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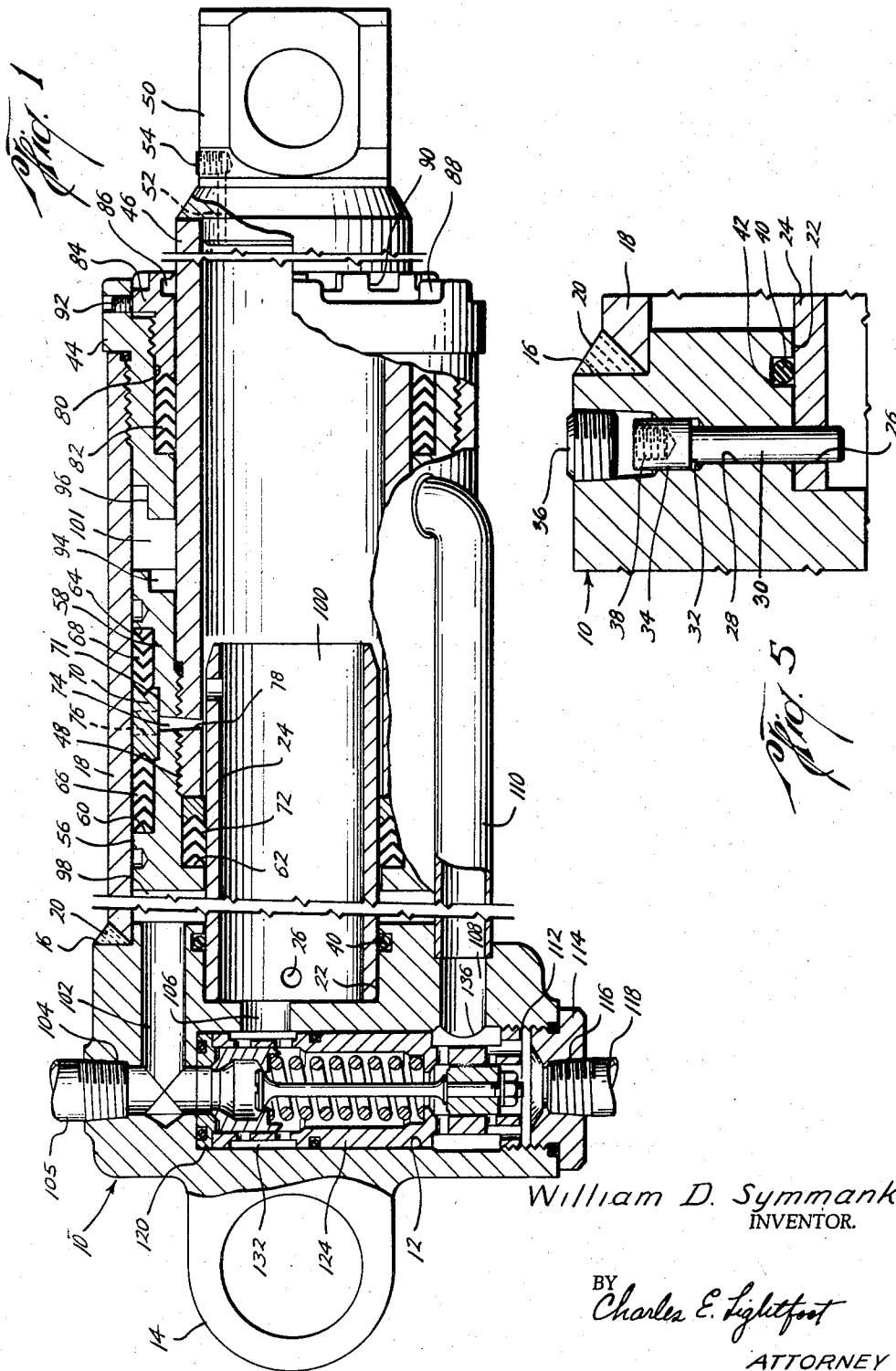
W. D. SYMMANK

