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PATENT SPECIFICATION

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(54) IMPROVEMENTS IN OR RELATING TO JACKS

- (71) We, MITSUBISHI JUKOGYO KABUSHIKI KAISHA, a Japanese body corporate of No. 10—2 chome, Marunouchi, Chiyoda-ku, Tokyo, Japan, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—
- 10 The present invention relates to a jack. According to the present invention, there is provided a jack comprising first and second rigid members; an elongate member extending through the rigid members; a plurality of spaced-apart protrusions disposed in a row along the elongate member; first jacking means for causing relative longitudinal displacement between the rigid members; an engagement member, on each rigid member, rotatable about an axis transverse to the longitudinal axis of the elongate member, between a position of engagement between two adjacent protrusions and a position in which relative longitudinal movement between the pertaining rigid member and the elongate member can be caused; the engagement surfaces of the engagement members and of the protrusions being planar and perpendicular to the longitudinal direction when said engagement takes place.
- 30 The present jack is particularly applicable for use with a floating barge carrying machines and materials necessary for works such as, for example, a underwater pile driving, boring at a sea or river bottom, laying a caisson in the water, etc., the elongate member forming a spud for supporting the barge from the river bottom, operation of the jack lifting or lowering the barge or the spud relatively to each other and locking them with each other at a desired relative position.
- 40 For a better understanding of the invention and to show how the same may be carried into effect, reference will now be made, by way of example, to the accompanying drawings, in which:
- 45 Figure 1 is a general perspective view of a jack,

Figure 2 is a top plan view of the jack shown in Figure 1,

Figure 3 is a longitudinal cross-sectional view of the jack shown in Figure 1 taken along line I—I in Figure 2,

Figure 4 is a partial side view of the jack shown in Figure 1 taken along line II—II in Figure 3 with an associated hydraulic circuit diagram, and

Figures 5 and 6 are partial cross-sectional views of the jack shown in Figure 1 taken along line III—III in Figure 3, respectively showing two operative states of a locking device of the jack.

Referring to the Figures, and particularly to Figure 1, the jack is generally denoted by reference numeral 6. A structure 1 such as, for example, a floating barge is provided with a plurality of vertical bores 2, in each of which is loosely fitted an elongated member 4 such as, for example, a spud. The elongated member 4 is provided along its length with a plurality of rows of protrusions 5 on its surface. The bore 2 is provided with guide channels 3 to allow the protrusions 5 to pass therethrough. The guide channels 3 also serve to restrict the movement in the circumferential direction of the protrusions 5 with respect to the structure 1, and thus the elongated member 4 cannot rotate relatively to the structure 1 about its axis.

Surrounding the elongated member 4 there are provided an upper rigid member 7 and a lower rigid member 8 vertically spaced-apart from the member 7, and between the rigid members 7, 8 are provided a plurality of hydraulic cylinders 10 for moving the lower rigid member 8 relatively to the upper rigid member 7. The upper rigid member 7 is connected to the structure 1 by means of connecting rods 9, so that no relative movement can occur between the structure 1 and the upper rigid member 7, while relative movement of the lower rigid member 8 with respect to the upper rigid member 7 results in a corresponding movement between the structure 1 and the lower rigid member 8.

Clawed rotary members 11 of cylindrical shape are supported on the upper rigid member 7 and the lower rigid member 8 at positions opposite to the protrusions 5 on the elongated member 4. The clawed rotary members 11 are connected to hydraulic cylinders 12 for driving the clawed rotary members so as to be rotated through approximately 90° about their axes, respectively, and are adapted to allow either relative locking or relative movement between the rigid members 7 or 8 and the elongated member 4 as will be described hereinafter.

In Figure 2, the upper rigid member 7 is provided with guide protrusions 13, there being a small clearance between the protrusions 5 and the guide protrusions 13 in the radial direction of the elongated member 4 as well as in the direction of width of the protrusions 5, so that the guide protrusions 13 serve to restrict the relative movement in the radial and circumferential directions of the upper rigid member 7 with respect to the elongated member 4. Thus, the guide protrusions 13 restrict the relative movement in the radial and circumferential directions of the clawed rotary members 11 with respect to the protrusions 5, except for the relative movement in the lengthwise direction of the rows of protrusions 5. Although the plan view of the lower rigid member 8 is not shown, it is to be noted that it is provided with similar guide protrusions.

