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3 Sheets-Sheet 1

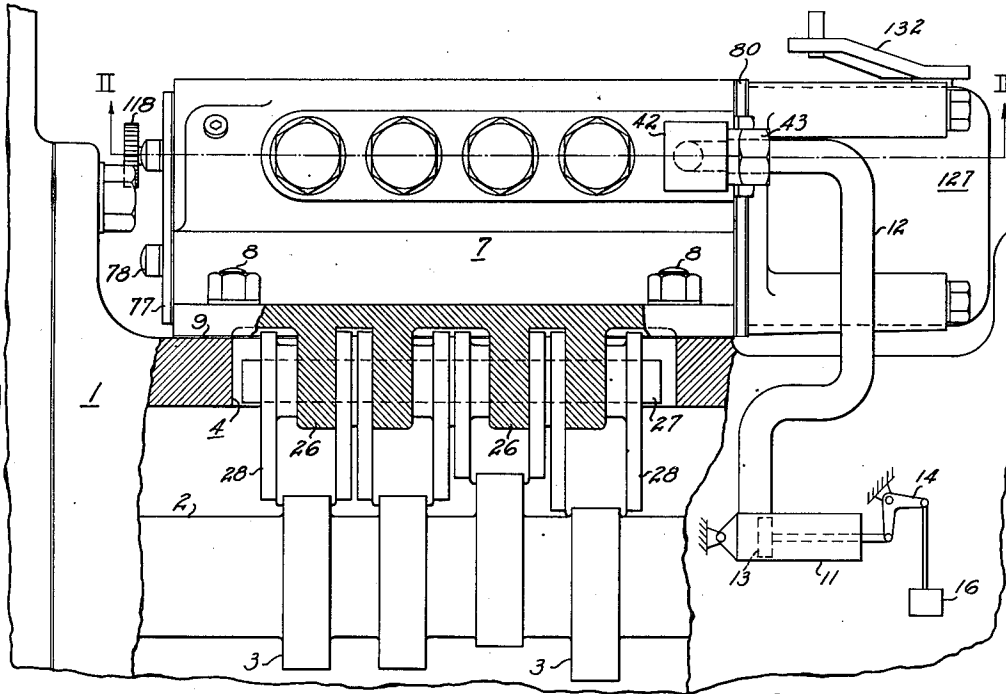


Fig. 1

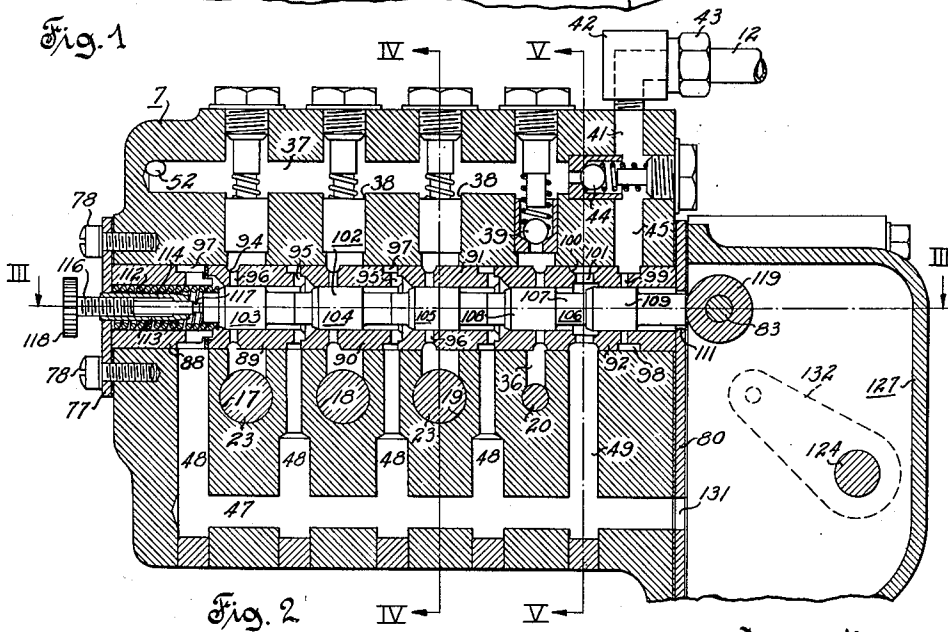


Fig. 2

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3 Sheets-Sheet 2

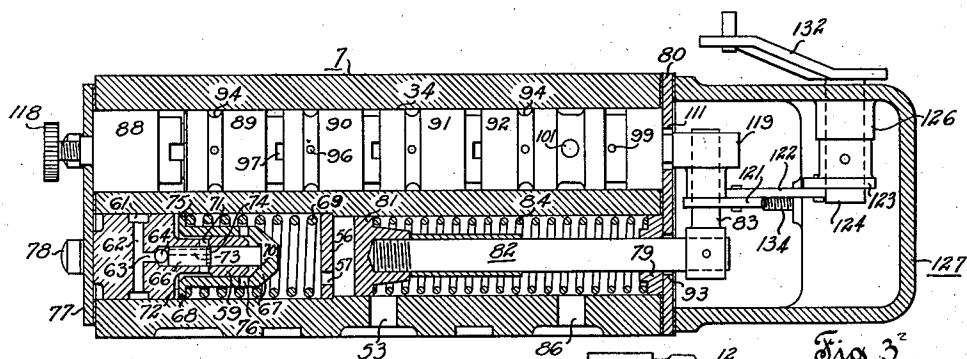


Fig. 3

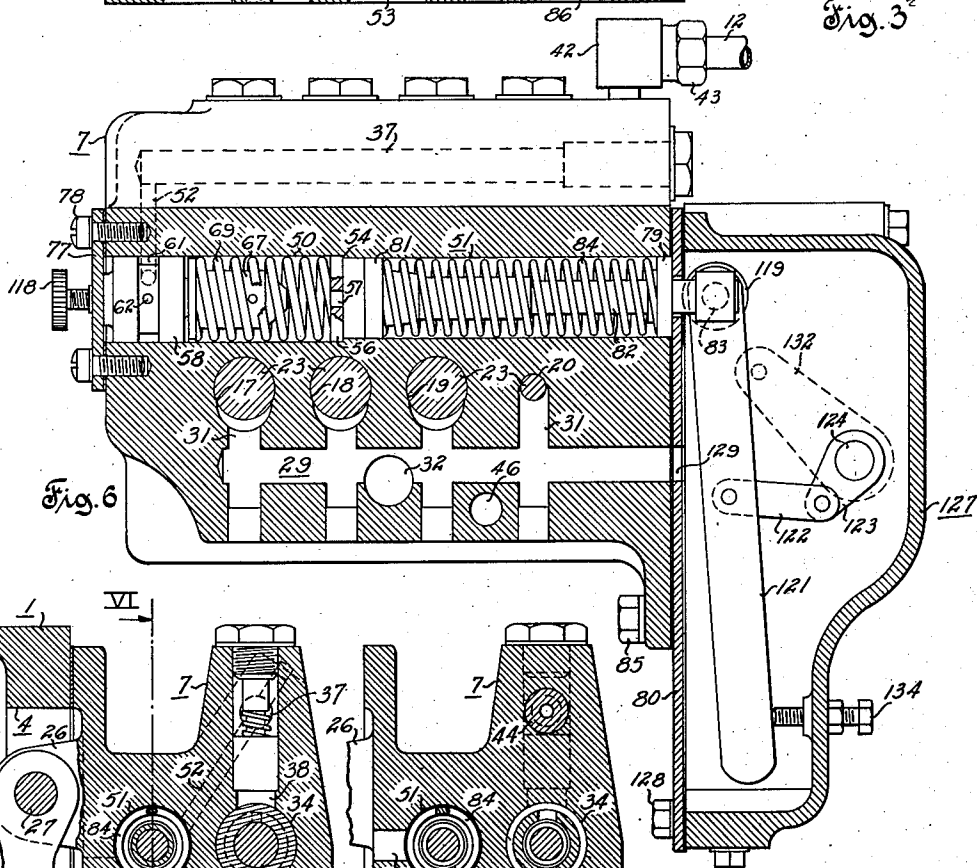


Fig. 6

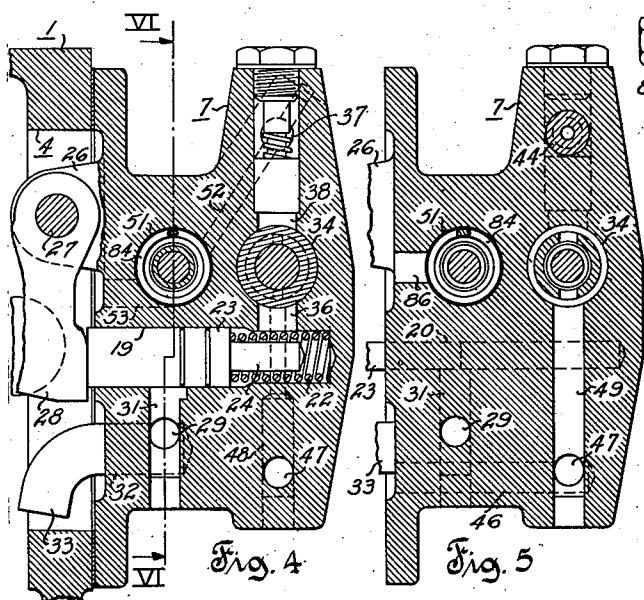


Fig. 4

Fig. 5

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3 Sheets-Sheet 3

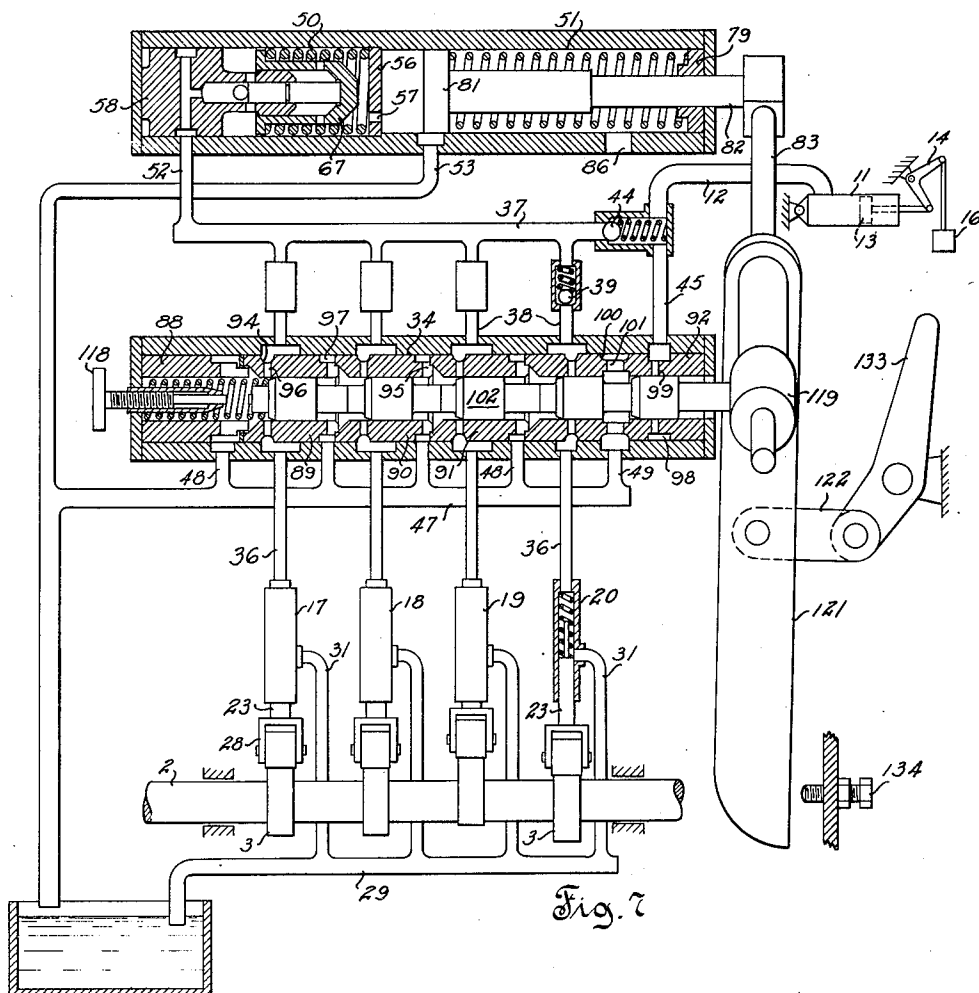


Fig. 7

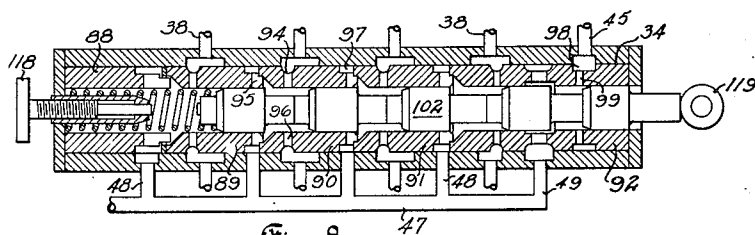


Fig. 8

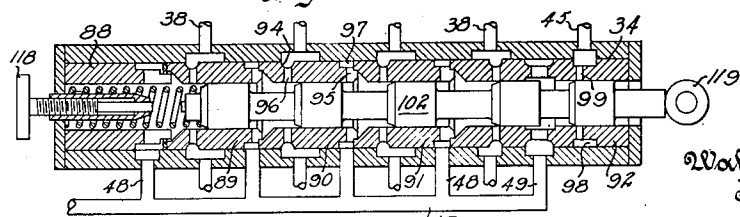


Fig. 9

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Application May 12, 1948, Serial No. 26,516

25 Claims. (Cl. 103—11)

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This invention relates generally to hydraulic control apparatus and is more particularly directed toward apparatus for controlling a hydraulic pump so as to afford a positive variable discharge of pressure maintaining fluid.

It is an object of the present invention to provide a hydraulic pump having parts, including a flow control valve and a pressure relief means, constructed and combined in an improved manner for efficiently decreasing the quantity of pressure maintaining fluid in response to attainment of a predetermined fluid pressure.

Another object of the present invention is to provide a hydraulic pump with control and pressure relief means combined for coaction in a novel and improved manner affording a reduction of hydraulic pressure on the pump upon attainment of a predetermined pressure head and thereafter operating to efficiently maintain a reduced pressure head.

It is also an object of this invention to provide a pump unit, adapted for operating a hydraulic motor, with a control valve and pressure relief means constructed and combined for coaction in an improved manner affording a manual control for selectively varying the quantity of pressure maintaining fluid discharged by the pump, as desired, and also affording means, independent of the manual setting of said control valve, for efficiently decreasing the discharge of pressure maintaining fluid whenever the fluid for operating the motor attains a predetermined pressure.

