Sept. 16, 1958 T. BERNTSEN 2,851,759

INSTALLATION FOR HYDRAULIC LIFTING OF SLIDING SHUTTERINGS

Filed Nov. 9, 1953 3 Sheets-Sheet 1

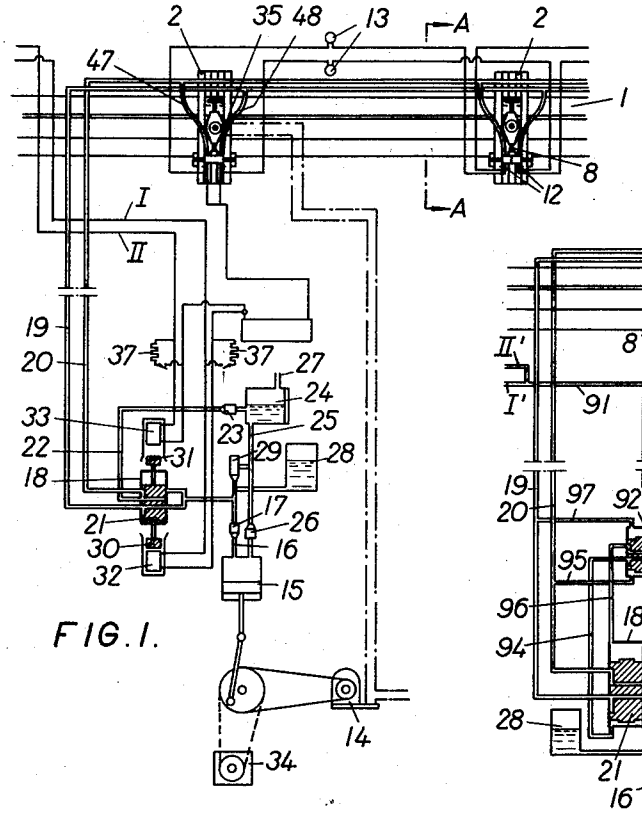


FIG. 1.

FIG. 10.

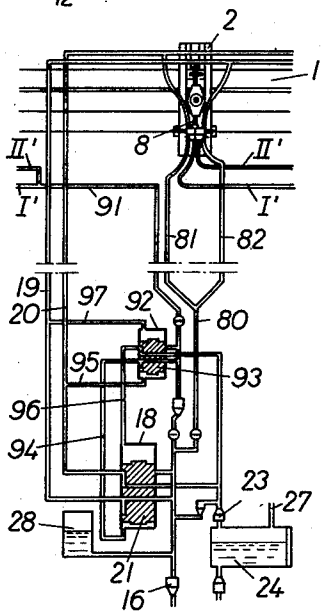


FIG. 11.

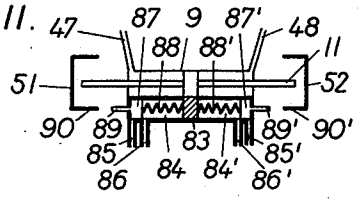
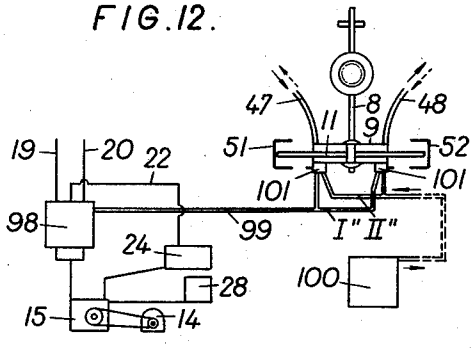


FIG. 12.



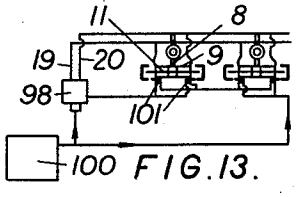


FIG. 13.

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FIG.2.

