the end of the chamber for said valve, plug 148 having quite a large aperture therethrough opening at one side of block 36. It will be seen that valve 146 has an inner land surrounding one end of spring 147 which controls rather wide ports in a passage communicating with conduit 57 from tank 41. These ports extend about the chamber of valve 146. Said valve varies in diameter adjacent said ports and is provided with slots 146a spaced circumferentially thereabout which act in the decelerating movement of the hoist. The chamber of valve 146 it will be noted communicates with passage 36o as well as with passage 36q, said latter passage being controlled by a separate land or pressure plunger on said valve. Pressure is applied to said valve through passage 36q to move it to the left as seen in Fig. 1. Valve 146 has a rod projecting at the right of block 36 having a fork at its outer end in which is journaled a cam roller 150 engaging the periphery of decelerator cam 28. A passage 36u extends from the circumferential passage formed by the ports about the head or inner end of valve 146 and extends to one end of the chamber of a valve 152. Valve 152 is bored to receive one end of a compression coiled spring 153, the other end of which engages a plug in the end of the chamber of valve 152. Valve 152 is adapted to close off passage 36u which extends from the chamber of a power reversing valve and communicates with a passage 36v to which conduit 56 is connected. Valve 152 opens when pressure is relieved from its upper or left hand side and unloads the main line. This occurs when valve 65 is in stop position. A passage 36w extends from the chamber of valve 146 to a passage 36y, which latter passage has branches and similar oppositely disposed ports connecting with the chamber of a power reversing valve 164 movable in block 36. Valve 164 has lands at the ends thereof cooperating with the ports of passage 36y and is bored to receive a rod 165 secured to a plug 166 in one end of its chamber. Rod 165 is encircled by a compression coiled spring 167 engaging collars 165a and 165b on rod 165 adjacent the ends of the chamber in valve 164. Said collars are movable on rod 165. Collar 165a seats against a shoulder on rod 165 and engages one end of the chamber in valve 164 as shown. Collar 165b abuts against a shoulder on rod 165 and also engages the other end of the chamber in valve 164. If valve 164 moves to the left it moves collar 165b

and spring 167 is compressed against collar 165a which is held by rod 165. When pressure is released spring 167 moves valve 164 back to central position. If valve 164 is moved to the right it moves collar 165a and spring 167 is compressed against collar 165b. When pressure is released spring 167 moves valve 164 back to central position. It will be noted that passage 36t communicates with said chamber of valve 164 and that passage 36r communicates with said chamber at the end opposite that with which passage 36t communicates. It will also be noted that conduits 34 and 35 connected to motor 15 connect with passages 36aa and 36bb which are connected to the chamber of valve 164 at substantially equal distances from the center of said valve when it is in central position as shown in Fig. 1. A passage 36cc extends from the chamber of valve 164 above the port of passage 36t to the chamber of a valve 170 above valve 164. A passage 36dd communicates with the chamber of valve 164 above the end of passage 36r and extends to the chamber of valve 170 in block 36 to be later described. Valve 170 is movable in a chamber adjacent the top of block 36, said chamber being shown as open at one end. Valve 170 projects at the other end of block 36 and is provided with two sockets 170a adapted to cooperate with plunger 119. Valve 170 has a reduced extension rod 170b surrounded by a coiled compression spring 171 which has one end bearing against the shoulder formed by rod 170b and its other end bearing against the inner end of a sleeve 172 movable in a casing 173. Sleeve 172 has a collar 172a thereon with a downwardly extending projection adapted to be engaged by lever arm 29. It will be noted that valve 170 has spaced lands or portions connected by two portions of reduced diameter, the inner and outer of said lands controlling branches from a vent passage 36ee opening at one side of block 36. The passage 36dd communicates with the chamber of reversing valve 164 above the end of passage 36r and communicates with the top of chamber of valve 170.

A hand drive unit designated generally as 176 shown in Fig. 1, is provided, the same having a casing 106 connected to a casing 106a as shown in Fig. 1. This hand drive unit is shown in Fig. 5 and comprises a shaft 179 to which is connected a spur gear 178. In the form shown in Fig. 1, shaft 179 will have a beveled gear connected thereto in place of gear 178 which will mesh with another beveled gear connected to portion 177. Shaft 178 extends from casing 106a through a bearing 180 of the ball bearing type, into casing 106. A compression coil spring 181 surrounds shaft 179 and is contained within and bears against one end of member 183 movable longitudinally of shaft 179. Spring 181 at its other end bears against a fixed member 182. Member 183 bears directly against a ball bearing casing 184 which in turn engages a clutch plate 185 at one end of a friction clutch 186 which comprises a multiplicity of friction disks 186a disposed between plate 185 and the other clutch plate 186. Conduit 184 is connected to a coupling gland 187 secured in the casing of the unit 176. Conduit 104 communicates with a chamber 188 in the casing of the unit 176 shown in Fig. 5 so that when pressure is placed in said chamber, member 183 will be moved against the pressure of spring 181 and release clutch 186. Said clutch connects shaft 179 and a member 190 which is in turn connected to a shaft 191 to which manual power is applied when the hoist is driven manually. A toothed

brake ring 192 is disposed in the casing of the hand drive unit having radially disposed teeth 192a on one face thereof adapted to engage similar teeth 193a on a member 193. The teeth 192a and 193a are normally held in engagement by a compression coil spring 194 engaging members 190 and 192. Members 190 and 192 are connected by interengaging radial teeth 192d and 190b. The shaft 191 is connected to a member 195 which carries a pair of radially and oppositely extended rollers 196 having trunnions which are disposed in member 195 and pinned therein by pins 197. Member 195 also has secured therein two oppositely disposed pins 198 which are disposed in elongated slots 192b, and member 192 has in its face oppositely disposed V-shaped grooves 192c in which rollers 196 are normally disposed. The described structure is such that upon rotation of shaft 191 through an arc sufficient to take up the lost motion of pins 198 in slots 192b the rolls 196 will move out of the slots or grooves 192c and will separate teeth 192a, 193a, member 192 thus moving toward member 190.

The required operation of the hoist is as follows:

With both flights of the hoist loaded or with articles on both carriers 200 and 201 the hoist is inoperable. With both of said flights or carriers empty the hoist is inoperable. With the lower flight or carrier loaded and the top flight or carrier empty and manual control lever in hoist position the hoist operates to move through one cycle. That is, the lower flight or carrier 200 will move to its upper position and the upper flight or carrier 201 will move to its lower position. In other words, with 200 as shown in Fig. 2 "loaded" and 201 "empty," when the proper combination of parts is secured the hoist will operate to move 200 to the upper flight, indicated in Fig. 2, and 201 will move to the lower level as indicated in Fig. 2. This movement comprises a cycle. As before stated the movement of the endless chain or endless member of the hoist is reversed for each successive cycle. With the hoist running in either direction (under power operation) throwing the manual control lever 66 to stop position stops the hoist.

Reviewing the different valves described it may be stated that valve 47 functions to insure a specific minimum pressure in conduit 50 which supplies the fluid or oil under pressure to control casing 36 and parts therein. The relief valve 54 opens at a specific pressure determined by the setting of pilot spring 51. This pressure is set according to the acceleration demands of the hoist. Valve 60 is manually operated through lever 64. When placed in power position pressure is admitted to the control system through conduit 56, passage 36a and passage 36d. Valve 60 is shown in power position in Fig. 1. When this valve is placed in manual position it moves to the right as shown in Fig. 1 and its central land cuts off passage 36a, thus shutting off fluid under pressure from the control casing 36 and parts therein. Pressure in the control system is relieved and spring 131 acts to engage clutch 186 and connect hand drive unit 176 with output shaft 21. If valve 60 is moved to its manual control position while the hoist is running this will cause no damage as the hoist will merely be braked through the friction clutch 186. Another function of valve 60 is to relieve the pressure on top of valve 152 or vent said valve. This is done through passage 36g which leads to the chamber

of valve 152 and then downward as shown at the left hand side of block 36 to valve 65. Passage 36f leads from valve 65 through the chamber of valve 60 to a vent passage 36c.

Valve 65 has two positions and is manually operated by the hand control lever 66. Said lever as above stated is movable to one position called the "hoist" position and another position called the "stop" position. With said lever 66 in stop position the hoist is inoperable regardless of the positions of the other parts or valves. As above stated throwing control lever 66 to stop position stops the hoist immediately and unloads the main flow if the decelerator valve 146 is in closed position. This is done by relieving the pressure on valve 152 through the passages just above traced. Valve 152 opens and the fluid passes from power pressure line 56 through passage 36u past valve 152 now open and around decelerator valve 146 to tank through conduit 57. Valves 75 and 76 as already described are actuated by the upper and lower flight level levers 77 and 78 respectively. When the lever 61 is moved to power position the positioning of these valves in combination with valve 65 causes an operative cycle to be initiated by admitting pressure to the valve 112. This pressure flow may be traced from pressure conduit 50 then passage 36a, valve 60, passage 36d, valve 65, passage 36h, valve 76 (lower flight loaded), passage 36m, valve 75 (upper flight empty) and passage 36n to valve 112.

Valve 112 is normally under pressure of spring 113 and serves two functions. When operating conditions are correct it acts to initiate a hoist cycle by being moved to the left as shown in Fig. 1 to swing start latch 126 out of engagement with latch cam 18. Valve 112 also acts to unload or relieve the main line whenever start latch 126 is engaged with cam 116. This unloading or relief can be traced from the chamber of valve 152 through the vertical portion of passage 36g through its horizontal portion to the intermediate part of valve 112 and then through passage 36p. The stop cam 17 and the latch cam 18 are rigidly splined to shaft 16.

Valve 140 has two positions and as shown, is actuated by a two-level decelerate valve pilot cam 31. Positioned in combination with valve 170 it admits pressure to or relieves pressure from the decelerating valve plunger 146 according to the operation of the hoist and the requirements of the control system. The admission of pressure to valve 146 may be traced from passage 36i through passage 36h through valve 65 through passage 36d and through valve 60 to the pressure line 58. From passage 36i the pressure is transmitted through passage 36dd through passage 36r through valve 140 and through passage 36q to the right hand end of valve 146. With valve 140 in its other position, that is, moved to the left from the position shown in Fig. 1, the pressure would be relieved from valve 146 through passage 36q, passage 36t, one end of valve 164, passage 36cc, through valve 170 and out through passage 36ee.

