

March 23, 1948.

R. HOULDSWORTH
TELESCOPIC HYDRAULIC JACK

2,438,285

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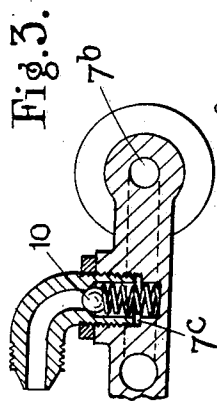
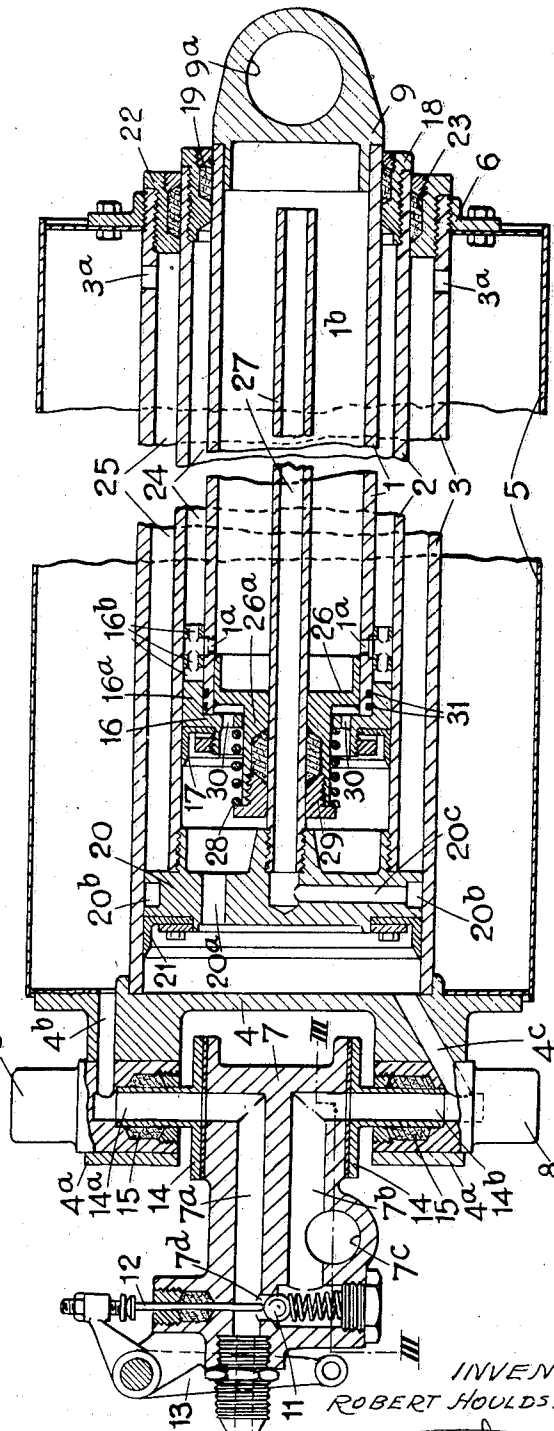


Fig. 1.



