June 2, 1964 A. CIALLIÉ 3,135,165

HYDRO-MECHANICAL LIFTING JACK

Filed Oct. 8, 1962

Fig.1

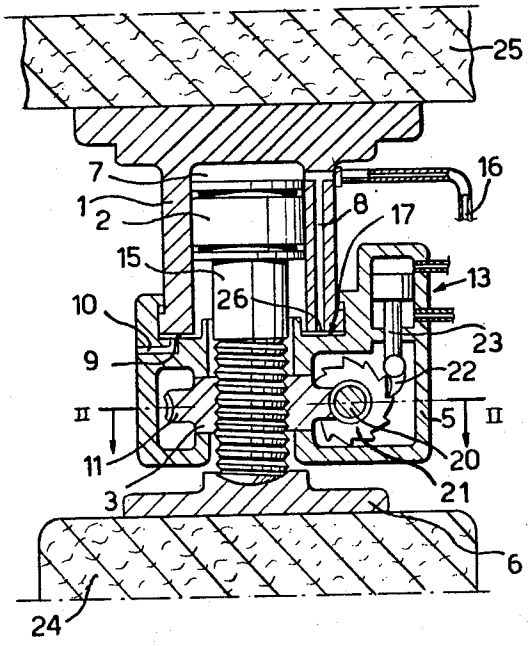


Fig.2

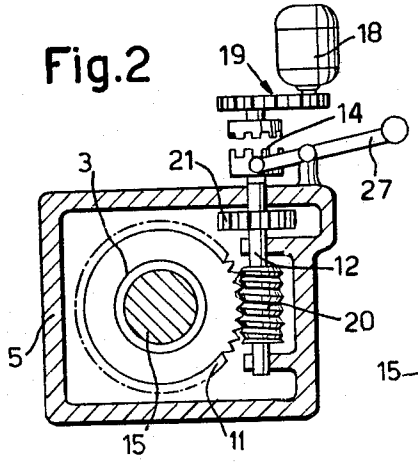
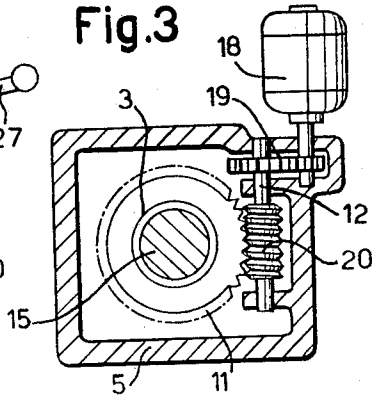


Fig.3



United States Patent Office 3,135,165
Patented June 2, 1964

3,135,165

HYDRO-MECHANICAL LIFTING JACK

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Filed Oct. 8, 1962, Ser. No. 228,920
Claims priority, application Italy July 26, 1962
1 Claim. (Cl. 91—47)

This invention deals with the problem of lifting large masses, such as monuments, buildings, etc., by means of a plurality of lifting jacks.

Successful lifting of such masses or loads implies an extremely accurate and synchronized control of all the jacks present both with respect of their stroke increments and lifting speed thereby to assure a correct load-distribution and avoid casual inclinations of the load beyond admissible limits. Since it is rather difficult, if not impossible at all, to provide and maintain, for all the jacks present, a perfect uniformity of operating conditions, such as non-yieldable or uniformly yieldable bases, identical partial loads, identical hydraulic liquid deliveries and pressures, etc., an efficient control of the jacks is likewise difficult or impossible.

It is an object of this invention to provide a lifting jack the operation of which can be successfully controlled in a perfect synchronism with further similar jacks irrespectively of their operating conditions. In other words, it is an object of this invention to provide a lifting jack which, when associated with further similar jacks for the purpose of jointly lifting a load, will lift the load at a speed and to an extent identical to those accomplished by said further jacks without requiring a complicate control system.

The basic structure of my jack comprises a single-effect hydraulic cylinder having a piston sealingly axially slidable therein, said piston having a piston rod outwardly protruding from the open end of the cylinder whereby the effective load may act between the piston rod and the cylinder, a load-distributing plat being advantageously associated with the free end of the piston rod, and the cylinder head being advantageously enlarged laterally to provide a similar load-distributing surface for the cylinder. A passage is formed in the cylinder adjacent the bottom of the latter whereby hydraulic liquid can be supplied to the pressure chamber in the cylinder confined between said bottom and the piston to thereby axially extend the jack and lift the load. Moreover, a discharge passage extends from the pressure chamber through a wall section of the cylinder ending by a discharge port. On the other hand, on the piston rod I provide a throttling member for said port, the member being axially supported by the rod and axially adjustable on the latter and the mutual arrangement of the member and port being such as to obtain a progressively decreasing throttling on extension (lifting stroke) of the jack and a progressively increasing throttling on retraction (return stroke) of the piston in the cylinder.