Valve 164 as stated is a reversing valve which directs flow to the hydraulic motor 15 in one direction or another according to the direction of rotation and the movement of the hoist required. It will be seen that when said valve is moved to the left the discharge pressure line 56 from pump 40 will be connected to conduit 34 and when said valve is moved to the right said pressure line 56 will be connected with conduit 35. The lands on valve 164 are undercut to permit bypassing of the

fluid with the valve positioned in its central position, as shown in Fig. 1. This is the normal position with the hoist inoperable and for manual operation of the hoist.

As above explained the valve 146 is a decelerating valve and cuts off the main line flow from the hydraulic motor 15 to the supply tank 41 at a rate determined by the contour of the decelerating cam 23. This cutting off as will be plainly seen is done between passage 36y and 36w and the passage communicating with conduit 57. Any desired or predetermined minimum terminal velocity of the hoist may be obtained by adjustment of the bypass creeper valve 110.

Valve 170 is a snap action detent valve and has two positions. This valve is put under spring pressure or cocked at the end of each operating cycle by the valve crank 29 placing spring 171 under pressure to move the valve in one direction or the other. When so cocked plunger 119 is engaged in one of the recesses or sockets 173a. At the completion of a cycle stop latch 128 drops into its notch on the timing cam 27. This allows movement of start latch 126 and permits spring 113 to move valve 112 to the right as shown in Fig. 1. This through lever arm 115 rotates shaft 116 and through lever arm 118 lowers plunger 119 so that spring 171 is free to move valve 170. The position of valve 170 determines whether reversing valve 164 will be in one position or the other. This is done through pressure being placed in either passage 36dd or passage 36cc from pressure passage 36i.

The purpose of valve 170 is to control movement of fluid to one side or the other of the reversing valve 164. The reversing valve must be moved to the proper position either to have the hoist lift or to have it lower. The valve 170 is cocked and held by the detent 119 until the proper time to start the cycle for the reversed movement of the hoist.

The start and stop latches 126 and 128 are oscillatable on shaft 129. Latch 126 may be disengaged only by motion of the extension 112a of valve 112. This motion may be initiated by manual operation of auxiliary hand lever 121 or by power through operation of valve 112. The main function of the start latch 126 is to prevent initiation of another or reverse cycle before the proper combination of valves and other interlocked portions has been obtained. There is sufficient lost motion between the arm of latch 128 which engages cam 27 and the sides of the shoulders on notches 27a to allow the camming surface on cam 17 at its high portion to disengage latch 128 from said notches or shoulders on cam 27. The lug 128a on latch 128 engages the pin 127 on latch 126 and this prevents the tendency of latch 126 to swing under pressure of spring 113 and to thus engage the notches in the high speed latch cam 18 before the end of a cycle has been reached. Valve 54 can be called a pilot-operated relief valve. As shown in Fig. 1 this valve is in closed position, shutting off the passage 46f leading downward therefrom into the tank 41. It does not obstruct passage 46c since liquid can pass around it since it is of smaller diameter than its chamber. It will be noted that the upper land of valve 47a is closing vent passage 46d and that there is a passage 46g extending from between the lands on valve 47a to the top of the chamber of valve 54 which contains spring 55. It will be noted that there are small passages 46h leading from passage 46b upward into the passage or chamber of valve 47a. Liquid can pass

through passages 46h so that pressure will be built up in the chamber of valve 47a, which pressure is exerted on top of valve 54 through passage 46g. When this pressure exceeds the pressure of spring 51 valve 47a will be moved upward by pressure on its lower land and the upper land thereof will uncover the port of passage 46d so that the pressure will be relieved. The lower land on valve 47a moves upward and shuts off admission of pressure to passage 46g so that there is no pressure on top of valve 54, passage 46g being now connected with passage 46d. Under these conditions valve 54 can lift and the main line will be vented or unloaded through passage 46f. Spring 55 is provided to start or normally urge valve 54 toward its seat. The described parts are provided to take care of excess pressure which might develop in the line or system. Such pressure actually develops at the beginning of a hoisting cycle during acceleration of the hoist. In one embodiment of the invention in actual practice the pressure at which spring 51 will compress has been 700 pounds.

The purpose of the device is to properly control the hoist and the hoist has been used to elevate a shell from the magazine of the warship to the gun. Hydraulic control is used as there is no danger of sparking as with electric devices, and a very accurate control can be secured. The hoist must move very rapidly. It must be decelerated so that there is absolutely no tendency for the shell to move away from the hoist at the end of the lift and so that the hoist comes to rest very gently. The hoist must be capable of being instantly reversed or stopped. All of these movements require the various valves, plungers and levers described. Each of these is necessary. As disclosed, the hoist is directly connected to the output shaft 21. This connection is not shown but the proper mechanical means will be used. The hoist can either be operated manually by putting a crank or other moving element on shaft 191, or it can be operated by power which of course, is the desired way of operating it. If lever 61 is moved to power position the parts will be set for "power" operation and if lever 61 is moved to "manual" position the parts will be set for manual operation. Lever 66 can be moved to "stop" position to stop the hoist at any time or it can be moved to "hoist" position and set the parts for the hoist to operate. Cam shaft 25 is driven at slow speed from the operating shaft 21 and moves through a comparatively small distance. Cams 27, 31, 28 and arms 29 are rotated by shaft 25. Shafts 16 and 21 will make quite a number of revolutions during the raising or lowering of the hoist. For either power or manual operation to have the hoist lift, the lower flight of the hoist must be loaded, the upper flight of the hoist must be empty and the door of the hoist must be in closed position. The terms "lower flight" and "upper flight" indicate the parts of the hoist which are loaded and which move from the lower position or lower flight level to the upper position or upper flight level and vice versa to carry the shells.

Bearing in mind the above facts the operation of the hoist is as follows:

With the parts in the position shown in Fig. 1, the lever 61 is shown in its "power" position and it will be seen that fluid under pressure is delivered from conduit 50 through valve 60 to passage 36d. As above stated however, the hoist is not to operate until the lower flight is loaded. With the parts in the position shown in Fig. 1, the low-

er flight is empty and lever 101 connected through the described linkage to lever 78, is held in position against lever arm 71a. Lever 71 therefore, cannot be moved and valve 112 or its extension 112a cannot be moved to release latch 126 which would permit shaft 16 to rotate. If now the lower flight be loaded, lever 78 will be moved upward as described and through the described linkage lever 101 will be moved away from the depending lever arm 71a. However, arm 71a is still engaged by lever 70. This is because hand control lever 66 is in "stop" position. This lever must be moved to "hoist" position before the hoist can operate. This lever now being moved to "hoist" position, thus being moved in counter-clockwise direction, link 68 will be actuated and lever 70 will swing away from arm 71a. The parts are now in position to start a cycle. It will be seen therefore, that in order to start a cycle, the levers 70, 101 and 102 must be in proper position. It will be seen that with said levers moved to the proper or operative position they are moved away from arm 71a so that spring-actuated plunger 133 will swing arm 71a and plunger or pin 73 will be moved into and through aperture 112b in extension 112a by movement of member 72 which is moved by lever 71. It will be seen that if lever 71 had been in manual position the auxiliary hand lever 121 could now be moved in a clockwise direction and its extension 121a would be in position and would engage pin 73 projecting through aperture 112b in extension 112a and thus move extension 112a. The start latch 126 would thus be disengaged from latch cam 18 so that a cycle could be started by manual operation. With any one of the levers 70, 101 or 102 in non-hoist or non-operative position it is impossible to initiate a cycle manually as lever 71 cannot be moved to project pin 73 through extension 112a and movement of auxiliary hand lever 121 would produce no result.

It may be stated that under normal operation as soon as the projectile or shell 93 being hoisted leaves the lower flight level, lever 101 by acting on lever 71 will cause plunger or pin 73 to be withdrawn from valve extension 112a. This will permit spring 113 to move extension 112a to bring latch 126 in position to again engage cam 18. Thus regardless of subsequent movement of the auxiliary lever 121 latch 126 will be in position to engage cam 18 at the completion of the cycle.

If the lever 66 has now been moved to "hoist" position thus moving valve 65 to the left from its position in Fig. 1 and with lever 61 in "power" position with the upper flight lever 77 in the position shown and the lower flight lever 78 in loaded position as above described, conditions are proper for a cycle to be initiated by power operation. The combined positions of valves 60, 65, 75 and 76 now admit pressure to the chamber of valve 112. This is done by pressure fluid from conduit 50 passing through passage 36a around valve 60 through passage 36d, around valve 65 now in "hoist" position, through passage 36h, to valve 76 now in loaded position, through passage 36m, around valve 75, through passage 36n to valve 112. This pressure of fluid on valve 112 will move the valve to the left as shown in Fig. 1 and start latch 126 will be moved out of engagement with cam 18. It will be noted that start latch 126 is first moved. Pin 127 is carried on latch 126 and when latch 126 is thus moved to permit the initiation of a cycle pin 127 moves away from lug 128a so that movement of latch 128 can take place. Latch 128 of course, does not move until the hoist

starts to operate. It may be stated that when latch 128 is actuated upon by its cam 27, lug 128a will again engage pin 127 and raise latch 126 so that it will be sure to be kept out of the path of cam 18 during the cycle. Cam 27 acts on latch 128 to hold it out of engagement with cam 17 during the proper period.