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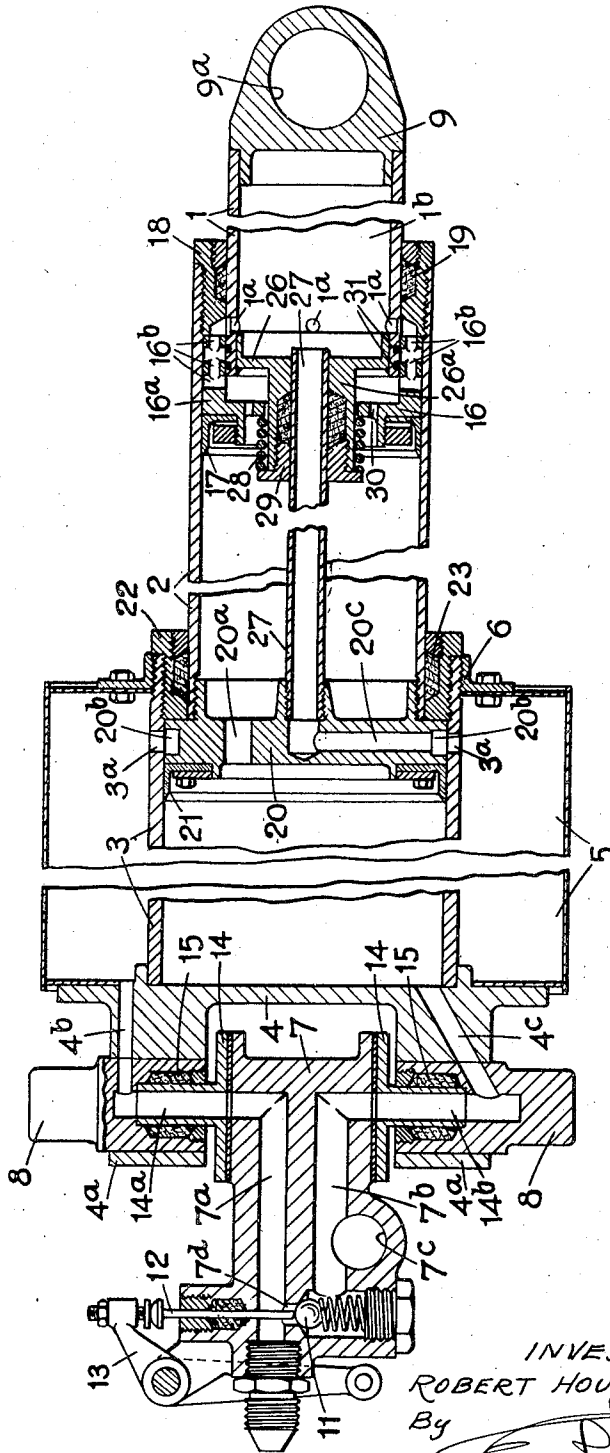
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3 Sheets-Sheet 2

Fig.2.



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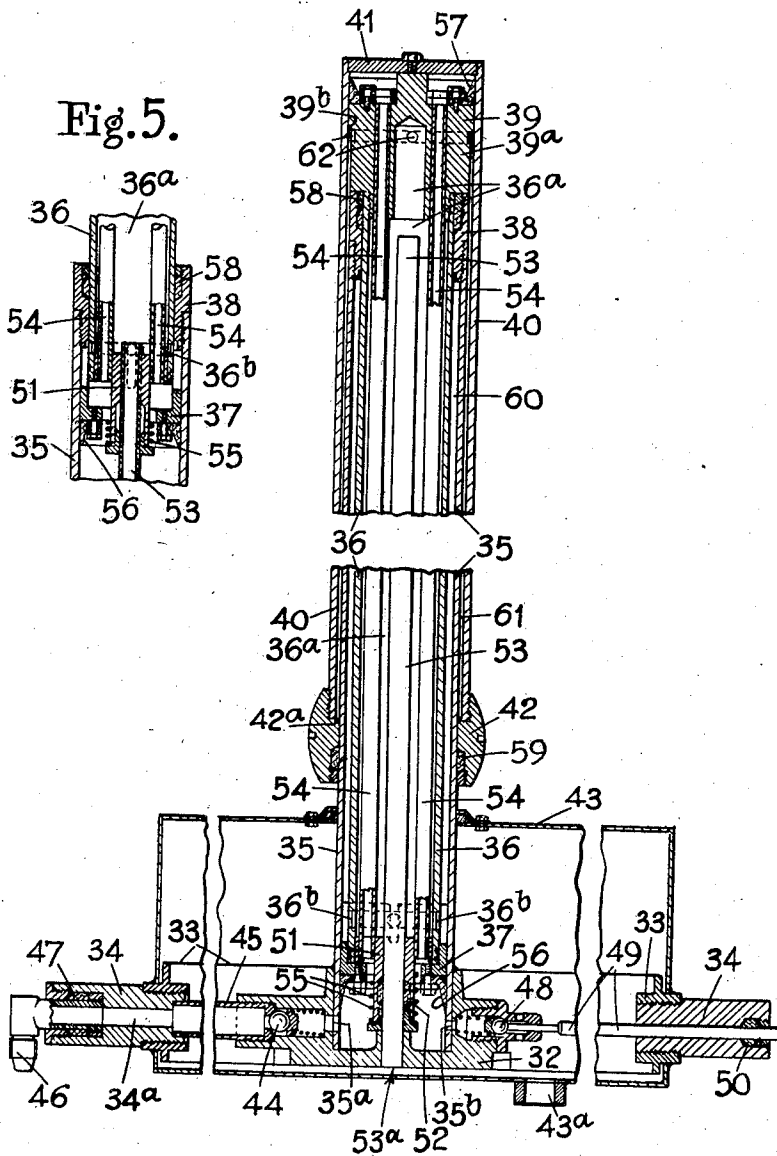
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3 Sheets-Sheet 3

