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Praddaude

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[54] **METHOD FOR REGULATING THE LIFTING OF AN ARM ARTICULATED ON A STRUCTURE AND LIFTING APPARATUS FOR CARRYING OUT THIS METHOD**

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[51] **Int. Cl.** **B66f 3/26,** B66c 23/54

[58] **Field of Search**.....254/93 R, 93 A, 93 VA, 93 L, 254/124; 91/176, 183, 412; 92/61, 66, 76; 269/24, 27, 31; 74/96, 99, 101, 105, 106

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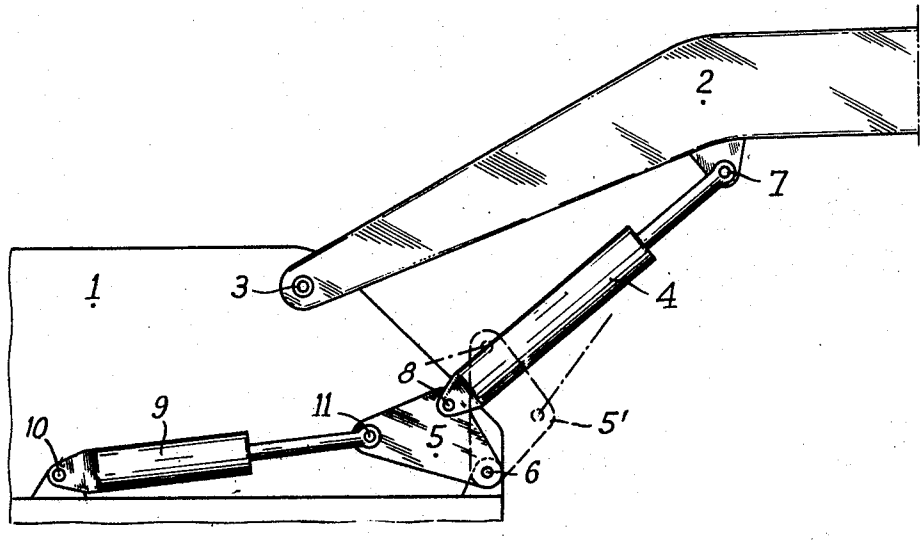
[57] **ABSTRACT**

This invention relates to a method of regulation for lifting, at the maximum possible speed, an arm articulated on a resistant structure, by means of a jack fed with pressurized fluid, without the power consumed exceeding a displayed value, wherein the position of at least one of the axes of articulation of the jack is servo-controlled to the value of the supply pressure of said jack. The invention also relates to lifting apparatus applying the above method, constituted by an arm articulated on a structure, by a jack coupled between the arm and an element whose position is adjustable with respect to the structure, and by a member for controlling the position of said element, wherein the control member is controlled by the feed pressure of the jack.