2,869,327

HYDRAULICALLY OPERATED POWER MECHANISM

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3 Sheets-Sheet 1



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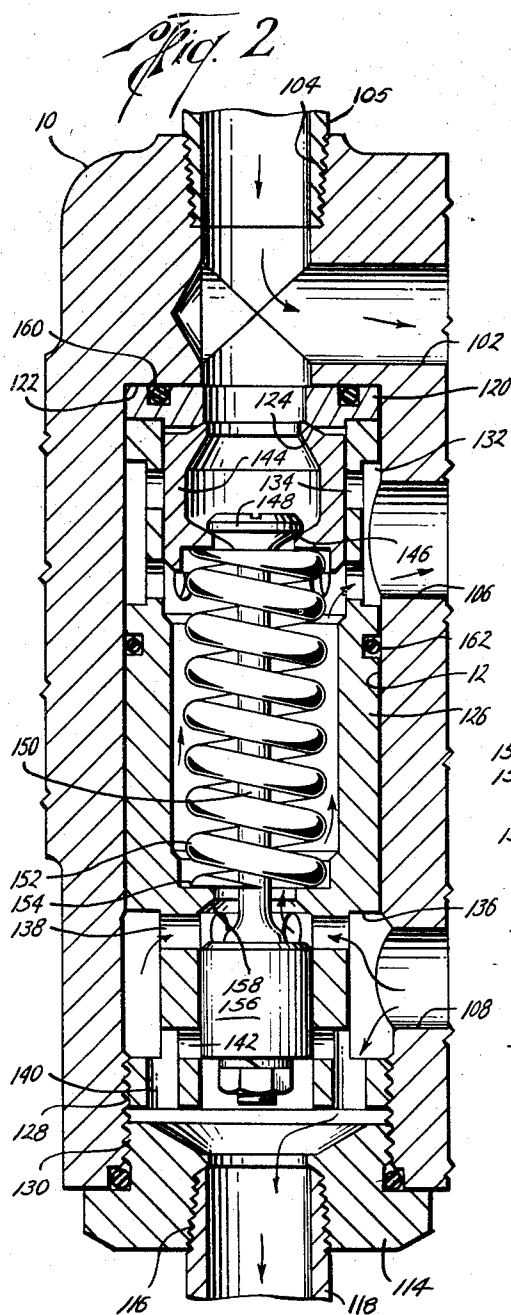
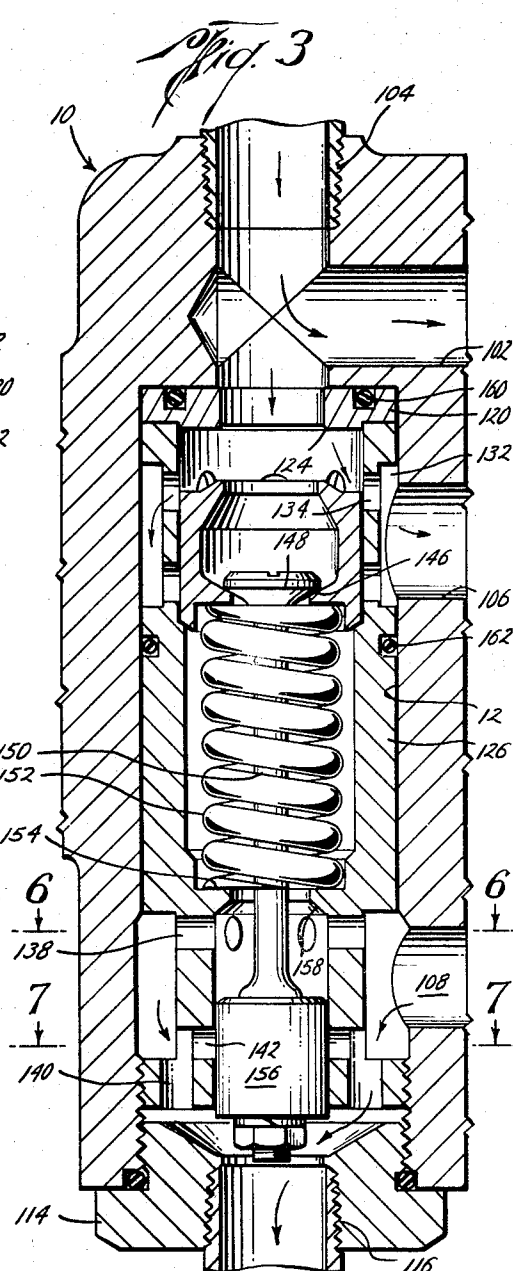
W. D. SYMMANK

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HYDRAULICALLY OPERATED POWER MECHANISM

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3 Sheets-Sheet 2



William D. Symmank
INVENTOR.