In Figure 3, the clawed rotary member 11 mounted on each of the rigid members 7 and 8 is provided with a pair of claws 15 to be fitted into the gap between upper and lower protrusions 5, on its end surface opposed to the elongated member 11. The clawed rotary member 11 is provided with a circumferential groove 11' in the proximity of the outer end in the radial direction of the elongated member, and by loosely fitting a propelling force receiver ring 14 affixed to the rigid body into the circumferential groove 11', the displacement in the axial direction of the clawed rotary member 11 is restricted.

As shown in Figure 4, the clawed rotary member 11 is adapted to be rotated through approximately 90° about its axis by means of the hydraulic cylinder 12 which is actuated by a hydraulic system 20, and the plurality of hydraulic cylinders 12 on the rigid member 7 or 8 are controlled by a single control valve 21 or 22, respectively. The angular position of the clawed rotary member 11 is detected by angular position detectors 19 and 19', which generate an electric signal when a dog 18 mounted on the rear end surface (outside the rigid member) of the clawed rotary member 11 pushes the levers of the angular position detectors, and the control valve 21 or 22 is adapted to be automatically restored by the abovementioned electric signal to its neutral position so that the clawed rotary member is stopped at the detected position. In this con-

nection, although the illustration is omitted with respect to the lower rigid member 8, the driving and angular position detecting devices for the clawed rotary members 11 of the lower rigid member 8 are the same as those of the illustrated upper rigid member 7, and a plurality of clawed rotary member driving hydraulic cylinders 12 are controlled by means of a single control valve 22.

As shown in Figure 5 and 6, the claws 15 of the clawed rotary member 11 are provided with plane loading surfaces 23 so that a heavy load may be transmitted through engagement with the protrusions 5, at the angular position as shown in Figure 5, the loading surfaces 23 being disposed horizontally between the protrusions 5 to lock the rigid member 7 or 8 and the elongated member 4 relatively to each other with respect to the vertical direction, and thus the clawed rotary member can transmit the load between the two. At the angular position that is rotated through 90° from the position shown in Figure 5 to that shown in Figure 6, since the loading surfaces 23 of the claws 15 are disposed vertically, the protrusions 5 can freely pass through the gap between the pair of claws 15, and thus relative movement between the rigid member 7 or 8 and the elongated member 4 is allowed with respect to the vertical direction.

It is to be noted that due to the fact that the loading surfaces 24 and 23 are plane and adapted to engage with the upper and lower plane faces of the protrusions 5, the surface pressure is uniformly distributed and thus a heavy load may be transmitted reasonably. It is, however, necessary that the loading surfaces 24 of the projections 5 and the loading surfaces 23 of the claws 15 are closely engaged with each other over their entire surface without making a partial abutment. In Figure 4, the clawed rotary member driving hydraulic cylinder 12 is shown substantially at its shortest state. Then the claws 15 of the rotary member are disposed at the angular position shown in Figure 5 with respect to the protrusions 5. However, since these hydraulic cylinders 12 are controlled by a single control valve 21 or 22, the retracting speeds of the hydraulic cylinders 12 are not the same because of small differences in the various conditions, and thus the hydraulic cylinders 12 reach the ends of their strokes in succession starting from the hydraulic cylinder having the least resistance. When the dog 18 of the hydraulic cylinder having the most resistance has actuated the angular position detector 19, the electric signal brings the control valve to its neutral position to stop the hydraulic cylinders. In other words, at the retracted rest position of each hydraulic cylinder 12 as shown in Figure 5, not all the clawed rotary members 11 take the relative positions in which the loading surfaces 24 of the protrusions 5 and the loading surfaces 23 of the claws 15

are perfectly in parallel, since in some of the clawed rotary members, the loading surfaces 23 of the claws 15 will be slightly inclined with respect to the loading surfaces 24 of the protrusions 5. On the other hand, the angular position detected by the angular position detector 19 may not be absolutely precise, and so the inclination of the loading surfaces 23 of the claws 15 must be allowed for.

