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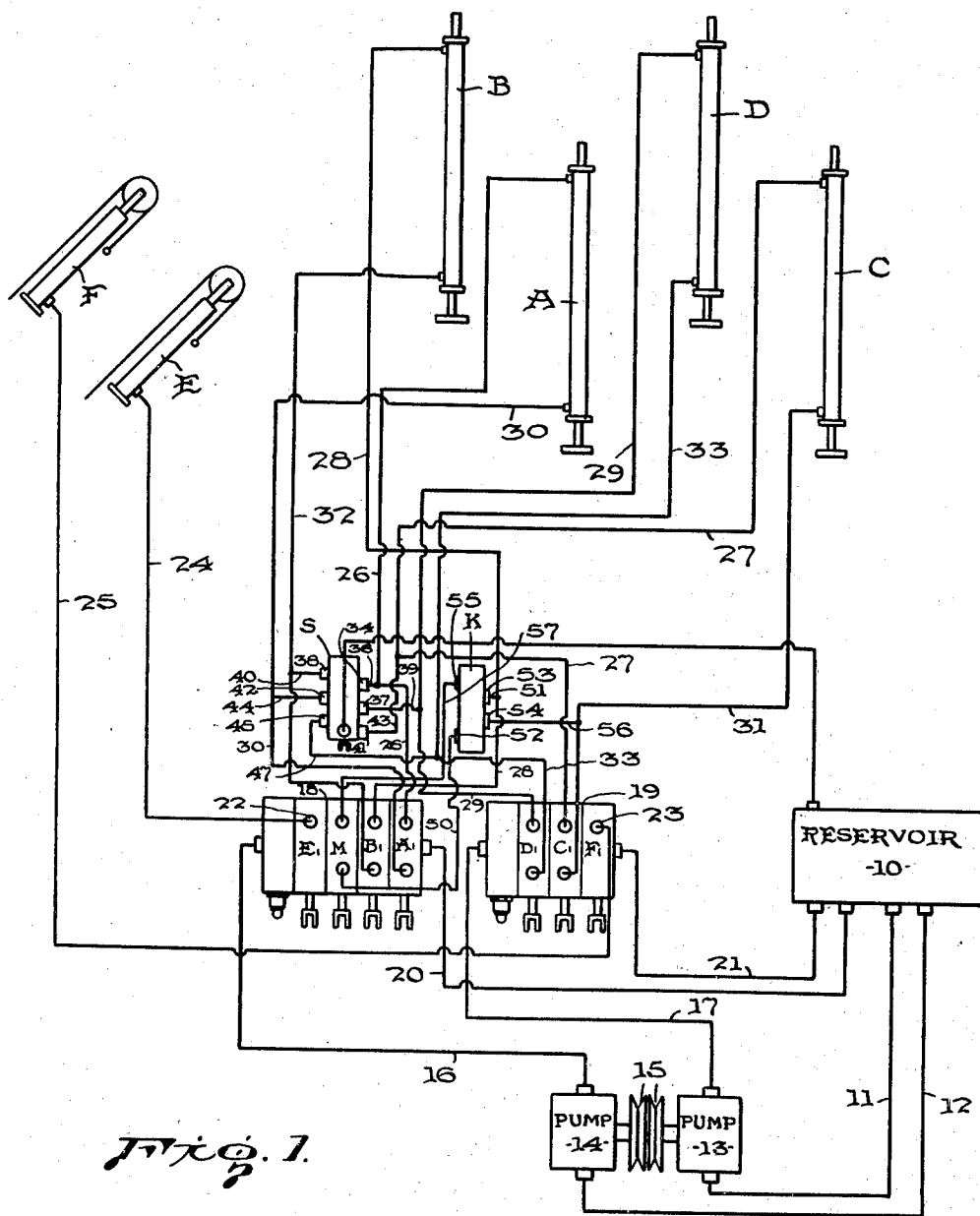
E. J. HRDLICKA, JR