When valve 112 thus moves to the left it cuts off the venting passage from valve 152 allowing pressure to build up above or at the left of said valve. Valve 152 is thus moved to closed position. When valve 65 is moved to "hoist" position pressure is admitted to conduit 104 through conduit 50 around valve 60 through passage 36d, around valve 65, through passage 36h and to passage 36i and conduit 104. This admits pressure to the chamber 188 in the hand driven unit and the friction clutch 186 is released. This clutch should be released so that it will not retard or interfere with the power operation. Snap action valve 170 admits pressure to the left hand end of reversing valve 164. This pressure is applied from passage 36i around valve 170 and through passage 36dd to the chamber of valve 164. Valve 164 is thus moved to its right hand position and fluid under pressure is now directed from conduit 56 through passage 36v and passage 36u and passage 36bb through conduit 35 to motor 15 and the fluid returns through pipe 34, passage 36aa and through reversing valve 164 to passages 36y and 36w around valve 146 to conduit 57 and back to tank 41. As pressure was admitted to valve 146 from passage 36i, through valve 170, passage 36dd through the chamber of valve 164, through passage 36r, through valve 140 and through passage 36q, which pressure admitted to deceleration valve 146, the same moves this valve to the left to open the ports connecting passage 36w and the passage of conduit 57 so that there is a free flow of the fluid. The motor 15 is thus operated and the hoist lifts. When valve 112 was moved to the left either by power or by the auxiliary lever 121, plunger 119 was raised and it engaged in one of the recesses 170a. Valve 170 is thus held in stationary position. As stated, the purpose of valve 170 is to control the movement of fluid to one side or the other of the reversing valve 164. Valve 164 determines whether the hoist lifts or lowers. Valve 170 is cocked or loaded and held by the detent 119 so that it will only act at the proper time. As soon as valve 76 moved to its left hand position the pressure on valve 112 was unloaded or vented and this action took place through passage 36n to and around valve 75, then through passage 36m to valve 76 through slots 76c and around valve end 76a to tank. Valve 75 operates to connect passage 36n to passage 36k and exhaust and to cut off passage 36m so that valve 112 is vented and even though valve 76 be operated when a shell is loaded at the lower flight to move lever 78, valve 112 will not be moved until the shell is unloaded at the upper flight. Lever 77 operates to move lever 102 to prevent lever 71 from operating until lever 77 is released on unloading. As the rotation of the output shaft 21 which drives the hoist progresses, the high side of the decelerate valve pilot cam 31 comes around shifting valve 140 to its left hand position. This acts to vent the deceleration valve chamber or the chamber of valve 146. This takes place through passage 36q then around valve 140 to passage 36t to the passage of valve 164, through passage 36cc, around valve 170 and to tank through the right hand end of passage 36ee. This venting in mid cycle has no effect on the

operation of the hoist, that is, on the flow from the hydraulic motor as the high side of the deceleration cam 28 is under the plunger roller at the moment of release. It however, prepares the deceleration valve for functioning under the action of its compression spring 147 at the end of the cycle. Near the end of the cycle, crank or lever 29 engages collar 172a to compress spring 171, valve 170 being held by detent plunger 119, and when the high point of cam 27 passes latch 128, 128 will be operated by 130 to move to the low point of cam 27 so that 128a may move up from pin 127 so that spring 113 moves extension 112a to the right, thereby releasing plunger 119 from its opening 170a so that valve 170 will be shifted at this time. Also when valve 112 moves to the right the chamber behind valve 152 is vented through passages 36g and 36p so that valve 152 will open to relieve pressure in line 55 and thus act to stop operation of motor 15. When plunger 119 releases valve 170, spring 171 will move valve 170 to the left so that pressure is admitted to passage 36cc to move valve 164 to the left at this time. Also as cam 31 has moved valve 140 to the left at this time to connect passage 36t to passage 36q, pressure will be admitted to move valve 146 to the left so that valve 164 will be ready to reverse the flow in motor lines 34 and 35 upon closure of valve 152. As the cycle continues spring 147 acts to move deceleration valve 146 to the right and the slots 146a gradually throttle the return of oil or fluid to tank so that the desired deceleration takes place. At the completion of the cycle the start latch 126 which is already described, has been moved to position to engage its cam, again engages with cam 18 and latch 128 engages with cam 17 and the cycle of lift is completed. Another cycle cannot be initiated until the levers 70, 101 and 102 are in proper position and lever 66 is either moved to "hoist" position or auxiliary lever 121 is again operated. If lever 66 is kept in "hoist" position the projectile removed at the top flight level, and another projectile placed on the lower flight, the hoist will continue to operate.

During a cycle therefore, as stated, 200 as shown in Fig. 2 moves from the lower flight level to the upper flight level and 201 moves from the upper flight level to the lower flight level, as indicated in said figure. As stated, with 200 at the lower flight loaded and lever 61 in "power" position, and lever 66 in "hoist" position, and 201 empty, a cycle will be initiated. The loading of the shell at the lower flight moves lever 78, as stated, to bring about one of the requirements for the initiation of a cycle. 200 then moves upwardly and lever 77 is operated as the shell nears the upper flight. Lever 77 is so held until the shell is unloaded at the upper flight. Reverse operation, therefore, cannot begin until 200 is unloaded. After 200 is unloaded and 201 is loaded (being now at the lower position) to move valve 112 to the left, to now latch plunger 119 into the other recess 170a, to hold valve 170 in its new position, the operation in the reverse direction will begin, i. e., 201 will rise and 200 will lower. When 201 rises, it operates valve 75 through lever 77 as described, so that pressure will be relieved from valve 112 and lever arm 29 will operate valve 170 to shift the same after the high point of the cam 27 passes latch 128 so that 112 can move to the right to release plunger 119 to permit such movement. Then, as already described, 201 must be unloaded to release valve 75 before loading of 200 at the lower level will cause release of latches

128 and 126, pressure being admitted to passage 36n to move valve 112 to the left on operation of levers 78 and 77. The main or pressure line being vented at the end of the cycle, the hoist will stop when the stop latch 128 engages stop cam 17. It will remain stopped until conditions are again present for the initiation of a cycle. As stated, if lever 61 remains in "power" position and lever 66 remains in "hoist" position, another cycle will start immediately if the lower flight is loaded and the upper flight is empty.

Referring to Figs. 3 and 4 a control system having many features similar to that illustrated in Fig. 1 is shown. The system comprises a hydraulic motor 215 having a driving shaft 216. Shaft 216 has secured thereto a gear 217 meshing with a gear 218 which is secured to and drives a shaft 219 which may be called the output shaft and which is directly connected to the hoist. Shaft 219 also has connected thereto a bevel gear 220 meshing with a beveled pinion 221 secured to a shaft 222 to which is secured a gear 223 in turn meshing with a gear 178 of the hand drive unit 176 illustrated in Fig. 5. Shaft 219 also has secured thereto a gear 224 meshing with a gear 225 secured to and driving a timing shaft 226. Timing shaft 226 has secured thereto a hoist stop cam 227, a lower stop cam 228, a snap action valve cam 229, a decelerating cam 230 and a flight level cam 231. Fluid is supplied to the motor 215 from a pump 43 disposed in the supply tank 41 and driven from electric motor 42 in tandem with pump 40. A supply conduit 234 extends from pump 43 to a valve block 235. Conduit 234 connects with a passage 235a in block 235 which is governed by a valve 236 acted on by compression coil spring 237. Valve 236 acts to maintain a certain minimum pressure in a passage 235b and a conduit 240, depending upon the adjustment of spring 237. Another valve 241 is acted upon by a spring 242. Valve 241 is pilot operated and controls a passage 235c. The pressure at which this valve opens is determined by the setting of a pilot spring 238 of a valve 239 adapted to control a vent passage 239d. Valves 236, 241 and 239 and their cooperating passages are identical with valves 47, 54 and 46a and their cooperating passages in Fig. 1 and need not be again described. A return conduit 244 is shown as connected to tank 41. Timing shaft 226 makes one revolution per cycle.

A valve block 248 is shown and conduit 244 communicates with a passage 248a therein leading to the cylindrical valve chamber of valve 249 which is a decelerator valve, the same being shown as acted upon by compression coil spring 250, one end of which engages the end of said valve and the other end of which engages the end of said valve chamber. A vent passage 248b extends from one end of said valve chamber to the side of block 248 and thus to a tank or casing in which block 248 will be disposed. Valve 249 has an operating head at its left hand end and is shown as having a plurality of circumferentially spaced arcuate passages or slots 249a at one end. Valve 249 also has an operating plunger shown at its right hand end and a passage 248c communicates with the valve chamber at the right of said operating plunger, said passage connecting with a conduit 251 leading to another valve control assembly comprising a casing or valve block 252. Valve 249 has a rod projecting therefrom arranged to engage a cam roller arm 247 having a cam roller 245 journaled therein adapted to be engaged by cam 230. Arm 247 is

oscillatably mounted on a shaft 247a. A passage 248d extends downward from the chamber of valve 249, this being one of the passages of the power line and is the passage adapted to be cut off by movement of valve 249. Passage 248d extends through the valve chamber of a valve 253. Said valve has a valve plunger acted upon by a compression coil spring 254. Pressure of spring 254 can be adjusted by plug 255 engaged by one end of said spring and threaded into block 248. A passage 248e extends from one end of the valve chamber of valve 253 to the valve chamber of a reversing valve 256. A short passage 248f extends from passage 248d to adjacent one end of the valve chamber of valve 253. The valve 253 is provided to impose a restriction in the return flow of fluid from the hydraulic motor during a lowering cycle. It is provided to prevent undue acceleration of the hoist if the direction is changed in mid-cycle from hoisting to lowering. Valve 253 also functions to impose a restriction on the flow of fluid in hydraulic motor 215 when the hoist is being operated manually in a lowering cycle. This restriction imposes a sufficient back torque on output shaft 216 to insure quiet operation of the hand drive unit 176 when performing a lowering cycle with a loaded hoist. Passage 248d also extends to the chamber of reversing valve 256. A ball check valve 258 is provided in block 248 shown as having its chamber connected to passage 248e. Said valve is of the usual ball and spring type. Passage 248d communicates with an annular port about valve 258 and one or more holes 258a communicate with this port. Valve 256 as stated, is a reversing valve having lands symmetrically disposed about the center thereof and being acted upon at each end by compression coil springs 259. It controls passages 248e and 248d as well as passages 249g and 249h which lead to the conduits 260 and 261 connected to hydraulic motor 215. It will be obvious that as valve 256 is moved to one side or the other that it will reverse the direction of flow through conduits 260 and 261 to the motor 215. A conduit 262 extends from one end of the valve chamber of valve 256 to the valve block 252. Another conduit 263 extends from the opposite end of the valve chamber 256 to the valve block 252. It will be seen that a passage 248i in block 248 communicates with conduit 243 leading from valve block 235 in tank 41 and is connected to a passage 248j shown as extending downwardly centrally from the valve chamber of reversing valve 256 to the closing or sealing end of a valve 264 shown as acted upon by a compression coil spring 265. Said end of the chamber of valve 264 is also connected by a passage 248k to passage 248a adjacent the top of block 248. Valve 264 is so constructed that it will open when pressure on top of it or at the right of it as shown in Fig. 1 is relieved. Valve 264 is similar to valve 152 shown in Fig. 1. It will be noted that the said valves have a central opening adjacent the seat thereof which communicates with a passage having lateral openings adjacent the seat. When said valve is moved to closed position by its spring oil from the pressure line can pass through said lateral openings and through said central opening and build up a pressure above the valve which will tend to hold it closed. When the chamber above the valve, however, is vented through conduit 267, around valve 326 and passage 252s, then this pressure cannot build up and said valve will open by the pressure around its lower or seating end.