Fig. 4.



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UNITED STATES PATENT OFFICE

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TELESCOPIC HYDRAULIC JACK

Robert Houldsworth, Brighton, Bolton,
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In Great Britain December 1, 1943Section 1, Public Law 690, August 8, 1946
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6 Claims. (Cl. 60—52)

1

This invention relates to hydraulic jacks of the telescopic type, especially such as are used in tipping gear for motor road vehicles, in which the jack is pivotally attached at one end to the chassis and at the other end to a body mounted so that extension of the jack (under pressure of hydraulic fluid, pumped from a low pressure vessel or reservoir) causes the body to tip about a hinged attachment to the chassis.

Although the invention is more especially intended for tipping gear for road vehicles, it may also be applied to jacks for retractable undercarriages on aircraft or to jacks for other purposes.

One object of the invention is to improve the action of such jacks and to prevent loss, by leakage, of the hydraulic operating fluid.

Another object is to provide a novel structure in a hydraulically operated telescopic jack comprising pressure-relieving means, which is actuated automatically by a supplementary movement of the jack at the end of its extended stroke to thereby return excess fluid to a low pressure reservoir.

A further object is to provide a novel arrangement of fluid seals, whereby any excess fluid trapped in the space defined between the telescoping members of the jack is returned to the low pressure reservoir instead of being allowed to seep out of the apparatus and be wasted.

In order that my invention may be fully understood, two embodiments thereof will now be particularly described with reference to the accompanying drawings, in which—

Figures 1 and 2 are views in axial section (and with parts broken away) of a double-lift jack which embodies the said invention and is suitable for mounting in "slant" position on a tip-waggon to act at an intermediate point in the length of the pivoted body. Figure 1 shows the relative positions of the cylinders, the relief valve and other working parts when the jack is closed, while Figure 2 shows how these various elements are related when the jack is fully extended.

Figure 3 is a sectional view of a detail of construction, the section being taken on line III—III of Figure 1.

Figure 4 is a view similar in character to Figure 1 but showing how the invention can be applied to a jack of the "vertical" type. In a tip-waggon such a jack would, as a rule, be mounted close to and would act upon the forward end of a body pivoted to the vehicle chassis at its rear end (or, for side-tipping there might be two of

2

such jacks, one on each side of the vehicle, with suitable lateral pivoting means, to allow of tipping to either side, as required).

Figure 5 is a fragmentary axial section illustrating the action of the relief valve when the jack of Figure 4 is fully extended.

Referring firstly to Figures 1 to 3, the reference numeral 1 designates the primary ram which is slidable in a hydraulic cylinder 2. The latter, in this embodiment, functions as a secondary ram and, in turn, slides in a fixed cylinder 3, mounted on the base structure 4. This same base 4 also forms a support or abutment for one end wall of an annular jacket 5, surrounding the fixed cylinder 3, which is fitted with an angle ring 6 to support the other end wall of the said jacket. This jacket, which may be fabricated in sheet metal, since it is not heavily stressed, is designed to act as a storage reservoir for the hydraulic fluid used to operate the jack. It is furnished with a capped filling orifice and an air vent—which maintains atmospheric pressure in the reservoir—but these items are not shown in the drawings.

The base 4 is formed with a pair of lugs 4^a, spaced to receive between them a hydraulic coupler 7, and in each lug is fixed a trunnion 8, these trunnions forming part of the means—known per se—for pivoting the jack to a vehicle frame or chassis. Pivotal connection with the body of the vehicle is established, in this example, through the head 9 of the primary ram 1: an eye 9^a in this head 9 receives the pivot pin (not shown).