2,445,781

CONTROL SYSTEM FOR MULTIPLE HYDRAULIC HOISTS

Filed Dec. 5, 1946

3 Sheets-Sheet 1



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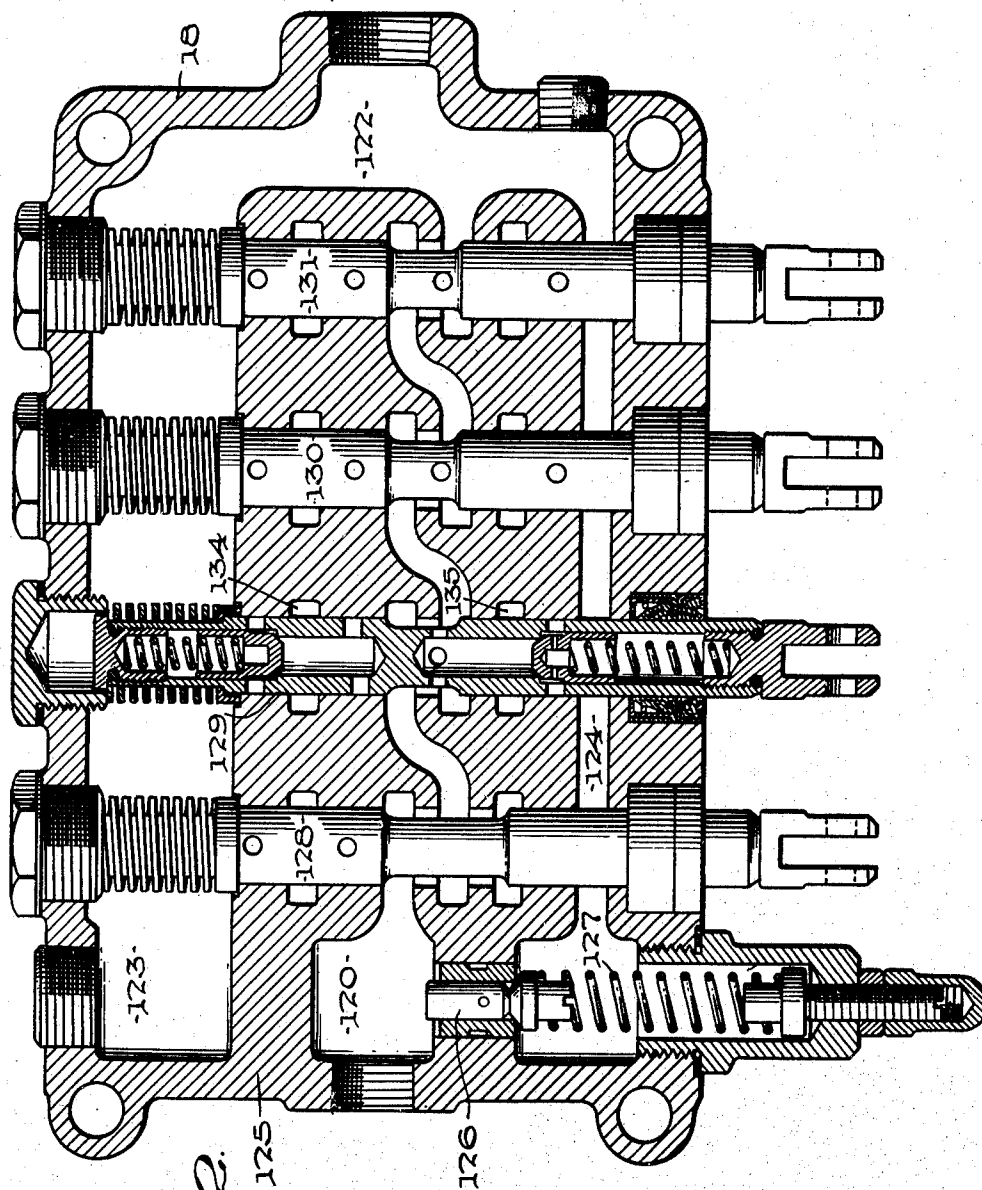
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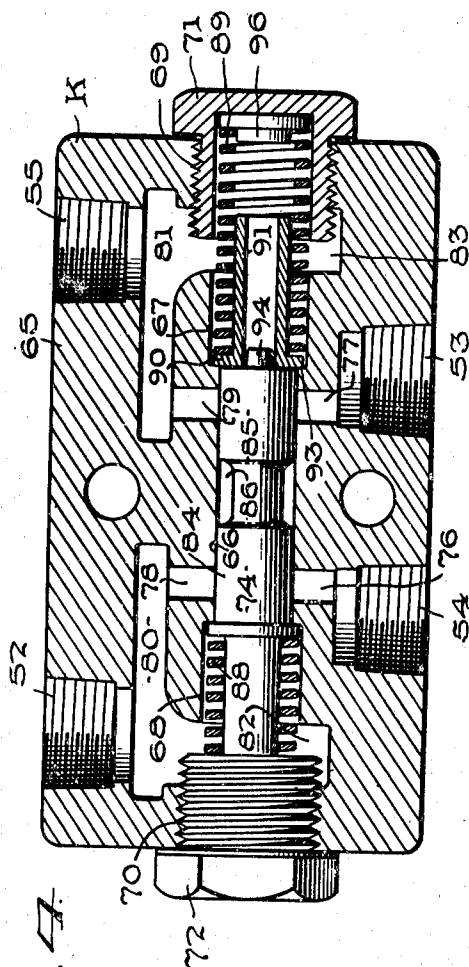
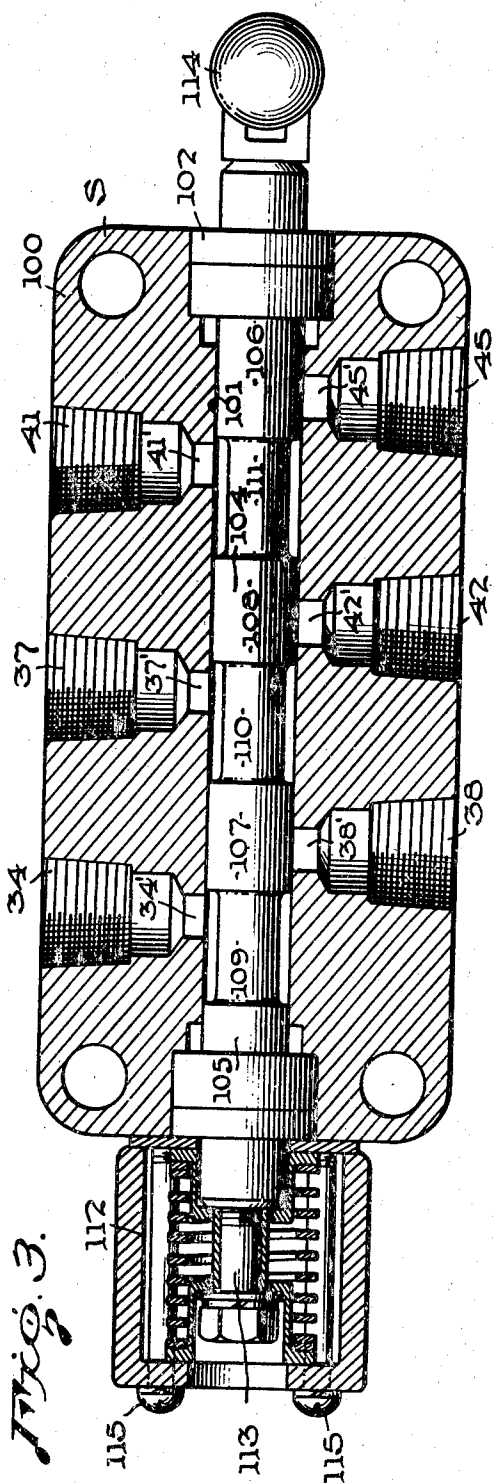
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CONTROL SYSTEM FOR MULTIPLE HYDRAULIC HOISTS