BY
Charles E. Lightfoot
ATTORNEY

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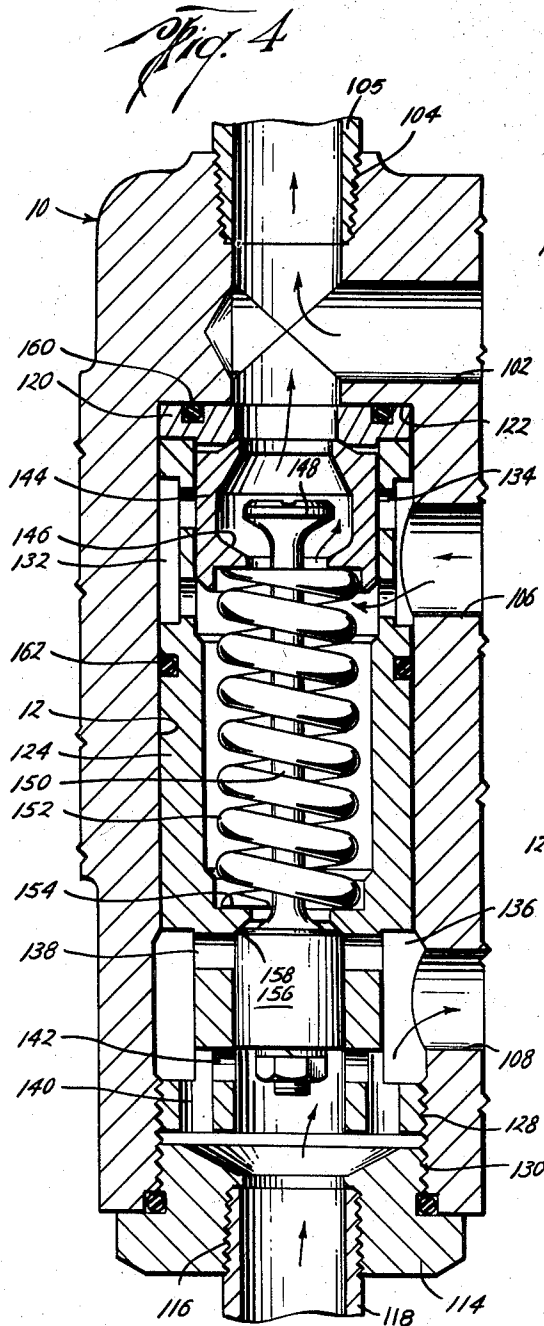
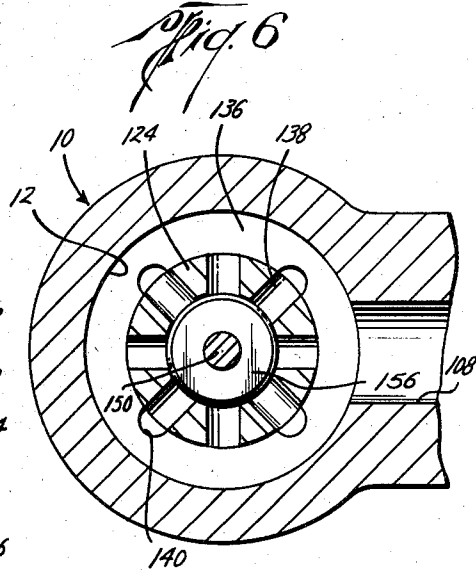
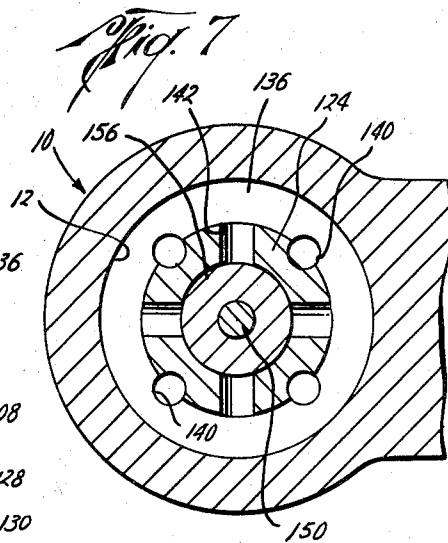
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HYDRAULICALLY OPERATED POWER MECHANISM

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3 Sheets-Sheet 3



William D. Symmank
INVENTOR.

