

Nov. 27, 1951

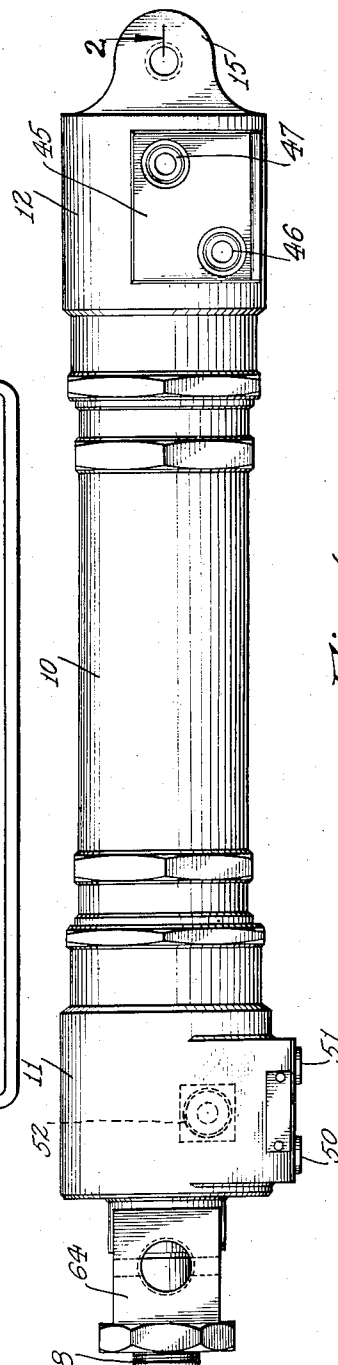
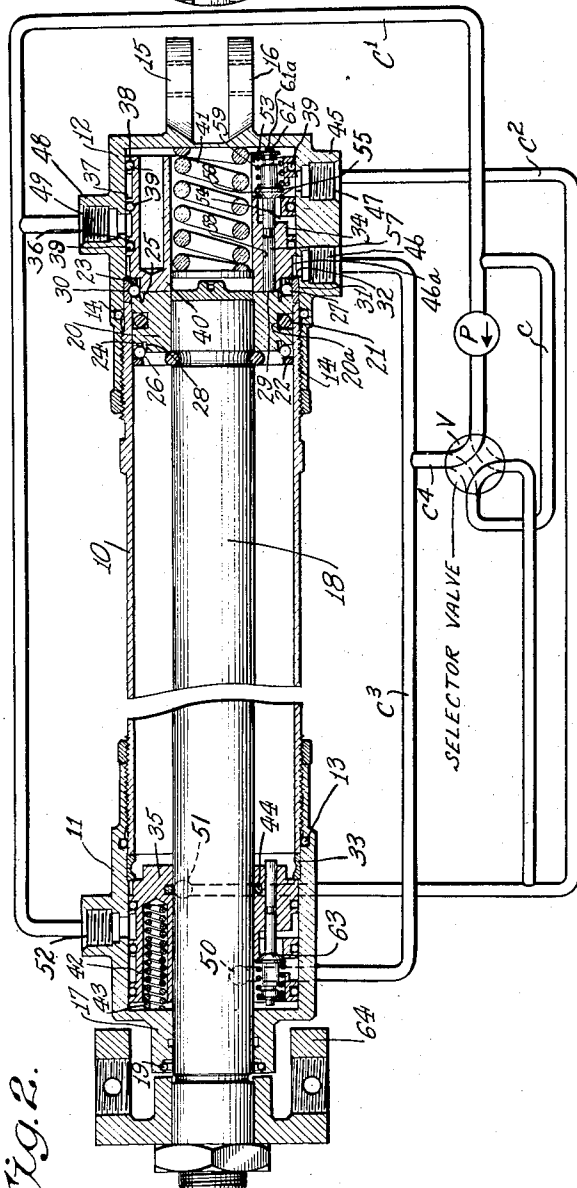
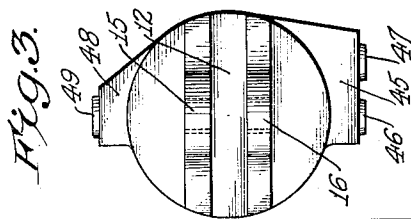
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2,576,554