The cylinder base 4 and the coupler 7 contain ducts forming parts of the hydraulic pumping system by means of which the jack is raised or extended. Thus, the suction side of the pump—usually a gear pump—is connected, through the ducts 7^a and 4^b, to the low pressure reservoir 5 while the delivery side is connected through ducts 7^b and 4^c to the interior of the cylinder 3 and, therefore, to the whole of the pressure space within the jack. High pressure fluid reaches the duct 7^b by way of a port 7^c with which there is associated a spring-loaded non-return valve 10 (Figure 3). A spring-loaded lowering valve 11 normally closes a port 7^d, connecting the ducts 7^a and 7^b but this valve can be displaced from its seating by means of a push-rod 12, actuated by a control (not shown), through the agency of the bell-crank lever 13.

The coupler 7 is a stationary member which not only provides one convenient means for coupling the hydraulic pumping system to the pivoted jack

3

also—as already explained—serves to accommodate the valves 10 and 11 which control the direction of flow of the operating fluid. This coupler is fitted with hollow spigot attachments 14, the spigots of which pass through packing glands 15 and are thus maintained in co-axial relationship with the trunnions 8. Spigot tube 14^a connects the ducts 7^a and 4^b whilst spigot tube 14^b connects the ducts 7^b and 4^c and it will be apparent that fluid-tight pivotal hydraulic connections are provided by this arrangement.

The primary ram 1 is guided in the secondary ram 2 by its piston head 16, sealed with a cup-washer 17, and by the ram nut 18, screwed in the outer end of the cylinder 2 and containing a packing gland 19. Somewhat similarly, the secondary ram 2 is guided in the fixed cylinder 3 by its piston head 20, sealed with a cup-washer 21, and by a ram nut 22, screwed into the outer end of said cylinder 3 and containing a packing gland 23.

In the closed position of the jack (Figure 1) there is an annular clearance space 24 between the cylinders 1 and 2 and this space communicates with the interior of the ram cylinder 1 through ports 1^a in the wall of that cylinder, near to the inner end thereof. Between the cylinders 2 and 3 there is another annular clearance space 25, which communicates directly with the low pressure reservoir 5 through ports 3^a in the wall of the cylinder 3 near to the outer end thereof. It will be obvious that as the ram 1 moves outwards the volume of the space 24 steadily diminishes and that the same applies to the space 25 when the ram 2 moves outwards; thus, in the extended position of the jack (Figure 2) the spaces 24 and 25 are substantially eliminated. The ports 1^a and 3^a, through which any fluid contained in the diminishing spaces 24 and 25 is ejected when the jack expands, participate also in the return of excess operating fluid and of leakage fluid to the low pressure reservoir—as hereinafter explained.

The outer end of the ram cylinder 1 is closed by the head 9 and at its inner end is fixed a closure member 26 having a central extension or boss 26^a, which houses a packing gland for the straight, rigid tubular element 27, the latter being co-axially related to the said cylinder. The space 1^b within the ram cylinder constitutes a low pressure relief chamber for excess operating fluid.

As shown, the piston 20 is fixedly secured to the inner end of the ram cylinder 2 and it is pierced by a passage 20^a which establishes direct and permanent communication between the interior of the fixed cylinder 3 and that of the ram cylinder 2. A peripheral groove 20^b in this piston is connected, through a radial passage 20^c, with a hollow central boss into which is screwed the inner end of the tube 27 aforesaid. This tube is of such length that it maintains sliding connection with the interior of the ram 1 throughout the full stroke of the latter (see Figure 2). Together with the passage 20^c and groove 20^b it forms the return duct for conveying excess operating fluid back from the chamber 1^b to the low pressure reservoir 5 by way of the port 3^a.

The ram piston 16 is separate from its ram 1, but is formed with a sleeve-like extension 16^a which fits slidably on the ram cylinder. The piston crown is centrally apertured to pass the boss 26^a and the latter is surrounded by a spring 28 which normally presses the piston against the

4

end of the ram cylinder 1. A flange of the gland nut 29 may provide the fixed abutment for this spring.