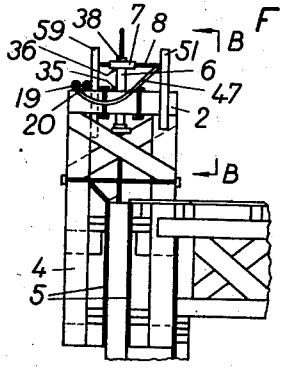


FIG.3.

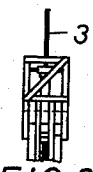


FIG.6.

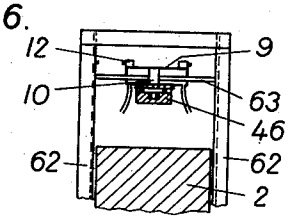


FIG.4.

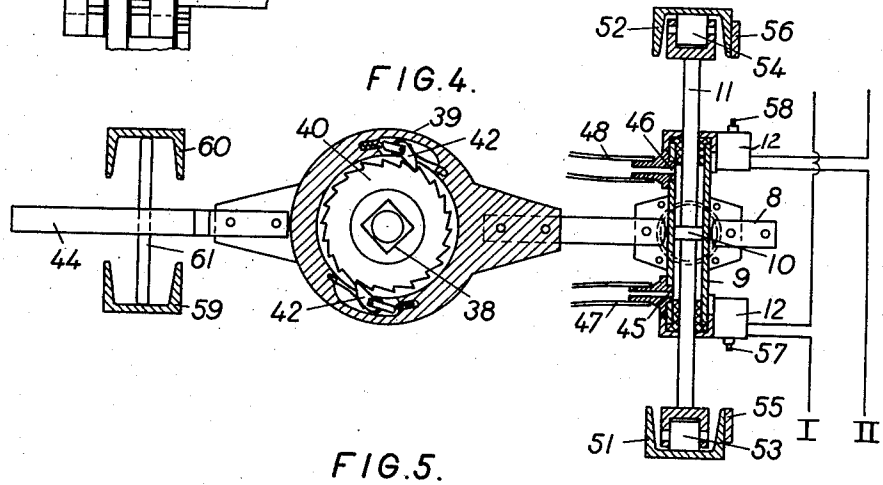


FIG.5.

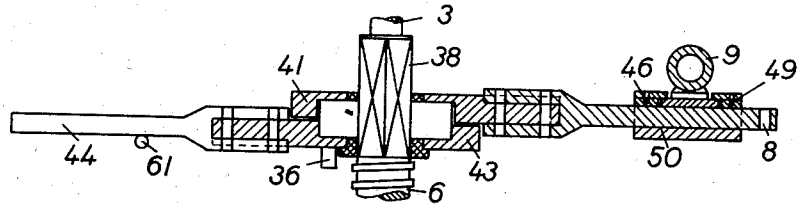


FIG.7.

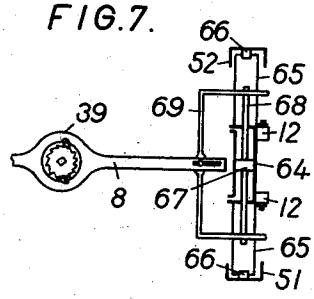


FIG.8.

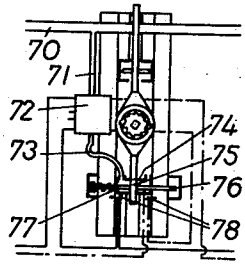
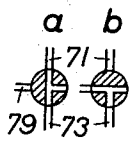


FIG.9.



