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HYDRAULIC JACK

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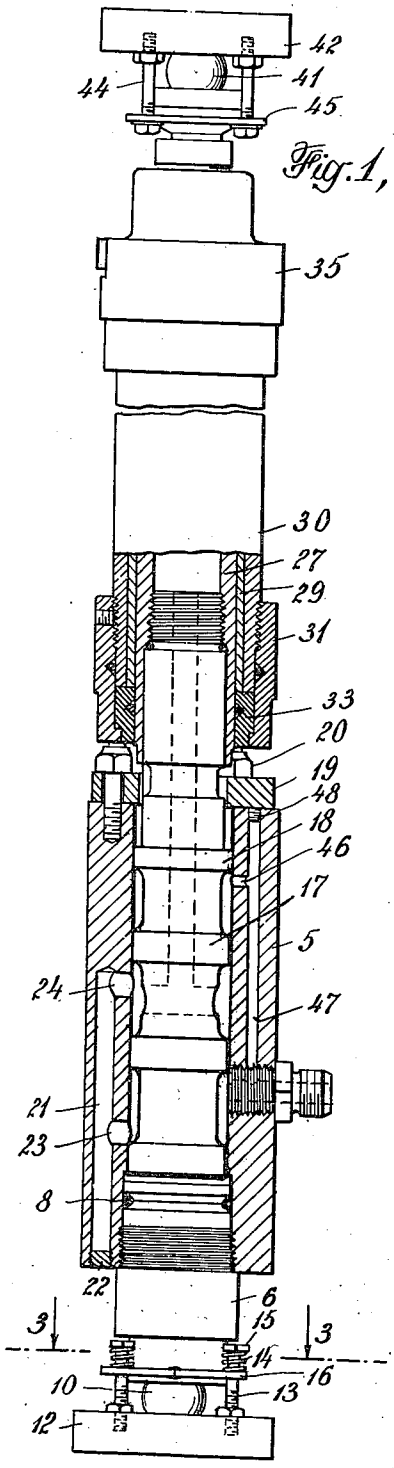

Fig. 1,

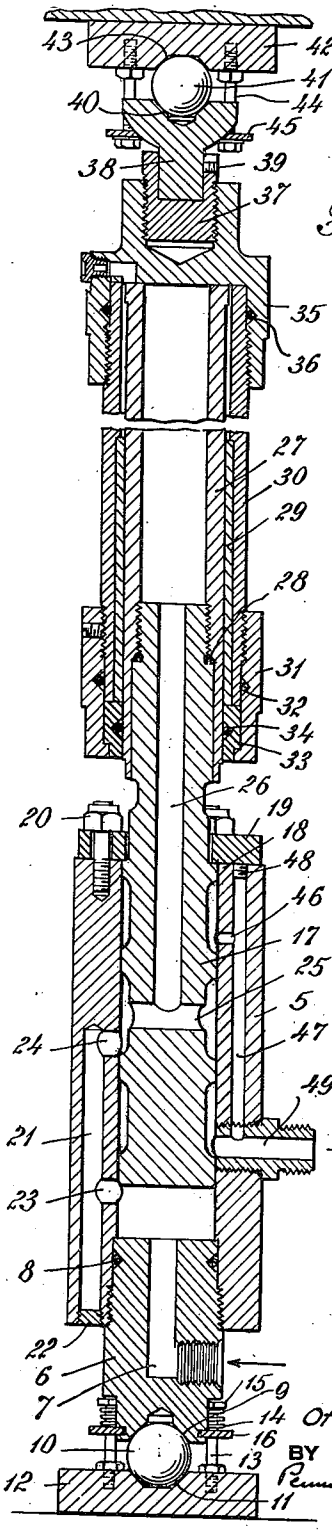

Fig. 2,

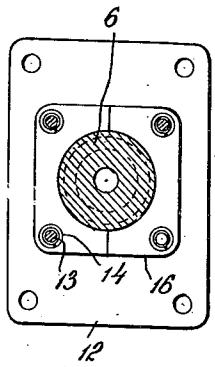

Fig. 3.