7 Claims, 3 Drawing Figures



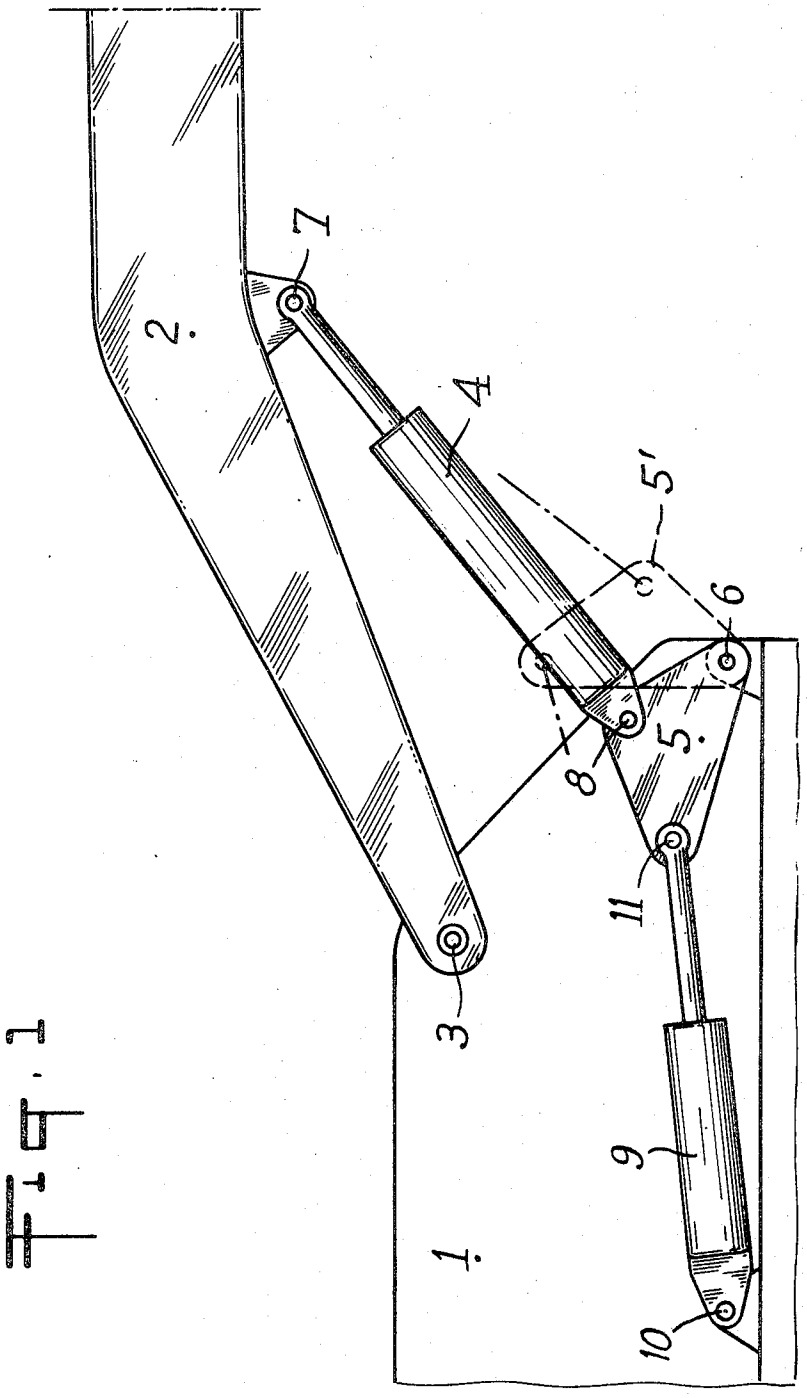


FIG. 1

FIG. 2