A conduit 267 leads from the top of valve 264 and its valve chamber to valve block 252.

Valve block 252 has a valve chamber therein at its bottom in which is disposed a valve 270. Valve 270 is moved by a manually operated lever 271 movable to two positions, one of which is for power operation of the hoist and the other of which is for manual operation of the hoist. These positions are indicated by M and P adjacent lever 271. Valve 270 in Fig. 3 is shown in position of power operation. Valve 270 controls the supply of fluid under pressure to the control assembly in block 252 and controls a passage 252a communicating with conduit 240 above described and through which fluid under pressure is supplied to the control assembly and block 252. Valve 270 controls venting ports 252b and 252c. Said valve at its upper side also controls passages 252d and 252e which lead to the valve chamber of a valve 272. Valve 272 is moved by a manually operated lever 273 which is movable to three positions, namely: a hoist position, a stop position, and a lower position which is the position for lowering the hoist. These positions are indicated in Fig. 3 by the letters H, S and L respectively. It will be noted that lever 273 is shown in its stop position. Valve 272 controls a vent passage 252f having two branches communicating with its valve chamber and said valve is shown as controlling passages 252g and 252h leading from the upper side thereof. It will be noted that with lever 273 in the stop position shown that the upper end of passage 252e is shut off so that no fluid under pressure from conduit 240 can pass above valve 272. It will be noted that passage 252e has a branch shown as leading to the right between valves 270 and 272, which passage extends upwardly to adjacent the top of block 252 and communicates with a valve chamber at the top of block 252 to be later described. It will be seen that with valve 270 in its power position as shown fluid under pressure is supplied to passage 252e. Lever 273 has one arm thereof connected to a link 274, the upper end of which is pivotally connected to a lever 275 having a vertically extending portion. Another valve 276 is disposed in a chamber above valve 272 in block 252. This valve has connected thereto a lever 277 which is controlled from the lower flight of the hoist. Said lever has three positions, one of which it occupies when the lower flight of the hoist is empty, another of which it occupies when the hoist is not operated or in neutral, and the other of which it occupies when the lower flight is loaded. These positions are indicated in Fig. 3 by the letters E, N and L. It will be seen that the chamber of valve 276 has an enlarged portion at its right hand end in which is disposed a compression coil spring 278 acting on valve 276 tending to move it to the position shown, which is the position with the lower flight of the hoist empty. It will be seen that valve 276 controls passages 252h and 252g at its lower side. Said valve also controls the passage 252i shown at the upper side thereof as well as another passage 252j at its upper side and a passage 252k at its upper side. It will be seen that a portion of the valve shown as adjacent the enlarged part of the chamber has circumferentially disposed slots 276a therein through which the fluid may pass from the valve chamber into the passage 252k. Lever 277 is secured to a shaft 279 about the axis of which lever 275 oscillates and which shaft has secured thereto a lever 280 shown as disposed adjacent lever 275 already described and

having a vertically extending portion adjacent the similar portion of lever 275. Block 252 also has therein a valve chamber in which is received the valve 282 shown at some distance above the valve 272 and this valve has connected thereto a lever 283 which is operated from the upper flight of the hoist, said lever having three positions, namely: one position when the upper flight is empty, another position when the upper flight is loaded and another position when the hoist is inoperable, or in neutral. The loaded, neutral and empty positions are indicated in Fig. 3 by the letters L, N and E. It will be seen that lever 283 has an arm connected to a link 284 which is shown as extending downwardly and pivotally connected at its lower end to a lever 290. Lever 290 is shown of the bell crank type similar to lever 275 and has an upstanding portion disposed adjacent the upstanding portions of levers 275 and 280. The levers 275, 280 and 290 are adapted to have said upstanding portions engage the depending end of a lever 291 pivoted on a shaft 292a having another end pivotally connected to the lower end of a vertically movable rod 292 guided in a bracket 293 and having a pin projecting laterally from its upper end disposed in the slot of a plunger head 294a of a plunger 294 for a purpose to be later described. Said vertically extending portions of lever 275, 280 and 290 are also adapted to engage with the depending end of a lever 296 also oscillatable about shaft 292a and having an arm pivotally connected to the lower end of a rod 297 also guided in bracket 293 and having a pin projecting laterally from its upper end disposed in a slot in a plunger head 298a of a plunger 298 to be later described. It will be seen that valve 282 like valve 276 thus has three positions. Valve 282 controls at its lower side a passage 252n which extends downward to the valve chamber of valve 276. Valve 282 also controls on its lower side a passage 252k already described which extends down to valve 276 adjacent the right hand end of the latter. Valve 282 also controls at its upper side a passage 252m which extends upward to another valve chamber in block 252 to be later described. Passage 252m has a branch 252o communicating with the chamber of valve 282 some distance from passage 252n. The chamber of valve 282 at its right hand end is enlarged and said valve has a portion thereof surrounded by a coil compression spring 299 one end of which bears against the inner end of said enlarged portion and the other end of which bears against a flange or collar on valve 282 so that said spring tends to move said valve to the right or to its position shown. A plunger 300 is disposed in a chamber of a casing 301 and is pressed upon at its inner end by a compression coil spring 302. Spring 302 tends to press plunger 300 against the lower end of lever 291. Another plunger 303 is disposed in a chamber in a casing 304 and is acted upon by a compression coil spring 305 tending to move it into engagement with the lower end of lever 296.

A valve 306 is disposed in a valve chamber above valve 276 in block 252, said valve having projections at its ends adapted to engage projections on closing plugs 307 and 308 in the ends of its valve chamber. Valve 306 is adapted to cooperate with passages 252i and 252j already described and with a passage 252p shown as disposed thereabove and which communicates with a conduit 309 shown as extending to portion 187 of the hand power unit and which will correspond

to conduit 104 illustrated in Fig. 1. Valve 306 is a shuttle valve and is provided to ensure that fluid under pressure will be admitted to chamber 188 of hand drive unit 176 regardless of the direction of flow of the fluid in the control system.

Above valve 306 block 252 has a valve chamber therein in which is disposed a valve 312. Valve 312 has a stem projected from block 252 having thereon a block 312a having an aperture therethrough through which pin or plunger 294 is adapted to be moved by rod 292 actuated by lever 291. Valve 312 is adapted to have pressure placed on its left hand end through a passage 252q and said valve has its right hand end disposed in a rather large chamber in block 252, which right hand end is acted upon by compression coil spring 313 which tends to move valve 312 to the left. The rod projecting from valve 312 is pivotally connected at its outer end to a stop latch 314 adapted to cooperate with and engage a step or shoulder on hoist stop cam 227. Latch 314 is shown as swingable about a shaft 315. Another valve 316 is disposed in a chamber in block 252 above valve 312, valve 316 also having a rod projecting from said block, the same carrying a rectangular block 316a which has a vertical aperture therethrough through which plunger 298 is adapted to be moved at certain times. An auxiliary hand control lever 317 is provided, the same being shown as oscillatable about a shaft 318 and having a downwardly extending arm provided with a central open-ended slot into which projects a pin 319 secured to a member or dog 320 which has arms or pins projecting therefrom disposed respectively over and movable over the blocks 312a and 316a. A tensile coil spring 321 is shown as connected to a third arm of lever 317 and extending to and connected to casing portion 322. The rod projecting from valve 316 is pivotally connected to a stop latch 311 cooperating with lower stop cam 228. It will be seen that if lever 317 is swung in a counter-clockwise direction that it will move dog 320 to the right as shown in Fig. 3. If one of the plungers 294 and 298 is projected above blocks 312a and 316a it will be engaged by the respective portion or pin projecting from dog 320 and will be moved to the right, thus moving with it the rod of either valve 312 or 316. Valve 316 is adapted to have fluid pressure applied thereto at its left hand end through a passage 252r, which passage extends upwardly to another valve to be later described. Valve 316 is engaged at its right hand end by a compression coil spring 324 which tends to move it to the left as shown in Fig. 3, or in a direction to engage stop 311 with its cam. Valves 312 and 316 are coupled to another valve 326 by a coupling member 326a which is also acted upon by a compression coil spring 327 tending to move it to the left as seen in Fig. 3. Valve 326 controls a vent passage 252s and also controls a passage 252t which communicates with the conduit 267 and has a portion extending downwardly and connecting with passage 252d just above valve 270. Valve 326 is an unloading valve pilot provided to unload the main line through valve 264 at the completion of a cycle of movement of said hoist in either direction when both stop latches 311 and 314 engage. Said valve controls the motion of unloading valve 264 by cutting off or venting a line from its chamber.

Another valve 330 is provided in valve block 252, the same having an extension or rod pro-

jecting from said block and provided with a cam roller 331 adapted to engage cam 229. Valve 330 is moved by the cam against the pressure of a compression coil spring 332a engaging the same and tending to move the same to the left as shown in Fig. 3 or to move roller 331 toward cam 229. Valve 330 has a recess 330a therein adapted to receive a detent plunger 333 which is moved toward said valve by compression coil spring 332. Plunger 333 is arranged to be moved away from valve 330 by fluid pressure applied thereto through a passage 252u. Passage 252u connects with passage 252r already described. Valve 330 also controls a passage 252v shown as leading from the lower side thereof down to and connecting with passage 252h. Valve 330 also controls a passage 252w shown as leading from the top of its chamber to the chamber containing spring 332 and thence to the outside of block 252. It will be understood that block 252 is contained in a casing or tank of oil so that oil may be vented or relieved therefrom to such casing or tank through passages leading from said block. Valve 330 also controls passage 252z with which connects conduit 251 which leads from decelerating valve 249.