LOCKING AND PRESSURE RELEASE MECHANISM FOR HYDRAULIC MOTORS

Filed Feb. 25, 1946

3 Sheets-Sheet 1



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3 Sheets-Sheet 2

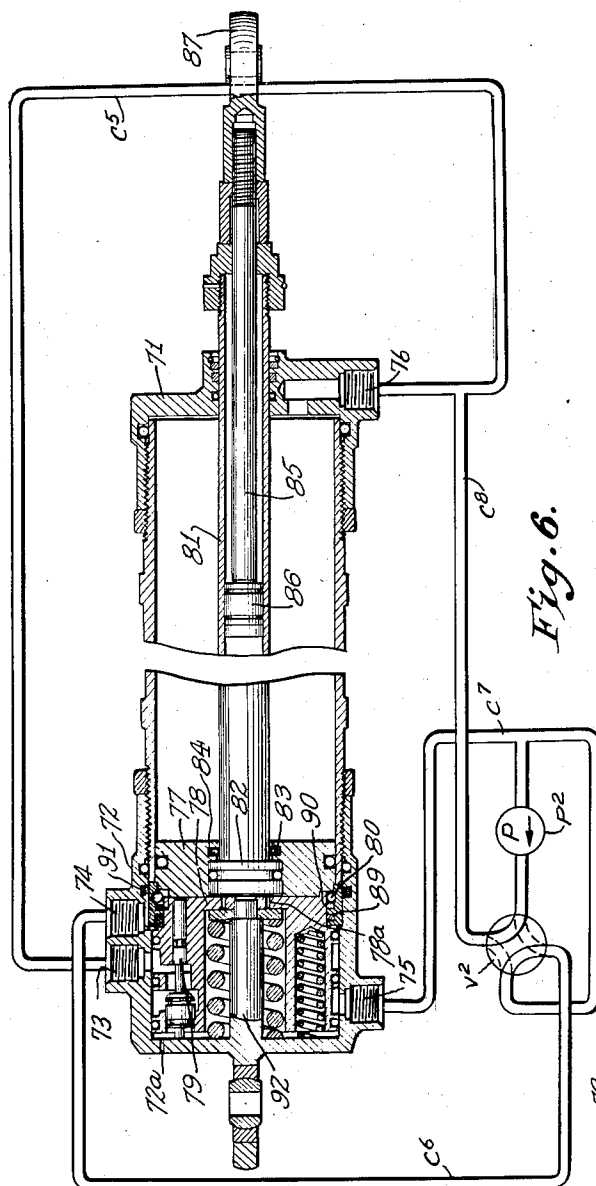


Fig. 6.

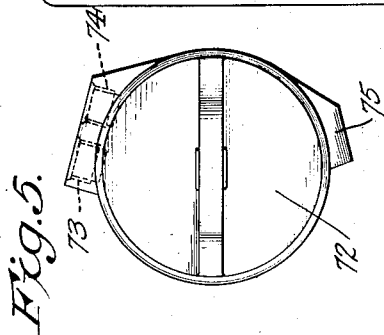


Fig. 5.