When a relative movement between the protrusion 5 and the rigid member commences from the state shown in Figure 5 and the loading surfaces 23 and 24 are about to make close abutment with each other, if there exists a small relative inclination between them, the clawed rotary member 11 is forced to rotate in either direction due to the close abutment. In case the clawed rotary member 11 is forced to rotate in the clockwise direction as viewed in Figure 4, the plunger of the hydraulic cylinder 12 is forced to be pulled out. However, since the control valve 21 or 22 is in an open circuit state, the plunger of the hydraulic cylinder can be pulled out without any resistance. On the contrary, in case that the clawed rotary member 11 is forced to rotate in the anti-clockwise direction as viewed in Figure 4, also no unreasonable load is applied to the hydraulic cylinder 12, because between a rectangular bearing piece 17 fitted around a shaft projecting from the rear end of the clawed rotary member and a plunger head 16 having a rectangular hole fixedly secured to the tip of the plunger rod of the hydraulic cylinder 12, there remains a suitable clearance d and the anti-clockwise rotation of the clawed rotary member 11 is such direction as to reduce the clearance. Thus, the rotation in either direction of the clawed rotary member 11 forced by the close abutment between the loading surfaces 23 and 24 may be freely admitted, and consequently the loading surfaces 23 and 24 can make close abutment with each other to transmit a heavy load.

In operation, Figure 3 shows a state in which the hydraulic cylinder 10 is in the most retracted state, the lower clawed rotary member 11 is in a fitted state with respect to the protrusions 5 as shown in Figure 5, and the upper clawed rotary member 11 is in a fitted state with respect to the protrusions 5 while the lower loading surface of its lower claw 15 is in close abutment with the protrusion 5 so that the load of the structure 1 suspended by the connecting rods 9 (see Figures 1 and 2) is supported by the elongated member 4 through the close abutment surfaces.

In the case where it is desired to raise the structure 1 with respect to the elongated member 4 starting from the above-mentioned state, at first the hydraulic cylinder 10 is slightly extended. Then the lower surface of the lower claw 15 of the clawed rotary member 11 in the lower rigid member 8 makes close abutment with the upper surface of the protrusion

5 to support the load of the structure through this abutment surface, while the lower surface of the lower claw 15 of the clawed rotary member 11 in the upper rigid body 7 is slightly separated from the upper surface of the protrusion 5, this state being shown in Figure 5. In this state, if electric power is fed to a solenoid SOL_1 of the control valve 21 in Figure 4 the clawed rotary member 11 in the upper rigid member 7 is rotated through 90° by extending the clawed rotary member driving hydraulic cylinder 12 to move to the state shown in Figure 6, and then the upper rigid body 7 becomes movable in the vertical direction relatively to the elongated member 4. Consequently, the upper rigid member 7 and the structure 1 connected thereto by means of the connecting rods 9 can be moved upwardly with respect to the elongated member 4 by extending further the hydraulic cylinder 10.

After the clawed rotary member 11 of the upper rigid member 7 has been moved to the position where it can be fitted into the gap space between the protrusions 5 one step above the previous position, electric power is fed to a solenoid SOL_2 (Figure 4) to rotate the clawed rotary member 11 through 90° to bring it again into the state shown in Figure 5. Thereafter, when the hydraulic cylinder 10 is slightly retracted, the load of the structure 1 is supported by the clawed rotary member 11 in the upper rigid member 7, and the claw 15 of the clawed rotary member 11 in the lower rigid member 8 is separated from the protrusion 5 and becomes rotatable as shown in Figure 5. In this state, after electric power has been fed to a solenoid SOL_3 of the control valve 22 to rotate the clawed rotary member 11 in the lower rigid member 8 through 90° to bring it into the state shown in Figure 6, the hydraulic cylinder 10 is further retracted to raise the lower rigid body 8 to the position where its clawed rotary member 11 can be fitted into the gap space between the protrusions 5 one step above the previous position, and then electric power is fed to a solenoid SOL_4 (Figure 4) to rotate the same clawed rotary member 11 through 90° to bring it again into the state shown in Figure 5. Thus the initial state as shown in Figure 5 has been recovered. By repeating the series of operations, the structure 1 can be moved upwardly to a desired position relatively to the elongated member 4. A downward movement of the structure 1 can be achieved by carrying out operations inverse to the above-described ones. Since this raising or lowering movement is a relative movement between the structure 1 and the elongated member 4, the operations in the case where the load of the elongated member is carried by the structure, the elongated member being moved either upwardly or downwardly, will be easily understood from the above description.