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3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE

2,445,781

CONTROL SYSTEM FOR MULTIPLE
HYDRAULIC HOISTSEdward J. Hrdlicka, Jr., Painesville, Ohio, as-
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Application December 5, 1946, Serial No. 714,279

17 Claims. (Cl. 60—97)

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This invention relates to control systems for multiple hydraulic hoists or rams, and more particularly to such systems in which any one of a plurality of hydraulic hoists may be individually operated; any pair of hoists, with each selected from a particular group, may be operated in unison to the same or varying degrees; and in which a plurality of hoists in a predetermined group may be simultaneously operated.

It is a general object of the present invention to provide a novel and improved system for the control of a plurality of hydraulic hoists or rams in the manner defined.

More particularly it is an object of the invention to arrange a system of pumps, hydraulic hoists and control valves whereby various combinations of valves may be operated simultaneously to control from one to a plurality of hoists in various combinations and to various degrees of extension.

One of the important features of the invention comprises the use of two banks of control valves suitably apportioned among the hoists and each provided with high pressure liquid from an individual pump whereby one hoist from each bank may be simultaneously operated.

Another important feature of the invention consists in the provision of a system in which each of a plurality of hoists may be individually operated, the valve mechanisms also being arranged for connecting some of the hoists in series whereby those elected hoists all may be simultaneously operated.

A further important feature of the invention consists in the use of a plurality of double acting hoists arranged in a system for providing individual operation or series operation whereby high pressure fluid is delivered to one end of one of the hoists and the liquid ejected from the opposite end used to actuate a succeeding hoist and so on throughout the series, whereby they may be operated in unison in either direction from a single control valve.

A still further important feature of the invention resides in the use in the system of a reversible type flow control valve whereby adequate control is had of the hoists of said series to insure against the weight of the load thereon moving the plungers at a higher rate than liquid is supplied to the opposite ends thereof.

Other and further objects and features of the invention will be more apparent to those skilled in the art on a consideration of the accompanying drawings and following specification wherein is disclosed a single exemplary embodiment of the

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invention, with the understanding that such variations and modifications may be made therein as fall within the scope of the appended claims without departing from the spirit of the invention.

In said drawings:

Fig. 1 is a schematic and wholly diagrammatic showing of the entire system, all piping being shown in single lines;

Fig. 2 is a longitudinal central section through one of the banks of control valves;

Fig. 3 is a longitudinal central section through the series valve which places some of the hoists in condition for operation in unison; and

Fig. 4 is a longitudinal central section through the reversible type flow control valve.