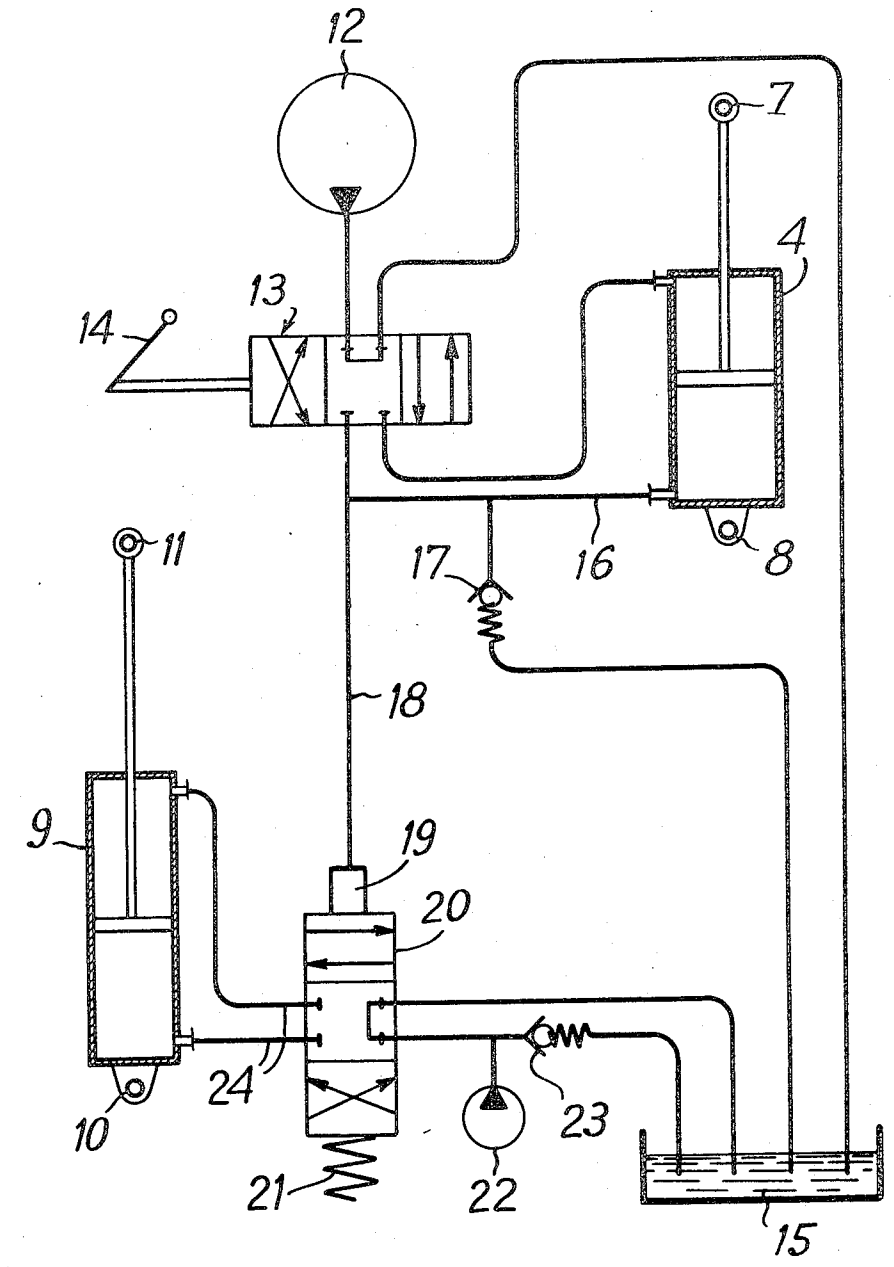
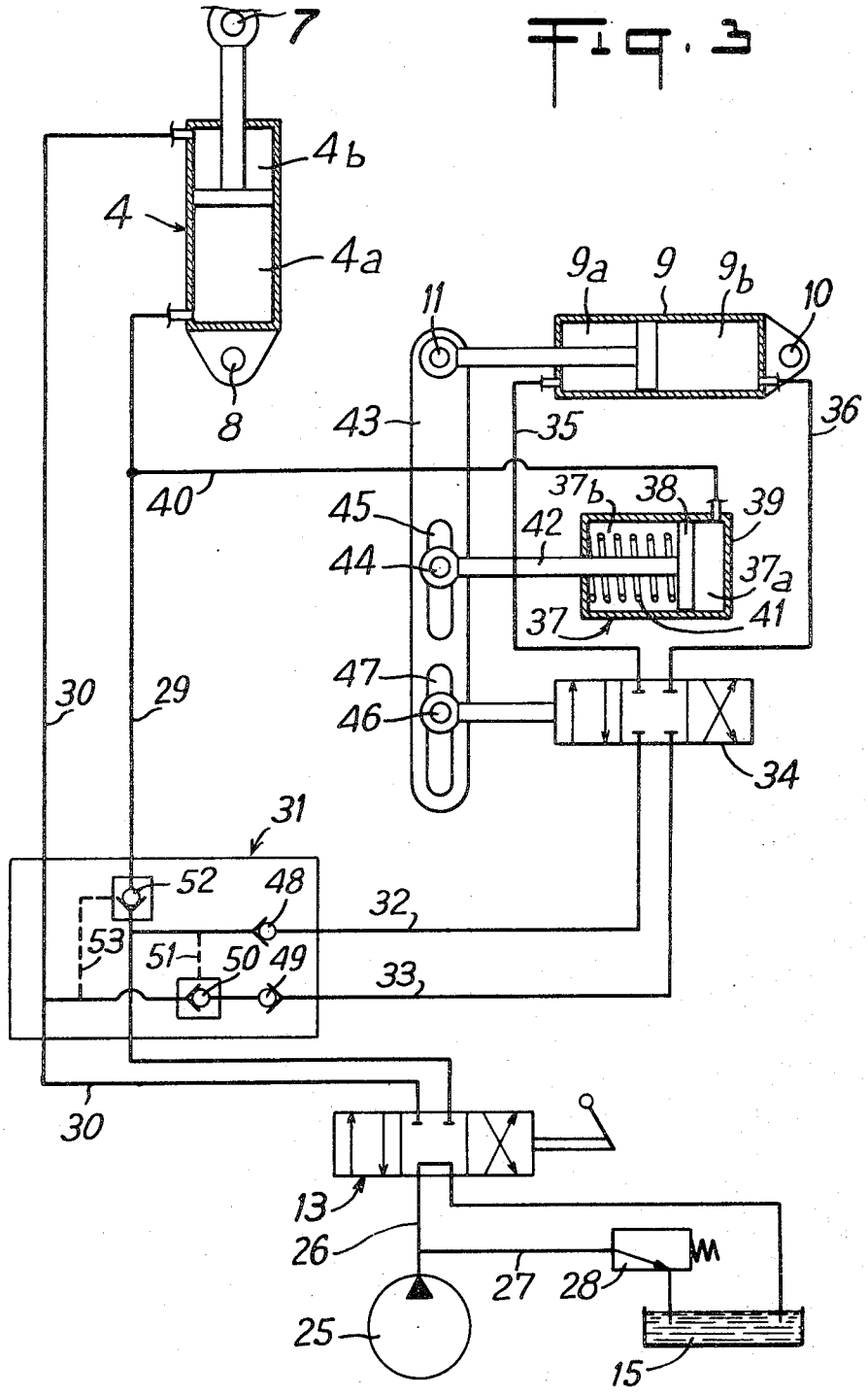