BY
Charles E. Lightfoot
ATTORNEY

1

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HYDRAULICALLY OPERATED POWER MECHANISM

William D. Symmank, Houston, Tex., assignor to Crown Engineering Corporation, Houston, Tex., a corporation of Texas

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8 Claims. (Cl. 60—97)

This invention relates to hydraulic power equipment and more particularly to power mechanism which is operated by hydraulic pressure and in which means is provided for automatically varying the power in accordance with the load requirement.

The invention is capable of use in many different kinds of power transmitting apparatus and finds particular application in connection with power transmission mechanism of the hydraulic cylinder and piston type wherein it is desired to maintain the speed of operation in relation to the power output under varying load conditions.

In hydraulic power mechanism of the pressure cylinder and piston type as heretofore commonly constructed difficulty is often encountered in selecting the size of the cylinder to be employed because of the limitations in the pressure which may be used and the volume of fluid flow which may be obtained in the system. Frequently one size of cylinder is required to obtain the desired speed of operation while a different size of cylinder is necessary to meet the load requirement, which may be a large initial load or a load which varies at different points throughout the travel of the cylinder's stroke. Thus, for example, a cylinder having a diameter of six inches may be required to initiate movement of a load which when moving requires only the power of a cylinder having a diameter of five inches. The speed of movement in such a system would be that which could be obtained by the use of a cylinder having a diameter of five inches. In hydraulic power mechanism of this kind, as heretofore constructed it would be necessary to employ a cylinder having a diameter of six inches and to operate the same at a correspondingly slow rate of speed, or to install a secondary volume and pressure circuit for the hydraulic fluid at greatly increased expense and risk of mechanical failure.

The present invention has for an important object the provision of hydraulic power mechanism of the cylinder and piston type embodying means for automatically varying the force applied in accordance with the load which is to be acted upon.

Another object of the invention is to provide hydraulic power mechanism of the kind referred to whereby the speed of movement of the load may be maintained substantially the same under widely varying load conditions.

A further object of the invention is the provision of hydraulic power mechanism of the multicylinder type embodying means for admitting fluid under pressure first into one cylinder of the mechanism, and, when the load on the mechanism reaches a predetermined value, automatically admitting such fluid into another cylinder thereof to increase the power exerted on the load.

Another object of the invention is to provide hydraulic power mechanism of the multicylinder type having inner and outer concentrically arranged, simultaneously expandible pressure chambers and including means for filling the inner chamber with fluid as the chambers are expanded in response to the introduction of fluid under pressure into the outer chamber.

A further object of the invention is the provision of

2

hydraulic power mechanism of the multicylinder type having inner and outer concentrically arranged, simultaneously expandible pressure chambers and embodying means for filling the inner chamber with fluid as the chambers are expanded in response to the introduction of fluid under pressure into the outer chamber and means for automatically introducing fluid under pressure into the inner chamber when the pressure of fluid in the outer chamber reaches a predetermined pressure.

Another object of the invention is to provide hydraulic power mechanism of the multicylinder type having inner and outer, concentrically arranged, simultaneously expandible pressure chambers and embodying means for introducing pressure fluid into the chambers to expand the chambers and hydraulically operable means for contracting the chambers.

A further object of the invention is the provision of hydraulic power mechanism of the type mentioned which is of simple design and rugged construction and wherein the various parts are easily replaceable for purposes of maintenance and repair.

The above and other important objects and advantages of the invention may best be understood from the following detailed description constituting a specification of the same when considered in conjunction with the annexed drawings, wherein—

Figure 1 is a fragmentary side elevational view, partly broken away and partly in cross-section illustrating a preferred embodiment of the invention;

Figure 2 is a longitudinal, central, cross-sectional view, on an enlarged scale of the valve mechanism of the invention, as illustrated in Figure 1, showing the same in position to admit fluid under pressure into the outer pressure chamber of the power mechanism;

Figure 3 is a view similar to that of Figure 2 showing the valve mechanism in position to admit fluid under pressure into both the inner and the outer pressure chambers of the power mechanism;

Figure 4 is a view similar to that of Figure 2 showing the valve mechanism in position to permit the outflow of fluid from the inner and outer pressure chambers and the inflow of fluid under pressure to the means by which contraction of the inner and outer pressure chambers is accomplished;

Figure 5 is a fragmentary cross-sectional view, on a greatly enlarged scale showing details of the means by which the innermost cylindrical component of the power mechanism is removably secured in place;

Figure 6 is a cross-sectional view taken along the line 6—6 of Figure 3, looking in the direction indicated by the arrows; and

Figure 7 is a cross-sectional view taken along the line 7—7 of Figure 3, looking in the direction indicated by the arrows.