Still another object of the present invention is to provide a pump unit with a pressure relief and control means combined for coaction in an improved manner operative to efficiently maintain a desired pressure head with a minimum discharge of pressure maintaining fluid.

An additional object of this invention is to provide a multiple plunger pump, adapted for use with a hydraulic ram, with parts including external control means combined for coaction in an improved manner such that a single movement of a control lever results in the ram piston moving to and being hydraulically locked in one of its limiting positions and such that a pressure head sufficient to retain the ram piston locked in its limiting position is maintained through delivery of a minimum quantity of pressure fluid.

The construction and operation of apparatus capable of accomplishing one or more of the above stated objects will become readily apparent as the disclosure progresses and particularly points out the various advantages and other features considered of special importance. And ac-

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cordingly, the present invention may be considered as comprising the various constructions, combinations, and/or subcombinations as is hereinafter more fully set forth in the detailed description and appended claims, reference being had to the accompanying drawings, in which:

Fig. 1 is a partial plan view of apparatus embodying the invention with parts broken away and other parts indicated schematically;

Fig. 2 is a sectional view taken on line II—II of Fig. 1;

Fig. 3 is a sectional view taken on line III—III of Fig. 2;

Fig. 4 is a sectional view taken on line IV—IV of Fig. 2;

Fig. 5 is a sectional view taken on line V—V of Fig. 2;

Fig. 6 is another sectional view taken on line VI—VI of Fig. 4;

Fig. 7 is a schematic showing, partly in section, of the apparatus embodying the invention;

Fig. 8 is a view of the valve structure shown in Fig. 7 indicating a different position thereof; and

Fig. 9 is a view somewhat similar to Fig. 8 illustrating still another position of the control valve.