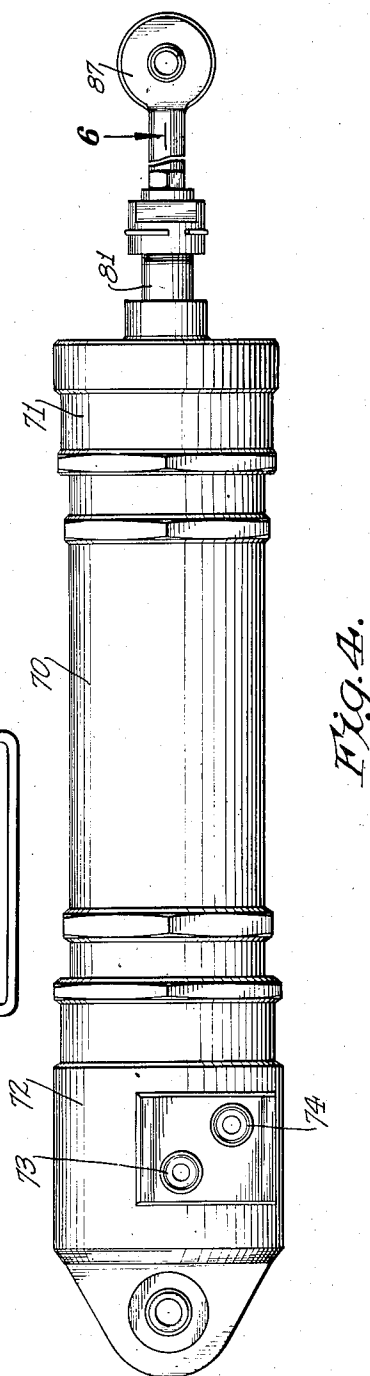


Fig. 4.

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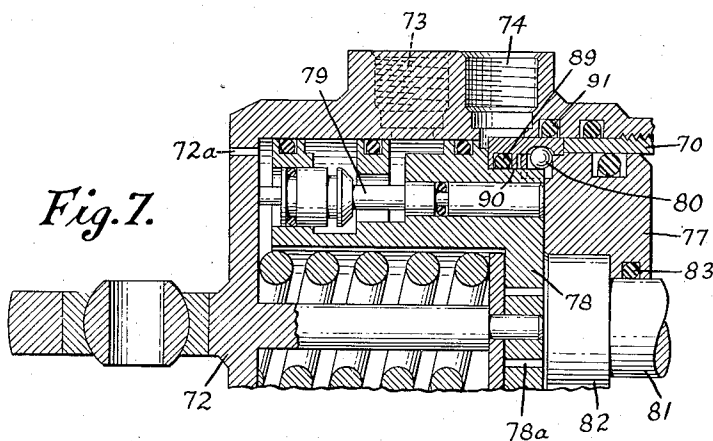
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LOCKING AND PRESSURE RELEASE MECHANISM FOR HYDRAULIC MOTORS

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3 Sheets-Sheet 3



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2,576,554

LOCKING AND PRESSURE RELEASE MECHANISM FOR HYDRAULIC MOTORS

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Application February 25, 1946, Serial No. 649,851

9 Claims. (Cl. 121—40)

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This invention relates to fluid operated motors, and it relates particularly to improvements in hydraulic jacks of the cylinder and reciprocating piston type.

An object of the invention is to provide hydraulic jacks with mechanisms for locking the piston at one or both ends of the stroke of the piston and for relieving the piston and cylinder of pressure when the piston is locked.

Another object of the invention is to provide hydraulic jacks or lifting motors in which the piston can be displaced by means of fluid pressure to one end of the cylinder and then locked to the cylinder and relieved of fluid pressure.

A further object of the invention is to provide hydraulic lifting jacks that may be locked in retracted position and may be projected to an extended position while retaining the ability to be varied in overall length while in the said extended position.

An additional object of the invention is to provide hydraulic lifting jacks suitable for use with retractable landing gear and the like, said jacks being variable in length while in an extended condition and under hydraulic pressure to compensate for variation in length of the oleo landing gear struts and for variation in inflation of the tires.

Other objects of the invention will become apparent from the following description of typical forms of hydraulic jacks embodying the present invention.

Such hydraulic jacks are provided with pressure-responsive mechanisms for releasably locking the piston to the cylinder at one or both ends of the cylinder and with a valve means that is opened as the piston is locked to the cylinder to relieve the piston and the cylinder of fluid pressure.

More particularly, the locking mechanism for the piston may include a series of locking elements, such as balls, that are carried by and are displaceable radially outwardly in the piston into engagement with recesses or a channel in the interior of the cylinder by means of a slidable locking member mounted in the end of the cylinder. The locking member is arranged to enter a recess in the piston near the end of the piston stroke to force the balls partially into the recess to lock the piston to the cylinder. The piston member is displaceable by means of fluid pressure to release the balls for retraction into the piston, thereby unlocking the piston and allowing it to be displaced axially of the cylinder.