In the operation of various devices, machines and the like there often occurs the need for operating a plurality of hydraulic hoists, rams or jacks. In many instances individual control of each of these is imperative and often for the sake of convenience, time saving and the like, simultaneous operation of a plurality of the hoists in unison and at the same rate as when individually operated is highly desirable. The present system contemplates provision for these several types of operation plus simultaneous but independent control of two hoists, wherein one is selected from among those of one group and the other from among those of a second group.

In the schematic drawing six hydraulic hoists are illustrated wherein four are of the double acting type and are arranged to be operated either individually, in pairs or simultaneously, while two single acting hoists are arranged for individual or simultaneous operation. Any suitable variations of this arrangement of parts can be made and the invention is not restricted to the exact number, relative sizes or types of hoists used. It is essential, however, in order to have equal simultaneous operation of the selected plurality of hoists if desired, that they be of the double acting variety, that each have the same displacement per unit of movement and the displacement of the opposite ends of each hoist be identical. To that purpose the hoists are illustrated as of the through piston rod type. However, it is clear that hoists of different sizes and total displacements per unit of movement may be used in the system and that when connected in series each will move at a rate inverse to its displacement per unit of movement.

Referring now to the drawings and first to the schematic illustration, it will be seen that the system includes a reservoir 10 for suitable hy-

draulic liquid. This is connected by pipes 11 and 12 to two independent pumps 13 and 14, respectively, shown as equipped with pulleys 15, whereby they may be driven from the same or separate sources of power. Preferably these pumps are of the positive displacement type, such for instance as the conventional gear pumps. Pump 14 is connected by pipe 16 to the bank 18 of control valves while pump 13 is connected by pipe 17 to the bank 19 of control valves. One such bank of valves is illustrated in detail in Fig. 2, which will be described later. Valve-bank 18 is connected by pipe 20 back to the reservoir, while pipe 21 serves the same purpose for valve bank 19. The valves in these control valve banks, as will be later described, provide through by-pass when in their neutral position from the pump to the tank or reservoir, whereby the pumps operate against substantially zero pressure when not called on to move one or more of the hoists. If the control plunger of any one of the valves in either bank is moved to an operative position it connects its respective pump to a load, which in this case is a hoist, and closes off the through by-pass.

In the system illustrated six hoists are provided, those lettered A and B being of the double acting variety and associated with valve bank 18, while those lettered C and D are also of the double acting variety but associated with valve bank 19. Each of hoists E and F is shown of the single acting type, although this has no particular bearing on the invention, and they can just as well be double acting hoists by the mere conversion of their control valves to the necessary type. The hoist E is associated with valve bank 18 and the hoist F with valve bank 19. Thus it will be seen that since each valve bank is independently provided with liquid from a separate pump, that any one of the valves in bank 18 can be operated to control its individual hoist in either direction while any one of the valves in bank 19 can be simultaneously operated to control one of the hoists in its bank. The two controlled hoists may be given any desired degree of movement independently of each other. The limitation of operating but one hoist from each bank of valves is directly related to the through by-pass feature for this must be shut off automatically by the movement of the control plunger of any valve which is placed in operative position whereby high pressure liquid is available.

In valve bank 18 the valves controlling the corresponding hoists have been given the hoist letter with the subscript 1 and therefore A₁ is the valve in control of double acting hoist A and so on. The same is true in valve bank 19. Each of valves E₁ and F₁ will be seen to have but a single hoist port, that of the first being numbered 22 and that of the second being numbered 23. Port 22 is connected to the lower end of hoist E by pipe 24, while port 23 is connected to the lower end of hoist F by pipe 25. Each of the single acting valves E₁, F₁ when moved to operative position cuts off the free by-pass in its bank between the respective pump and the reservoir and connects the high pressure liquid from the pump to the hoist port. Any degree of extension of these hoists may be effected, and when the valve plungers are returned to the neutral positions the hoists are held in the positions to which they were extended. To permit them to be retracted under the weight of their loads, the valve plungers are moved to the opposite positions, whereupon the hoist ports are connected to the

respective low pressure discharge pipes 20 and 21, for returning the liquid in the hoists to the reservoir.

Each of identical valves A₁, B₁, C₁ and D₁ is of the double acting variety, so that when its operating plunger is at one end the upper port thereon is connected to the upper port of its corresponding hoist, while the lower port of that hoist is connected to the liquid return pipe to the reservoir. This then permits the delivery of the desired quantity of liquid to the upper end of the hoist and the removal of the corresponding quantity from the lower end. A reversal of the position of the valve plunger reverses the connections, while in the neutral position fluid is locked in the two ends of the hoist to maintain it in whatever position it may have been set. At the same time through by-pass is established as far as this particular valve is concerned.

It will be seen that the upper ports of each of valves A₁, B₁, C₁ and D₁ is connected respectively by pipes 26, 28, 27 and 29 to the upper ports respectively of hoists A, B, C and D, while the corresponding lower ports of these same valves are connected respectively by pipes 30, 32, 31 and 33, respectively, to the lower ports of hoists A, B, C and D.