Referring to Fig. 1 it will be seen that the illustrated embodiment of the present invention comprises a hollow lubricant confining casing 1 operatively enclosing a rotating shaft 2 driven from any suitable power source (not shown) and provided with cam portions 3. A side wall of hollow structure 1 is provided with an opening 4 therethrough which exposes the cam portions 3 on shaft 2. And a hydraulic pump and control unit comprising a housing 7 is detachably secured to the side of hollow structure 1 (as by bolts 8) in covering relation with respect to the opening 4 therethrough. The side of housing 7 opposing opening 4 in hollow casing 1 is provided with marginal surfaces 9 for sealingly engaging the side wall surfaces of casing 1 which bound opening 4. A hydraulic motor 11, in this case a single acting ram unit, is operatively connected with the pump and control unit housing 7 by a conduit 12 for the flow of lubricant to and from the ram. Ram piston 13 is operatively connected with one arm of a bellcrank lever 14 having a weight 16 or other device attached to its other arm for actuation by the ram unit. As shown, the ram is in its retracted position and upon admission of pressure fluid thereto piston element 13 moves to the right and raises weight 16.

Referring also to Figs. 2 to 6, inclusive, it will be apparent that the side of pump housing 7 enclosing the opening in hollow structure 1 is

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provided with four inwardly extending parallel cylindrical chambers 17, 18, 19 and 20, chambers 17, 18 and 19 being of equal diameter and chamber 20 having a materially reduced diameter. A compression spring 22 (see Fig. 4) is positioned within each chamber at the inner end thereof and each chamber includes a pump plunger 23 having a reduced inner end portion 24 disposed in guiding relation within the associated compression spring 22. The side of housing 7 adjacent hollow casing 1 is also provided with outwardly extending projections 25 having aligned holes therethrough receiving and fixedly mounting a shaft or rod part 27 disposed at a right angle with respect to the axes of pump plungers 23 and generally parallel to a plane therethrough. And a plurality of cam followers 28, one for each pump, are pivotally supported on shaft part 27 for swinging movement relative thereto and relative to each other, the lower end portions of these followers being disposed between the outer ends of pump plungers 23 and the opposed cam portions 3 on shaft 2 thereby establishing an operative connection between power driven shaft 2 and pump unit 6. (See Fig. 1.)

Pump housing 7 is provided with an intake manifold passage 29 severally communicating with pump chambers 17 to 20 through intake passages 31 and communicating with the lubricant in hollow structure 1 through a main intake passage 32 terminating in the adjacent side of housing 7 below the pump plungers therein. Passage 32 includes an extending conduit portion 33 (see Fig. 4) projecting outward therefrom through the opening 4 and downward into the fluid confined in hollow casing 1. Housing 7 is also provided with a cylindrical valve chamber 34 which extends therethrough in spaced overlying relation with respect to pump cylinders 17 to 20 and in parallel right angle relation thereto. A plurality of passages 35, one for each pump, severally connect the inner or discharge ends of the pump cylinders with longitudinally spaced portions of cylindrical valve chamber 34. In addition, housing 7 includes a horizontal bore 37 which is disposed above valve chamber 34 in generally parallel relation thereto and which is connected therewith through a group of passages 38 corresponding in number to pump discharge passages 35. And in this connection it should be noted that passages 38 communicate with valve chamber 34 in diametrically opposed relation to passages 35. Each passage 38 is provided with a spring biased ballcheck valve 39 controlling the flow of fluid therethrough and into bore 37. This bore, which may be considered a manifold space, communicates at its right hand end (note Figs. 1 and 2) with an outlet passage 41 for working fluid which terminates in an upwardly extending pipe connection 42 provided with a suitable connector 43 for coupling a ram hose or the like thereto. Communication between outlet passage 41 and manifold space 37 is controlled by a spring biased ballcheck valve 44 preventing a back flow of fluid from passage 41 into the manifold space. In addition it should be noted that this discharge fluid passage 41 has a branch portion 45 on the discharge side of check valve 44 placing same in communication with the right hand end of cylindrical valve chamber 34.

Housing 7 is also provided with a main fluid return passage means comprising a horizontal bore opening 46 through the side surface of the housing closing the opening in hollow casing 1

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at a point somewhat below and to one side of intake conduit 33 (Fig. 6). The inner end of return passage bore 43 communicates with a bore 47 at right angles thereto (Fig. 5) which extends nearly through the pump housing in generally parallel relation to and below valve chamber 34. This bore 47 is also disposed below pump chambers 17 to 20 and a plurality of passages 43 corresponding in number to pump discharge passages 35 place this bore in communication with longitudinally spaced portions of cylindrical valve chamber 34, these passages 43 being disposed adjacent the pump cylinder chambers and the passages 35 severally connecting the discharge side of the pumps with longitudinally spaced portions of cylindrical valve chamber 34 as previously described. Another passage 49 places main return passage bore 47 in communication with a right end portion of valve chamber 34 in longitudinally offset diametrically opposed relation with respect to the branch portion 45 of outlet passage 41.

In addition, housing 7 is provided with a cylindrical unloading chamber 51 extending therethrough in laterally spaced parallel relation with respect to cylindrical valve chamber 34 and on a horizontal level therewith. The left hand end of manifold bore 37 communicates with the adjacent end of unloading chamber 51 by means of a passage 52 (Fig. 6) and an intermediate portion of this unloading chamber communicates with a horizontal discharge passage 53 (Figs. 3 and 4) opening through the side surface of the pump housing above the pump chambers.

The left end portion 50 of unloading chamber 51 is somewhat enlarged to provide an internal shoulder 54 against which is positioned a disk type spring seat 56 having an opening 57 therethrough. The opposite or left hand end of chamber portion 50 is closed by a cylindrical plug element 58 having an inner end portion 59 of reduced diameter projecting axially toward spring seat 56 in spaced relation with respect to the surrounding wall of chamber 51. The left hand end of plug member 58 is provided with a circumferential external groove 61 communicating with passage 52 leading thereto from manifold space 37. A transverse bore 62 connects diametrically opposed portions of groove 61 with a central bore 63 which extends inward from transverse bore 62 and coaxially through the reduced portion 59 of plug member 58. Central bore 63 is enlarged from a point adjacent transverse bore 62 to the discharge side thereof to provide a seat for a ball valve 64 and to receive cylindrical valve element 65. A cylindrical spring seat element 67 slidably surrounds the reduced end portion 59 of plug member 58 and is provided at its open end with a peripheral flange 68 slidably engaging the internal surface of unloading chamber portion 50, this flange also affording a seat for a compression spring 69 disposed between same and disk seat 56. The inner end of element 67 is provided with an internal recess forming a cylindrical seat 70 receiving the inner end of cylindrical valve element 66 which, through the action of spring 69, acts to hold this valve element and ball valve 64 positioned as shown in Fig. 3, that is, with the ball valve firmly engaged with its seat thereby preventing a flow of fluid therepast from manifold 37. And when thus positioned, it will be noted that the flanged end of spring seat element 67 is spaced from the opposed inwardly facing shoulder presented by plug member 58. The reduced portion 59 of plug

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member 58 is provided with a transverse bore 71 therethrough and is further reduced from its junction with the main portion of the plug member 58 inward to point beyond transverse bore 71 so as to provide an annular relief passage 72 which communicates with the spring housing portion of chamber 50 through one or more axial slots 75 in the peripheral edge portion of flange 68. Cylindrical valve element 66 is also provided with an axial bore 73 extending from the ball valve end thereof approximately to its midpoint where it communicates with a circumferential groove 74 adapted to place the space between the end of valve element 66 and the seat for ball valve 64 in communication with the transverse bore 71 in plug member portion 59, thus providing a relief passage means for the space surrounding ball valve 64 when seated as shown in Fig. 3. Also, the inner end portion of cylindrical spring seat element 67 is provided with transverse bore 76 therethrough for relief of liquid tending to accumulate between same and the inner end of plug member reduced portion 59.

The left hand end of unloading chamber 51 and of cylindrical valve chamber 34 are closed by a cover plate 77 secured in end abutting relation to housing 7 by means of cap screws 78 or the like. The right hand end of unloading chamber 51 mounts a cylindrical spring seat 79 and is closed, as is also the corresponding end of valve chamber 34, by means of a cover plate 80 fixedly secured thereto by one or more cap screws 85. A pressure responsive piston 81 is mounted in unloading chamber 51 in down stream relation with respect to spring seat disk 56 and is detachably connected with a movement transmitting rod 82 which extends coaxially through cylindrical spring seat 79 and through an aligned and somewhat enlarged opening 93 in cover plate 80. The outer or exposed end of control rod 82 is fixedly connected with and carries a stub shaft 83 which projects at a right angle therefrom in the direction of valve chamber 34 and in generally parallel relation to cover plate 80. A compression spring 84 is interposed between seat 79 and the opposed end of piston 81 in surrounding relation to piston rod 82, this spring acting to move the piston toward the left as viewed in Fig. 3 in closed relation with respect to fluid return passage 53. It will be noted that the right hand end of unloading chamber 51 is provided with another fluid return passage 86 (Fig. 3) opening through the side face of the housing enclosing opening 4, this additional passage functioning to return any liquid tending to become trapped between piston 81 and cylindrical spring seat 79.