In this manner, and as will be better understood from the following detailed description of some embodiments of this invention, the hydraulic liquid continuously circulates in operation through the pressure chamber and maintains the cylinder in an axially "floating" condition with respect of the piston, the floating condition being self-stabilized owing to the more or less powerful throttling of the discharge port occurring on even slight mutual axial displacements of the piston and cylinder. It will be also understood that a controlled displacement of the throttling member on the piston rod directed to increase the throttling action will immediately produce an extension of the piston/cylinder unit through a corresponding amount, whereas a controlled displacement of the throttling member on the piston rod to reduce the throttling action will immediately produce a retraction of the unit through a corresponding extent under the applied load.

Since the load-lifting hydraulic pressure is limited to the pressure chamber, an insignificant amount of such pressure being present between the discharge port and throttling member, the axial control of the latter involves a but insignificant power in either continuous or intermittent form, easily synchronizable with that controlling all other jacks present on the lifting set, as will be more clearly seen hereinafter.

In the accompanying drawing:

FIGURE 1 is a schematic axial sectional view of an embodiment of this invention wherein a hydraulic reciprocating motor is employed for displacing the throttling member on the piston rod in the load-lifting direction;

FIGURE 2 is a cross-sectional view on line II—II of FIG. 1;

FIGURE 3 is a cross-sectional view, similar to that of FIG. 2, of a modification of the throttling member control.

A single-acting ram or cylinder **1** has sealingly reciprocable therein a piston **2** having a screw-threaded piston rod **15** protruding outwardly from the open end of the cylinder. The free end of the piston rod bears on a load-distributing plate **6** and the head portion of the cylinder **1** is laterally enlarged as shown, as that the piston-cylinder unit can be placed on a foundation **24** to lift a load **25**.

Hydraulic liquid is supplied to the cylinder **1** from a pressure source (not shown) through a conduit **16** opening into the pressure chamber **7** in the cylinder between the bottom of the latter and piston **2**. The pressure source can consist of a suitable gear-pump, for example, or any other pump capable of continuously delivering hydraulic liquid at a pressure sufficient for operation of the jack.

A passage **8** extends in the cylinder wall from the pressure chamber **7** to the free end of the cylinder and axially opens on the transverse surface of said edge by a discharge port **26**; further conduits and ports such as **8** and **26** may be advantageously provided uniformly distributed on the circumference of the cylinder.

A rigid casing **5** encloses the free end section of the cylinder and is axially guided by said section with a view of a limited axial reciprocation between the cylinder and casing, an annular transverse abutment surface **17** being formed in the casing on which the free edge of the cylinder bears when no hydraulic pressure is applied to the pressure chamber **7**. In the latter condition the discharge port **26** is fully throttled by the abutment surface **17** so that, by energizing the pressure source, hydraulic pressure can be established in the chamber **7** to lift the cylinder with respect of the piston **2**. The casing **5** is axially supported by the piston rod **15** by means of a worm-wheel **3**, which is screwed on the piston rod and the flanks of which axially abut the casing while allowing the wheel **3** to rotate in the casing. In this manner the casing **5** is firmly supported by the piston rod to thereby provide a support for the cylinder in the case of absence or failure of hydraulic pressure.

When hydraulic fluid is supplied to the pressure chamber at a sufficient pressure, a moment is reached in which the cylinder starts lifting and the free edge of the latter is progressively removed from the abutment surface **17**, so that a gap **9** is formed between said edge and surface; an outflow passage **10** (or a circumferential series of such conduits) extends to the outside through the wall of the casing **5** from the abutment surface **17** at a location staggered with respect of the port **26**, whereby, as the cylinder starts lifting, a progressively increasing leakage of hydraulic liquid is established through the passage **8**, port **26**, gap **9** and passage **10**, till a balanced condition is reached in which the cylinder **1** "floats" on the piston **2** while the hydraulic liquid supplied from the conduit **16**

circulates through the pressure chamber 7, passage 8, port 26, gap 9 and passage 10. The load 25 is thus lifted through, say, a millimeter or fraction thereof, and this condition obviously prevails in all further similar jacks associated with the jack shown, so that no unbalance is set in the load position and so that each of the jack-engaged portions of the load has applied thereto a hydraulic lifting force exactly equal to the weight of its respective portion of the load. The supply conduits 16 for the jacks are advantageously connected to a common pressure manifold of a comparatively large cross-sectional area, thereby to put the jacks in uniform pressure-supply conditions.