Another valve 336 is disposed in block 252, the same being shown as acted upon at one end by a compression coil spring 337 which acts to move said valve to the right. Valve 336 controls passage 252m extending from valve 282 and also controls passage 252r which leads to valve 316. Valve 336 controls a vent passage 252aa shown as disposed at its lower side and is moved by pressure in a passage 252bb extending from its upper side, and in a passage 252cc extending from its upper side.

Another valve 340 is disposed in block 252 being shown adjacent the top thereof, which valve has an extension or rod projecting from casing 252 and equipped with a cam roller 341 engaging the flight level cam 231. Valve 340 is acted upon by coil compression spring 342 tending to move the same to the left as seen in Fig. 3 or in a direction to engage cam roller 341 with cam 231. Valve 340 controls passage 252bb and passage 252cc. It also controls the passage 252e which extends upward from valve 270 as well as controlling vent passages 252dd and 252ee. A vent passage 252ff extends along one side of block 252 communicating with the valve chambers of valves 270, 272, 276, 282, 330 and 340.

The valve 330 has two positions and is a snap action valve which is placed under tension or cocked by its cam 229. This cocking takes place approximately midway of the hoisting cycle and immediately after the initiation of the lowering cycle. The function of said valve is to supply pressure to or relieve pressure from the plunger of deceleration valve 249 at the proper time during the movement of said hoist.

Valve 340 is provided to admit fluid under pressure to the right hand chamber of the valve 336 which could be called a shuttle valve, which pressure is admitted only at a flight level. At this time roller 341 enters a notch or depression 231a in cam 231 as seen in Fig. 3. It will be seen that valve 336 has pressure applied thereto as shown in Fig. 3 from line 240 through valve 270, then through passage 252e through valve 340 and through passage 252cc. The function of valve 336 in turn is to insure that fluid under pressure will be admitted to detent plunger 333 and to valves 316 and 312 for withdrawing latches 311 and 314 only at a flight level. A by-pass creeper

valve 360 is mounted in valve block 248 controlling a passage 248m leading from the chamber of decelerator valve 249 to tank. Valve 360 may be adjusted as desired.

Referring again briefly to some of the valves described it may be stated that valve 270 which is manually operated when placed in power position, admits the liquid under pressure to the control assembly. Said valve is shown in its power position and it will be seen that the liquid under pressure from conduit 240 can pass through valve 270 to passage 252e which extends to valves 272 and to valve 340. When valve 270 is placed in manual position fluid from pressure in line 240 is cut off and pressure in the control system is relieved permitting spring 181 to engage clutch 186 and thus connect the hand power unit 176 to the power shaft 222 for operating the hoist. Positioning valve 270 in manual position while the hoist is running will cause no damage since the hoist motion will merely be braked through the above mentioned clutch 186. A further function of valve 270 is to unload or relieve the pressure from above or at the right of valve 264. This relief may be traced from said valve through conduit 267 through passage 252t to and through passage 252d, around valve 270 now in manual position and to tank through passage 252c. This relieving or unloading of valve 264 prevents the building up of fluid pressure in the pump circuit when the hoist is being driven manually with the electric motor 42 running and the reversing valve 256 in centered position.

Valve 272 as stated has three positions determined by its control lever 273. With the control lever in stop position as shown in Fig. 3 the hoist is inoperable regardless of the positions of the other valves. When in power operation with the hoist running in either direction and the flights at any point of their travel throwing control lever 273 to stop position stops the hoist immediately and unloads the main line flow by unloading valve 264 causing it to open. This unloading may be traced through conduit 267, passage 252t, passage 252d, through the chamber of valve 272 and through passage 252f to tank. With the main line thus relieved or unloaded the hoist is inoperable.

Valves 276 and 282 as stated are actuated from the lower and upper flight levels by the interlocked levers at the lower and upper flights respectively. With lever 271 in power position it is the positioning of valves 276, 282 and 272 in combination which causes an operating cycle to be initiated by admitting pressure to the plunger or to the left hand ends of valves 312 and 316. This pressure is admitted through the flight level shuttle valve 336 as already described, which is controlled by the cam 231 acting on valve 340. The flow of liquid under pressure to valves 312 and 316 and to detent plunger 333 may be traced from conduit 240, through passage 252a, around valve 270, through passage 252e, around valve 272 now in hoist position, upward through passage 252h to valve 276 now in loaded position, around valve 276 and upward through passage 252n to valve 282, around valve 282, upward through passage 252m to valve 336, around valve 336 and down through passage 252r to valve 316 and through passage 252q to valve 312. The fluid also passes from passage 252r through passage 252u to detent plunger 333. When valves 276, 282 and 272 are in any one of the non-operating combinations they act to vent the line from valves 312 and 316. This venting by valve 276 can be

traced from vent passage 252h adjacent valve 276 through the chamber of said valve through passage 252n through valve 282 through passage 252m through valve 336 and thence through passages 252r and 252q to the pressure chambers of valves 312 and 316. As stated valve 276 is in a position with its control lever 277 at the position of lower flight empty so that a hoisting cycle cannot be initiated.

Pressure operated valves 312 and 316 serve to disengage the latches 314 and 311 as above described. These valves are linked to the unloading pilot valve 326 which functions to unload the main line pressure at the completion of a cycle of movement of the hoist in either direction when the stop latch is engaged. Valve 326 cuts off the unloading line from valve 264. This line extends from said valve through conduit 267 to passage 252t. As stated, the stops on cams 227 and 223 and the latches 314 and 311 are arranged so that one of the cams is free to rotate in a direction corresponding to hoist regardless of the position of its engaging latch the other cam is free to rotate in a direction corresponding to lowering the hoist regardless of the position of its engaging latch. Thus in order to have movement of the hoist in either direction it is necessary to disengage the latch which would otherwise prevent rotation in that direction. In power operation both stop latches 311 and 314 are withdrawn simultaneously by the action of the rods extending from valves 316 and 312. In manual operation one or the other of said stop latches are withdrawn by the action of the auxiliary hand lever 317.

The requirements for operation of the hoist are follows:

It may be stated that with the embodiment of the invention illustrated one practical use of the hoist contemplated is that of an ammunition or powder hoist on a war ship. The hoist is shown diagrammatically in Fig. 4. With ammunition units in both flight level stations, that is, at the upper flight 210 and lower flight 211, the hoist is inoperable. With both flights of the hoist empty the hoist is inoperable. With the lower flight or station loaded and the upper station or flight empty and the manual control lever 273 moved to hoist position, the hoist will operate to raise or move upward one cycle. With the upper station or flight loaded, the lower station or flight empty and the manual control lever 273 in its "lower" position the hoist will operate to move downward or lower through one cycle. With the hoist running in either direction (in power operation) throwing the manual control lever 273 to stop position, stops the hoist. This unloads the main line as has already been described.

To initiate a cycle of movement of the hoist in manual operation, it is necessary that each of the three independently actuated levers, 275, 280 and 290 be positioned in the proper combination. This is necessary to permit movement of the auxiliary hand lever 317 which is used to initiate a cycle of movement of the hoist manually to become effective in disengaging one or the other of the stop latches which in their engaged position prevent operation of the hoist. When an operating combination is obtained, such as, upper flight empty, lower flight loaded, and hand control lever 273 in its hoist position, movement of lever 317 will move the extensions of one of the valves 312 and 316 and withdraw the proper latch 314 or 311. It will be seen that when lever 277 is moved to its loaded position that this will rotate

shaft 279 and move lever 280 clockwise so that its upper portion as shown in Fig. 3 will move to the right. When lever 273 is moved to hoist position it will swing lever 275 through the link 274 and will engage the lower end of lever 296, the latter being already positioned by the action of lever 290 as shown, to its extreme right hand setting. When lever 290 is in an operative position as with the upper flight empty as shown in Fig. 3, its vertical extension also engages the lower end of lever 296. All three levers thus have their upwardly extending ends as shown in Fig. 3 moved to the right into engagement with the lower end of lever 296. This permits plunger 309 to swing the lower end of lever 291 to the right, moving said lever 291 in a counterclockwise direction, raising rod 292 and plunger head 294a to move plunger 294 through the aperture in block 312a. The plunger 294 now projects upwardly through the block 312a so that when lever 317 is swung in a counterclockwise direction the pin projecting from dog 320 movable over block 312a will engage the plunger 294 and move block 312a to the right as shown in Fig. 3, thus moving stop latch 314 away from its cam 227 and permitting rotation of power shaft 219 to operate the hoist. It will be understood that with lever 273 in neutral or stop position plunger 294 is not projected above block 312a. It will also be noted that plunger or pin 298 is withdrawn through block 316a by movement of upper flight lever 283. As soon as the ammunition unit which is being hoisted leaves the lower flight level, plunger 294 will be withdrawn below the top of block 312a by action of the lower flight level lever 277 moving to its empty position, thus rotating shaft 279, swinging lever 280, moving lever 291 in a clockwise direction and pulling down on rod 292. Spring 313 can now move valve 312 and its extension to the left so that latch 314 will be in position to engage its cam 227 at the end of the cycle. Thus regardless of how the operator may subsequently move the auxiliary lever 317 the extension of valve 312 will be in position to permit engagement of the stop latch 314 at the completion of the cycle.

In power operation as already stated the latches 311 and 314 are withdrawn by pressure being applied to valves 316 and 312 to move them to the right as shown in Fig. 3 and thus disengage latches 311 and 314. In Fig. 3 the parts are shown in position with the hoist inoperative. Manually operated lever 273 is as stated set in its stop position. Both flights of the hoist are empty and as stated, the main line is unloaded through valve 264, which unloading line has been previously traced. The main line is also unloaded due to the position of pilot valve 326 as well as the position of hand control valve 272. Both of the stop latches 311 and 314 are engaged with their respective cams 228 and 227. Line 309 from the clutch 186 in hand drive unit 176 is vented to tank through conduit 309, around valve 306, passage 252i, around valve 276, passage 252h, through the chamber of valve 272 and through passage 252f to tank. Pressure from line 240 to the control system is blocked by valve 272, blocking passage 252e. Reversing valve 256 is in centered position, both lines to the pressure chambers at the ends thereof being vented to tank. The venting from one side of the valve takes place through conduit 263, passage 252j, around valve 276, passage 252g, chamber of valve 272 through passage 252f to tank. The venting from the other side of the valve occurs through conduit 262, through passage 252i, around valve 276,

through passage 252h to valve 272 and through said valve and passage 252j to tank. Deceleration valve 249 is in closed position, shutting off passage 248a. The line 251 extending to the pressure chamber of deceleration valve 249 is vented through passage 252z, through valve 330 and through passage 252w to tank. The motor 42 is running as is pump 43, valve 236 is open and valve 241 is closed. The pilot 239 and its spring 238 which controls the opening of this valve has been set to the pressure required for acceleration of said hoist, which in one embodiment in practice was about 600 pounds.