Operating fluid from the cylinder 2, passing through openings 30 in the piston 16, can act on the end wall 26 of the ram 1 but normally it is prevented from escaping to the relief chamber 1^b of the said ram, cut-off being effected at the adjacent end zone of the cylinder 1 where packing rings 31 bear on a solid annular part of the piston sleeve 16^a. Another part of this sleeve, which performs the functions of a slide-valve, is provided with a system of radially and axially directed ports (indicated collectively by the reference 16^b) through some of which communication is normally maintained between the clearance space 24 and the ram ports 1^a (see Figure 1). Other parts of the same port system are so located that they will be opened for escape of the operating fluid if the outward travel of the ram cylinder be caused to continue after the piston has been arrested by contact of the sleeve 16^a with the ram nut 18. This condition is clearly shown in Figure 2 which also indicates how such supplementary outward movement of the cylinder 1 can be finally terminated by total compression of the valve-closing spring 28. Further, it can be seen that, as the ram ports 1^a are still uncovered, any fluid escaping through the open slide-valve can pass freely through these ports to the ram chamber 1^b.

When the jack is at rest in the closed condition (Figure 1) the bulk of the operating fluid is stored in the low pressure reservoir 5, from which the space 25 is also filled, through the ports 3^a. The ducts of the pumping system and the residual cylinder spaces in front of the pistons 20 and 16 are also filled with fluid at low pressure (substantially at atmospheric pressure). On starting the pump, fluid is drawn from the reservoir 5 and forced past the automatically opening non-return valve 10, into the cylinder 3 and thence, by way of the passage 20^a, into the cylinder 2. Under the operating pressure, acting on their piston heads, the rams 1 and 2 move outwards together until the ram 2 is arrested by reason of its piston 20 coming into contact with the ram nut 22, screwed into the fixed cylinder 3. It is at this stage that the peripheral groove 20^b of the piston 20 comes into register with the ports 3^a in the cylinder 3, thereby placing the relief chamber 1^b of the ram 1 freely in communication with the low pressure reservoir 5. Under continued pressure from the operating fluid (acting in the now stationary cylinder 2) the piston 16 and ram 1 are forced to move outwards together until the piston sleeve 16^a meets the ram nut 18, screwed into the cylinder 2. In this condition the jack can be said to have reached the limit of its useful lift but, if the pump still continues to deliver operating fluid, it will build up excess pressure, which must be relieved before it becomes unduly or dangerously high. To meet this requirement, the ram 1 is permitted, under excess fluid pressure, arising after the piston 16 has been stopped, to execute a limited additional outward movement, sufficient to open the relief valve 26 for the escape of excess fluid from the high pressure space. This supplementary phase of ram movement sets in when the excess pressure acting on the inner end of the ram 1 is high enough to overcome the force of the spring 28 (which may be calibrated for a predetermined rise of pressure). The ram cylinder then moves to the position shown in

Figure 2 wherein its inner end, sliding in the piston sleeve 16^a, is seen to have opened the ports 16^b for the passage of fluid from the high pressure space to the ram ports 1^a and thence to the relief chamber 1^b. From this latter the duct system 27, including passages 29^a, 29^b conveys the excess fluid to the ports 3^a through which it discharges into the reservoir 5. The described relief action will be maintained for so long as the pump continues to deliver excess fluid but if pumping ceases then the ram 1 will sink until it again closes the ports 16^b and comes to rest on the crown of the piston 16. Hereafter the jack can remain extended to its useful limit until it is released by opening the lowering valve 11 (which connects the pressure space to the reservoir 5 by way of the ducts 4^c, 7^b, 7^a and 4^b).

Instead of relying on the closing together of the valve spring convolutions to limit the extent of supplementary movement of the ram cylinder 1, some other form of positive stop may be employed.

The double-lift "vertical" jack depicted in Figure 4 is especially suited for use on a low-loading vehicle in which, owing to the low level of the load platform, there is no room for installing a jack underneath the body. To meet such conditions, a high lift tipping jack is mounted outside the body (usually at the front end thereof) and is pivotally connected to the body and to the chassis, the arrangement being such that when the body is in its normal (lowered) position the jack column stands more or less upright, the pivotal connection to the body being then as close to the lower end of the column as practical considerations will permit. The apparatus of Figure 4 incorporates these special features as well as the essential features of the present invention.