Fig. 3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METHOD FOR REGULATING THE LIFTING OF AN ARM ARTICULATED ON A STRUCTURE AND LIFTING APPARATUS FOR CARRYING OUT THIS METHOD

The present invention relates to a method for regulating the lifting of an arm articulated on a structure and lifting apparatus for carrying out this method.

For certain uses, the relative orientation of two elements is controlled with the aid of a hydraulic jack, for example coupled between the two elements. The jib of a public works machine is oriented thus with respect to the turret or the platform on which said jib is articulated.

In the majority of these uses, the maneuver should be carried out in the shortest possible time. To this end, it is sufficient to choose the different elements, type of jack and position thereof on the turret and on the arm, length of the arm, etc., accordingly. However, it is observed with the machines used at present that although the maneuver of certain load, at the end of a jib for example; is effected in a certain time, the maneuver of a load which is twice as small is carried out in the same amount of time. As the torque necessary for lifting is twice as low in the second case as in the first, it would have been desirable, while operating at constant power, to effect the second maneuver twice as rapidly as the first, assuming, moreover, that the first load were equal to the limiting lifting load. This is not the case, as no known device permits this type of operation.

However, machines are known on which the adjustment of the maximum lifting torque of a jack is made possible, without changing the jack, by modifying the position of the point of application of the force of said jack, this modification being carried out when required and not automatically.

The applicants desired to remedy this state of affairs and to this end, imagined proceeding in a novel manner, having the possibility of maneuvering at the maximum speed permitted by the torque necessary for lifting, it being understood that said maneuver must be carried out at a power not exceeding a prescribed value.

The invention therefore has for its object, in the first place, a method of regulation for lifting, at the maximum possible speed, an arm articulated to a resistant structure, by means of jack fed with pressurized fluid, without the power consumed exceeding a displayed value. The servo-control of the position of at least one of the axes of articulation of the jack to the value of the speed pressure of said jack is effected.

The invention also has for its object a lifting apparatus constituted by an arm articulated to a structure by a jack coupled between the arm and an element whose position is adjustable with respect to the structure, and by a member for controlling the position of said element. The control member is controlled by the feed pressure of the jack.

In an advantageous embodiment of the invention, the member for controlling the position of the element is constituted by a second jack coupled between the structure and said element, this second jack being placed in selective communication with a pressurized fluid supply and with a discharge tank. The selective communication is effected by a slide valve, said slide being subjected to the action of the fluid of a conduit branched to the pressurized fluid feed of the jack coupled between the arm and the adjustable element.

An advantageous variant embodiment consists in that in addition, a cutting unit, interposed on the feed and delivery conduits of the jack coupled between the arm and the adjustable element, ensures the communication of the second jack with the pressurized fluid supply when a first chamber of the jack coupled between the arm and the adjustable element is fed with pressurized fluid, while it isolates said second jack when said first chamber of the jack coupled between the arm and the adjustable element is isolated.

The first chamber of the jack coupled between the arm and the adjustable element is that which is placed in communication with the pressurized fluid feed during the lifting of the arm articulated to the structure.

Finally, the cutting unit is preferably constituted by a first non return valve arranged on a conduit branched in shunt on the conduit that may be connected to the feed of the first chamber of the jack coupled between the arm and the adjustable element and capable of being connected to one of the chambers of the second jack.

Second and third non-return valves are arranged on a conduit capable of being connected to the other chamber of the second jack and are mounted in opposition.