Referring now to the drawings in greater detail the power mechanism of the invention includes a cylinder base or lower cylinder head 10, having a bore 12 for the reception of valve mechanism to be fully described hereinafter and ports for the control of the flow of hydraulic fluid under pressure into and out of the pressure chambers of the mechanism. The cylinder base may be formed with suitable means, such as the perforated lug 14, whereby the base may be anchored to any desired structure with which the power mechanism is to be associated.

The base 10 may be of generally annular configuration formed with an external annular shoulder 16, upon which one end of an outer cylinder or barrel 18 is seated, which barrel is attached to the base in any suitable manner as by welding as indicated at 20. The base 10 also has a centrally located annular recess 22 within which one end of an inner cylinder 24 extends, which cylinder has an opening 26 within the recess positioned for alignment

3

with an opening 28 in the base, whereby the inner cylinder may be removably connected to the base by a pin 30 positioned in the openings 26 and 28. The opening 26 may have an internal shoulder 32 formed therein, positioned for engagement with an external enlargement or head 34 on the pin 30 to limit inward movement of the pin in the opening, and the opening 26 may be internally threaded at its outer end to receive an externally threaded plug 36 whereby the pin is held in place. The pin 30 is provided with an internally threaded recess 38 at its outer end for the reception of a bolt or threaded tool whereby the pin may be removed from the openings 26 and 28 should this be necessary.

Suitable seal forming means, such as an O-ring 40 disposed in an internal groove 42 provided therefor in the recess to form a fluid tight seal between the base and inner cylinder.

An externally threaded, annular cylinder head 44 is threadably connected to the internally threaded end of the outer cylinder a barrel 18 remote from the base 10, and through this cylinder head a tubular piston rod 46 is slidably extended, whose outer end is closed and whose inner end is externally threaded as indicated at 48. At its outer end the piston rod 46 may be provided with a perforated lug 50 for the attachment thereto of any desired mechanism to which power is to be delivered. The piston rod 46 has a bleeder passageway 52 at its outer end leading from the interior of the piston rod to the exterior thereof and which is closed by a screw plug 54.

The inner end of the piston rod 46 is slidably extended between the inner and outer cylinders 18 and 24 and carries thereon a two-part piston made up of two internally threaded annular sections 56 and 58, respectively. The piston section 56 has an end enlargement forming an external annular shoulder 60 and an internal annular shoulder 62 thereon, and the section 58 is formed with an external annular shoulder 64 which faces the shoulder 60. Between the shoulders 60 and 64 of the sections 56 and 58 oppositely facing packing elements 66 and 68, preferably of the chevron type, are positioned in surrounding relation to the sections to form fluid tight seals between the piston and outer cylinder, and a wear ring 70 of suitable material, such as bronze, surrounds the sections between the packing element 66 and 68.

Suitable packing, such as the chevron type packing element 72 surrounds the inner cylinder 24 between the internal shoulder 62 of the section 56 and the inner end of the piston rod 46 to form a fluid tight seal between the piston and inner cylinder. In assembling the piston and piston rod, the piston section 58 may first be threaded onto the piston rod to the desired location, whereupon the packing elements 66, 68 and 72 and wear ring 70 may be placed in position and the section 56 then threaded onto the piston rod until it abuts the section 58. The sections 56 and 58 are each provided with an end notch, which notches form an opening through the sections when assembled for the insertion therethrough of a tapered pin 74 through an opening 76 in the wear ring 70, which pin also extends into an opening 78 in the piston rod 46 whereby the sections are locked against rotation relative to each other and relative to the piston rod. After the pin 74 has been inserted the wear ring 70 may be rotated to move the opening 76 out of registration with the pin to prevent the pin from backing out.

The cylinder head 44 has an outer end recess 80 surrounding the piston rod 46 within which suitable packing 82, preferably of the chevron type, is located and a retainer ring 84 is threaded into the recess into engagement with the packing 82 to hold the same in sealing contact with the head and piston rod. Suitable sealing means, such as a packing ring 86 surrounds the piston rod in an internal groove provided for that purpose in the retainer ring 84. The outer ends of the cylinder head 44 and retainer ring 84 may be of castellated or notched construction, indicated at 88 and 90, respectively, as to pro-

4

vide a means whereby a suitable tool may be used to tighten the ring against the packing 82. A set screw 92 may also be provided in the head 44 which may be tightened against the ring 92 to hold the ring against loosening in the head.