At S in Fig. 1 is shown a series valve which is illustrated in more detail in Fig. 3. Primarily it comprises means for stopping or permitting fluid flow simultaneously through three sets of passages. This is a two position valve. Valve S has six ports, of which number 34 is connected to pipe 26 leading to the upper member of valve A₁ by pipe 36. The corresponding port on the other side, numbered 38, is connected by pipe 40 to pipe 32. Port 37 of valve S is connected by pipe 39 to pipe 29. Corresponding port 42 is connected by pipe 44 to pipe 30, port 41 is connected by pipe 43 to pipe 27, and corresponding port 45 is connected by pipe 47 to pipe 33.

It will be remembered that when the plungers of valves A₁, B₁, C₁ and D₁ are in the neutral positions the pipes connected thereto are isolated both from the pump and from the reservoir. With this condition existing, if the plunger of valve S is moved to the position for making connection respectively between 34 and 38; 37 and 42; and 41 and 45, then the following fluid circuit may be traced: Pipe 31, bottom port of hoist C, top port hoist C, pipe 27, pipe 43, ports 41 to 45 of valve S, pipe 47, pipe 33, bottom port hoist D, top port hoist D, pipe 29, pipe 39, ports 37, 42 of valve S, pipe 44, pipe 30, bottom port hoist A, top port hoist A, pipe 26, pipe 36, ports 34 and 38 of valve S, pipe 40, pipe 32, bottom port hoist B, top port hoist B, pipe 28. It will be realized that this is not a full and complete fluid circuit, for it is separated into four sections by the respective pistons of the several hoists, but it will be appreciated that if fluid is introduced through pipe 31 and permitted to escape through pipe 28 simultaneously movement of all four hoists in the upward direction will take place, because each hoist displaces from its opposite end the same quantity of fluid introduced into its high pressure end, and acts then as a servo motor for operating the next hoist. The hoists so arranged have all of the advantages in effect in a series circuit and can be operated in either direction by proper control of the fluid thereto to all move in unison and to distances determined by their relative displacements.

Such control for the simultaneous operation of hoists A to D, inclusive, is effected by the con-

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control valve M in bank 18. This valve is of identical construction with all of the other double acting valves A₁ to D₁, inclusive. Its lower hoist port is connected by pipe 50 to port 52 of flow control valve K which when this valve is open connects with port 54, connected by pipe 56 to pipe 31, thus delivering fluid to the lower side of hoist C as above described to actuate the series. Pipe 28 is connected by pipe 51 to port 53 of valve K, which when the valve is open is connected to port 55, which through pipe 57 is connected to the top hoist port of valve M. Thus it will be seen that the valve M may have its plunger pushed in or withdrawn to determine the direction of motion of all four hoists A, B, C and D simultaneously, provided only that all of the plungers of the valves for individual control of these hoists are in their neutral positions and that valve S is open.

The flow control valve K is shown in greater detail in Fig. 4. Its purpose is to regulate the rate at which liquid is returned from the last piston in the series, as affected by opening of valve S, so that it never becomes greater than the rate at which liquid is delivered by the pump to the other end of the series. Thus there is insurance against the load or loads falling away from the liquid forcing its piston or pistons down by virtue of its own weight. This effectively prevents uncontrolled dropping of the load. The valve K operates to control the rate of return of liquid to the reservoir in accordance with the rate of delivery of the fluid by the pump and operates in accordance with and dependent on the pressure in the pump circuit.

Referring now to Fig. 4, it will be seen that the housing 65 is provided with a longitudinal bore having a small diameter central section 66, intermediate counterbores 67 and 68 and finally enlarged and threaded counterbores 69 and 70, closed by hollow screw threaded caps 71 and 72 after the insertion of the valve plunger 74 and its fittings. The housing is provided with two ports 52 and 55, as numbered on the diagram of Fig. 1, which are adapted for direct connection to the two ports of valve M and with two opposed ports 54 and 53, as numbered on the diagram, adapted to be connected to the opposite ends of the series circuit of hoists A, B, C and D. The ports 54 and 53 are respectively extended as bores 76 and 77 intersecting the plunger bore 66 near its opposite ends. Corresponding aligned bores 78 and 79 are connected respectively to ports 52 and 55 by way of chambers 80 and 81, each of which has an enlargement 82, 83, respectively, intersecting the counterbores 68 and 67.

The valve plunger 74 is a generally cylindrical member having a close working fit in the bore 66, provided with end lands 84 and 85 separated by a central groove 86 and adapted to be positioned in the neutral position shown by means of the opposed springs 88 and 89 in the end chambers and hollows of the caps. Each of these springs bears against the inner end of its cap and the radial flange 90 of a guide and stop tube 91 arranged inside of the spring. This flange 90 abuts against shoulder 93 at the junction of the bore 66 and the corresponding counterbore, thereby limiting its inward movement. Each tube and its flange 90 is centralized by means of an integral pin 94 on each end of the valve plunger.