Referring again to Fig. 2 it will be seen that a cylindrical liner comprising axially separable sections 88 to 92 is disposed in cylindrical valve chamber 34 with innermost section 92, that is, the section adjacent the right hand end of chamber 34, abutting cover plate 80. The opposite end section 88, that is, the section at the left hand end of chamber 34 is held in position by end abutting engagement with cover plate 77. Cylindrical sections 88 to 92 are provided with circumferential external grooves 94 placing pump discharge passages 36 in communication with check valve control passages 38. In addition each section is provided with transverse bores 96 (see also Fig. 3) placing the interior thereof in communication with diametrically opposed pairs of passages 36 and 38. Furthermore the end abutting

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portions of cylindrical sections have parts thereof cut away and shaped to afford circumferential external grooves 97, rectangular in cross section, each of which communicates with the interior of the chamber formed by these sections through diametrically opposed transverse passages 95. The rectangular external passages 97 formed between end portions of cylindrical liner sections 88 through 92 communicate with passages 48 placing same in communication with the main fluid return passage 47. In addition, the innermost cylindrical section 92 is provided with two circumferential external grooves, the innermost groove 98 communicating with ram outlet passage 41 and having a transverse bore 99 therethrough placing diametrically opposed portions of grooves 98 in communication with the interior of section 92, and a second groove 100 communicating with a passage 49 which in turn communicates with the right hand end of main fluid return passage 47. Groove 100 also communicates with the interior of liner section 92 through diametrically opposed transverse bores 101.

A cylindrical control valve 102 is positioned in the generally cylindrical chamber formed by the end abutting liner sections 88—92 and preferably this valve is formed by a series of separable cylindrical elements, 103—106 inclusive, disposed in end abutting relation, the end abutting portions of these cylindrical valve elements being reduced to form annular spaces between same and the surrounding internal surfaces of the liner sections. In this connection it should be noted that the right hand or innermost valve element 106 comprises an intermediate reduced portion 107 uniting enlarged cylindrical portions 108 and 109 which in turn terminate in reduced oppositely projecting end portions, the inner one of which abuts the reduced portion on adjacent element 105 and the other of which projects through a coaxial opening 111 in cover plate 80. The valve elements are held in end abutting relation for movement as a unit by means of a compression spring 112 seated on valve element 103 in surrounding relation to the reduced outer end portion thereof with its opposite end abutting the inner surface of cover plate 77. Movement of the valve element to the left as viewed in Fig. 2 may be adjustably limited through the medium of an inwardly projecting part 113 carried by cover member 77, this part having an internally threaded bore 114 extending therethrough in which is adjustably mounted a screw threaded element 116 having a reduced end portion 117 disposed in coaxial abutting relation with respect to a similar projection on the adjacent valve element 103. The outer exposed end of element 116 is provided with a knurled adjusting knob 118.

Referring more particularly to Figs. 3 and 6 it will be noted that the shaft portion 83 carried by control rod 82 operatively mounts a roller 119 positioned in opposed engaged relation with respect to the reduced end portion of the innermost valve element 106 which extends through cover plate 80. Shaft 83 also has connected therewith the upper end of a lever 121 having an intermediate portion thereof pivotally connected with a link 122 which in turn is pivotally connected with an arm 123 fixed to an inner end portion of a shaft 124 rotatably supported in a bearing structure 126 carried by control linkage housing 127. This housing is detachably secured in abutting sealed relation against cover plate 80 by means of suitable cap screws or the like 128. And in this connection it should be noted that cover plate 80

is provided with suitable openings 129 and 131 which are aligned with and place main inlet passage bore 29 and main return passage bore 47, respectively, in communication with the interior of the linkage housing 127. Consequently this housing contains oil at a level conforming with that in hollow structure 1. The outer end of shaft 124 has a lever arm 132 fixed thereto which in turn may be connected through a link or other means (not shown) with a suitable manually actuable control lever 133 as indicated in Fig. 7. The bottom portion of housing 127 is provided with an adjustable stop means 134 positioned in opposed engageable relation in respect to the lower edge of lever 121. Spring 84 in unloading chamber 51 is relatively strong as compared with the spring 112 acting on control valve 102 and consequently piston 81, control rod 82 and valve 102 tend to assume the position shown in Figs. 2 and 3. However, it should be noted that the manual control lever 133 may be moved so as to shift the fulcrum for lever 121, that is the fulcrum afforded by the connection of link 122 to an intermediate portion of lever 121, and thereby move the rod 82 and piston 81 toward the right as viewed in Fig. 4 which in turn compresses spring 84. As a result of such movement, spring 112 urges control valve 102 toward the right (note Fig. 3) and acts to maintain the reduced right-hand end of this valve in engagement with roller 119. Movement of the valve 102 in the direction just described, that is, toward the right is limited by engagement of the enlarged portion 109 of valve element 106 with cover plate 80.

When operating with the parts positioned as shown in Figs. 2 and 3, it will be noted that the enlarged cylindrical portions of the valve elements 103—106 inclusive, close transverse bores 96 and that, therefore, the pumps are severally connected with manifold space 37 through passages 36, external grooves 94, and through check valve controlled passages 38. The liquid entering manifold space 37, assuming all liquid has been drained from the ram 11, flows therefrom through check valve control passage 41 and quickly attains a pressure sufficient to rapidly effect a weight lifting power stroke or expansion of the ram unit. When this occurs the pressure of the liquid in manifold space 37 continues to increase until the pressure attained is sufficient to unseat pressure relief ball valve 64 whereupon the check valve assembly comprising ball valve 64 and cylindrical valve element 66 moves toward the right compressing spring 69 until a valve element 66 opens transverse pressure relief bore 71. When this occurs, pressure fluid flows there-through into annular space 72, then through the axial passages 75 in the periphery of flange portion 63 of spring seat element 67, then into the spring housing chamber from which it flows through the opening 57 in disk valve seat 56 and then into the space between this seat and the head of piston 81. This pressure fluid then acts on piston 81 and moves same toward the right thereby opening relief passage 53, which is in communication with the source of oil in hollow structure 1 and in linkage housing 127. This movement of piston 81 results in a movement of control rod 82 toward the right sufficient to bring the lower end of lever 121 into engagement with the side of cover plate 80 which engagement limits the movement of the piston 81 and control rod 82 in this direction. As a result spring 112 causes control valve 102 to move toward the right in following engaged relation to roller part 119 and to the position indicated in Fig. 7. In this

position, the enlarged bore controlling portions of valve elements 103, 104 and 105, place transverse bores 96 in the associated liners in communication with return passages 48 thereby severally connecting the discharge sides of pumps 17, 18 and 19 in communication with the main return passage bore 47. However, it should be noted that the enlarged portions 108 and 109 of valve element 106 remains in closed relation with respect to transverse bores 96 and 99, respectively, and therefore pump 20 continues to deliver fluid through circumferential groove 110 and into manifold space 37 through the associated check valve control passage 38.

It should be noted that the end area of cylindrical relief valve element 66 is considerably greater than the area of the passage controlled by ball valve 64 and that consequently it requires a relatively high pressure to effect an initial opening movement of these two valves. However, once an opening relation is established, the increase in effective area afforded by cylindrical relief valve element 66 operates to maintain the relief passage means open under a considerably reduced pressure head. Therefore, in the position just described, that is, the unloading position of main control valve 102, three plungers 17, 18 and 19 are delivering fluid to the return passage means 47 whereas only one plunger 20 is delivering fluid to the manifold space 37 and this fluid, assuming there is no appreciable leakage from the ram circuit, returns to the source through the relief means comprising passage 52, bores 62 and 63 in plug element 58, relief valve elements 64 and 66, transverse bore 71 in plug element reduced portion 59, passages 72 and 75, the opening 57 through disk seat 56, and passage 53. In this connection it may be well to note at this time that although the enlarged cylindrical flow controlling portions of valve 102 are of substantially equal axial length, the reduced portions are of different axial lengths and in addition the axial spacing of the circumferential grooves 94, 97, 100 and 98 and of the transverse bores or passages 95, 96, 101 and 99 connected therewith vary somewhat as to their axial spacing so as to afford the above mentioned regulation in response to an unloading movement of the control valve.