The fluid pressure exerted on the piston may

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be relieved, when the piston is in its locked position, by means of a valve interposed between a relief port in the cylinder and the interior of the cylinder on the pressure side of the piston. The valve mechanism is so arranged that when the piston and the locking member move into position to lock the piston to the cylinder, the valve is opened, thereby diverting the pressure fluid to the relief port and relieving the cylinder and the piston from pressure.

When it is desired to use jacks of the type embodying the present invention in connection with a mechanism that is to be locked in two different positions, the hydraulic jack may be provided with locking mechanisms and pressure relief valves at opposite ends. In other cases, it may be desirable to provide a lock at only one end of the cylinder, for example, for locking the piston in its innermost or retracted position.

The invention may be utilized with a jack that is used solely for lifting purposes such as, for example, for lifting the landing gear of an airplane which is extended by gravity. In this case, only one locking mechanism is provided. The piston in this form of jack may be forced outwardly or extended by means of hydraulic pressure or gravity. One form of the invention includes a piston rod that is slidably coupled to the piston so that it is capable of movement relatively thereto axially of the cylinder. Such a piston rod and piston arrangement permits variation in the overall length of the hydraulic jack, permitting the jack to adjust itself to variations in the length of the shock absorbing struts and to the inflation of the tires on the landing gear.

For a better understanding of the present invention, reference may be had to the accompanying drawings in which:

Figure 1 is a plan view of a typical form of hydraulic jack having locking and pressure relief means at both ends thereof;

Figure 2 is a view in section taken on line 2—2 of Figure 1;

Figure 3 is a view in elevation of the right-hand end of the hydraulic jack as viewed in Figure 2;

Figure 4 is a view in side elevation of a modified form of hydraulic jack having a locking mechanism and a pressure relief means at one end only, the piston rod being of variable length;

Figure 5 is a view in elevation of the left-hand end of the modified form of hydraulic jack as viewed in Figure 4;

Figure 6 is a view in section taken on line 6—6 of Figure 4; and

Figure 7 is a view in section of a portion of the jack shown in Figure 5 illustrating details thereof.

The form of hydraulic jack illustrated in Figure 1 includes a tubular cylinder 10 which is provided at opposite ends with caps 11 and 12 screwed on the ends of the cylinder and sealed thereto by means of suitable sealing rings 13 and 14. The cap 12 is provided with a pair of spaced apart lugs 15 and 16 on the end thereof permitting the cylinder to be connected pivotally to a suitable supporting structure, not shown.

The cap 11 is provided with an annular collar 17 within which is slidably received a piston rod 18 of generally cylindrical shape. The collar 17 may be provided with suitable sealing gaskets or packings 19 for preventing leakage therethrough.

One end of the piston rod 18 is provided with a generally cylindrical piston 20 having a groove 20a therein for receiving a piston ring or, as illustrated, a rubbery toroidal ring 21 for sealing the piston to the wall of the cylinder 10. The piston is further provided with annular flanges 22 and 23 at opposite ends thereof which are provided with a plurality of radially extending openings 24 and 25 within which are received a plurality of steel balls 26 and 27. The balls 26 and 27 are retained in the openings 24 and 25 by means of shoulders 28 and 29 on the piston partially underlying the recesses.

As shown in Figure 2, the balls 27 cooperate with an annular recess 30 formed by a channel member 31 mounted between the end of the cylinder 10 and a shoulder 32 on the cap member 12, the recess 30 being of such depth as to partially receive the balls 27. The opposite end of the cylinder 10 is provided with a similar channel member 33 for receiving the balls 26 to lock the piston at this end of the cylinder.

The piston 20 may be locked at either end of the cylinder 10 by means of slidable piston-like locking members 34 and 35 which are mounted within the caps 12 and 11 respectively and are capable of limited axial movement therein. The locking member 34 fits snugly within the cap member 12 and is provided with grooved flanges 36, 37, and 38 spaced longitudinally of the piston which contain toroidal rubbery sealing rings 39 for sealing the piston 34 at spaced apart zones to the interior of the cap. The locking member 34 also includes a projecting annular portion 40 of smaller diameter than the exterior diameter of the piston 20. The portion 40 is received snugly within the flange 23 when the piston 20 is at the right hand end of the cylinder 10. The projection 40 is so arranged that it will engage the balls 27 and force them partially into the recess 30 to lock the piston at the end of the stroke. The locking member 34 may be urged toward the left by means of a spring 41 disposed in a central recess therein and engaging the end of the cap 12 or by means of a series of smaller springs received in bores extending parallel to the axis of the piston.