To initiate the cycle of movement of the hoist in power operation, lever 273 is moved to hoist position. As stated, the lower flight must be loaded and lower flight valve lever 277 and its valve 276 are thus moved to loaded position. Also as stated, upper flight level must be empty and thus the upper flight lever 283 and its valve 282 are at the empty position or the valve will move to its normal right hand position. Shuttle valve 306 will move to its right hand position admitting liquid under pressure to line 309 which will be transmitted to hand drive unit 176 and will disengage clutch 186 so that the hand drive unit is disconnected from the output shaft. This liquid under pressure is delivered to conduit 309 from conduit 240, through passage 252a, around valve 270, through passage 252e, around valve 272 now moved to the right to its hoist position, through passage 252h to valve 276 now in its loaded position, around said valve and through passage 252i to shuttle valve 306 and through said valve to conduit 309. With the valves 340 and 336 in the position shown in Fig. 3 liquid under pressure is admitted to the detent plunger 333 and valves 312 and 316 as soon as an operative combination of the three valves 272, 276 and 282 is obtained. As above explained, a cycle can only be initiated when such as an operative combination is obtained. With the levers 273, 277 and 283 in the positions described pressure is admitted to valves 312 and 316 through passages 252r and 252q and pressure is admitted to detent plunger 333 through passage 252u as above traced and valves 312 and 316 move to the right disengaging latches 314 and 311. Valves 312 and 316 have thus moved to the right and through coupling 326a have moved valve 326 to the right. Valve 326 thus has cut off passage 252t which communicates with conduit 267. Said conduit is thus closed off and with valve 272 in hoist position any pressure to conduit 267 is also cut off. Conduit 267 is thus closed and this allows pressure to build up on top of or at the right of valve 264 as seen in Fig. 3 and valve 264 is moved to closed position. This cuts off passage 248k so that fluid under pressure is delivered to the main line and to hydraulic motor 215. Pressure is supplied from pressure conduit 240 through passage 252a, around valve 270, through passage 252e, around valve 272, into passage 252h, around valve 276, to passage 252i and into conduit 262 to the right of valve 256. This moves valve 256 to the left, the release from the left side of said valve occurring through conduit 263, passage 252j, around valve 276, through passage 252g and around valve 272 through passage 252f to tank. With valve 264 closed, fluid from the pressure line goes into passage 248i and into passage 248j. The valve 256 being in hoist position, the fluid then goes from passage 248j into line 248g and into conduit 260 and to the hydraulic motor 215. Returning from the motor, the fluid goes through conduit 261 into passage 248h and into passage 248d through the

exit path, through the decelerating valve 249 and back to tank. A cycle is thus started. When this occurs cam 231 moves the extension rod of valve 340 to the right and this admits liquid under pressure to the left hand side of valve 336. This pressure line can be traced from pressure conduit 240, through passage 250a, around valve 270, through passage 252e to the top of valve 340, through said valve to passage 252bb and thus to the left of valve 336. Valve 336 thus moves to the right and this relieves pressure on the valves 312, 316 and the detent plunger 333 through passage 252r with which passage 252u from said detent plunger connects, around valve 336 now moved to the right and out through passage 252aa. Valves 312 and 316 can thus be moved to the left by their springs and position latches 311 and 314 so that they will be again engaged when cams 228 and 227 arrive at the proper position. Reversing valve 256 will be moved to its left hand position in response to the setting of valve 272 in its hoist position. Pressure on the right of reversing valve 256 can be traced through conduit 262 to passage 252i, around valve 276 now in its loaded position, around valve 272 now in its hoist position and around valve 270 in its power position as shown in Fig. 3 to pressure conduit 240. It may be stated that spring 332a moves valve 330 to the left when detent plunger 333 is acted upon by pressure through passage 252u, so that vent passage 252w is cut off and pressure from 252v is admitted to passage 252z and conduit 251 to move valve 249 to the left. Decelerating valve 249 is thus open as pressure is applied to its right hand end from passages 252h and 252v around valve 330 through passage 252z and conduit 251 and the flow through the power line from conduit 243 through passage 234i, through reversing valve 256 as stated in its left hand position, through passage 248j, passage 248g through conduit 260 to motor 215, through conduit 261 from the motor through the reversing valve 256, through passage 248d, through the chamber of valve 253 and passage 248d through the decelerating valve 249 now moved to the left from its position in Fig. 3, through conduit 244 to tank 41, is unrestricted and the hoist is operated. As soon as the ammunition unit leaves the lower flight, valve 276 will be shifted to the position shown in Fig. 3. As the hoist moves valve 330 will be cocked in mid-cycle by its cam, detent plunger 333 moving into recess 330a. When this valve is in this position pressure is relieved in the pressure chamber or at the right hand end of decelerating valve 249. This relief takes place through conduit 251, passage 252z, around valve 330 and out to tank through passage 252w. The spring 250 is thus put in control of valve 249 to cause the deceleration as permitted by cam 230. The said relief occurs at a point where cam roller 246 is at the high side of cam 230 so that deceleration is delayed by the cam until the proper point in the operating cycle. As the hoist reaches the end of the cycle, valve 340 will take the position shown in Fig. 3 as cam roller 341 will drop into recess 231a. This will again permit a new operating cycle to be initiated as above described when the proper combination of valves 272, 276 and 282 is again obtained. As the hoist comes to the end of the cycle the lower stop latch 311 will drop off the high side of its cam 228 and this will permit movement of valve 316 under the influence of spring 324 which will allow valve 326 to move to the position shown in

Fig. 3 under the action of spring 327. Valves 312 and 316 are under control of springs 313 and 324 respectively as previously set forth in the description of the initiation of a cycle. This relieves pressure on valve 264 which will open and unload the main line through passages 248j, 248k and conduit 244. The hoist thus again comes to stop position. If the load is removed from the top flight another load placed on the lower flight and lever 273 left in hoist position, another cycle will be immediately instituted which will take place as above described.

To initiate a lowering cycle of movement of the hoist the operation is much the same as described except that hand lever 273 will be set for its "lower" position, lever 283 will be in "loaded" position and lever 277 will be in "empty" position. With this combination pin plunger 298 will be projected through block 316a and a cycle can be initiated manually by swinging lever 317. The projection on dog 320 movable over block 316a will engage pin 298, move said block and withdraw latch 311 permitting movement of the hoist in a direction to lower. With hand lever 273 in "lower" position valve 272 will direct liquid under pressure to the left hand end of reversing valve 256. This liquid under pressure will be transmitted from conduit 240 through passage 252a, through valve 270 in power position, through passage 252e to and through the valve chamber of valve 272 now in its lower position, through passage 252g to and through valve 276, through passage 252j to conduit 263 to the left hand end of reversing valve 256. Valve 276 will be moved to its empty position since to lower the hoist the lower flight must be empty. Valve 282 will be moved to its left hand position or with lever 283 in loaded position, since to lower the hoist the upper flight must be loaded. Owing to the position of valve 272 no liquid under pressure is admitted to the pressure chamber of decelerating valve 249 through conduit 251. The valve 360 will be opened sufficiently to allow slow speed rotation of the hydraulic motor 215 even with deceleration valve 249 completely closed off. The valves 272, 276 and 282 will be brought to an operative combination by their levers being moved to the positions just above mentioned. Pressure is admitted through conduit 240, passage 252a, around valve 270 to passage 252e around valve 272 to passage 252g, through slots 276a to passage 252k, around valve 282 (now in "loaded" position) into passage 252o, around valve 336 to passage 252r and passage 252q to the left end of valves 316 and 312 to withdraw the latches 311 and 314 so that the cycle is initiated. The deceleration valve 249 will be gradually opened by its cam 230. The return flow from the hydraulic motor will pass through the adjustable foot valve 253. This in combination with the gradual opening of the valve 249 prevents undue acceleration of the hoist in its lowering movement. The function of the hoist in its lowering movement is similar to that already described for the cycle of hoisting.

The cycle of lowering movement for the hoist can, of course, be initiated by power as above described or by use of the hand power unit 176. If the hoist is to be lowered manually, lever 271 will be moved to its manual position thus cutting off liquid under pressure to the control assembly by shutting off conduit 240. This as already described cuts off liquid under pressure to conduit 309 permitting engagement of clutch 186 in the hand drive unit so that said unit is connected to output shaft 219. With an operating com-

bination placing levers 275, 280 and 290 in an operative combination, auxiliary hand lever 317 can be moved as already described for releasing one or the other of the latches 311 or 314. In a manual lowering cycle circulation of fluid in the hydraulic motor 215 is restricted to a degree determined by the adjustment of foot valve 253. This restriction is imposed as it is desirable to have a back torque in the hydraulic motor 215 when lowering to insure quiet operation of the hand drive unit.