It is to be noted that in the jack described,

since the load of the structure or the elongated member is transmitted through close abutment between the plane upper and lower loading surfaces of the protrusions 5 provided in alignment on the surface of the elongated member and the plane loading surfaces formed at a part of the claws 15 of the clawed rotary member 11, the surface pressure is uniformly distributed, and thereby a heavy load may be transmitted reasonably. In addition, it will be appreciated that, so long as a load is applied, even if an external torque is exerted upon the clawed rotary member 11, a resistive moment of force around the axis of the clawed rotary member, which is large enough to oppose to the external torque, is generated because the claw 15 of the clawed rotary member 11 is urged against the loading surface of the protrusion 5 through a plane, and consequently there is no risk that the clawed rotary member 11 will rotate resulting in disengagement of the claw 15 from the protrusion 5. This resistive moment of force becomes larger as the transmitting load is increased, so that the safeness of the clawed rotary member 11 against the external torque is enhanced as the transmitting load is increased.

In addition, since the load is transmitted through plane-to-plane close abutment, it is unnecessary to make the centre line of the row of protrusions 5 on the elongated member 4 precisely coincide with the centre of the clawed rotary member 11, and even if there exists any deviation therebetween, it makes no matter provided that it is within an allowable range.

Since the clawed rotary member is positively restricted in its movement in either axial direction by means of the circumferential groove in the proximity of the outer end of the rotary member and a propelling force receiver ring which is loosely fitted in said groove to admit their relative rotation and fixedly secured to the rigid body, the clawed rotary member may move in the direction for disengagement, even if a component of force for extracting the same in its outer axial direction should be generated.

When the clawed rotary member is fitted into the spaces between the protrusions on the elongated member, even if the loading surfaces of the claws of the clawed rotary member are inclined with respect to the upper or lower surfaces of the protrusions on the elongated member, a small amount of rotation upon close abutment of the both loading surfaces may be admitted by the provision of a small clearance between the plunger head having a rectangular hole of the clawed rotary member driving hydraulic cylinder and the rectangular bearing as well as the open cir-

cuit condition in the hydraulic system at the neutral position of the control valve, and consequently a large load can be transmitted through plane abutment without causing a partial abutment.

WHAT WE CLAIM IS:—

1. A jack comprising first and second rigid members; an elongate member extending through the rigid members; a plurality of spaced-apart protrusions disposed in a row along the elongate member; first jacking means for causing relative longitudinal displacement between the rigid members; an engagement member, on each rigid member, rotatable about an axis transverse to the longitudinal axis of the elongate member, between a position of engagement between two adjacent protrusions and a position in which relative longitudinal movement between the pertaining rigid member and the elongate member can be caused; the engagement surfaces of the engagement members and of the protrusions being planar and perpendicular to the longitudinal direction when said engagement takes place.

2. A jack as claimed in claim 1, wherein said jacking means is disposed between said first and second rigid members; wherein each engagement member has a pair of claws on its end surface which surface faces the row of protrusions; and wherein the jack further comprises second jacking means provided on said first and second rigid members respectively for rotating said engagement members through substantially 90° about said axis.

3. A jack as claimed in claim 1 or 2, wherein said first rigid member is connected to said structure by means of connecting rods.

4. A jack as claimed in claim 2 or 3, wherein said second jacking means comprises a pressure-responsive device connected to said engagement member at an eccentric position with respect to said axis.

5. A jack as claimed in claim 4, wherein the portion connecting said pressure-responsive device with said engagement member is provided with a clearance to provide a small rotation of said engagement member, even when said pressure-responsive device reaches the end of its stroke.

6. A jack substantially as hereinbefore described with reference to the accompanying drawings.

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