In the absence of excessive leakage, more particularly leakage through the flexible hose 12 and the connections between such hose and the ram cylinder 11 and pump housing 7, the main control valve will remain in its unloading position until the fulcrum of lever 121 is shifted by actuation of manual control lever 133. Under these conditions the hydraulic ram unit 11 will remain in its extended weight lifting position but if for any reason the pressure in manifold space 37 should decrease below that necessary to hold ball valve 64 and cylindrical relief valve 66 in their passage opening positions (note Fig. 7), these valves will close the relief passage means 52 and as the liquid drains from the space ahead of piston 81, the spring 84 will move the piston and control rod 82 to the left thus repositioning the main control valve 102 to connect all pumps with the check valve control passages 38 leading to manifold space 37, this initial position of the main control valve being determined, as previously indicated, by the position of manual control lever 133.

However, if with the control valve 102 in either its full lift or unloading positions previously described it becomes desirable to lower the weight, all that has to be done is to move manual control

lever 133 in a direction effective to shift the fulcrum for lever 121 away from cover plate 80 a distance sufficient to permit spring 112 to move the main control valve 102 to the right until the enlarged end portion 109 thereof engages cover plate 80 as shown in Fig. 8. This position, termed the lowering position of the valve, places the discharge sides of all pumps and the ram relief passage means 45 and 99 in communication with return passages 48 and 49 which in turn are in continuous communication with the main return passage means 47. Under these conditions liquid rapidly drains from the ram circuit, the ram piston moving to its retracted position through gravity action of the weight or other means actuated thereby. In other words, if the weight were to be considered as representing an agricultural implement or other load, movement of the valve 102 to its lowering position rapidly drops the implement onto the ground. If, however, it is desired to gradually lower the weight or implement onto the ground, this can be readily accomplished simply by moving the main control valve 102 so as to just barely open the passage means 99 placing the ram relief passage 45 in communication with the return passage means 49 and 47. And if in this connection it should be desired to place all pumps in communication with the return passage means 47 through passages 48 and yet retain the ram in its extended position, this can be readily done by manually shifting the fulcrum of lever 121 so as to position the main control valve 102 as indicated in Fig. 9. When thus positioned, it will be seen that the enlarged portion 109 of the cylindrical control valve 102 closes the transverse bore 99 placing the ram relief passage in communication with the return passage means 49 and 47.

It should also be obvious that in addition to the various positions of the main control valve 102 hereinbefore described, the valve may be also positioned by a manual shifting of the fulcrum for lever 121 so as to, if desired, effect a ram expanding action by connecting the discharge sides of two or more pumps with the check valve control passages 38 connecting same with manifold space 37. And while it is normally intended that the enlarged cylindrical portions of the main control valve 101 will be positioned so as to either open or close the radially extending transverse bores or passages placing the circumferential external grooves in communication with the interior of the valve chamber formed by the liner sections, it should be obvious that the valve elements may be positioned so as to only partially open one or more transverse passages. Furthermore, it should be apparent that while the particular arrangement of the passages and valve elements herein shown for purposes of illustration constitutes a preferred embodiment of the present invention, other arrangements can be readily made as desired simply by changing the actual spacing of the control passages, circumferential grooves and/or the axial length of the enlarged passage controlling portions of the valve elements.

Referring again to Figs. 2, 7, 8, and 9, it will be apparent that the position of valve 102 determines whether the weight, implement or device connected with the ram unit is to be raised, lowered or held in a selected position and, if the weight is being either raised or lowered, the rate of movement thereof. In addition, it should be apparent that irrespective of the rate of lift, as soon as the pressure head on the pump attains a predetermined value, the relief passage

means is immediately opened through the co-action of ball valve 64, cylindrical valve element 66, and piston 81. Furthermore, if the lift position of valve 102 is such that more than one plunger is delivering fluid to manifold space 37, opening of the relief passage means results in an immediate movement of this valve to its unloaded position shown in Fig. 7. In any case, once the relief passage means is initially opened in response to attainment of a pressure sufficient to unseat ball valve 64, it is held open by the then dominating action of cylindrical valve element 66 thereby effecting a material reduction in pressure head, as previously described.

In the operation of hydraulic motors, and more particularly ram units, a high initial pressure is usually required to overcome the inertia of the load and/or effect a desired acceleration thereof. And in order to rapidly effect a complete power stroke, the capacity of the liquid supplying pump must be such as to quickly establish and maintain an effective pressure for any rate of ram displacement. However, upon completion of a load shifting or moving power stroke, generally only a fraction of the initial pressure is required to retain the load in the position to which it has been shifted. For example the operation of a ram system such as herein disclosed, particularly if applied to various types of agricultural implements, may require a power stroke pressure of as much or more than 3500 pounds per square inch and a load retaining pressure of only 1200 pounds per square inch. In addition, if it were possible to maintain perfect seals, particular reference being had to the seating of valves 39 and 44 and the sealing action of the enlarged portion 109 of main valve section 106, operation of the pump means could be discontinued providing ram operation is infrequent. Usually, however, the ram is frequently operated and its operation is nearly continuous when applied as a draft regulating device. Consequently, the feature of effecting a reduction in pressure head as previously pointed out is important in that it not only reduces pump load and heating, both of which are detrimental to pump life, but it also efficiently compensates for leakage and conditions the system for an immediate response to load requirements.

It should also be apparent that the unloading of the pump be done quickly and automatically whenever a reduction in pressure head is feasible in order to minimize both operating and maintenance costs. This automatic rapid unloading of the pump is readily achieved by apparatus embodying the invention and is an important feature for the reasons just stated and for the further reason that it eliminates the possibility of damage which might result from failure of an operator to quickly effect the necessary regulation. Still another feature of importance afforded by the unloading control herein disclosed is that it eliminates the use of an accumulating chamber for pressure liquid in order to maintain the system conditioned for ready response to load requirements. Consequently, this feature also lends itself to the construction and use of a compact pump and control device.

Thus far the valves 39 and 44 have been considered as spring biased check valves and no mention has been made as to the degree of biasing action afforded by the springs associated therewith. However, it should be apparent that the pressure maintaining action afforded by these valves may be varied as desired simply by the

selection of suitable springs. For example, the strength of the spring associated with valve 44 may be such that this valve actually controls the discharge of working fluid from manifold space 37 or merely prevents a return flow of liquid into manifold space 37 in the event the pressure therein should become less than the pressure in passage 41. And in applying apparatus embodying the invention to the control of a ram unit as herein disclosed, the valve 44 could be omitted without materially affecting operation, since the primary function of this valve is to prevent a pressure relieving back-flow of liquid from the ram into manifold space 37. Consequently, it should be obvious that although certain advantages are afforded by the use of back-flow preventing valves in the working fluid passage means connected with a ram unit or like device, the invention in its broad aspects is applicable to any hydraulic apparatus utilizing a pressure maintaining pump and a valve means selectively positionable to vary the volume of pressure maintaining fluid discharged by the pump.

As to the advantages afforded by the inclusion of check valves 39 and 44, it should be apparent that when the pump unit is applied to a draft regulating device valve 44 prevents the relief mechanism from responding to pressure surges or impulses transmitted to the system whenever the ram operated by the pump unit is subjected to a shock load. And, in the event that valve 44 sticks in a passage opening position, valves 39 provide protection for plungers 23 and parts associated therewith by preventing the back pressure created by action of the shock load on the system from reaching the plunger chambers. Furthermore, should the pump operating means stop for any reason while control valve 102 is in its lift or unloaded position ball valve 44 will seat itself and the fluid in the ram and passage 41 will be locked therein preventing the weight or implement being lifted by the ram from dropping suddenly and causing possible damage. And, as previously mentioned, when valve 102 is in hold position (Fig. 9) with no pumps delivering to space 37 valves 39 prevent any leakage past valve 44 from being transmitted back through passage 38 to the plunger chambers. In the last mentioned case, if valves 39 are biased sufficiently they will also serve to keep fluid discharged from the pumps from entering manifold 37 instead of flowing back to the source by way of grooves 97, passages 95, and return passage means 48. Also, when less than all of the pumps are used for lifting, valves 39 are necessary to prevent a return flow of fluid from manifold 37 through those passages 38 which are in communication with return passages 48 through the interior of the valve chamber.