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INSTALLATION FOR HYDRAULIC LIFTING OF SLIDING SHUTTERINGS

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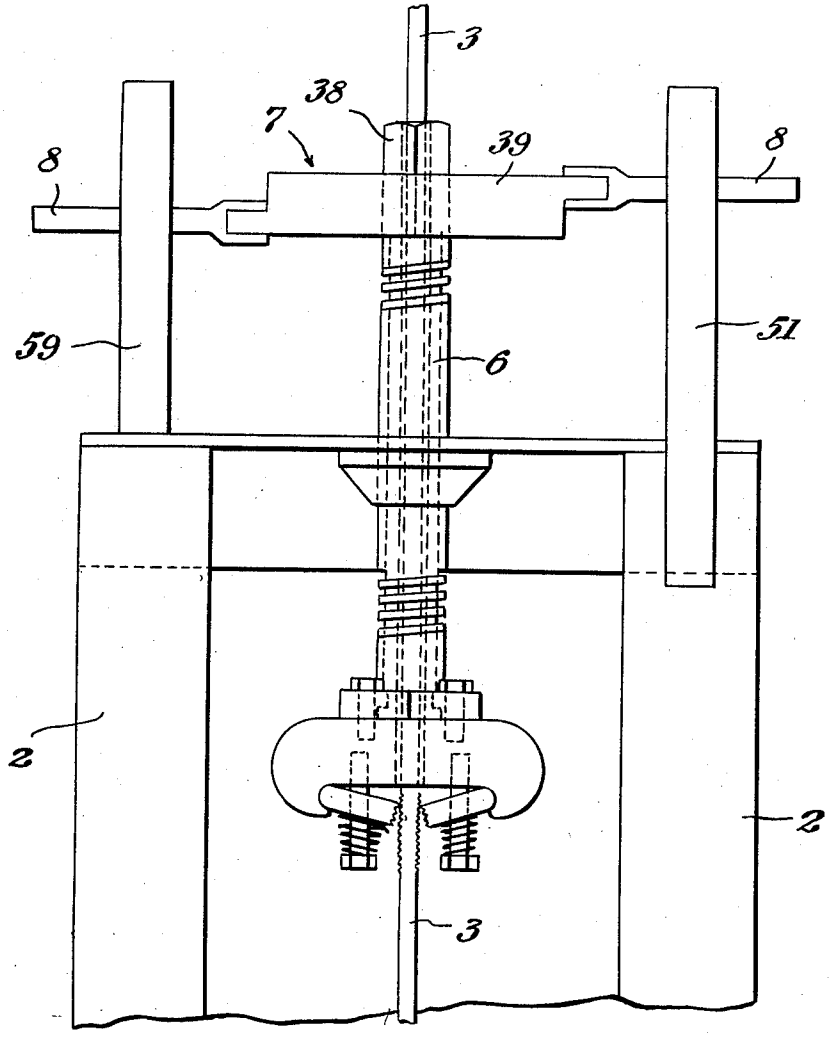


Fig. 14.

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ATTYS.

United States Patent Office 2,851,759
Patented Sept. 16, 1958

2,851,759

INSTALLATION FOR HYDRAULIC LIFTING OF SLIDING SHUTTERINGS

Trygve Berntsen, Oslo, Norway

Application November 9, 1953, Serial No. 390,856
Claims priority, application Norway November 12, 1952
8 Claims. (Cl. 25—131)

The present invention relates to lifting of sliding shutterings by causing them to climb on stationary, vertical elements, so-called climbing-irons.

An essential requirement for mechanisms which are to be used for this purpose is that they are working precisely. It must further be assured that pouring of concrete, once started, can be continued without stop day and night to the very top of the structure to be erected.

With increasing costs of labor the demand for mechanization of the movement of the climbing mechanism, which for a long period of time was done manually, has constantly increased and has also resulted in the construction of hydraulic jacks. These hydraulic jacks are based on the principle that the jack lifts by means of two groups of "wedge-jaws" which are alternately jammed against the climbing rod while they are alternately lifted to a new "clutch" at the same time lifting the shutterings. Due to the frequent alternations of "clutch" even the best types of such jacks constantly have a factor of uncertainty which increases with increasing wear and tear of the mechanism. Another inconvenience is that when working it is not possible to see the group of wedge-jaws or to get access to the internal parts of the jacks. A very careful control with levelling and frequent adjustments is therefore required if an even climbing of the shutterings is to be obtained. As a matter of fact with this system separate jacks still act individually and may climb a fraction of a millimeter differently from all of the others or most of the others with each new clutch made at short intervals over some few centimeters.

For these reasons the manually moved lifting mechanisms of the screw type are regarded as the most reliable.