The third non-return valve arranged beyond the second non-return valve with respect to the second valve, is controlled by the pressure of the fluid of the conduit capable of being connected to the feed of the first chamber of the jack coupled between the arm and the adjustable element, and permits the circulation in the two directions of the fluid contained in the conduit on which it is arranged when its control pressure is greater than a given value.

The invention will be described in greater detail with reference to the accompanying drawings, in which:

FIG. 1 is a part elevational view of a machine on which a lifting device according to the invention is mounted;

FIG. 2 is a schematic view of a lifting device according to the invention;

FIG. 3 is a schematic view of a variant embodiment of the device shown in FIG. 2.

Referring now to the drawings, the machine on which the apparatus according to the invention is used comprises a turret 1, on which is articulated a jib 2, about axis 3. A first jack 4 is coupled between the jib 2 and an element 5 mounted to pivot on the turret 1 about an axis 6. The jack 4 is articulated by axis 7 on the jib 2, and by axis 8 on the pivoting element 5. Finally, a second jack 9 is coupled between the turret 1 and the element 5 by axes 10 and 11.

According to a first variant embodiment, shown in FIG. 2, the feed circuit of the jacks 4 and 9 comprises a source of pressurized fluid 12, such as a hydraulic pump, which feeds the jack 4 by means of a three-way valve 13, manually controlled by a lever 14 for example. A discharge tank 15 is arranged for the return of the fluid.

In the direction of lifting of the jib, the jack 4 is fed by the conduit 16. The pressure of the fluid in the conduit 16 is limited by a calibrated valve 17 which possibly evacuates the fluid to the tank 15.

On the conduit 16 there is branched a conduit 18 which terminates in a jack 19 for controlling the position of the slide of a three-way slide valve 20, said slide being in equilibrium under the antagonistic actions of the fluid of the conduit 18 and of a spring 21. It is by means of the distributor 20 that the jack 9 is fed by a source of pressurized fluid 22. A calibrated valve 23 limits the feed pressure of the jack 9.

It will be noted that the sources 12 and 22 of pressurized fluid may be combined in one pump, as is moreover provided in the second variant embodiment. Conduits 24 connect the two chambers of the jack 9 to the valve 20.

A second variant embodiment is shown in FIG. 3. Certain elements are found here which are similar to those described previously and which bear the same reference numerals as those already used.

The device is completed by a single pump 25 which is connected to the distributor 13 by a conduit 26. A conduit 27, which returns to the tank 15 through a calibrated valve 28, is branched in shunt on the conduit 26, as is moreover known.

Two conduits 29 and 30 connect the two chambers 4*a* and 4*b* of the jack 4 to the valve 13, the conduit 29 connecting the chamber 4*a* which is placed in communication by the valve 13 with the delivery conduit 26 of the pump 25 at the moment of lifting of the jib 2.

A cutting unit 31 is interposed on the conduits 29 and 30. Two conduits 32, 33 connect this cutting unit 31 to a three-way slide valve 34 and are extended beyond the valve 34 by conduits 35, 36 connected to the chambers 9*a* and 9*b* of the jack 9. The valve 34 selectively ensures the isolation of the conduits 35, 36 or the communication of said conduits 35, 36 with the conduits 32, 33, or inversely 33, 32.

Furthermore, a pressure pick-up **37**, constituted by a piston **38** mounted to slide in the body of a cylinder **39**, is connected by a conduit **40** to the conduit **29**. Opposite the chamber **37***a* in which the conduit **40** opens out and on the other side of the piston **38**, a spring **41** is arranged in the chamber **37***b* between said piston **38** and the cylinder **39**. The rod **42** of the piston **38** is substantially coaxial with the piston **38**.

It will be noted that, in the example chosen, the bodies of the valve **34** and the pressure pick-up **37** are unitary with the frame of the machine, the turret **1** for example, while a link lever **43** connects the movable elements of the slide valve **34**, the pressure pick-up **37** and the jack **9**. Therefore the axis **11** of the rod of the jack **9** is articulated to the lever **43**, the axis **44** of the rod **42** of the pressure pick-up **37** slides in an aperture **45** provided in the lever **43**, and similarly, the axis **46** of the slide of the valve **34** slides in an aperture **47** in the lever **43**.

The cutting unit **31** will now be described. It will firstly be specified that its function is to isolate the chambers **9***a* and **9***b* from the jack **9**, when the jack **4** is not actuated, in other words, when the chamber **4***a*, for example, is isolated both from the pump **25** and from the tank **15**.