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HYDRAULIC JACK

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9 Claims. (Cl. 254—93)

1

This invention relates to hydraulic jacks and particularly to a lapped valve controlled compression jack having a relatively long stroke and adapted for use in testing structural members and for other purposes.

In constructing certain types of structural members such as wings of experimental aircraft, a procedure known as "static testing" is employed to determine maximum loadings as compared with calculated loadings. One of the most accurate and reliable means for applying test loads of any desired magnitude is the hydraulic jack or series of jacks generally used in conjunction with a device known as a load maintainer valve and with strain gauges applied to the structure being tested. Hydraulic jacks of sufficiently long stroke for the purpose described, as heretofore constructed, have been subject to the disadvantage of inaccuracy arising from friction between the movable members of the jack.

It is the object of the present invention to provide a long stroke hydraulic jack capable of applying a load proportional to the hydraulic pressure available and of avoiding inaccuracies due to friction.

Other objects and advantages of the invention will be apparent as it is better understood by reference to the following specification and the accompanying drawing, illustrating a preferred embodiment of the invention, in which

Fig. 1 is an elevation partially in section showing the jack in retracted position;

Fig. 2 is a sectional view showing the jack partially extended; and

Fig. 3 is a section on the line 3—3 of Fig. 1.

Referring to the drawing, 5 indicates a cylinder, one end of which is threadedly secured to a plug 6 having an inlet passage 7 and a doughnut type packing 8 to prevent escape of fluid. The plug 6 has a seat 9 for a ball 10 which is mounted in a seat 11 provided in a foot 12. Bolts 13 supported in the foot 12 engage springs 14 mounted between the heads 15 of the bolts and a flange 16. The construction affords flexibility in the support to correct any misalignment of the jack.

Within the cylinder 5, which is relatively short, is a lapped piston valve 17 which is adapted to move through a relatively short stroke limited by engagement of a flange 18 with a head 19 held by bolts 20 at the top of the cylinder 5. A passage 21, closed by a plug 22, is provided in the wall of the cylinder 5 and has ports 23 and 24. When the piston valve 17 is elevated by introduction of hydraulic fluid as indicated in Fig. 2, the

2

fluid flows through the port 23 into the passage 21 and thence through the port 24 into a transverse passage 25 in the piston valve 17, and thence through a longitudinal passage 26 in the valve.

The upper end of the piston valve 17 extends beyond the cylinder 5 and affords a support for a hollow piston 27 threadedly mounted on the end of the piston valve 17 and provided with doughnut type packing 28 to prevent leakage. The piston 27 is slidable in a sleeve 29 mounted within a cylinder 30 which is threadedly connected to a head 31 with doughnut type packing 32 to prevent leakage. A sleeve 33 with doughnut type packing 34 is disposed within the head 31 forming a bearing for the piston 27.

The other end of the cylinder 30 is closed by a head 35 threadedly connected to the end thereof and provided with doughnut type packing 36. The head carries a threaded plug 37 which in turn supports a member 38 held by a set screw 39 having a seat 40 for a ball 41. A bearing member 42, having a seat 43, rests on the ball and is held in alignment by bolts 44 extending through openings in the flange 45. The bearing member 42 is thus capable of movement to correct for any misalignment of the jack.

It will be noted that the internal diameter of the sleeve 29 somewhat exceeds the internal diameter of the cylinder 5. When fluid is introduced under pressure through the passage 26 in the piston valve 17, the cylinder 30 will be lifted to extend the jack until the bearing member 42 engages the work. Thereupon pressure will increase until, owing to the difference in internal diameters of the sleeve 29 and cylinder 5, the piston valve 17 is forced downwardly, thus closing the port 23. This action traps the hydraulic fluid in the cylinder 23, whereupon the mechanism operates as a lapped jack. Since the load is constantly floating on the lapped piston valve, the force applied is always equal to the product of the piston valve area and the hydraulic pressure of the fluid, regardless of the amount of extension of the jack.