The outer end of the piston section 58 has an annular end recess 94 therein, and the inner end of the head 44 is formed with an annular end projection 96 positioned to fit into the recess 94 when the piston approaches the outer limit of its movement in the cylinder 18 to form a trap wherein fluid will be confined to cushion the impact of the piston against the head.

In the above described cylinder and piston structure it will be apparent that an outer pressure chamber 98 is formed between the inner and outer cylinders and the base and piston and an inner pressure chamber 100 is formed within the inner cylinder and the piston rod between the closed outer end of the piston rod and the base. A retracting chamber 101 is also formed between the outer cylinder 18 and the piston rod between the piston and the cylinder head.

The base 10 has a passageway 102 which is in communication with the interior of the chamber 98 and which leads to a source of hydraulic fluid under pressure through an internally threaded port 104 in the base into which a supply pipe 105 is threaded. A passageway 106 is also provided in the base which is in communication with the interior of the chamber 100 and with the bore 12. A passageway 108 in the base is in communication with the bore 12 and with an external pipe 110 which leads to the interior of the retracting chamber 101 through an opening in the outer cylinder 18.

The bore 12 of the base 10 is internally threaded at one end, as indicated at 112 to receive an externally threaded plug 114 having an internally threaded opening 116 into which a supply pipe 118 is threaded.

Within bore 12 valve mechanism is positioned by which the flow of hydraulic fluid into and out of the chamber 100 and 101 is controlled. This valve mechanism is constructed and designed to be inserted and removed from the bore 12 as a unit whereby replacement of the valve mechanism is facilitated. The control valve mechanism of the invention includes an annular valve seat element 120 adapted to seat on an interval annular shoulder 122 within the bore 12 and forming a valve seat 124. A valve cage 126 of generally cylindrical configuration is positioned in the bore 12 and bears at one end against the valve seat element 120 and is positioned at its other end with external threads 128 positioned for threadable engagement with internal threads 130 of the bore whereby the cage is removably retained in the bore. The valve cage is of tubular construction having an external annular recess 132 into which the passageway 106 opens and having one or more ports 134 which communicate with the passageway 106 and with the interior of the cage.

The valve cage also has an external annular recess 136 into which the passageway 108 opens and is provided with one or more ports 138 in communication with the passageway 108 and with the interior of the cage. Passageways 140 are provided in the cage 124 which are in communication with the recess 136 and with the supply pipe 118 and into which ports 142 in the cage open which are also in communication with the recess 136.

A valve 144 of tubular construction is movably disposed in the valve cage 124 for longitudinal movement into and out of engagement with the valve seat 124, and has an internal valve seat 146 formed therein positioned to be engaged by a second valve 148 located within the valve 144 and movable longitudinally relative thereto. The valve 148 has a stem 150 surrounded by a coil spring 152 which bears at one end against the valve 144 and at its other end is seated on an internal shoulder 154 formed in the valve cage 124, to yieldingly urge the valve 144 toward the seat 124.

The valve stem 150 carries another valve element 156 which is positioned for movement into and out of engagement with an internal valve seat 158 formed in the valve cage and to open and close the passageways 138 and 142 of the cage.

Suitable sealing means, such as the O-ring 160 is carried by the seat forming element 120, disposed in position to form a seal between the seat forming element and the base 10, and similar means, such as the O-ring 162 is disposed about the cage 126 in an external groove provided therefor to form a seal between the cage and base at a location in the bore between the external annular recesses 132 and 136.

The hydraulic power mechanism of the invention is supplied with hydraulic fluid under pressure from a hydraulic system, not shown, under the control of suitable valve mechanism, whereby the fluid under pressure may be supplied to either end of the bore 12 through the supply pipes 105 and 118 or back flow of fluid from either end of the bore may be permitted as desired.

In the operation of the power mechanism of the invention the base 10 may be connected by the perforated lug 14 to any desired structure, such as the frame of a crane or other mechanism with which the power mechanism is to be used, while the piston rod 46 is connected by the perforated lug 50 to the device to which power is to be delivered.

The chambers 98, 100 and 101 and the bore 102 and passageways connecting the same with the chambers will be entirely filled with hydraulic fluid which also fills the hydraulic fluid supply system.