From the various devices that may be produced for ensuring this function, the cutting unit **31** is preferably chosen. It advantageously comprises four non-return valves, two of which are controlled.

A first non-return valve **48** is arranged on the conduit **32** which is connected to conduit **29**. The non-return valve **48** enables the fluid to pass from conduit **29** towards the valve **34**.

A second non-return valve **49** is arranged on the the conduit **33**, which is connected to conduit **30**. This non-return valve **49** permits the fluid to pass from valve **34** towards conduit **30**.

A third non-return valve **50** is arranged on the conduit **33** beyond the non-return valve **49** with respect to the distributor **34**. This non-return valve **50** is connected by a conduit **51** to conduit **32**; The conduit **51** is connected to conduit **32** between the non-return valve **48** and the connection of said conduit **32** to the conduit **29**. It is mounted in opposition with the non-return valve **49**.

Moreover, a fourth non-return valve **52** is arranged on the conduit **29**, downstream of the connection of the conduits **32** and **29**. This non-return valve **52** is connected to conduit **33** by a conduit **53**, which is connected to said conduit **33** between the non-return valve **50** and the connection of the conduits **30** and **33**. The valve **52** enables the fluid to pass from the valve **13** toward the chamber **4***a* of the jack **4**.

It will be specified that the non-return valves **50**, **52** permit the fluid to pass in the two directions in conduits **33**, **29**, on which they are arranged, when the control pressures of the fluid contained in the conduits **51**, **53** are higher than given threshold values, for example when these pressures are not zero.

The operation of the machine described hereinbefore is in fact entirely novel with respect to prior known machines.

Concerning the first variant embodiment, shown in FIG. **2**, two cases of operation will be described, the first corresponding to the lifting of the jib **2** practically without a resistant torque being applied, the second to the lifting of a heavy load.

It therefore in a first stage the jib **2** is to be lifted with no load for example, the jack **4** is fed by conduit **16**, by arranging the slide of the valve **13** in the suitable position. As the resistance opposite the lifting is low, the pressure in the conduit **16**, necessary for said lifting, is low and on this side of the calibration pressure of the valve **17**, in order to fix ideas. The action of the pressure in the jack **19** for controlling the slide of the valve **20** is less strong than that of the spring **21**, so that the valve **20** is arranged in order to feed the jack **9** on the side of the articulation **11**.

In this way, the jack **9** draws on the element **5**, in order to make it pass from position **5'** in broken lines, to position **5** in solid lines. This has for its effect, for a given feed pressure in the conduit **16**, and for a given discharge thus for a given power, to shorten the lever arm of the lifting torque, thus finally, to lift with a torque weaker than before, but nevertheless sufficient for lifting, but also at a greater lifting speed. It is in fact this which is important for lifting a small load very quickly.

On the contrary, in the second case, and starting from the preceding configuration, the pressure in the conduit **16** is practically equal to the calibration pressure of the valve **17**. The slide of the valve **20** is thus repelled by the jack **19**, so that it is the chamber of the jack **9** located on the side of the articulation **10** which is fed with pressurized fluid. The element **5** is repelled at **5'**. The arm of the lifting torque increases, thus the torque increases and, correlatively, the speed decreases. Lifting is carried out less quickly than before, but a heavier load is lifted.

It will be noted that it is sufficient to provide the equilibrium of the slide of the valve in median position for a pressure of the conduit **18** slightly lower than the calibration pressure of the valve **17**, in order that the jack **9** is fed so as to arrange the element **5** in order to lift the load at the maximum possible speed, the pressure in the jack **4** being limited to a given value.

In other words, the device according to the invention permanently regulates the position of the element **5**, thus the position of the axis of articulation **8** of the jack **4** on the turret, so that lifting is carried out at the maximum speed permitted by a given lifting power. As soon as the lifting pressure falls below the maximum pressure given for the feed of the jack **4**, by action of the jack **19** on the slide of the distributor **20**, the jack **9** is fed, in order to shorten the lifting lever arm, thus in order to increase the lifting speed.

Of course, the speed too is nonetheless limited by an extreme position of the element **5** and by a maximum feed discharge of the jack **4**, said discharge being at the most equal to a given value.

If on the contrary, the lifting torque became lower than the resistant torque, the lifting speed would be automatically reduced until the torque becomes greater than the resistant torque.