The locking member 35 that cooperates with the locking balls 26 is similar to the locking member 34 and, as illustrated, may be provided with one or more bores 42 for receiving springs 43 that engage the end of the cap 11 and force the locking member 35 to the right. The locking member 35 is provided with a central opening through which the piston rod 18 passes. Suitable sealing means such as a rubbery toroidal ring 44 engaging the piston rod 18 may be carried by the locking member 35 to prevent leakage therethrough.

In order to reciprocate the piston 20 lengthwise of the cylinder 10, the caps 11 and 12 are provided with suitable inlet and discharge or return ports. The cap 12 is provided with an enlarged boss or projection 45 having two staggered ports 46 and 47 therein and an oppositely extending boss or projection 48 having a port 49 therein. The port 46 may be connected through a suitable selector valve V to a source of fluid under pressure and communicates with the interior of the cylinder 10 through a groove 46a to the left of the flange 36. The port 47 may be connected through the return port of the selector valve to a return line c for the system. The flange 36 is interposed between the port 46 and the port 49, and the flanges 37 and 38 are disposed on opposite sides of the port 47 for preventing direct communication between that port and the ports 46 and 49.

The port 49 is connected to the low pressure side of the system, for example, to the inlet of a pump.

The cap 11 similarly is provided with three ports 50, 51, and 52, the port 52 being connected to the conduit c¹ at the low pressure side of the system, the port 51 being connected through the selector valve V to the pump P and to the port 47 at the opposite end of the cylinder by means of the conduit c². The ports 50, 51, and 52 are separated by suitable sealing flanges on the locking member 35 like the flanges 36, 37, and 38 on the member 34. The port 51 corresponds to the port 46; the port 50 to the port 47; and the port 52 to the port 49. The port 50 is connected also to the port 46 at the opposite end of the cylinder by the conduit c³ and to the selector valve V by means of the branch conduit c⁴ for a purpose to be described.

With the above described arrangement of the ports, when pressure is applied to the piston through the port 46, and the pressure at the port 51 is relieved by means of the selector valve, the locking member 34 is forced to the right, thereby releasing the balls for inward movement. Inasmuch as the port 46 communicates with the interior of the cylinder to the left of the locking member 34, it will force the piston 20 and the piston rod 18 to the left until the piston 20 strikes the locking member 35 displacing it to the left until the balls 26 enter the recess 33, at which time they are displaced outwardly by the return of the locking member 35 to the right under the biasing action of the springs 43. The piston 20 may be released and moved to the right by applying fluid pressure at the port 51 and relieving the fluid pressure at the port 46 by means of the selector valve V, as shown in dotted lines.

In order to relieve the piston and the cylinder of pressure when the piston has moved to locking position at one end of the cylinder, the locking members 34 and 35 each may be provided with a suitable relief valve construction. This valve construction, as illustrated, includes a recess 53 formed in the body of the piston member 34 having opposite ends communicating with the interior of the cap 12 on opposite sides of the flange 37 and connecting the port 47 to the port 49. The flange 37 may be provided with a suitable internal bore 54 having a right hand edge forming a valve seat 55 which cooperates with a poppet valve 56. The valve is mounted on a valve stem 57 which is slidably received in a bore 58 extending parallel to the axis of the piston member 34. The valve stem 57 extends slightly beyond the face of the projection 40 when the valve is seated.

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The valve 56 is normally urged to the left by means of a spring 59 that engages the valve 56 and a plug member 60 slidably mounted in a bore 61 in alignment with the bore 58. The plug 60 is provided with a pin 61a adapted to engage the end of the cap 12 and thus can adjust itself relatively to the valve plug. The plug member 61 may be provided with sealing means for preventing leakage thereby. The spring 59 normally retains the valve plug 56 seated except when an excessively high pressure is present in the cylinder, as, for example, when the pressure fluid therein expands due to increased temperature conditions and when the piston 20 engages the valve stem 57.