Under conditions of no pressure or equal pressure in the ports 52 and 55 the valve assumes the neutral or closed position shown. If the control valve M is actuated to deliver high pressure liquid to port 52 it will be seen that pressure will be

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built up in chamber 80 and will act against the left end of valve plunger 74, moving it toward the right to allow groove 86 to connect bores 77 and 79 and the left end of land 84 to uncover and connect the bores 76 and 78. High pressure fluid then flows from 52 to 54 via this last mentioned passage and exhaust fluid is returned to the other port of control valve M via 53, 77, 79 and port 55. It is thus evident that sufficient pressure must exist in chamber 80 to overcome the action of spring 89 if the above flow through the valve is to be maintained. If the plunger of valve M is moved to the opposite position the exact reverse operation of valve K is effected.

When exhaust fluid is being delivered to valve K as first described above, it will be clear that if the weight of the load on the hoists tends to move the exhaust liquid faster than the pressure liquid is being supplied by the pump, there will be a drop in pressure in chamber 80 and spring 89 will move plunger 74 to the left to partially or wholly close off communication between the bores 77 and 79 and 76 and 78. Valve K is so proportioned that groove 86 will choke off communication between the bores used to convey the exhaust liquid at a faster rate than the bores conveying the pumped liquid are choked off by the end lands of plunger 74, thus as plunger 74 is moved to the left by means of spring 89, passage of exhaust liquid through the valve is restricted and the rate of flow of said liquid is reduced until this rate is below that of the incoming pumped liquid. This allows the pump to again build up a pressure in chamber 80 to again move plunger 74 to the right. Ordinarily this plunger assumes an optimum position holding the flow of effluent liquid to a rate exactly equivalent to the rate of delivery of the pump to insure complete control of the system.

Valve S for effecting the series connection between the hoists A, B, C, and D is fully illustrated in Fig. 3 and is a simple, suitable valve providing a single plunger for opening and closing off connections between three inlets and their corresponding outlets. The ports have been numbered to correspond with those in Fig. 1. The housing 100 is seen to comprise a rectangular block drilled lengthwise by a single through passage 101 having counterbores at the two ends to accommodate packing and sealing means 102 surrounding the outer ends of the plunger 104. This plunger comprises a cylindrical member having a close working fit in the bore 101 and provided with end lands 105 and 106, respectively, and intermediate lands 107 and 108. The lands are separated by three grooves 109, 110 and 111. In the closed position illustrated passages 38', 42' and 45' connected to the correspondingly numbered ports are closed off by the lands 107, 108 and 106. Passages 34', 37' and 41' open into the bore 101 in the positions occupied by the three grooves. No through passages are now provided. If the plunger is withdrawn to the right until each groove forms a passageway between the cooperating passages such as 41', 45' of a pair, then three through passages are provided as required for the operation of the system.

Mounted on the left end of the housing is a return spring assembly 112 having a portion of it attached by bolt 113 to the outer end of the plunger and serving to maintain the latter in the neutral position as shown, and to return it to this position on the release of the operating handle 114 after the valve has been moved to the open position previously described. The assembly

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is attached by means of screws 115 to the end of the housing.

In Fig. 2 is illustrated in detail the preferred arrangement of one of the multiple control valve banks, in this case that numbered 18 and containing four control valves. The valve assembly of Fig. 2 is not substantially different from that illustrated in Fig. 1 of Stephens Patent No. 2,359,802, granted October 10, 1944, except that all but one of the valve plungers in the instant case are of the double acting variety, as shown at 26 in the patent. Because of the full disclosure in the patent it is believed that only brief mention need be made of the arrangement herein. At 120 is shown the chamber in the housing to which high pressure liquid is delivered by pipe 16 from pump 14. At 122 is illustrated the low pressure chamber to which liquid is returned from the hoists for delivery through pipe 20 to the reservoir. This chamber 122 has a top arm 123 and a bottom arm 124 each extending the full length of the housing 125 of the valve assembly. A relief valve 126 held closed by spring 127 serves to vent chamber 120 to low pressure chamber branch 124 in the event of overloading or excess pressures.

With all of the control plungers 128, 129, 130 and 131 in the neutral position as shown, it will be seen that liquid can flow by the so-called free by-pass from chamber 120 to chamber 122 through the sinuous passage involving the groove in each plunger. If any one of the double acting plungers is moved in either direction from the neutral position shown, or if the single acting plunger is moved downwardly, it will be seen that the appropriate end land thereon will close this through by-pass and permit high pressure liquid to be delivered to the corresponding chamber in one end or the other of the valve plunger in question, from which it is delivered through the check valve therein to one of the hoist ports such as 134 or 135 having top outlets as illustrated in Fig. 1. At the same time liquid returning from the other port of a double acting hoist is delivered via the groove in the outside of the plunger, if it is at one end, or by the appropriate chamber therein if it is positioned at the other end, and returned to the tank, all in accordance with the disclosure in the patent. It will be noticed that the three double acting plungers are all in the same size, since it requires no greater flow of liquid when the plunger 129 of valve M is operated than when any of the individual plungers are operated to obtain the same rate of movement of the pistons in the hoist, because of the series connection used when the valve M is being operated.