Any leakage around the lapped piston valve 17 escapes through a port 46 to a passage 47 closed by a plug 48 and extending to an outlet passage 49 connected to the pressure fluid return line (not shown). When the line pressure of the pressure fluid is relieved, the piston valve 17 returns to the position indicated in Fig. 1 of the drawing. Thereupon fluid drains from the cylinder 30 and piston 27 through the passages 26 and 25 into the passage 21 and through the

port 23 into the outlet passage 49. The same result follows when the load applied to the jack increases beyond the load which can be supported by the pressure on the lower surface of the lapped piston valve 17. In that event, the piston valve 17 is forced downwardly to the position indicated in Fig. 1, and the fluid drains from the jack without flowing back through the pressure line.

Since the piston valve 17 is relatively short and the lapped surfaces thereof of relatively small area, the amount of friction introduced in the operation is negligible. At the same time, the entire stroke of the jack is limited only by the length of the cylinder 30, which may be of any desired dimensions. The friction introduced through movement of the cylinder 30 upon its piston is also negligible. Hence it is possible to afford the necessary stroke to accomplish the desired purpose and at the same time ensure the application of a load which is directly proportional to the pressure of the fluid. As indicated, overloading, that is the attempt to apply a load beyond the capacity of the apparatus, results in immediate collapse without danger of forcing fluid backwardly through the fluid pressure line.

Various changes may be made in the form and construction of the apparatus without departing from the invention or sacrificing the advantages thereof.

I claim:

1. A hydraulic jack comprising a relatively fixed valve cylinder, a piston valve slidable therein and having a portion extending beyond said cylinder, a second cylinder mounted for longitudinal movement on and relative to said extending portion of the piston valve, means to admit fluid under pressure to the valve cylinder to actuate the piston valve, and a fluid passage adapted to place the interiors of the two cylinders in communication and controlled by the piston valve, whereby when fluid is admitted to the valve cylinder and actuates the piston valve to open said passage some of the fluid will be admitted to the second cylinder to move it longitudinally on the piston valve extension and thereby extend the overall length of the jack.

2. A hydraulic jack comprising a valve cylinder, a piston valve slidable therein with a relatively short stroke, said piston valve having a relatively long portion extending beyond said cylinder, a second cylinder mounted for longitudinal movement on and relative to said extending portion of the piston valve with a relatively long stroke, means to admit fluid under pressure to the valve cylinder to actuate the piston valve, and a fluid passage adapted to place the interiors of the two cylinders in communication and controlled by the piston valve, whereby when fluid is admitted to the valve cylinder and imparts the relatively short stroke to the piston valve to open said passage some of the fluid will be admitted to the second cylinder to impart the relatively long stroke to it and thereby extend the overall length of the jack considerably more than accomplished by the relatively short stroke of the piston valve.

3. A hydraulic jack comprising a relatively short valve cylinder, a piston valve slidable therein with a relatively short stroke and having lapped surfaces of relatively small area, said piston valve having a relatively long portion extending beyond said cylinder, a second cylinder mounted for longitudinal movement on and relative to said extending portion of the piston valve with a relatively long stroke, the area of contact between the second cylinder and the piston valve extension on which it slides being relatively small, means to admit fluid under pressure to the valve cylinder to actuate the piston valve, and a fluid passage adapted to place the interiors of the two cylinders in communication and controlled by the piston valve, whereby when fluid is admitted to the valve cylinder and imparts the relatively short stroke to the piston valve to open said passage some of the fluid will be admitted to the second cylinder to impart the relatively long stroke to it and thereby extend the overall length of the jack considerably more than accomplished by the relatively short stroke of the piston valve.

4. A hydraulic jack comprising a valve cylinder, a piston valve slidable therein and having a portion extending beyond said cylinder, a second cylinder carrying a work-engaging portion and mounted for longitudinal movement on and relative to said extending portion of the piston valve, means to admit motive fluid under pressure to said valve cylinder to produce a forward stroke of the piston valve, a fluid passage adapted to place the interiors of the two cylinders in communication and having an entrance port in the wall of the valve cylinder arranged to be opened for admission of some of the motive fluid during the latter part only of the forward stroke of the piston valve and to be closed during the first part of the return stroke thereof, whereby when motive fluid is admitted to the valve cylinder the piston valve is actuated to open said port for admission of some of the motive fluid to the second cylinder to move it longitudinally until its work-engaging portion contacts with the work, the effective pressure area in the second cylinder which is responsible for relative movement between it and the piston valve extension being greater than the effective pressure area of the piston valve so that after pressure is applied to the work by the jack the piston valve will be moved in the opposite direction by the fluid pressure in the second cylinder to close said port and thereby trap the motive fluid in the valve cylinder.