With the piston rod 46 in its retracted position as shown in Figure 1, the valve mechanism will be in the condition illustrated in Figure 2 with the valve element 144 in closing contact with the seat 124, valve 148 in closing contact with seat 146 and valve 156 uncovering the passageways 138 and out of contact with seat 158. Under these conditions hydraulic fluid under pressure from the supply pipe 105 may flow from the bore 12 through passageway 102 into chamber 98 to exert pressure on the piston to move the piston toward extended position. At the same time hydraulic fluid will be displaced from chamber 101 through pipe 110, passageway 108, recess 136, passageways 138, seat 158, passageways 134, and passageway 106 into chamber 100 to maintain chamber 100 filled as the piston rod moves outwardly.

In Figures 2, 3 and 4 the passageways 140 have been shown as arranged in intersecting relationship with passageways 142 for purposes of convenience in illustrating the manner in which the hydraulic fluid may flow during the operation of the mechanism. The passageways 140 are, however, preferably spaced peripherally 45 degrees from the passageways 142, as illustrated in Figures 6 and 7. By thus spacing the passageways the flow of fluid from the retracting chamber 101 through the valve mechanism, as the piston rod moves toward extended position will be somewhat divided, as seen in Figure 2, when it reaches the recess 136, so that sufficient of the fluid may readily flow into the chamber 100 to keep the same completely filled, while any excess fluid will be diverted through the passageways 140 back to the supply system through pipe 118.

The cross-sectional area of the retracting chamber 101 is preferably so related to the cross-sectional area of the pressure chamber 100, that there will always be more hydraulic fluid displaced from the retracting chamber upon outward movement of the piston, than is required to maintain the pressure chamber 100 in a completely filled condition.

During the operation of the power mechanism, should the force exerted by the piston due to the pressure of fluid entering the chamber 98 be insufficient to move the load on the piston rod 46, then the pressure in the passageway 102 will be increased until the valve 144 is moved away from the seat 124 against the pressure of

the spring 150. The cross-sectional areas of the valve 144 and of the opening through the seat forming element 120 may be varied as desired and the cross-sectional area of the valve is preferably substantially greater than this opening, so that as soon as the valve moves away from the seat the area of the valve which is then subjected to fluid will be greatly increased to cause the valve to open quickly to the position indicated in Figure 3. In this condition of the mechanism hydraulic fluid from the supply system will also enter the chamber 100, through passageways 134 and 106, to increase the power exerted on the piston rod 46. While the pressure of the fluid is thus acting in both the chambers 98 and 100, the valve 144 will be in a position to close off the flow of fluid from the retracting chamber 101 to the chamber 100, and such fluid will be returned to the supply system through the pipe 118 as will be seen in Figure 3.

In the event that the load on the piston rod 46 should decrease, the pressure in the chambers 98 and 100 will be reduced and the valve 144 will return to the position of Figure 2 under the influence of the spring 150, whereupon the volume of fluid which flows into the chamber 98 at the pressure necessary to move the load will be greatly increased causing the piston rod 46 to be exerted more rapidly.

After the piston rod 46 has been extended and it is desired to retract the power mechanism, this may be accomplished by admitting fluid under pressure from the supply system into the bore 12 through the supply pipe 118, while fluid from the chambers 98 and 100 is permitted to flow back through the pipe 105. When the fluid from the supply system enters the bore 12 through pipe 118, the valves 146 and 156 will be moved by the pressure of the fluid to the position shown in Figure 4, wherein the valve seat 148 is open and the valve 156 is in closing contact with the seat 158. Fluid under pressure is then supplied to the retracting chamber 101 through passageway 108 and pipe 110, while fluid from chamber 98 returns through passageway 102 and fluid from chamber 100 returns through passageway 106 and seat 146. By thus introducing fluid under pressure into the retracting chamber 101 to exert a retracting force on the piston while permitting the outflow of fluid from the chambers 98 and 100, the mechanism may be quickly returned to retracting position.

It will thus be seen that the invention, constructed and operated as described above, provides hydraulic power mechanism embodying means whereby the effective area of the application of pressure will be varied automatically in response to variations in the power required to move the load.

While the invention is disclosed herein in connection with a certain specific embodiment of the same, it will be understood that this is intended by way of example only and that various changes can be made in the construction and arrangement of the parts within the spirit of the invention and the scope of the appended claims.