It will be appreciated that multiple unit valves may be substituted for the single housing multiple plunger type illustrated in Fig. 2 so as to be more in keeping with the illustration in Fig. 1, but the system is in general independent of the specific type of control valves used as long as they are capable of providing through by-pass and selective connection of the hoist ports to high pressure and reservoir returns.

The system as defined in this application is entirely capable of operation with different numbers of hoists and the appropriate corresponding numbers of control valves. Any desired number of hoists can be arranged in series and others associated therewith for independent or simultaneous operation in groups of two. In review it may be pointed out that in addition to the individual operation of hoists A, B, C, D, E and F the following conditions may be effective: Hoists

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A, B, C, and D may be operated simultaneously and to the same degree by the operation of valves S and M. Hoists E and F may be operated simultaneously to varying degrees by the individual control of their separate valves. Hoist D may be operated simultaneously with hoist A, B or E; hoist C may be operated simultaneously with hoists A, B or E, and hoist F may be operated simultaneously with hoists A, B or E. These latter conditions are possible because of the dual pump and dual control valve combination. Further subdivision of groups with one pump per group is obvious.

The drawings illustrate double-acting hoists capable of individual or series operation and while they are all shown as of the same size and with the piston rods extending through both heads to provide similar displacements at opposite ends, this elementary arrangement is only essential when uniform simultaneous operation of all series hoists is desired. Obviously any or all of the hoists may be of different sizes, lengths of stroke and displacements and need not have the piston rods extending clear through. In fact, the characteristics of the individual hoists of the series may be widely different to provide other desired operational characteristics than those shown in the drawings. It need only be remembered that in series operation the hoists will operate their plungers distances inversely proportional to the displacements of the ends of the hoist which move them. Thus by properly proportioning the effective sizes of the hoists it is possible to get substantially any ratio of extensions and contractions as well as relative speeds of hoist plunger operation in a series system. Since speed of operation of the plunger is in proportion to the relative distance moved, it will be seen that this relates back to displacement so that the hoists will operate at the same speeds when in the series system as they would when individually operated because of the constant displacement characteristics of the pumps.

I claim:

1. In a system for hydraulic hoist control, in combination, a plurality of double acting hoists, a pump, a reservoir, a control valve for each hoist adapted to be positioned to connect the pump thereto to actuate it in either direction or to lock it in any position, a series valve adapted when actuated to connect the hoists in series and a separate control valve adapted to be associated with said series by said series valve to enable the simultaneous actuation of all of the series by said pump in either direction or to lock all hoists.

2. A hydraulic hoist system including in combination, a plurality of double acting hoists, a pump, a reservoir, a control valve for each hoist having "raise," "lower" and "hold" positions, piping connecting said elements into a system, a series valve piped into said system and arranged to connect all said hoists into a series when their respective valves are set to "hold," and an additional control valve effectively connected into the series by said series valve for simultaneous manipulation of all hoists.

3. The system as defined in claim 2 in which all of the hoists are identical and each has equal displacement at the two ends thereof.

4. The system as defined in claim 2 in which said series valve is arranged to open or close one less piping passage than there are hoists in the system.

5. A hydraulic hoist system including in combi-

nation, a plurality of double acting hoists, a pump, a reservoir, a control valve for each hoist having "raise," "lower" and "hold" positions, piping connecting said elements into a system, a series valve piped into said system and arranged to connect all said hoists into a series when their respective valves are set to "hold," an additional control valve effectively connected into the series by said series valve for simultaneous manipulation of all hoists, and a reversible flow-control valve in said system and effective only when said series valve is open to limit the rate of movement of any hoist to that effected by the delivery of liquid thereto by said pump.

6. In a hydraulic hoist system in combination, a plurality of double acting hoists of equal dimensions and each having equal displacement at its two ends, a control valve connected to each hoist and one additional control valve, and all adjustable to "raise," "lower," and "hold" positions, means conducting high pressure liquid to said valves and for conducting return liquid therefrom, a series valve having one less pair of ports than hoists in the series and adapted to open or shut off connections between the ports of each pair, said series valve being connected with each pair of its ports between opposite ends of a pair of adjacent hoists in a series, and the remaining ends of the end hoists in the series being connected to said additional control valve whereby all of the hoists are connected in series under control of said additional valve when the series valve is opened and the individual control valves are at "hold."

7. The system as defined in claim 6 in which a flow-control valve is arranged in the series connections only, said last mentioned valve being constructed to regulate the discharge of liquid from the series to equal that delivered thereto.