The valve 56 and the valve seat 55 are interposed between the port 49 and the port 47. When the piston moves to the right as viewed in Figure 2 under the pressure of fluid introduced through the port 51, the balls 27 will engage the projection 40 on the locking member 34 and will move it to the right until the balls come into alignment to the recess 30, at which time they are moved radially outwardly by the movement of the locking member 34 to the left. As the locking member 34 moves toward the left, the valve plug 56 is unseated and connects the ports 47 and 49. Inasmuch as the port 47 is connected to the pressure port 51 through which fluid is admitted to force the piston 20 to the right, and the port 49 is connected to the return line, the fluid is bypassed from the interior of the cylinder 10 to the return line, thereby relieving the piston 20 of pressure.

The locking member 35 is provided with a similar valve and valve seat assembly 63 so that the same action takes place upon movement of the piston to the left.

The piston rod 18 may be coupled in any desired way to mechanism to be operated. For example, a coupling yoke member 64 may be secured to the end of the piston rod.

The jack illustrated in Figures 4 to 7 is similar to that described above, with the exception that this jack is utilized only for lifting operations and thus is provided with a locking mechanism and a pressure relief valve like those described above, at only one end. This form of device includes a cylinder 70 having caps 71 and 72 at the opposite ends thereof. The cap 72 is provided with the ports 73, 74, and 75 connected respectively to an inlet or pressure port 76 in the cap 71 by means of the conduit c^5 , a source of fluid under pressure, for example, the pump p^2 by means of a conduit c^6 and the return line c^7 of the hydraulic system. The port 76 is likewise adapted to be connected to a source of fluid under pressure through a conduit c^8 a suitable selector valve V^2 by means of which fluid can be directed selectively to one of the ports 74 and 76 while the other of these ports is relieved of fluid pressure.

The device includes a reciprocating piston 77 which cooperates with the slidable lock member 78 having a bypass valve assembly 79 therein like that in the lock member 34 described above. The slidable lock member 78 and the piston 77 are also provided with ball and recess locking means 80, as described above.

In this form of the invention, a tubular, open end piston rod 81 extends slidably through the piston 77 and is provided with an enlarged head 82. A toroidal ring 83 is mounted in a recess 84 in the piston 77 and engages the piston rod 81. Within the piston rod 81 is a second piston rod

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85 having a piston 86 thereon. The piston rod 81 is slidably received in, and sealed to the cap 71.

A suitable eye coupling member 87 may be secured to the end of the rod 85 in order to connect it to an apparatus or a weight to be lifted.

In order to allow the piston rod 81 to be protected by gravity, a sealing ring assembly 89 is mounted between the ball locking assembly 80 and the cylindrical surface 90 on the locking piston 78. Also a ring seal assembly 91 is positioned to the right of the port 74 to prevent leakage around the outside of the ball lock 80. Inasmuch as these seals prevent leakage past the ball lock 80 and the locking piston 78, the effect of liquid pressure at the port 74 is to displace the locking piston 78 to the left, thereby freeing the piston 77 for movement to the right under gravity or externally applied stresses.

In operation, when the fluid under pressure is introduced through the port 74 and the port 76 is relieved of pressure as indicated by the dotted line position of the selector valve, the locking member 78 will be forced to the left, thereby freeing the locking mechanism 80 and allowing the piston 77 to move to the right. The piston rod 81 and the piston 82 may move relatively to the piston 77 and likewise the piston rod 85 and the piston 86 may be stroked back and forth in the piston rod 81. Air displaced by the movement of the piston rod 81 and the piston 86 may escape or be admitted through the hole 78a in the locking member 78 and the hole 72a in the cap 72.