The so-called screw-jack of the best type is arranged in such a way that it seizes the climbing rod by means of a pair of spring loaded "eccentric jaws" and a hollow screw is firmly but rotably secured to the housing of the pair of jaws. When it is turned, the hollow screw lifts a nut which carries the yoke to which the sliding shutterings are secured and consequently lifts these as the turning of the screw proceeds.

The jaws of the screw jack are simple and robust and do not cause uncontrollable errors because they are constantly visible and cannot slip once they are fastened. When all of the jacks are turned the same number of revolutions during the lifting the shutterings must be lifted equally, which is a considerable guarantee of a good result.

The only real objection to this type of jack is that it has not been possible to operate it mechanically with ease.

A principal object of the present invention is to make possible automatic hydraulic or pneumatic lifting of sliding shutterings when using the screw jacks described.

A further object of the invention is to obtain sure control of the functioning of all of the jacks.

Another object is to provide a controlling device which

can be used for various types of lifting mechanisms and which is in a position to work uninterruptedly even if during the pouring period it is necessary temporarily to pass from one method of operation to another, for instance from hydraulic to manual operation.

A further object of the invention is to provide hydraulic driving devices suitable for driving screw jacks.

A still further object of the invention is to procure an effectively cooperating combination of a control device for the operation of the lifting mechanisms and the controlling of the hydraulic or pneumatic driving medium.

With all hydraulically (or pneumatically) driven mechanisms which are intended for the lifting of sliding shutterings or the like a reversing of the pumped medium which preferably is sent from a central pumping member to the driving devices for the separate lifting mechanisms has to be carried out at certain intervals in order to permit them to work satisfactorily. These driving devices will however inevitably be working against different resistances because frictional forces on the shutterings and various other loads will vary from one lifting yoke or trestle to another. Consequently, that climbing mechanism which meets the smallest resistance will be inclined to move ahead of the others, and the one with the largest resistance to "be late," thus deforming the system of shutterings. It is therefore imperative that the possibilities of the mechanisms to arrive at different levels are reduced to a minimum. With the mechanisms used up to now, preferably driven hydraulically or by air, it has frequently happened that they have been moving differently in relation to each other, which condition must be controlled by frequent measuring, levelling or the like in order to make corrections as often as necessary by resetting all mechanisms to the same level. In the meantime the irregularity will necessarily have had certain more or less apparent inconvenient results on the work.

To make certain a practically mathematically equal and simultaneous lifting of all lifting mechanisms together with no possibility of an uncontrollable failure anywhere, there are arranged, according to the invention, two circuits each comprising a number of valves connected in series, one at each lifting mechanism and connected with a member reciprocating during the functioning of the lifting mechanism in such a way that the valves in one of the circuits are open for passage of the current only when said member is in position at one of its extreme positions and the valves in the other circuit are open for passage of the current only when said member is in position at its other extreme position, the installation being arranged in such a way that a current movement appears alternately in one or the other circuit each time said movable members of all of the lifting mechanisms have arrived at one or the other of their extreme positions.

The circuits may advantageously be electrical circuits, but hydraulic or pneumatic circuits can also be used. The designation "valve" should be ragarded as comprising electrical switches as well as valves or blocking a fluid current.

Said current movements can, as will be explained more in detail below, be used for the activation of devices for giving visible or audible signals as well as for the control of the hydraulic driving medium.

The signal device can, by use of electrical circuits, also simply consist of one or several signal lamps which flashes at each movement. If any failure arises, if for instance one lifting mechanism is prevented by a foreign body or for other reasons from moving, the flashes cease and give thereby notice of the failure to the man in charge. This signal device is per se independent of the construction and working of the lifting mechanism and

only supposes that each lifting mechanism has one reciprocating member.

The invention is preferably intended for the use in an installation comprising a driving motor, a pump for a pressure medium driven by the motor, pipes connecting the pump unit with said hydraulic driving devices, and a valve for reversing the streaming direction of the pressure medium arranged between the pump and the driving devices, and finally a number of conventional valves and pipe lines.