It will also be noted that the previously mentioned unloading feature is of additional advantage in the event the manual control is in lift position and the ram is subjected to an excessive load. In such event the pump continues to attempt to lift the load until a predetermined maximum (unloading) pressure is built up in manifold 37 at which instant the unloading and relief mechanism in chamber 51 functions, as previously described, to relieve manifold 37 of excess pressure fluid and also to reduce the number of plungers 23 delivering to space 37. When the excess load ceases to exist the pressure in passage 41 and in the ram cylinder drops below the pressure in space 37 and valve 44 opens to thereby

reduce the pressure in space 37 and permit the ball valve and piston assembly in unloading chamber 51 to reseal itself. The return of the unloading mechanism to a passage closing position causes control valve 102 to move back to a full lift position and fluid is once more directed to the ram. Thus, there is provided a relief means which reduces the number of plungers delivering to the manifold space as long as the excess load exists and then automatically cuts the plungers back into communication with the manifold when the excess load disappears. This feature is of considerable importance in reducing the wear on the pump structure which otherwise might be considerable, particularly when relatively high pressure fluid is being used in the system.

And although the invention is illustrated as applied to a multiple plunger pump-ram combination, it is to be understood that certain of the objects can be accomplished either with or without the inclusion of a ram unit or other form of hydraulic motor and that it is not intended to limit the invention to the exact constructions and combinations herein shown and described as certain features thereof are of more general application and as various modifications within the scope of the appended claims may occur to persons skilled in the art.

It is claimed and desired to secure by Letters Patent:

1. In a hydraulic apparatus including a pump means, means defining a valve chamber in continuous communication with said pump means for receiving pressure fluid therefrom, a fluid return passage means communicating with said valve chamber, and a working fluid passage means communicating with said valve chamber and with said return passage means through inlet and relief valves respectively of a nature operating to maintain the fluid confined therein at a predetermined working pressure, and including a control valve in said chamber positionable to selectively connect said pump means with either said working fluid passage means or said return passage means, or with both, the combination of an unloading control comprising a part responsively associated with said relief valve and being operatively connected with said control valve so as to move the latter to a position wherein less fluid is delivered to said confining space in response to a pressure relieving actuation of said relief valve.

2. In a hydraulic apparatus including a source of fluid, a plurality of pumps, means defining a valve chamber in continuous communication with said pump means for receiving pressure fluid therefrom, a return passage means placing said valve chamber in communication with said source, and a pressure fluid confining space having a valve controlled outlet for working fluid and communicating with said valve chamber and with said source of fluid through inlet and relief passage means including check valves controlling the flow of fluid therethrough, and including a control valve in said chamber selectively positionable to connect one or more of said pumps with said inlet passage means and the remaining pumps, if any, with said return passage means, the combination of a relief and unloading means comprising a part associated with said relief passage means and movable in response to fluid pressure exerted thereon as a result of movement of the relief passage check valve to a position estab-

lishing a flow of fluid therepast, and means operably connecting said part with said control valve so that movement of the former results in movement of the latter to a position preventing the flow of fluid between one or more of said pumps and said working fluid passage.

3. In a hydraulic apparatus including a pump means, means defining a valve chamber receiving pressure fluid from said pump means, a fluid return passage means communicating with said valve chamber, and a working fluid passage means communicating with said valve chamber and including check valves therein biased to establish a pressure fluid confining space therebetween, and including a valve in said chamber manually positionable to selectively connect said working and return passage means jointly and severally with the discharge side of said pump means, the combination of a pressure relief and unloading control comprising a relief passage means placing said pressure fluid confining space in communication with said return passage means, and means controlling flow of fluid through said relief passage means and including a part operatively connected with said valve, said means initially responding to attainment of a predetermined high pressure in said fluid confining space to open said relief passage means and move said valve to a pump unloading position wherein less fluid flows into said confining space, and then operating in response to a relatively low pressure in said confining space to maintain said relief passage means open for flow of fluid therethrough and said valve in its said pump unloading position.

4. In a hydraulic apparatus including a pump means, means defining a valve chamber receiving pressure fluid from said pump means, a fluid return passage means communicating with said valve chamber, and a working fluid passage means communicating with said valve chamber and including check valves therein operative to establish a pressure fluid confining space therebetween, and including a valve in said chamber manually positionable to selectively connect said working and return passage means jointly and severally with the discharge side of said pump means, the combination of a pressure relief and unloading control comprising a relief passage placing said pressure fluid confining space in communication with said return passage means, a flow control means for said relief passage including a first portion of small area subjected to the pressure in said fluid confining space and a second portion of considerably larger area which is subjected to the pressure in said fluid confining space as a result of said first portion moving to its passage opening position, and additional means operatively connected with said valve to move same as a result of a movement of said flow control means to its passage opening position, said flow control and additional means initially operating in response to attainment of a predetermined high pressure in said working fluid passage means to open said relief passage and move said valve to a pump means unloading position wherein less fluid flows into said fluid confining space, and then operating in response to a relatively low pressure in said working fluid passage means to maintain said relief passage means open for flow of fluid therethrough and said valve in its said pump means unloading position.

5. In a hydraulic apparatus including a plurality of pumps, means defining an intake pas-

sage for said pumps, a valve housing severally communicating with the discharge sides of said pumps, a fluid return passage means in communication with said valve housing, a working fluid passage means communicating with said valve housing and including valves establishing a pressure fluid confining space, and a pressure relief passage means placing said pressure fluid confining space in communication with said return passage means, and including a control valve in said housing positionable to selectively connect the discharge sides of said pumps with said working and return passage means or with either said working passage means or said return passage means, the combination comprising means controlling the flow of fluid through said relief passage and including a part operatively connected with said control valve, said means operating in response to attainment of a predetermined pressure in said pressure fluid confining space to open said relief passage and move said control valve to a position wherein one or more of the pumps is prevented from delivering fluid to said confining space.

6. A hydraulic apparatus comprising a source of fluid, a plurality of pumps, means defining an intake passage placing said pumps in continuous communication with said source, a valve chamber severally communicating with the discharge sides of said pumps, a first return passage means placing said valve chamber in communication with said source, a manifold space, a plurality of separate passages, one for each pump, connecting said valve chamber with said manifold space, a valve controlled outlet to said manifold space, and a second return passage means placing said manifold space in communication with said source, a control valve in said chamber selectively positionable to connect one or more of said pumps with said separate passages and the remaining pumps with said first return passage means, an additional control for said pumps including a movable element controlling the flow of fluid through said second return passage means and operative in response to attainment of a predetermined pressure in said manifold space to open said second return passage, and means operably connecting said movable element with said control valve so that a passage opening movement of said element results in a movement of said control valve to a position wherein a fewer number of said pumps are delivering fluid to said pressure manifold.

7. In a hydraulic apparatus comprising a source of fluid, a plurality of pumps, means defining an intake passage placing said pumps in communication with said source, a valve chamber, pump outlet passages severally connecting said pumps with said valve chamber, a fluid return means connecting said valve chamber with said source of fluid through a first group of passages conforming in number and generally related to said pumps, a manifold space communicating with said valve chamber through a second group of check valve controlled passages conforming in number and generally related to said pumps, a valve controlled outlet to said manifold space, and defining a relief passage means placing said manifold space in communication with said source, and comprising a control valve in said chamber positionable to selectively severally connect one or more of said pumps with one or more of said first group of passages or with one or more of said second group of passages, the combination of a pressure relief and unloading control in-

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cluding an element movable in response to attainment of a predetermined pressure in said manifold space to open said relief passage means for the flow of fluid therethrough, and including means connected with said control valve and operating as a result of a passage opening movement of said element to move said control valve to a position wherein one of said pumps continues delivering pressure fluid to said manifold space and the remainder of said pumps are prevented from discharging fluid into said manifold space and deliver fluid to the related passages of said first group.

8. In a hydraulic apparatus comprising a source of fluid and parts constructed and combined to operatively house a plurality of pumps and define an intake passage means placing said pumps in continuous communication with said source, a control valve chamber severally communicating with the discharge sides of said pumps, return passage means placing said control valve chamber in communication with said source of fluid, a pressure manifold communicating with said control valve chamber through passages each including a pressure maintaining valve therein, said passages conforming in number and being generally related to said pumps, a valve controlled outlet means for said pressure manifold, a control valve in said chamber selectively positionable to place all of said pumps in communication with said return passage means or to place one or more of said pumps in communication with its related passage leading to said pressure manifold, and comprising a relief passage means placing said pressure manifold in communication with said return passage means, the combination of a control for said relief passage means including an element movable in response to attainment of a predetermined pressure in said manifold to open said relief passage means for the flow of fluid therethrough, and means connecting said movable element with said control valve for effecting a pump unloading movement of the latter in response to a pressure produced movement of the former.