When fluid under pressure is supplied to the port 76 and the port 74 is relieved of pressure, the piston 77 is moved to the left, thereby drawing the piston rod 81 along with it and displacing the piston member 78 sufficiently to permit the balls to lock the piston to the cylinder. In the locked position, the valve assembly 79 is opened, thereby bypassing the fluid pressure applied to the port 76 and to the port 73 through the return line 75 and relieving the cylinder to the right of the piston 77 of fluid pressure. A stop rod 92 is fixed to the cap 72 to prevent displacement of the locking piston 78, if the momentum of the rod 81 tends to carry it too far to the left. The hydraulic jack disclosed in Figures 4 to 7 is a lifting jack, and for that reason, pressure is applied to the piston only through the port 76 to lift an element supported on the eye 87. The piston rods and the piston are moved to the right, as viewed in Figure 6, by the weight of an article suspended thereon and not by fluid pressure against the left-hand end of the piston 77.

The hydraulic fluid is supplied to the port 74 to release the locking mechanism so that the piston and the piston rods can travel to the right.

The loose connection between the piston rod 81 and the piston 77 permits relative movement between them to accommodate changes in the length of the device with which they are associated. The sliding connection between the piston rod 81 and the rod 85 serves the same purpose. Neither of the piston rods 81 or 85 is forced by the action of the hydraulic fluid in either direction. In other words, they are capable of moving relative to each other and to the piston 77 when the piston is at the right-hand end of the cylinder, as viewed in Figure 6. Such relatively movable piston rods are useful in connection with aircraft landing gear to permit unrestricted movement of the oleo strut. It is useful also when the full stroke of the piston might exceed the lifting distance or when the object being lifted must move independently of the piston 77.

From the preceding description of typical forms of devices embodying the present invention, it will be apparent that I have provided hydraulic jacks that are capable of being locked in one or more positions and which in such locked positions are relieved of the pressure of the fluid so that a quick response of the jack to operation of the selector valve is assured.

It will be understood that the size and shape of the jacks may be modified and that the type of relief valve and spring actuating mechanism for the locking piston member may be modified considerably. Therefore, the forms of the invention disclosed herein should be considered as illustrative and not as limiting the scope of the following claims.

I claim:

1. A hydraulic motor comprising a hollow cylinder, a piston reciprocable axially of said cylinder, inlet ports at opposite ends of said cylinder for supplying fluid under pressure to said cylinder, a fluid return port at one end of said cylinder isolated from said inlet ports, a discharge port at said one end, said discharge port being connected to the inlet port at the opposite end of said cylinder, a member between said discharge and return ports having a passage therein connecting said return and discharge ports, valve means in said passage, said valve means being normally biased to closed position to disconnect said discharge port from said return port, and means on said valve means engageable by said piston when the latter is at said one end for opening said valve means to connect said discharge and return ports and by-pass the fluid from the inlet port at said opposite end through said discharge and return ports to relieve said piston of the pressure urging said piston toward said one end.

2. A hydraulic motor comprising a hollow cylinder, a piston reciprocable in said cylinder, an inlet port for supplying fluid under pressure to one end of said cylinder, a discharge port at the other end of the cylinder, means to connect said inlet port to said discharge port, a return port, a return line connected to said return port to discharge liquid from said cylinder, a partition in said cylinder between said discharge and return ports, said partition having a passage therein connecting said discharge port to said return port, and a valve in said passage, said valve being normally biased to closed position to prevent communication between said discharge port and said return port and means on said valve engageable by said piston to open the valve when the piston is at said other end of said cylinder to connect the inlet port to the return port through said passage to by-pass liquid from said inlet port to said return port to relieve the piston of fluid pressure.

3. A hydraulic motor comprising a hollow cylinder, a piston reciprocable in said cylinder, means for supplying fluid under pressure to opposite ends of said cylinder, a radially movable member carried by said piston, a recess at one end of said cylinder for partially receiving said member to lock said piston to said cylinder, a piston-like locking member in said one end of said cylinder and having limited sliding movement relatively thereto, said locking member being engageable with said radially movable member to urge it into said recess and being movable in response to fluid pressure for disengaging said radially movable member to release said piston, means for discharging fluid from said one

end of said cylinder, means at said one end forming a port adapted to be connected to the fluid supply means at the opposite end of said cylinder and valve means normally biased to closed position carried by said locking member and interposed between said port and said fluid discharging means, said valve being opened in response to movement of said piston to said one end of said cylinder.