According to a preferred embodiment of the invention the movement of said valve is controlled by means of said circuit movements. Thereby on one hand the reversing of the driving medium does not take place until all of the lifting mechanisms have been activated and on the other hand that the reversing takes place without delay as soon as all of the lifting mechanisms are moved.

As already mentioned the invention is preferably intended for use in connection with so-called screw-jacks. The invention also comprises special devices for the hydraulic driving of such screw-jacks. Some of these devices will be described below in connection with the drawings, which illustrate the principle of the invention as well as its practical execution.

Figure 1 is a partial plan view of a wall during casting where an installation according to the invention is shown schematically.

Figure 2 is a partial sectional view on the line A—A in Figure 1.

Figure 3 is a side view corresponding with Figure 2 seen in the direction of the arrows B—B in Figure 2 which shows the upper part of a yoke upon which mechanisms are arranged.

Figure 4 is an enlarged plan view, partly in section, of the mechanisms for the turning of the screw-jack.

Figure 5 is a front elevation view of the mechanism of Fig. 4.

Figure 6 is an enlarged partial front view corresponding to Figure 2 showing a modified embodiment of the mechanism.

Figure 7 is a plan view of a further modification.

Figure 8 is, on smaller scale, a plan view of another embodiment, and

Figure 9 is a detail of Figure 8.

Figure 10 is a partial plan view similar to Figure 1 and showing the use of hydraulic circuits.

Figure 11 is a detailed view on a larger scale of the valves used in the embodiment according to Figure 10, which valves open and close the circuit.

Figure 12 is a schematic view of an embodiment with pneumatic circuits.

Figure 13 is a schematic view of an installation with completely pneumatic drive.

Fig. 14 is an enlarged view of the upper portion of Fig. 2.

The principle of the invention will most clearly appear from Figure 1, where **1** designates a wall being poured. In the drawing are shown two yokes **2** or climbing trestles which are suspended in climbing irons **3**, Figure 2, and carry the shuttering plates **5** on their downwardly extending legs **4**. As will best appear from Figure 2 the yokes are suspended on hollow screws **6**. For the turning of the screws **6** there is provided ratchet mechanisms **7** with transversely protruding arms **8** which arms can be moved to and fro by means of hydraulic driving devices **9**, **10** and **11** (see Figure 4).

The form of the ratchet mechanisms, which will be described more in detail below, is not an essential feature of the invention. The ratchet mechanisms can be of a known construction or may be replaced by other equivalent mechanisms.

Neither is the invention necessarily combined with the suspension of the yokes in hollow screws, although this must be regarded as most convenient. However, in all events it is supposed that the lifting mechanisms include members or arms which like the arms **8**, can be moved to and fro or up and down (for instance by operation of so-called pump jacks, having vertically movable drive arms), by means of hydraulic driving devices arranged in connection with each of the lifting mechanisms.

Of essential importance to the invention is the provision of two circuits I and II. In the embodiments shown in Figures 1–9 these circuits are electrical. In each of these circuits there is connected in series a number of switches **12**, one for each of the lifting mechanisms, and the installation is made in such a way that the circuit is cut during the movement of the mechanisms—that is the arms **8**—and is not closed until all the arms or corresponding members have reached one or the other of their extreme positions. In the circuits, or at least in one of them, is connected signal means for giving visible or audible signals. In Figure 1 such signal means are represented as signal lamps **13**. These lamps will be lit alternately each time the lifting mechanisms have all been moved by the arms **8** to one or the other extreme position.

In the installation shown in Figure 1 the circuits simultaneously serve the purpose of reversing the driving medium for the separate hydraulic driving devices. This is achieved in the following way:

An electric motor **14** drives a pump **15**. From the pump a pipe **16** leads through a valve **17** to a reversible three-way valve **18**. From this extend two main pipes for the pressure medium. From the main pipes branch pipes extend to each of the hydraulic driving devices of the lifting mechanisms. These driving devices will be described more in detail below, but they consist principally of a piston and a cylinder which can move in relation to each other and to which cylinder a driving medium can be fed alternately to one end or the other, the driving medium being withdrawn at the opposite end.