Having thus clearly shown and described the invention, what is claimed as new and desired to secure by Letters Patent is:

1. In hydraulic power mechanism the combination with first and second expansible power chambers and an expansible retracting chamber arranged to be retracted upon expansion and to be expanded upon retraction of said power chambers, of means forming a passageway in communication with said chambers, means responsive to the pressure of fluid in said first chamber for closing the passageway at a point between said source and said second chamber and said retracting chamber when the pressure in said first chamber falls below a predetermined pressure and for closing the passageway between said power chambers and said retracting chamber when the pressure in said first chamber exceeds said predetermined pressure.

2. In hydraulic power mechanism the combination

with first and second expansible power chambers and an expansible retracting chamber arranged to be retracted upon expansion and to be expanded upon retraction of said power chambers, of means forming a passageway in communication with said chambers, means for introducing fluid under pressure into said first chamber and for establishing communication between said retracting chamber and said second chamber when the pressure in said first chamber falls below a predetermined pressure and means for causing the introduction of fluid under pressure into both of said power chambers and for causing an outflow of fluid from said retracting chamber when the pressure in said first chamber exceeds said predetermined pressure.

3. In hydraulic power mechanism the combination with first and second expansible power chambers and an expansible retracting chamber arranged to be retracted upon expansion and to be expanded upon retraction of said power chambers, of means forming a passageway in communication with said chambers, means for causing the introduction of fluid under pressure into both of said power chambers and for causing an outflow of fluid from said retracting chamber when the pressure in said first chamber exceeds a predetermined pressure and means for causing the introduction of fluid under pressure into said retracting chamber and for causing an outflow of fluid from said power chambers.

4. In hydraulic power mechanism the combination with means forming first and second expansible power chambers and a retracting chamber arranged to be expanded upon retraction of and retracted upon expansion of said power chambers, of means having a passageway in communication at one end with said first chamber and at the other end with said retracting chamber, said passageway being in communication at a location between its ends with said second chamber, means for introducing fluid under pressure into the ends of said passageway, means for closing the passageway between said first and second chambers when the pressure in said one end falls below a predetermined pressure and for opening the passageway to the flow therethrough of fluid from said retracting chamber to said second chamber and means for closing said passageway to the flow of fluid from said retracting chamber to said second chamber when the passageway is open between said power chambers.

5. In hydraulic power mechanism inner and outer concentrically arranged, radially spaced cylinders, a tubular piston rod slidably extended between the cylinders, a piston formed of annular sections surrounding and threadably connected to the rod in endwise abutting relation, each of said sections having an external shoulder formed thereon in longitudinally spaced facing relation to the external shoulder of the other section, an external

annular groove formed in the piston between said shoulders, a retainer ring surrounding the sections in said groove, seal forming means surrounding the sections between each of said shoulders and the adjacent end face of said ring and seal forming means positioned between said piston and said inner cylinder.

6. In hydraulic power mechanism inner and outer concentrically arranged, radially spaced cylinders, a tubular piston rod slidably extended between the cylinders, a piston formed of annular sections surrounding and connected to said rod in endwise abutting relation, said sections having externally reduced portions at their abutting ends forming an annular groove surrounding the piston and external annular flanges spaced longitudinally from said groove in facing relation, a retaining ring surrounding the sections in said groove, packing elements of V-shape in cross-section surrounding each section between said ring and the shoulder of the section, the elements of one section being arranged in oppositely facing relation to the elements of the other section and seal forming means between said piston and said inner cylinder.

7. In hydraulic power mechanism inner and outer concentrically arranged, radially spaced cylinders, a tubular piston rod slidably extended between the cylinders and whose inner end portion is externally threaded, a piston formed of internally threaded annular sections surrounding and threaded onto the inner end of the rod in endwise abutting relation, end notches in the abutting ends of the sections positioned to form an opening between the sections, the threaded end portion of the rod having an opening therein positioned for registration with the opening between the sections and means extending into said openings in engagement with the rod and sections to hold the sections against rotation relative to each other and to said rod.

8. In hydraulic power mechanism inner and outer concentrically arranged, radially spaced cylinders, a tubular piston rod slidably extended between the cylinders, a piston formed of annular sections surrounding and threadably connected to the rod in endwise abutting relation, each of said sections having an external annular shoulder thereon in longitudinally spaced facing relation to the external shoulder of the other section, packing positioned between said shoulders, one of said sections having an internal annular shoulder spaced longitudinally from and facing an end of said rod and packing positioned between said internal shoulder and said end.

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