8. The system as defined in claim 6 in which a reversible flow-control valve is so arranged in the series connections only and constructed to regulate the discharge of liquid from either end of the series to equal that delivered to the opposite end.

9. In a system for controlling hydraulic hoists, in combination, a plurality of hoists adapted for individual and combined operation, at least some of said hoists being of the double acting type, a control valve for each hoist having "raise," "lower" and "hold" positions, a plurality of constant volume pumps to supply high pressure liquid for operating said hoists, a single reservoir for liquid for all pumps, said valves being arranged in banks, one for and connected to each pump, the valves in each bank including at least one for a double acting hoist and providing through by-pass for the liquid from the pump to the reservoir when all are set to "hold," piping connecting each valve to its hoist, and a single "series" valve piped to each of a plurality of double acting hoists including at least one connected to each valve bank, said series valve being so arranged and piped as when opened to place the selected hoists in series for simultaneous operation by one of said pumps.

10. In a system for controlling hydraulic hoists, in combination, a plurality of hoists adapted for individual and combined operation, at least some of said hoists being of the double acting type, a control valve for each hoist having "raise," "lower" and "hold" positions, a plurality of constant volume pumps to supply high pressure liquid for operating said hoists, a single reservoir for liquid for all pumps, said valves being arranged in banks, one for and connected to each pump, the valves in each bank including at least one for

a double acting hoist and providing through by-pass for the liquid from the pump to the reservoir when all are set to "hold," piping connecting each valve to its hoist, a single "series" valve piped to each of a plurality of double acting hoists including at least one connected to each valve bank, said series valve being so arranged and piped as when opened to place the selected hoists in series for simultaneous operation by one of said pumps and an additional control valve in the bank to which the last mentioned pump is connected for controlling the operation of said series of hoists.

11. In a system for controlling hydraulic hoists, in combination, a plurality of hoists adapted for individual and combined operation, at least some or said hoists being double-acting, a control valve for each hoist having "raise," "lower" and "hold" positions, a pair of independent constant volume pumps to supply high pressure liquid for operating said hoists, a single reservoir for liquid for both pumps, said valves being arranged in two banks, one for and connected to each pump, the valves in each bank including at least one for a double-acting hoist and providing through by-pass for the liquid from the pump to the reservoir when all are set to "hold," piping connecting each valve directly to its hoist, and a single "series" valve having controlled passages connected to the piping of a plurality of double-acting hoists including at least one associated with each valve bank, said "series" valve being so arranged and connected as to place the selected hoists in a "top to bottom" series for simultaneous operation by one of said pumps.

12. The system as defined in claim 11 in which the number of passages in said series valve is one less than the number of hoists in the series.

13. The system as defined in claim 11 in which the number of passages in said series valve is one less than the number of hoists in the series and in which a separate control valve is provided for the series effective only when the series valve is open and the individual valves of the hoists in the series are set at "hold."

14. In a system for controlling hydraulic hoists, in combination, a plurality of hoists adapted for individual and combined operation, at least some or said hoists being double-acting, a control valve for each hoist having "raise," "lower" and "hold" positions, a pair of independent constant volume pumps to supply high pressure liquid for operating said hoists, a single reservoir for liquid for both pumps, said valves being arranged in two banks, one for and connected to each pump, the valves in each bank including at least one for a double-acting hoist and providing through by-pass for the liquid from the pump to the reservoir when all are set to "hold," piping connecting each valve directly to its hoist, a single "series" valve having controlled passages connected to the piping of a plurality of double acting hoists including at least one associated with each valve bank, said "series" valve being so arranged and connected as to place the selected hoists in a "top to bottom" series for simultaneous operation by one of said pumps, a separate control valve for the series arranged in the bank connected to the pump for supplying the series, and a flow-control valve having two independent passages interposed in said series circuit adjacent said separate control valve.

15. The system as defined in claim 14 in which the flow-control valve regulates the size of one of said passages dependent on the pressure in the other passage.

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16. In a system for hydraulic hoist control, in combination, a plurality of hoists in two groups, one group consisting of hoists selected from among single and double acting types and a second group consisting of double acting hoists only, a plurality of pumps, a reservoir, a control valve for each hoist having "raise," "lower" and "hold" positions, said valves being arranged in banks, one for each pump, the valves in each bank including at least one for each group of hoists and serially providing a through by-pass for the liquid from the pump to the reservoir when all are set in the "hold" position, one bank of said valves also including one extra valve, piping connecting each valve to its hoist and a series valve piped to said

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extra valve and to each of the hoists of group two whereby hoists of either group one or group two or both groups connected to valves of different banks may be operated individually or simultaneously when said series valve is closed and said extra valve is in "hold" position and said second group of hoists may be operated simultaneously in series when said series valve is open and said extra valve is positioned in either "raise" or "lower" position and the other valves are positioned in "hold."

17. The system as defined in claim 16 wherein the hoists in group two are of various diameters and stroke lengths.

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