When the position of the valve body **21** in the valve **18** is as shown in the drawing it will be seen that the driving medium from the pump will leave the pump through the pipe **19** while the pipe **20** is connected with a pipe **22**, which through a valve **23** leads to a container **24**, from which the driving medium, for instance oil, returns through a pipe **25** and a valve **26** to the pump **15**. The container **24** is open to the atmosphere through a pipe **27**. **28** is an air vessel and **29** a safety valve.

The valve body **21** of the valve **18** is provided with an electromagnetic armature **30** and **31** outside of each end of the valve. These armatures co-operate with electromagnets **32** and **33** connected in the two electric circuits I and II. When the arms **8** of all the lifting mechanisms have been moved to one of their extreme positions by feeding of driving medium through the main pipe **19** the circuit II is closed by means of switches **12**, the switch buttons **58** abutting the abutment **56**, and the electromagnet **33** attracts the armature **31** whereby the driving medium from the pump **15** is led out through the main pipe **20**, while the pipe **19** now is connected with the pipe **22** and through the container **24** with the pump **15**. The arms **8** will now be moved in the opposite direction until all of the arms have reached their other extreme position, whereby the circuit I is closed by means of switches **12**, the switch buttons **57** abutting the abutments **55**, and the electromagnet **32** attracts the armature **30** whereupon the process repeats itself.

As soon as the arms **8** start moving in the opposite direction to that which closed a circuit, the circuit is broken anew.

34 is a spare-motor, for instance a gasoline motor, which can be used in case of failure of current. In the circuit of the motor **14** are connected switches **35** on one or several of the climbing trestles. These switches cooperate with abutments **36** on the ratchet devices, and are adjusted so that the circuit is broken when the switches bear against the abutments. Thus the motor and thereby the pump automatically stops when the climbing

trestles have reached a level such that the lifting screws have to be lifted to the next position to get a new clutch. As soon as the pump stops working because the supply of current is broken this may be indicated by a lamp in the circuit of the motor which goes out.

By installation of the two circuits I and II according to the invention a completely automatic operation of the lifting mechanisms can be obtained and at the same time there is assured an exactly equal, step by step, simultaneous climbing of all climbing mechanisms with no possibility of failure, because none of the mechanisms can get in advance of or behind the others, since the reversing is caused by the switches which are connected in series. As long as the climbing proceeds the signal devices **13** will flash periodically, or give another similar signal. If the signals disappear, the man in charge of the climbing work will at once observe this and can discover the reason which normally is that one defect or other has appeared which prevents one or several or all of the mechanisms from moving.

If the stoppage is caused by outside failure of the current the spare gasoline motor **34** can as mentioned above be started. If there is a defect in the electromagnet the remainder of the circuit can be short circuited over the resistance and the reversing be carried out manually each time the signal devices **13** operate until the electromagnets are repaired. A spare reversing mechanism can be installed for instance based on hydraulic control by means of a liquid pressed through a high pressure valve, which for instance is opened when an over pressure has appeared in the system which under normal conditions is sufficiently high to assure that all of the working cylinders have performed their work.

In case of the breaking down of a single driving mechanism it can be replaced by a new one quickly and if it should be necessary a single driving mechanism or some other equivalent mechanisms may be driven manually. Also under these abnormal working conditions the signal devices are useful in giving the exact moment for the reversing. The installation of the two circuits I and II will thus retain their importance even if they temporarily or permanently cannot be used for the reversing of the driving medium. An installation according to the invention is consequently not only reliable but also very elastic so that continuous providing operations can be assured also in case of failures, current failure and the like. This is a very important feature of the invention because, as mentioned, pouring concrete with sliding shutterings has to be done without interruption day and night until the concreting has reached the top.