The cam 229 has a high portion for the greater part of its circumference adapted to engage cam roller 331. As above stated valve 330 is put under tension or cocked by cam 229 in mid-cycle and is held so by plunger 333. With valve 330 in this position the pressure chamber of decelerating valve 249 is vented to tank through conduit 251 as above described. Pressure is only admitted to the pressure line from conduit 240 through passage 252e and upward through passage 252v and to the decelerating valve when lever 273 is in its hoist position and the conditions to initiate a cycle as previously set forth, are present. This means that valve 272 must be in its "hoist" position so that passage 252e will be connected to passage 252h, valve 276 must be in its "loaded" position so that passage 252h is connected to passage 252n, valve 282 must be in its "empty" position so that passage 252n is connected to passage 252m, valve 236 must be moved to the left so that 252m is connected to passage 252r leading to passage 252u to lift plunger 333 and thus permit spring 332a to move valve 333 to the left to connect passages 252v and 252z, and valve 340 must be in its left position as shown in Fig. 3 before valve 336 is moved to its left position by fluid admitted through passage 252e, valve 340 and passage 252cc to move valve 336 to the left. Should the hoist be running in a lowering direction and be reversed by the lever 273 being moved to hoist position pressure will be admitted through the line as above indicated to decelerating valve 249, moving it to its left hand position and allowing unrestricted flow through the hydraulic motor 215 and to tank. Under such conditions if valve 330 were not controlled the hoist would wheel into the mechanical stops of cams 227 and 228 at full speed. To prevent this the high portion is provided on cam 229 so that if the timing shaft 226 revolves through a comparatively small arc this will be sufficient to move valve 330 and cut off the pressure to decelerating valve 249. This valve will then be acted on by its spring 250 and the hoist can move no faster than permitted by the decelerating valve and the creeper valve 360. In the lowering cycle pressure goes from pressure line 240 through passage 252a, around valve 270, passage 252e, around valve 272 into passage 252g, through passage 252k, around valve 282 (now in "loaded" position) into passage 252o to passage 252m through the chamber of valve 336 through passage 252r through passage 252u. As soon as pressure is present in passage 252u, plunger 333 lifts and valve 330 is moved to the left by spring 332a.

From the above description it will be seen that we have provided a very compact, efficient and quickly operating control for a hoist. The movement of the hoist is controlled with great precision. As pointed out in the description it is impossible for the hoist to operate until the desired operating conditions are present. The hoist may be changed from power drive to manual drive at will as described and can be started either with a hydraulic control or by the auxiliary hand con-

trol. The movement of the hoist is accurately decelerated as described. A cycle of movement of the hoist as will be apparent from the preceding description embodies the movement of the hoist from the time it is started until it is stopped.

The control system has been amply demonstrated in actual practice, found to be very successful and efficient and is being made for actual use.

It will, of course, be understood that various changes may be made in the form, details, arrangement and proportions of the parts, without departing from the scope of applicants' invention, which generally stated, consists in a device capable of carrying out the objects above set forth, in the parts and combinations of parts disclosed and defined in the appended claims.

What is claimed is:

1. A control system for a hoist having a lower flight position and an upper flight position having in combination, a hydraulic motor connected to said hoist for driving the same, means for supplying fluid under pressure to said motor to operate the same, an output member driven by said motor, a hand drive unit by which said output member may be actuated, a clutch for connecting said hand drive unit and said output member, means normally holding said clutch engaged, a hydraulic control unit for said hoist including a member movable to power and manual positions, said hydraulic control unit acting with said first mentioned means when said member is moved to power position to release said clutch so that said hoist may be driven from said hydraulic motor and acting when said member is moved to manual position to permit operation of said hand drive unit.

2. A hydraulic system for a hoist having in combination, a hoist movable through a cycle from an upper flight to a lower flight and vice versa, a hydraulic motor directly connected to said hoist for moving the same, a pump for supplying fluid to said hydraulic motor, an electric motor for driving said pump, a hydraulic control unit including a reversing valve for reversing the direction of flow of liquid through said motor for reversing the movement of said hoist in successive cycles, a manually operated control lever, control elements operated from said flights respectively cooperating with said control lever to initiate a cycle of said hoist when said control lever and control elements are in definite combinative positions, means for setting said reversing means in accordance to whether said hoist moves in one direction or the other and means for stopping the movement of said hoist at the end of a cycle.

3. A hydraulic control system for a hoist having a lower flight position and an upper flight position having in combination, a hydraulic motor connected to said hoist for driving the same, means for supplying fluid under pressure to said motor for operating the same, an output member driven by said motor, a hand drive unit for said hoist adapted to be connected to said output member, a manually operative clutch for connecting said hand drive unit and said output member and a hydraulic control unit including means operated by said first mentioned means for hydraulically rendering said clutch inoperative for disconnecting said hand drive unit and output member when said hoist is operated by said motor.

4. A hydraulic control system for a hoist having upper and lower flight positions and movable

through a cycle to move from one of said positions to the other having in combination, a hydraulic motor directly connected with said hoist for moving the same, a motor driven pump for supplying fluid to said motor, means connecting said pump and motor including a hydraulic control unit, a member movable to hoist and stop positions, control members movable from said hoist cooperating with said last mentioned member to initiate a cycle of movement of said hoist, a valve in said hydraulic control unit for causing deceleration of said hoist as it approaches the end of a cycle and means driven from said hydraulic motor cooperating with said decelerating valve to control the deceleration of said hoist.

5. A control system for a hoist having upper and lower flight levels and movable through a cycle from one to the other having in combination, a hydraulic motor connected to said hoist for moving the same, a pump for supplying fluid to said motor, an electric motor for driving said pump, a shaft driven from said hydraulic motor, a timing shaft driven from said first mentioned shaft, fluid conducting means connecting said pump and motor including a hydraulic control unit for controlling movement of said hoist and including a decelerating means, automatic means for moving said decelerating means and a cam on said timing shaft cooperating with said automatic means to control said decelerating means.

6. A hydraulic control system for a hoist adapted to be operated in successive cycles respectively to move between upper and lower flight positions having in combination, a hydraulic motor directly connected with said hoist for driving the same, a motor operated pump for supplying fluid to said motor, a power shaft driven by said motor, a timing shaft driven from said power shaft, fluid conducting means including a hydraulic control unit for governing supplying of fluid to said hydraulic motor also including a reversing valve, a pilot valve for directing fluid to either end respectively of said reversing valve and a member driven from said timing shaft for placing said pilot valve under tension during a cycle of movement of said hoist to move to another position upon initiation of the next cycle to properly position said reversing valve for said next cycle of movement of said hoist.

7. A control system for a hoist having upper and lower flights comprising a hydraulic motor for driving said hoist, a stop means for preventing movement of said hoist, means for supplying fluid under pressure to said motor including a hydraulic control unit having a manually operated control member movable to hoist and stop positions, a second manually operated control member movable to power and manual positions, means operated by said hydraulic control unit to release said stop means when said second manually operated member is in power position and an auxiliary manually operated means for releasing said stop when said first mentioned manually operated member is in hoist position.

8. A control system for a hoist having a lower flight position and an upper flight position and movable through a cycle from one of said positions to the other having in combination, a hydraulic motor connected to said hoist for driving the same, a stop means preventing movement of said hoist, a manually operated member adapted to release said stop means to initiate a cycle of movement of said hoist and means for supplying fluid under pressure to said motor for operating the same including a hydraulic control

unit for releasing said stop means to initiate a cycle of movement of said hoist.

9. A control system for a hoist having a lower flight position and an upper flight position and movable in a cycle from one position to the other having in combination, a hydraulic motor connected to said hoist for driving the same, a member movable for manually initiating a cycle of movement of said hoist, a second member movable to hoist or stop positions, a control element at said lower flight movable to positions to permit or prevent the initiation of a cycle of movement of said hoist according to whether said flight is loaded or empty, a second control element at said upper flight movable to positions to permit or prevent initiation of a cycle of movement of said hoist according to whether said upper flight is loaded or empty and means rendering operable said first mentioned movable member to initiate a hoisting cycle of movement when said second member is movable to hoist position, said first mentioned control element is in loaded position and said second mentioned control element is in empty position and means for stopping said hoist at the completion of a cycle.

10. A hydraulic system for a hoist having in combination, a hydraulic motor connected to said hoist for moving the same, a driven pump for supplying fluid to said hydraulic motor, fluid conducting means connecting said pump and motor including a hydraulic control unit including a decelerating valve, means normally urging said valve in one direction to cause deceleration of said hoist, means driven from said motor acting on said valve and cooperating with said second mentioned means to control the movement thereof for decelerating said hoist and means for controlling the delivery of fluid to said valve to move said valve to non-decelerating position including means driven from said hydraulic motor.

11. A hydraulic system for a hoist having in combination, a hydraulic motor connected to said hoist for moving the same, a driven pump for supplying fluid to said hydraulic motor, fluid conducting means connecting said pump and motor including a hydraulic control unit which includes a decelerating valve, means normally urging said valve in one direction to decelerate said hoist, means driven from said motor acting on said valve and cooperating with said second mentioned means to control the movement thereof for decelerating said hoist, a second valve for controlling fluid delivered to said first mentioned valve for moving it to non-decelerating position, means normally urging said second valve in one direction and means driven from said hydraulic motor cooperating with said last mentioned means to control the movement of said second valve.

12. A hydraulic system for a hoist movable in a cycle from an upper to a lower flight position and vice versa having in combination, a hydraulic motor connected to said hoist for moving the same, means for supplying fluid under pressure to said motor including a hydraulic control unit which includes a reversing valve, a control valve for said reversing valve, means for moving said control valve during a cycle of movement of said hoist to place the same under stress tending to move it to one position, means for holding said control valve under said stress and means operable near the end of said cycle for permitting movement of said control valve under said stress to direct fluid to one end or the other of said reversing valve to determine whether

said hoist moves through a lifting or lowering cycle.

13. A control system for a hoist movable in a cycle from a lower flight position to an upper flight position and vice versa, having in combination, a hydraulic motor connected to said hoist for driving the same, means for supplying fluid under pressure to said motor for operating the same, an output shaft driven from said motor, a stop cam on said shaft, a latch cam on said shaft, a stop engaging said latch cam and preventing movement of said shaft and hoist, means for moving said stop to permit movement of said shaft and hoist, a plurality of levers movable to positions respectively to permit and to prevent the operation of said last mentioned means and a plurality of means including means depending on the position and loaded condition of said hoist for moving said levers to positions respectively to permit operation of said means for moving said stop, means for conducting fluid to said motor when said stop is so moved and a stop latch for engaging said stop cam at the end of said cycle to stop said hoist at the completion of a cycle.

14. A hydraulic control system for a hoist, which hoist has upper and lower flight positions, a hydraulic motor for driving said hoist, a driven pump for supplying fluid to said motor, fluid conducting means connecting said pump and motor, a member driven by said motor, a stop engaging said last mentioned member to prevent operation of said hoist, a member movable to positions according to whether the lower flight is loaded or empty, a control member movable to "hoist" and "stop" positions, means for releasing said stop, a manually operated member for actuating said last mentioned means, a hydraulically operated member for actuating said last mentioned means, said means being operable only when said control member is moved to "hoist" position and when said second mentioned member is in position to which it is moved by the lower flight being loaded.