The maximum possible speed is therefore constantly kept, this corresponding to the shortest possible maneuvering time, thus to the best possible yield of the lifting installation, and being entirely automatic.

It will have been noted that, in the direction opposite lifting, the question of maximum speed is not raised in the same way. The pressure in the conduit **16** is then zero (return of fluid to the discharge tank **15**), and the element **5** is therefore arranged in order to ensure the maneuver at maximum speed.

When the orientation of the jib **2** is not actuated, but when the pressure increases in the chamber of the jack **4**, which is usually fed during the lifting of the jib **2**, the jack **19** and consequently the jack **9** is actuated, this bringing about an indirect and undesired modification of the jib **2**. This operation may be that of a crane jib for example when the load is lifted from the ground by means of a lifting cable, without wishing to modify the position of the jib with respect to the ground. Where it is desired to be able to maintain the jib immobile, it appears necessary provisionally to neutralize the servo-control device described previously.

This result is obtained by using, for example, the second variant embodiment described hereinafter with reference to FIG. **3**.

In fact, if the chamber **4***a* of the jack **4**, which is usually fed with pressurized fluid at the moment of lifting of the jib **2**, is isolated from the tank **15** and the pump **25**, in the position of the valve **13** shown in FIG. **3** for example, it is observed that there is only little, if any, pressure in the conduit **30**, and thus in the conduit **53**, that the non-return valve **52** prevents the passage of the fluid from the chamber **4***a* towards the valve **34**, and that the pressure of the fluid in the conduit **29** upstream of the valve **52** with respect to the jack **4** is then low of zero. The pressure in the conduit **51** is also low or zero, so that the non-return valve **50** is controlled in order to allow fluid to pass only from the conduit **30** towards the non-return valve **49**. It may easily be understood that the non-return valves **49** and **50** which are mounted in opposition block the passage in the con-

duit 33 and in this way isolate one of the chambers of the jack 9 whatever the position of the slide of the valve 34. The result of this configuration is that said jack 9 remains blocked and provisionally no longer corrects the position of the element 5, this enabling the jib 2 to be maintained immobile, whatever the momentary excess pressures in the chamber 4*a* of the jack 4, due to the lifting of a load for example, without desired movement of the jib. Of course, it is nonetheless known that the pressure in the different jacks is limited by a discharge valve and that, if it was desired inadvertently to life a load greater than the maximum characteristics of the machine, there would still be discharge of the chamber 4*a* of the jack 4, contrary to what has just been said. However, this would then be outside of the cases of normal operation of the machine and it would be a safety device which would operate in this exceptional case.

The device according to FIG. 3 also makes it possible automatically to correct the position of the element 5. If in a first case it is desired to lift the jib 2, the conduit 29 is fed through pump 25 through the suitable maneuvered valve 13. The chamber 4*a* is thus fed with pressurized fluid whilst the chamber 4*b* is delivered to the tank 15 by conduit 30.

When the pressure of the fluid in the conduit 29, thus in conduit 40 diminishes, when the lifting resistance is low, the spring 41 completely repels the piston 38 of the pressure pick-up 37. The result of this configuration is that with the axis 11 being momentarily fixed, the piston rod 42 of the pressure pick-up 37 draws on the lever 43 which it causes to pivot about the axis 11. This moves the slide of the valve 34, which then connects the conduits 32 and 35, and 33 and 36. Through conduits 32 and 35, through the non-return valve 48, the pressurized fluid contained in the conduit 29 feeds, in addition to chamber 4*a* of the jack 4, the chamber 9*a* of the jack 9. Concomitantly, the non-return valve 50 is maintained open by the control pressure of the conduit 51, so that the fluid may escape from the chamber 9*b* of the jack 9 through conduits 36 and 33, through non-return valves 49 and 50 towards the conduit 30 and the tank 15. This phase of the operation brings about the displacement of the axis 11 in the right direction for adjusting the position of the element 5, and moreover, the pivoting of the lever 43 about the axis 44 of the rod 42 of the pressure pick-up 37, this axis 44 becoming fixed for a given pressure in the conduit 40. The movement of the lever 43 replaces the slide of the valve 34 in median position.

If, contrary to the preceding case, the pressure increases in the conduits 29 and 40, an operation is obtained which is similar to that preceding, but in the opposite direction.