The lifting proper of the load 25 is performed by screwing the worm wheel 3 up on the piston rod 15, such screwing requiring but a little power inasmuch the effective lifting pressure is transmitted from the piston 2 directly to the base plate 6 and foundation 24 without appreciably involving the wheel 3. On screwing the wheel 3 on the piston rod 15, the casing 5 is progressively raised with respect of both piston and cylinder, so that the gap 9 starts progressively reducing; such a condition immediately causes an increase of liquid pressure in the pressure chamber 7, whereby the cylinder 1 is lifted through an increment sufficient to reestablish the original width of the gap corresponding to the original "floating" condition, such increment being obviously equal to that by which the wheel 3 has been screwed on the piston rod. In this manner a "follow-up" control is obtained, in which a mechanical incremental displacement of a throttling member (as represented by the casing 5 with its abutment surface 17 for the cylinder) produces a similar but hydraulic incremental mutual displacement of the cylinder and piston under a practically constant hydraulic pressure in the pressure chamber 7 corresponding to the load-fraction bearing on the jack.

Controlled displacement of the casing 5, as well as exactly mutually tuned and synchronized displacements of the corresponding casings on all further jacks present can be obtained by extremely simple and reliable means. In the embodiment shown in FIGURE 1 the worm wheel 3 has operatively associated therewith a worm 20 meshing with the teeth 11 on the wheel, the worm 20 having its shaft 12 (FIG. 2) journaled in the casing 5. A ratchet wheel 21 is keyed on the shaft 12 and is driven by a hydraulic reciprocating double-acting motor 13 fitted to the casing 5, the piston rod of said motor having a pawl 22 on its free end engaging the ratchet wheel 21. Hydraulic fluid supply to the motor 13 in "on" direction produces a one-step angular displacement of the ratchet wheel 21 in the "lifting" direction, whereas fluid supply to the motor in "off" direction withdraws the pawl from the wheel preparatory to the subsequent "on" stroke. Since no difficulty is seen in simultaneously energizing the hydraulic motors on all the jacks present on the lifting set, it will be apparent that all the jacks will simultaneously operate in the desired manner.

For a quick approach and withdrawal operation of the jack a structure shown on FIG. 2 can be employed, comprising an electric motor 18 arranged for rotating the shaft 12 through a reducing gear 19 and a dog-coupling 14, the latter being controlled by means of a control lever 27 pivotally supported by the casing 5; quick rotation of the shaft 12 is performed in "off" condition of the hydraulic motor 13, i.e. in a condition wherein the pawl

22 is raised out of engagement with the ratchet wheel 21.

According to the modification shown on FIG. 3, the electric motor 18 is employed replacing the hydraulic motor 13 of FIGS. 1 and 2. To that end, the motor 18 is constantly coupled with the shaft 12 through the reducing gear 19 which latter replaces the ratchet wheel 21, the motor 18 being of a reversible synchronous type, so that all the jacks present may be synchronously operated for lifting the load; single adjustments of the various jacks can be carried out by individually operating their respective synchronous motors.

It will be apparent from the foregoing description that lowering of the case 5 or, generally, withdrawal of the case 5 with respect of the cylinder 1 will increase the gap 9, whereby the piston-cylinder unit will retract through an amount corresponding to the extent of the casing displacement. It will be also apparent that the jack described can be employed in practice both in the "cylinder-up" and "cylinder-down" condition, although the former condition (shown on the drawing) appears to be more appropriate for an efficient lubrication of the components contained in the casing 5.

The worm gearing 3, 20, and the screwed arrangement of the worm wheel 3 on the piston rod 15 in the embodiments shown are employed on account of a reliable irreversibility and mechanical strength providing a solid support for the casing 5 and cylinder 1; however, other suitable control means can be employed in lieu thereof, if desired.

What I claim is:

A hydromechanical lifting jack comprising a hydraulic piston-cylinder unit having a piston rod protruding from one end of the cylinder and a hydraulic liquid pressure chamber in the cylinder between the opposite end of the latter and the piston, passage means opening into the pressure chamber to supply hydraulic liquid thereto to thereby axially extend the unit for lifting a load, a discharge passage for the hydraulic fluid extending from the pressure chamber to said one end of the cylinder and axially opening through a discharge port in said one end, a screw-threaded section on the protruding portion of the piston rod, a worm wheel having a threaded central bore screwed on said piston rod portion, a throttling member for said discharge port axially supported by said worm wheel, a worm meshing with the worm wheel and rotatably mounted in the throttling member, motor means operatively connected to the worm for rotating the latter, said throttling member having an annular axially effective abutment surface thereon turned towards the said one end of the cylinder and port therein, the arrangement being such that a mutual approach of the throttling member and cylinder in absence of hydraulic pressure will first produce an increasing throttling of the port by the abutment surface and then cause the member and cylinder to axially abut each other in a mutually supporting relation with respect of the load applied on the jack.

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