5. A hydraulic jack comprising a valve cylinder, a piston valve slidable therein and having a portion extending beyond said cylinder, a second cylinder mounted for longitudinal movement on and relative to said extending portion of the piston valve, means to admit motive fluid under pressure to said valve cylinder to produce a forward stroke of the piston valve, a fluid passage adapted to place the interiors of the two cylinders in communication and having a port in the wall of the valve cylinder arranged to be opened by the piston valve during its forward stroke for admission of some of the motive fluid to the second cylinder to move it longitudinally, and an exhaust port in the wall of the valve cylinder, the piston valve when in normal position serving to place said exhaust port in communication with said first-named port so that when the line pressure of the motive fluid is relieved and the piston valve returns to normal position the motive fluid will be exhausted from the second cylinder through said first-named port and said exhaust port.

6. A hydraulic jack comprising a valve cylinder, a piston valve slidable therein and having a portion extending beyond said cylinder, a second cylinder carrying a work-engaging portion and mounted for longitudinal movement on and relative to said extending portion of the piston valve, means to admit motive fluid under pressure to said valve cylinder to produce a forward stroke

of the piston valve, a fluid passage adapted to place the interiors of the two cylinders in communication and having a port in the wall of the valve cylinder arranged to be opened by the piston valve after it has moved a predetermined distance on its forward stroke for admission of some of the motive fluid to the second cylinder to move it longitudinally until its work-engaging portion contacts with the work, the effective pressure area in the second cylinder which is responsible for relative movement between it and the piston valve extension being greater than the effective pressure area of the piston valve so that after pressure is applied to the work by the jack the piston valve will be caused to start a return stroke by the fluid pressure in the second cylinder and will close said port and thereby trap the motive fluid in the valve cylinder, and an exhaust port in the wall of the valve cylinder, the piston valve having a passage adapted to place the exhaust port and said first-named port in communication upon further return movement of the piston valve to exhaust the motive fluid from the second cylinder when the jack is overloaded or when the line pressure of the motive fluid is relieved and the piston valve thereby returned to normal position.

7. A hydraulic jack comprising a relatively fixed valve cylinder, a piston valve slidable therein and having a portion extending beyond said cylinder, a second cylinder mounted for longitudinal movement on and relative to said extending portion of the piston valve, means to admit fluid under pressure to the valve cylinder to actuate the piston valve, and a fluid passage adapted to place the interiors of the two cylinders in communication, said passage having one portion located within the wall of the valve cylinder and another portion extending through a portion of the piston valve and its extension and opening directly into the second cylinder, the portion of the passage within the valve cylinder wall entering the valve cylinder at one point where it is opened and closed by movement of the piston valve and entering the valve cylinder again at a second point where the piston valve has a recess adapted in all positions of the valve to establish communication between the two portions of the passage, whereby when fluid is admitted to the valve cylinder and actuates the piston valve to open said passage some of the fluid will be admitted through the passage to the second cylinder to move it longitudinally on the piston valve extension.

8. A hydraulic jack in accordance with claim 1 having a work-engaging member associated with the second cylinder, a ball-and-socket connection between said member and the second cylinder, and a ball-and-socket support for the valve cylinder.

9. A hydraulic jack comprising a short stroke cylinder and piston valve, a long stroke piston and cylinder supported on the piston valve, the cross-sectional area of the long stroke cylinder being slightly greater than the cross-sectional area of the short stroke cylinder, and the short stroke cylinder and piston valve having passages and ports whereby fluid under pressure is delivered to and trapped within the long stroke cylinder to extend and maintain it in extended position.

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