Moreover, it is ascertained that to each feed pressure of the chamber 4*a* of the jack 4 there corresponds a position of the piston 38 of the pressure pick-up 37. An adjustment of the element 5 is thus obtained for a continuous range of feed pressures of the chamber 4*a*, and not an adjustment by pressure thresholds, such as that of the first variant.

Finally, it will be noted that when the lowering of the jib 2 is controlled by action on the distributor 13, this time by connecting the conduit 30 to the delivery of the pump 25 and the conduit 29 to the tank 15, flow is permitted through the non-return valve 52, which is maintained open by the control pressure of the fluid of the conduits 30 and 53, of the fluid contained in the chamber 4*a*.

The invention is not limited to the description which has just been given, but covers on the contrary all the variants that may be made thereof without departing from its scope.

Thus it is that the element, whose position is controlled by the jack 9, could be replaced by a device, with slideways for example, for guiding the axis 8 of the jack 4, said device controlled, in one variant embodiment, by a motor actuating an endless screw.

Similarly, not only the axis of articulation 8 of the jack 4 may be regulated in position to ensure that the method according to the invention is carried out, but the second axis of articulation 7 may also be provided with a device for adjusting its position similar to that of axis 8.

To the same end, means may also be provided to adjust the position of at least one of the axes of articulation of a jack coupled between the jib and a balance beam (not shown) pivoted at the end of the jib.

What is claimed is:

1. A method of regulation for lifting, at the maximum possible speed, an arm articulated on a resistant structure, by means of a jack fed with pressurized fluid and articulated between said arm and said structure, without the power consumed exceeding a displayed value, said method comprising the steps of sensing the supply pressure of said jack and servo-controlling the position of at least one axis of articulation of the jack in response to the deviation of the value of the supply pressure of said jack from a pressure corresponding to said displayed value.

2. A lifting apparatus comprising an arm articulated on a structure, a jack coupled between the arm and an element whose position is adjustable with respect to the structure, a control member for controlling the position of said element, and means for operating the control member in response to the feed pressure of the jack.

3. An apparatus as claimed in claim 2, wherein the member for controlling the position of the element is constituted by a second jack coupled between the structure and said element, and, the second jack being selectively placed in communication with a pressurized fluid feed and with a discharge tank, the selective communication is effected by a slide valve, said slide being subjected to the action of the fluid of a conduit branched to the pressurized fluid feed of the jack coupled between the arm and the adjustable element.

4. An apparatus as claimed in claim 3, wherein a cutting unit, interposed on the feed and delivery conduits of the jack coupled between the arm and the adjustable element, in addition ensures the communication of the second jack with the pressurized fluid feed when a first chamber of the jack coupled between the arm and the adjustable element is fed with pressurized fluid, while it isolates said second jack when said first chamber of the jack coupled between the arm and the adjustable element is isolated.

5. An apparatus as claimed in claim 4, wherein the first chamber of the jack coupled between the arm and the adjustable element is the chamber in communication with the pressurized fluid feed during the lifting of the arm articulated on the structure.

6. An apparatus as claimed in claim 5, wherein the cutting unit is constituted by a first non-return valve arranged on a conduit branched in shunt on the conduit capable of being connected to the feed of the first chamber of the jack coupled between the arm and the adjustable element and capable of being connected to one of the chambers of the second jack, while second and third non-return valves are arranged on a conduit capable of being connected to the other chamber of the second jack and are mounted in opposition, while the third non-return valve, arranged beyond the second non-return valve with respect to the second jack, is controlled by the pressure of the fluid of the conduit capable of being connected to the feed of the first chamber of the jack coupled between the arm and the adjustable element, and permits circulation in the two directions of the fluid contained in the conduit on which it is arranged when its control pressure is higher than a given value.

7. An apparatus as claimed in claim 4, wherein the cutting unit is constituted by a first non-return valve arranged on a conduit branched in shunt on the conduit capable of being connected to the feed of the first chamber of the jack coupled between the arm and the adjustable element and capable of being connected to one of the chambers of the second jack, while second and third non-return valves are arranged on a conduit capable of being connected to the other chamber of the second jack and are mounted in opposition, while the third non-return valve, arranged beyond the second non-return valve with respect to the second jack, is controlled by the pressure of the fluid of the conduit capable of being connected to

the feed of the first chamber of the jack coupled between the arm and the adjustable element, and permits circulation in the two directions of the fluid contained in the conduit on which it is arranged when its control pressure is higher than a given value.

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