15. A control system for a hoist, which hoist has a lower flight position and an upper flight position and is movable from one position to the other during a cycle of operation, having in combination, a hydraulic motor connected to said hoist for driving the same, means for conducting fluid under pressure to said motor for driving the same, a stop preventing operation of said hoist, a member movable to release said stop, a control element for controlling the operation of said member, means located at one of said flights for controlling the position of said control element, a second control element for controlling the operation of said member, means located at said other flight position for controlling the position of said second control element, whereby said member cannot operate to permit said first mentioned means to operate until said elements are in positions respectively to permit said member to be moved to release said stop.

16. A control system for a hoist having a lower flight position and an upper flight position and movable through a cycle from one position to another, having in combination a hydraulic motor connected to said hoist for driving the same, means for supplying fluid under pressure to said motor, a control member normally urged to a position to prevent operation of said hoist but movable to position to permit operation of said hoist, a plurality of control elements cooperating with said member to determine its position,

means at one of said flights for controlling one of said elements to determine the position of said member, depending on whether said hoist is loaded or unloaded at said flight, means at said other flight for controlling another of said elements to determine the position of said member depending on whether said hoist is loaded or unloaded at said last mentioned flight whereby said hoist cannot operate until the proper loaded and unloaded conditions are present for positioning said control elements to permit movement of said control member and operation of said first mentioned means.

17. A control system for a hoist, which hoist has a lower flight position and an upper flight position and is movable from one position to the other during a cycle of movement having in combination, a hydraulic motor connected to said hoist for driving the same, means for supplying fluid under pressure to said motor including a hydraulic control means, a deceleration valve forming part of said control means, resilient means acting to move said valve in one direction, and a cam cooperating with said means for controlling the position of said valve and the degree of deceleration of said hoist.

18. The structure set forth in claim 17 and fluid operated means for moving said valve in the opposite direction to open position during the first part of said cycle.

19. A control system for a hoist, which hoist has a lower flight position and an upper flight position and is movable from one position to the other during a cycle of movement having in combination, a hydraulic motor connected to said hoist for driving the same, means for supplying fluid under pressure to said motor including a hydraulic control means, a fluid operated reversing valve movable to positions respectively to direct fluid in one direction or the other to said motor, a second valve for controlling the supply of fluid to said reversing valve, means for moving said second valve during said cycle, and placing the same under spring pressure, means for holding said second valve in position under spring pressure, and means for releasing said second valve so that it is moved under said spring pressure to direct fluid to and move said reversing valve to move said hoist in the proper direction in the next cycle.

20. A control system for a hoist, which hoist has a lower flight position and an upper flight position and is movable from one position to the other during a cycle of movement having in combination, a hydraulic motor connected to said hoist for driving the same, means for supplying fluid under pressure to said motor including a hydraulic control means, said hydraulic control means including a valve, means connected to said valve for moving the same and having a position for "manual" operation of said hoist and a position for "power" operation of said hoist, a second valve, means connected to said second valve for moving the same and having a "hoist" position and a "stop" position, a third valve, means connected to said third valve for moving the same and disposed at the lower of one of said flight positions and adapted to be operated to "loaded" and "empty" positions, a fourth valve, means connected to said fourth valve for moving the same and having a portion disposed at the upper of said flight positions adapted to be moved to "loaded" and "empty" positions, and means preventing operation of said hoist until said first mentioned valve is moved to "power" position,

said second valve is moved to "hoist" position, said portion at said lower flight is moved to "loaded" position and said portion at said upper flight is moved to "empty" position.

21. The structure set forth in claim 20, a cam, a start latch engaging said cam preventing starting of said hoist, a manually operated means for moving said start latch away from said cam to permit operation of said hoist, and means rendering said last mentioned means operative when said means connected to said first mentioned valve is moved to manual position.

22. The structure set forth in claim 20, a hand driving unit for said hoist including a clutch, means normally holding said clutch in engaged driving position, and fluid operated means for moving said clutch to disengaged position when said means connected to said first mentioned valve is moved to power position.

23. A control system for a hoist, which hoist has a lower flight position and an upper flight position and is movable from one position to the other during a cycle of movement, having in combination a hydraulic motor connected to said hoist for driving the same, means for supplying fluid under pressure to said motor, a start latch cam, a stop latch cam, a start latch adapted to engage said start latch cam, a stop latch adapted to engage said stop latch cam, fluid operating means for moving said start latch away from its cam to permit movement of said hoist, means for moving said stop latch away from its cam, and means on said stop latch engaging said start latch for holding the latter away from its cam.

24. A hydraulic control system for a hoist having in combination, a hydraulic motor constructed and arranged to be directly connected with said hoist for moving the same and having a power output member, a driven pump for supplying fluid to said motor, a hydraulically controlled means, a hand drive unit for said hoist adapted to be connected to said output member, a control lever movable to power and manual positions, said hand drive unit comprising a clutch, means normally holding said clutch in engaged position, a member movable by said control lever when moved to power position to supply fluid to said hydraulic control means to disengage said clutch and movable when said control lever is moved to manual position to cut off fluid to said hydraulic control means and permit engagement of said clutch so that said hoist can be manually operated.

25. A control system for a hoist having a lower flight and an upper flight position having in combination, a hydraulic motor connected to said hoist for driving the same, a stop preventing operation of said hoist, means for moving said stop to permit operation of said hoist, a plurality of control elements, means at one flight of said hoist for controlling one of said elements and moving the same to positions either to permit or prevent movement of said stop, means at said other flight for controlling another of said elements and moving the same to positions either to permit or prevent movement of said stop, means for actuating said first mentioned means operative only when said control elements have been moved to positions permitting movement of said stop, and means for supplying fluid under pressure to said motor to operate said hoist when said stop is moved by said first mentioned means.

26. A hydraulic control system for a hoist, which hoist has upper and lower flight positions, a hydraulic motor for driving said hoist, a driven pump for supplying fluid under pressure for said

motor, a member driven by said motor, a stop engaging said last mentioned member to prevent operation of said hoist, a control element movable to different positions when said lower flight is loaded or empty respectively, a second control element movable to different positions when said upper flight is loaded or empty respectively, a control member movable to hoist and stop positions, means for releasing said stop, a manual means for actuating said last mentioned means, a hydraulically actuated member for actuating said first mentioned means, said first mentioned means being operable only when said third control member is moved to hoist position and when said control elements are in the positions to which they are moved by the lower flight being loaded and the upper flight being empty, and means for conducting fluid from said pump to said motor to operate said motor when said stop is released.

27. The structure set forth in claim 26, a hydraulic control member movable to power and manual positions, said hydraulically actuated member being operable only when said first mentioned control member and said control elements are in position as set forth and when said hydraulic mentioned control member is in power position.

28. A hydraulic control system for a hoist having an upper flight position and a lower flight position having in combination, a hydraulic motor connected to said hoist for driving the same, a motor driven pump for supplying fluid under pressure for said hydraulic motor, a stop means for preventing operation of said hoist, a member for moving said stop means to release position to permit operation of said hoist, a control element operated from said lower flight position and movable to different positions when said lower flight is loaded or empty respectively, a second control element operated from said upper flight position and movable to different positions by said upper flight being loaded or empty respectively, a control member movable to hoist and stop positions, means for causing operation of said first mentioned member when said control member is in hoist position when said first control element has been moved to position by said lower flight being loaded and said second control element has been moved to position by said upper flight being empty, and means for conducting fluid to said motor to operate the same and said hoist when said first mentioned member is operated.

29. A control system for a hoist having a lower flight position and an upper flight position having in combination, a hydraulic motor connected to said hoist for driving the same, a stop preventing operation of said hoist, a plurality of control elements, a member movable to hoist and stop positions controlling one of said elements, means at said flight positions respectively for controlling the other of said elements to move them either to positions permitting or preventing movement of said stop, means for releasing said stop to initiate a hoisting cycle operable when said last mentioned member is in hoist position and said other control elements are in positions permitting movement of said stop, and means for supplying fluid under pressure to said motor for driving the same and said hoist when said stop is released.

30. A control system for a hoist having a lower flight and upper flight position having in combination, a hydraulic motor connected to said hoist for driving the same, an output member between said motor and hoist driven by said motor, a stop preventing operation of said output member, a

control element, means at the lower flight of said hoist for controlling said element and moving the same to different positions when said flight is loaded or empty respectively, a second control element, means at the upper flight of said hoist for controlling said second control element and moving the same to different positions when said upper flight is loaded or empty respectively, a manually controlled member movable to "hoist" position to cause said hoist to raise, means for releasing said stop operable only when said control member is moved to "hoist" position, said first control element is in position with said lower flight loaded and said second control element is in position with said upper flight empty, and means for supplying fluid under pressure to said motor when said last mentioned means is operated.

31. The structure set forth in claim 30, a control mechanism including a selector member movable to power and manual positions, a manually operated member for releasing said stop and means rendering said last mentioned member operative when said selector member is moved to manual position with said control member in hoist position, said first control element in position with the lower flight loaded and said second control element in position with said upper flight empty.

32. A hydraulic control system for a hoist movable through successive cycles from a lower flight position to an upper flight position and vice versa having in combination, a hydraulic motor, a shaft driven by said motor connected to said hoist for moving the same, a stop cam connected to said shaft, a latch cam connected to said shaft, an oscillatable latch engageable with said stop cam at the end of a cycle to stop said hoist, a timing shaft driven from said first mentioned shaft, a timing cam on said timing shaft adapted to operate said stop latch, a starting latch engaging said latch cam to prevent operation of said hoist, a manually operated means, a plurality of means operated from said flight positions of said hoist and movable to certain relative positions for permitting movement of said starting latch to release position to permit initiation of a cycle of movement of said hoist, means for moving said starting latch to permit initiation of said cycle when said last two mentioned means and said manually operated means are in said certain relative positions, and means for supplying fluid under pressure to said motor to operate the same and said hoist when said last mentioned means is operated.

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