9. A hydraulic device comprising a housing operatively enclosing a pump means and including therein an intake passage means for said pump means, a valve chamber in communication with the discharge side of said pump means, a fluid return passage means in communication with said valve chamber, a manifold space, a first passage means placing said manifold space in communication with said valve chamber, an outlet passage for said manifold space, said first passage means and outlet passage including valves controlling the admission and discharge of pressure fluid into and out of said space, respectively, a control valve in said chamber positionable to selectively connect the discharge side of said pump means with said first and return passage means or with either said first passage means or said return passage means, an additional control for said pump means comprising a second passage connecting said manifold space with said return passage means and an element controlling the flow of fluid through said second passage, said element moving to its passage opening position in response to attainment of a predetermined pressure in said manifold space, and means connected with said control valve and with a portion of said second passage in downstream relation with respect to said element, said last mentioned means including parts operative in response to the presence of pressure

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fluid in said second passage portion to move said control valve to a position wherein less fluid flows into said manifold space.

10. A hydraulic device comprising a housing operatively enclosing a pump means and including therein an intake passage means for said pump means, a valve chamber in communication with the discharge side of said pump means, a fluid return passage means in communication with said valve chamber, a manifold space, a first passage means placing said space in communication with said valve chamber, an outlet passage for said space, said first passage means and outlet passage including check valves biased to control the admission and discharge of pressure fluid into and out of said space, respectively, a control valve in said chamber positionable to selectively connect the discharge side of said pump means with said first and return passage means or with either said first passage means or said return passage means, an additional control for said pump means comprising a second passage connecting said manifold space with said return passage means and an element controlling the flow of fluid through said second passage, said element moving to passage opening position in response to attainment of a predetermined pressure in said manifold space, and means operatively connecting said movable element with said control valve so that a passage opening movement of said element results in a movement of said control valve to a position wherein less fluid flows into said manifold space.

11. A hydraulic device comprising a housing operatively enclosing a pump means and including therein an intake passage means for said pump means, a valve chamber in communication with the discharge side of said pump means, a fluid return passage means in communication with said valve chamber, a first passage means communicating with said valve chamber, a control valve in said chamber positionable to selectively connect the discharge side of said pump means with said first and return passage means or with either said first passage means or said return passage means, said first passage means including check valves disposed in series flow relation therein and biased to control the admission and discharge of pressure fluid into and out of the space between said check valves, an additional control for said pump means comprising a second passage connecting said space with said return passage means and an element controlling the flow of fluid through said second passage, said element moving to passage opening position in response to attainment of a predetermined pressure in said space, and means connected with said control valve and with a portion of said second passage in downstream relation with respect to said element, said last mentioned means including parts operative in response to the presence of pressure fluid in said second passage portion to move said control valve to a position wherein less fluid flows into said space between said check valves.

12. A hydraulic device comprising a housing operatively enclosing a pump means and including therein an intake passage means for said pump means, a valve chamber in communication with the discharge side of said pump means, a fluid return passage means in communication with said valve chamber, a manifold space, a first passage means placing said manifold space in communication with said valve chamber, an outlet passage for said manifold space, said first

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passage means and outlet passage including check valves therein, a control valve in said chamber positionable to selectively connect the discharge side of said pump means with said first and return passage means or with either said first passage means or said return passage means, an additional control for said pump means comprising a second passage connecting said manifold space with said return passage means, and means controlling the flow of fluid through said second passage and including a part operatively connected with said control valve, said means operating in response to attainment of a predetermined pressure in said manifold space to open said second passage and move said control valve to a position wherein less fluid flows into said manifold space.

13. In a hydraulic apparatus including a pump means, means defining an intake passage for said pump means, a valve housing in communication with the discharge side of said pump means, and defining a fluid return passage means in communication with said valve housing, a hydraulic motor communicating with said valve housing through a working fluid confining passage means; for relieving fluid pressure on said motor comprising passage means including a portion of said valve housing, and including a valve in said housing positionable to selectively connect the discharge side of said pump means with said working fluid and return passage means or with either said working fluid passage means or with said return passage means, said valve, when moved to a position wherein all fluid discharged from said pump means is delivered to said return passage means, being further movable to also place said motor relieving passage means in communication with said return passage means, and a further control for said pump means operative when said valve is positioned so as to attain a high pressure in said working fluid passage means, said further control comprising means defining a relief passage placing said working fluid passage means in communication with said return passage means, and additional means controlling the flow of fluid through said relief passage and operatively connected with said valve, said additional means operating in response to attainment of a predetermined pressure in said working fluid passage means to open said relief passage and move said valve to a position wherein less fluid flows into said working fluid passage means, and also operating in response to a failure of pressure in said working fluid passage means to effect a return of said valve to its initial high pressure attaining position.

14. A hydraulic control device comprising a housing having a main inlet passage adapted for communication with a source of liquid, a plurality of pumps within said housing, said housing including inlet passages severally connecting said pumps with said main passage, a cylindrical valve chamber, a first group of passages severally connecting the discharge sides of said pumps with said valve chamber, a return passage means communicating with said source, a second group of passages placing said valve chamber in communication with said return passage means and conforming in number and generally related to said pumps, a pressure fluid confining space having a check valve controlled outlet, said space being in communication with said valve chamber through a third group of check valve controlled passages conforming in number and generally related to said pumps, an annular grooved

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cylindrical control valve in said valve chamber selectively positionable to connect one or more of said pumps with said fluid confining space through related ones of said third group of passages and the remaining pumps, if any, with said return passage means through related ones of said second group of passages, a separate means for relieving the pressure head on one or more of said pumps comprising an auxiliary passage placing said pressure fluid confining space in communication with said return passage means and an element controlling the flow of fluid through said auxiliary passage, said element being movable to open said auxiliary passage in response to attainment of a predetermined pressure in said manifold, and linkage means operably connecting said movable element with said control valve so that a passage opening movement of said element results in a movement of said control valve to a position wherein a fewer number of said pumps are delivering fluid to said pressure confining space.

15. A hydraulic apparatus comprising a housing having a main inlet passage adapted for communication with a source of fluid, a plurality of pumps within said housing, said housing including inlet passages severally connecting said pumps with said main passage, a cylindrical valve chamber, a first group of passages severally connecting the discharge sides of said pumps with said valve chamber, a bypass duct in said housing arranged to return fluid to said source, a second group of passages placing said valve chamber in communication with said bypass duct and conforming in number and generally related to said pumps, and a pressure fluid confining space having a check valve controlled outlet, said space being in communication with said valve chamber through a third group of check valve controlled passages conforming in number and generally related to said pumps, a hydraulic motor connected with said check valve controlled outlet, means for relieving fluid pressure on said motor comprising passage means including a portion of said valve chamber, an annular grooved cylindrical control valve in said valve chamber selectively positionable to selectively severally connect one or more of said pumps with said bypass duct through said second group of passages and the remaining pumps, if any, with said pressure fluid confining space through said third group of passages, said control valve when moved to a position severally connecting all of said pumps with said bypass duct being further movable to also place said motor relieving passage means in communication with said bypass duct, a separate means for relieving the pressure head on one or more of said pumps comprising, in said housing, an additional passage means placing said pressure fluid confining space in communication with said bypass duct and an unloading valve chamber communicating with said passage means, a check valve and piston assembly disposed in said unloading valve chamber and controlling communication with said fluid confining space, said assembly moving in response to attainment of a predetermined pressure in said fluid confining space to place portions of said unloading valve chamber on opposite sides of said assembly in communication with said fluid confining space, a spring biased piston disposed in said unloading valve chamber in spaced relation to said assembly and movable in response to pressure fluid entering the space therebetween, and means operably connecting said spring biased piston with said control valve

so that movement of the former results in movement of the latter to a position wherein only one of said pumps is delivering fluid to said fluid confining space.

16. In a hydraulic apparatus including a source of fluid, a plurality of pumps, means defining intake passages adapted to connect said pumps with said source of fluid, pump outlet passages, a valve chamber communicating with said outlet passages, a return passage means connected with said valve chamber and adapted to conduct fluid to said source, and a working fluid passage means communicating with said valve chamber and including valves operative to establish a pressure fluid confining space therebetween, and including a control valve in said chamber operable to place one or more of said pumps in communication with said working fluid passage means and the remaining pumps, if any, in communication with said return passage means, an additional control comprising means defining a pressure relief passage communicating with said fluid confining space, and an unloading chamber communicating with said relief passage and with said return passage means, a check valve and piston assembly disposed in said unloading chamber and controlling communication with said fluid confining space, said assembly moving in response to attainment of a predetermined pressure in said fluid confining space to place portions of said chamber on opposite sides of said assembly in communication with said space, a spring biased piston disposed in said chamber in spaced relation to said assembly and movable in response to pressure fluid entering the space therebetween, said biased piston controlling communication between said unloading chamber and said return passage means, and means operably connecting said spring biased piston with said control valve so that movement of the former results in movement of the latter to a position wherein only one of said pumps is delivering fluid to said fluid confining space and the remaining pumps are delivering fluid to said return passage means.