The cylinder base 32 of this jack is fixed in a supporting frame 33 furnished with trunnions 34 by means of which it can be pivoted to the vehicle chassis. The fixed hydraulic cylinder 35 is made fast in the base 32 and in it slides the primary ram 36, guided by its piston slide valve 37 and by the ram nut 38 of the said cylinder 35. At its upper end the primary ram has a fixed piston head 39, serving to guide a secondary or supplementary ram cylinder 40 which has a top closure 41 and an internal diameter such that it can pass freely over the fixed cylinder on which it is also guided by means of a collar 42, screwed to its lower end. This collar 42 has a spherically shaped outer surface enabling it to form part of a universal attachment connecting the supplementary ram to the vehicle body. It will be apparent from Figure 4 that the arrangement whereby the ram cylinder 40 substantially envelops the other cylinders when the jack is closed permits the connection with the vehicle body to be located at a low level, although a high lift is obtained when both rams are fully extended.

A low pressure reservoir 43 is built around the frame 33 so as to envelop the base 32 and the lower part of the cylinder 35 but, since the supply of hydraulic fluid to that cylinder and the release of fluid therefrom are controlled by valves in the base, the requisite external connections to those valves can be established most conveniently through axial bores in the trunnions 34. Thus the cylinder 35 receives high pressure fluid through the port 35^a by way of the non-return valve 44, the pipe connection 45, the trunnion bore 34^a and the union fitting 46, held in a packing gland 47. On the other hand, the release of fluid from the cylinder 35 takes place through the

port 35^b when the lowering valve 48 is opened and the actuating rod 49 for this valve extends through a bore and through a packing gland 50 in the other trunnion 34.

The intake side of the pump is connected to the reservoir outlet 43^a, its delivery side to the high pressure inlet 46 and flexible hydraulic tubing may be used for the connections.

The ram cylinder 36 is closed at its upper end by the piston 39 and at its lower end by a fixed closure member 51 which, with the aid of a packing gland 52, fits slidably on the rigid central tubular element 53. This latter, fixed in the base 32 and opening at 53^a into the reservoir 43, constitutes the return duct for excess fluid received in the relief chamber 36^a.

In order that the external or supplementary ram 40 may be supplied with operating fluid from the cylinder 35, the primary ram 36 is traversed from end to end by tubular ducts 54.

The piston slide valve 37 works in exactly the same way as the corresponding member 16, 16^a of the embodiment shown in Figures 1 and 2. Under the action of the loading spring 55, the valve normally cuts off communication between the high pressure space (in the cylinder 35) and the ports 38^b, which gives access to the relief chamber 36^a, but in the presence of excess pressure, after the jack has extended to the useful limit, the valve is opened, as shown in Figure 5.

The pistons 37 and 39 are provided, respectively, with cup-washers 56 and 57 while packing glands 58 and 59 serve to prevent leakage of fluid from the inter-cylinder clearance spaces 60 and 61. Leakage through the piston seal 56 finds its way to the ports 38^b while leakage through the seal 57 ultimately reaches the chamber 36^a by way of passages 62 in the piston head 39.

In the operation of this jack the high pressure fluid occupies the space below the ram 36, the space above the piston head 39 and the tubes 54 connecting these spaces. When operating fluid is pumped into the cylinder 35 of the closed jack (Figure 4) the fluid pressure transmitted through the tubes 54 and acting on the closure member 41 causes the ram 40 to rise first. Its collar 42 and packing gland 59 slide on the outside of the cylinder 35 and finally ride first on to the ram nut 38 and then on to a slightly reduced part 39^a of the piston 39. As the parts 35, 38 and 39^a are all equal as to diameter the sealing action of the gland 59 is not lost during this phase of ram movement, which is terminated by contact of a shoulder 42^a in the collar with the shoulder 39^b of the piston head. Under continued fluid pressure the ram 40 still continues to rise and, through the agency of the contacting shoulders 42^a, 39^b, it carries with it ram 36, this phase continuing until the sleeve of the piston slide valve 37 meets the ram nut 38. The limit of useful lift has now been reached but, if the delivery of operating fluid still continues, the ram 36 will execute the small supplementary movement necessary to open the relief valve, as shown in Figure 5. The escaping fluid will then pass to the chamber 36^a and will flow down the return duct 53 to the reservoir 43.