4. A hydraulic motor comprising a hollow cylinder, a piston reciprocable in said cylinder, means for supplying fluid under pressure to opposite ends of said cylinder, a radially movable member carried by said piston, a recess at one end of said cylinder for partially receiving said member to lock said piston to said cylinder, a piston-like locking member in said one end of said cylinder and having limited sliding movement relatively thereto, said locking member being engageable with said radially movable member to urge it into said recess and being movable in response to fluid pressure for disengaging said radially movable member to release said piston, means for discharging fluid from said one end of said cylinder, means at said one end forming a port adapted to be connected to the fluid supply means at the opposite end of said cylinder and valve means in said cylinder normally biased to closed position interposed between said port and said fluid discharging means, said valve being opened in response to movement of said piston to said one end of said cylinder.

5. A hydraulic motor comprising a cylinder, a piston reciprocable in said cylinder, supply ports for supplying fluid under pressure to said cylinder on opposite sides of said piston, a fluid return port at one end of said cylinder, said return port being isolated from said supply ports, another port in said one end of said cylinder communicating with the supply port at the opposite end of the cylinder, a member in said one end of said cylinder interposed between said another port and said return port and having a passage therethrough connecting said another port and said return port, a normally closed valve in said passage between said return port and said another port to prevent flow of fluid from said another port to said return port, and means responsive to movement of said piston toward said one end of said cylinder for opening said valve to divert the fluid from said supply port in said opposite end of said cylinder to said return port to relieve the piston of pressure.

6. A hydraulic motor comprising a cylinder, a piston reciprocable in said cylinder, cooperating means on said cylinder and said piston for locking the latter to one end of said cylinder, means for supplying fluid under pressure to opposite ends of said cylinder, a movable piston-like locking member in said one end of said cylinder, said locking member being movable relatively to said piston to actuate said locking means to lock and release said piston and cylinder, means forming a pair of ports at said one end of said cylinder, one of said ports adapted to be connected to a return conduit and the other adapted to be connected with the fluid supply means at the opposite end of said cylinder, a normally closed valve interposed between said ports, and means responsive to movement of said piston into locked position for opening said valve.

7. A hydraulic motor comprising a cylinder, a piston reciprocable in said cylinder, cooperating means on said cylinder and said piston for locking the latter to one end of said cylinder, means

for supplying fluid under pressure to opposite ends of said cylinder, a movable piston-like locking member in said one end of said cylinder, said locking member being movable relatively to said piston to actuate said locking means to lock and release said piston and cylinder, means forming a pair of ports at said one end of said cylinder, one of said ports adapted to be connected to a return conduit and the other adapted to be connected with the fluid supply means at the opposite end of said cylinder, a normally closed valve carried by said locking member interposed between said ports, and means responsive to movement of said piston into locked position for opening said valve.

8. A hydraulic motor comprising a cylinder, a piston reciprocable in said cylinder, cooperating means on said cylinder and said piston for locking the latter to one end of said cylinder, fluid pressure responsive means for locking and unlocking said locking means, means for supplying fluid under pressure to said cylinder on opposite sides of said piston, means forming a fluid return port at said one end of said cylinder, a normally closed valve in said cylinder and interposed between said return port and the fluid supply means connected to the opposite end of said cylinder, and means responsive to movement of said piston into locked position for opening said valve to divert the fluid from said opposite end of said cylinder, and a tubular piston rod slidably connected to said piston and movable relatively thereto.

9. A hydraulic motor comprising a cylinder, a piston reciprocable in said cylinder, cooperating

means on said cylinder and said piston for locking the latter to one end of said cylinder, fluid pressure responsive means for locking and unlocking said locking means, means for supplying fluid under pressure to said cylinder on opposite sides of said piston, means forming a fluid return port at said one end of said cylinder, a normally closed valve interposed between said return port and the fluid supply means connected to the opposite end of said cylinder, and means responsive to movement of said piston into locked position for opening said valve to divert the fluid from said opposite end of said cylinder, a first tubular piston rod slidably connected to said piston and movable relatively thereto, and a second piston rod slidable in said first piston rod and having a connecting element thereon.

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