17. In a hydraulic apparatus including a source of fluid, a plurality of pumps, means defining a valve chamber receiving pressure fluid from said pumps, a return passage means placing said valve chamber in communication with said source, and a first passage means communicating with said valve chamber and including valves establishing a pressure confining space therebetween, and including a control valve in said valve chamber selectively positionable to connect one or more of said pumps with said first passage means and the remaining pumps, if any, with said return passage means, the combination of a relief and unloading means comprising a relief passage placing said fluid confining space in communication with said source, a first part controlling the flow of fluid through said relief passage and movable in response to an excess of pressure in said fluid confining space, a second part disposed in flow-controlling down-stream relation with respect to said first part and movable in response to fluid pressure exerted thereon as a result of a movement of said first part to a position establishing a flow of fluid therepast, and a linkage operatively connecting said second part with said control valve so that movement of said second part results in a movement of said control valve to a position wherein the fluid discharged from one or more of said pumps is prevented from flowing into said fluid confining space and flows

through said return passage means and back to said source.

18. In a hydraulic apparatus having a source of liquid, a plurality of pump in communication with said source, a pressure fluid confining space, a fluid return passage means, and having a valve selectively positionable to connect one or more of said pumps with said pressure fluid confining space and the remaining pumps, if any, with said return passage means, the combination of a relief and unloading means comprising an unloading chamber communicating with said fluid confining space and with said return passage means, a check valve and piston assembly disposed in said unloading chamber and controlling the flow of fluid therethrough, said assembly moving in response to attainment of a predetermined pressure in said fluid confining space to place portions of said chamber on opposite sides of said assembly in communication with said space, a spring biased piston disposed in said chamber in spaced relation to said assembly and movable in response to pressure fluid entering the space therebetween, and means operably connecting said spring biased piston with said control valve so that movement of the former results in movement of the latter to a position wherein only one of said pumps is delivering fluid to said pressure manifold.

19. In a hydraulic apparatus having a source of liquid, a plurality of pumps in communication with said source, a pressure fluid confining space, a fluid return passage means, and having a valve selectively positionable to connect one or more of said pumps with said pressure fluid confining space and the remaining pumps, if any, with said return passage means, the combination of a relief and unloading means comprising an unloading chamber communicating with said fluid confining space, a first part of said chamber including therein a check valve and piston assembly operative to move to a position for flow of fluid therepast in response to attainment of a predetermined pressure in said fluid confining space, a second part of said chamber communicating with said first part and with said return passage means, a spring biased piston disposed in said second part and movable in response to fluid pressure exerted thereon as a result of movement of said assembly to a position establishing a flow of fluid therepast, and means operably connecting said spring biased piston with said control valve so that movement of the former results in movement of the latter to a position wherein only one of said pumps is delivering fluid to said fluid confining space.

20. In a hydraulic apparatus having a source of liquid, a plurality of pumps in communication with said source, a pressure fluid confining space, a fluid return passage means, and having a valve selectively positionable to connect one or more of said pumps with said pressure fluid confining space and the remaining pumps, if any, with said return passage means, the combination of a relief and unloading means comprising an unloading valve chamber communicating with said pressure manifold and said return passage means, a check valve and piston assembly disposed in a first portion of said chamber and controlling the flow of fluid from said manifold to said source and movable in response to an excess of pressure in said manifold, a spring biased piston disposed in a second portion of said chamber in spaced relation to said assembly and controlling communication between said unloading

valve chamber and said return passage means, said piston being movable in response to fluid pressure exerted thereon as a result of a movement of said first part to a position establishing a flow of liquid therepast, and a linkage operatively connecting said spring biased piston with said control valve so that movement of said piston results in a movement of said control valve to a position wherein the fluid discharged from one or more of said pumps is prevented from flowing into said fluid confining space and flows through said return passage means and back to said source.

21. In a hydraulic apparatus including a pump means, means defining an intake passage for said pump means, a valve housing in communication with the discharge side of said pump means, a fluid return passage means in communication with said valve housing, a pressure maintaining working fluid passage means communicating with said valve housing, and defining a pressure relief passage means placing said working fluid passage means in communication with said return passage means, and including a valve in said housing positionable to selectively connect the discharge side of said pump means with said working and return passage means or with either said working fluid passage means or said return passage means, the combination comprising additional means controlling the flow of fluid through said relief passage means and including a part operatively connected with said control valve, said means operating in response to attainment of a predetermined pressure in said working fluid passage means to open said relief passage means and move said control valve to a position wherein less fluid flows into said working fluid passage means.

22. In a hydraulic apparatus including a pump means, means defining an intake passage for said pump means, a valve housing in communication with the discharge side of said pump means, a working fluid confining passage means, and defining a fluid return passage means in communication with said valve housing, a hydraulic motor communicating with said valve housing through said working fluid confining passage means, and including a valve in said housing positionable to selectively connect the discharge side of said pump means with said working fluid and return passage means or with said working fluid passage means so as to attain a high pressure in said working fluid passage means, the combination comprising means defining a relief passage placing said working fluid passage means in communication with said return passage means, and an additional means controlling the flow of fluid through said relief passage and operatively connected with said valve, said additional means operating in response to attainment of a predetermined pressure in said working fluid passage means to open said relief passage and move said valve to a position wherein less fluid flows into said working fluid passage means.

23. In a hydraulic apparatus including a pump means, means defining a valve chamber receiving pressure fluid from said pump means, a fluid return passage means communicating with said valve chamber, and a working fluid passage means communicating with said valve chamber, check valves operatively associated with said working fluid passage means so as to maintain the working fluid confined therein at a pressure less than a predetermined value, and including

a valve in said chamber manually positionable to selectively connect said working and return passage means jointly and severally with the discharge side of said pump means, the combination of a pressure relief and unloading control comprising a relief passage means placing said working fluid passage means in communication with said return passage means, and means controlling flow of fluid through said relief passage means and including a part operatively connected with said valve, said means operating in response to attainment of said predetermined value of working fluid pressure to open said relief passage and move said valve to a position wherein less fluid is delivered to said working fluid passage means.

24. In a hydraulic apparatus including a pump means, means defining an intake passage for said pump means, a valve housing in communication with the discharge side of said pump means, a working fluid confining passage means, and defining a fluid return passage means in communication with said valve housing, a hydraulic motor communicating with said valve housing through said working fluid confining passage means, and including a valve in said housing positionable to selectively connect the discharge side of said pump means with said working fluid and return passage means or with said working fluid passage means so as to attain a high pressure in said working fluid passage means, the combination comprising means defining a relief passage placing said working fluid passage means in communication with said return passage means, and additional means controlling the flow of fluid through said relief passage and operatively connected with said valve, said additional means initially operating in response to attainment of a predetermined high pressure in said working fluid passage means to open said relief passage and move said valve to a position wherein less fluid flows into said working fluid passage means, and then operating in response to a relatively low pressure in said working fluid passage means to maintain said relief passage open for flow of fluid therethrough and said valve in its said position wherein less fluid flows into said working fluid passage means.

25. In a hydraulic apparatus including a pump means, means defining an intake passage for said pump means, a valve housing in communication with the discharge side of said pump means, and defining a fluid return passage means in communication with said valve housing, a hydraulic motor communicating with said valve housing through a working fluid confining passage means, and including a valve in said housing positionable to selectively connect the discharge side of said pump means with said working fluid and return passage means or with said working fluid passage means so as to attain a high pressure in said working fluid passage means, and a further control for said pump means comprising means defining a relief passage placing said working fluid passage means in communication with said return passage means, a flow control means for said relief passage including a first portion of small area subjected to the pressure in said working fluid passage means and a second portion of considerably larger area which is subjected to the pressure in said working fluid passage means as a result of said first portion moving to its passage opening position, and additional means operatively connected with said valve to move same as a result of a movement

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of said flow control means to its passage opening position, said flow control and additional means initially operating in response to attainment of a predetermined high pressure in said working fluid passage means to open said relief passage and move said valve to a pump means unloading position wherein less fluid flows into said working fluid passage means, and then operating in response to a relatively low pressure in said working fluid passage means to maintain said relief passage means open for flow of fluid there-through and said valve in its said unloading position.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,002,306	Perkins -----	Sept. 5, 1911
1,770,297	Bussmann -----	July 8, 1930
1,888,542	Rosberg -----	Nov. 22, 1932
2,247,261	Towler et al. -----	June 24, 1941