When the lowering valve 48 is opened the ram 36 descends first and when the piston part 39^a meets the ram nut 38 an unbroken cylindrical surface is presented to the collar 42, to guide it back on to the ram cylinder 35 when the ram 40 descends.

A simplified—and, therefore, a cheaper—form of assembly is possible in circumstances which

7

permit the use of a single-lift jack and, in this connection, it may be remarked that the apparatus shown in Figure 4 could be converted very easily into a single-lift jack embodying the essential features of the present invention. In making such conversion the outer ram 40 would be omitted and the inner ram 36 (i. e., the ram associated with the piston slide valve) would be replaced by a ram having a solid (un-perforated) outer end closure and an inner end closure pierced only to receive the excess fluid return duct. In other words, the ram 1 of Figures 1 and 2 could be substituted for the ram 36.

I claim:

1. A hydraulically operated telescopic jack, comprising a cylinder having openings through the forward end of its wall, a low pressure reservoir mounted around said cylinder, a hollow ram having one end closed by an operating piston reciprocable in said cylinder, said piston having an opening for admitting fluid into the interior of the ram and a central aperture with radial passages leading therefrom adapted to register at the end of its stroke with the openings in said cylinder, a second hollow ram telescopically mounted within said first ram and having its inner end closed by a piston, said piston comprising a closure member including a boss extending into the interior of the first ram, a spring on the pressure side of the piston around the boss, means for holding said spring pressed against the piston, said second ram having openings therein above the said end closure member adapted to be normally sealed against the entry of operating fluid except at pressures greater than the resistance of said spring to thereby serve as a pressure-relieving chamber, an elongated duct extending from said radial fluid passages mounted in the piston of said first ram, said duct extending into the interior of said second ram through said spring-holding means, means adapted to supply operating fluid into said cylinder to thereby move said first and second mentioned rams forward until said first mentioned ram abuts the end of the cylinder, said second mentioned ram being fed forward longitudinally of said duct until it abuts the end of said first mentioned ram, said duct remaining in permanent connection with the interior of said second ram throughout the full stroke of said ram, said closure and said spring coacting with the abutted end of said first ram at the end of the lifting stroke of the second ram upon an excessive pressure build-up in the first ram to thereby provide an additional outward movement of the second ram to align the openings above the closure with passages from the interior of the first ram for the admission of fluid into the second ram and out through said duct and radial openings when they are aligned with the openings in the cylinder to the low pressure reservoir.

2. A hydraulic jack in accordance with claim

8

1, wherein the spring pressed piston of the second ram has a sleeve-like ported extension fitted slidably on the said ram, the ports therein being adapted to slide forward into registry with the openings in the second ram by coaction with abutment means in the end of the first ram under conditions of excess pressure.

3. A hydraulic jack in accordance with claim 1, wherein the first ram substantially envelops the second ram of the jack when the latter is closed, and wherein said first ram receives excess operating fluid through said elongated ducts for recirculation of said excess fluid.

4. The hydraulic jack as described in claim 1, wherein the said second hollow ram operates as a piston slide valve for aligning the openings in the walls of said ram with passages leading from the interior of said first ram upon an excess of pressures beyond the normal lifting pressures of the jack.

5. The hydraulic jack in accordance with claim 1, wherein the second ram serving as the pressure relief chamber carries and guides the first hollow ram as it is driven forward by lifting pressures.

6. A hydraulically operated telescopic jack, comprising a hollow ram, a cylinder, a fluid supply reservoir connected to said cylinder, a pressure relief chamber in said hollow ram, a spring-closed relief valve adapted to normally seal said chamber and adapted to open at excessive pressure, a return duct anchored at an end to the inner end of said cylinder in which the ram slides, said duct being connected to said chamber and to said reservoir to return fluid to the reservoir a packing gland mounted in said hollow ram, said duct extending through said gland into the interior of the ram and maintaining sliding connection with said chamber throughout the full stroke of the ram, and abutment means adapted to limit the outward stroke of the ram under operating pressure, whereby at the end of said stroke an excessive pressure increase serves to open said relief valve, so as to permit escape of excess fluid into said relief chamber.

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