Referring to Figures 4–6 some special driving devices for the lifting mechanisms according to the invention will now be described. On the square head **38** at the top of each of the hollow screws **6** is placed a driving mechanism **39** similar to various types of tools called "ratchet mechanism" or "slamming mechanism" by means of which a wheel **40** having teeth is turned by an arm **8** secured to a ratchet **41** with driving pawls **42**, which ratchet is located around and above and partly enclosing the wheel **40** and which arm moves regularly to and fro, whereby the pawls by movement in one direction slip over a tooth (or several teeth) and by movement in the opposite direction turn the wheel **40** through a certain angle. In this way the screw is turned to lift the sliding shutterings. To prevent the upper ratchet in its return movement to a "new clutch" from pulling the screw along due to the friction, the device is provided with brake means in the form of a lower ratchet **43** which is constantly kept in the same vertical plane by means of the arm **44**. **9** is a cylinder in which is arranged a piston **10**, mounted on a piston rod **11** extending therethrough. The cylinder **9** has openings **45** and **46** near its ends, which by flexible conduits **47** and **48** are connected with the hydraulic main conduits **19** and **20**.

The cylinder **9** can rotate on a vertical axis on a connecting piece **49** which is provided with a horizontal bore **50** therethrough for the arm **8**, in which bore the arm may be moved to and fro and thus translate the straight movement of the cylinder to the circular movement of the arm.

51 and **52** are guiding rails fastened to the climbing trestle **2**. These will prevent the piston from moving along its axis, as the ends of piston rod **11** are resting against the guiding rails. In order to reduce the friction during the vertical movement of the guiding rails, rolls **53** and **54** have been mounted at the ends of the piston rod. These may, however, be omitted. On the guiding rails **51** and **52** have been fastened abutments **55** and **56** for protrusions **57** and **58** on the switches **12**.

59 and **60** are guiding rails corresponding to the rails **51** and **52** and are similarly fastened to the climbing trestle, for the guiding of the arm **44** which for this purpose has been supplied with a cross-arm **61**. Rolls are here superfluous, as no transmission of power of any importance takes place.

Instead of fastening the guiding rails **51**, **52** and **59**, **60** to the trestles which move while the piston rods **11** and arms **44** remain at the same level during a lifting stage of about 50 cm., the guiding rails **62** may, as shown in Figure 6, be fastened directly to the piston rods **63**, and during the lifting stage may remain at the same level while the climbing trestles **2** move up between the guiding rails.

Figure 7 is an illustration of how the mechanism which is shown in Figure 4 may be altered in such a way that the piston moves while the cylinder remains stationary. The cylinder **64** is provided on both ends of the cylinder with extensions in the form of protruding arms **65**, with rolls **66** on the ends thereof resting against the guiding rails **51** and **52**. The piston rod **68** for the piston **67** is connected with the arm **8** by a U-formed connection rod **69**.

The guiding rails **51**, **52** and **59**, **60** may be fastened to the trestles as shown in Figure 2, and in this case move up and down together with the trestles, while the piston rods **11** and arms **44** with the cross bars remain at the same level.

In Figures 8 and 9 is shown a somewhat different embodiment of the driving device. Also here the system is based upon the fact that all of the lifting mechanisms are forced to operate equally so that the reversing mechanism which in this case is placed on each of the lifting mechanisms, is controlled electrically and the electrical control is made by a system of series connections.

A main pressure pipe **70** for air has a branch pipe **71** for each lifting mechanism to a three-way valve **72** with a reversing mechanism wherefrom the airpipe **73** extends further to one end of a cylinder **74** in which a piston **75** is movable and which has a piston rod **76** therethrough of the same type as earlier described. The opposite end of the cylinder is in communication with the open air. On the same side as the air inlet is a return spring **77**. Furthermore two switches of the same type as previously mentioned are mounted on the cylinder and connected in series with the corresponding micro switches on all of the remaining lifting mechanisms in such a way that all the switches on the one side form one system and all on the other side form another system. When air is fed to the cylinder, it is forced over against the vertical guiding element with contact impact. When all of the mechanisms are driven completely over, a circuit will be closed and an electro magnet, not shown in the drawing, reverses the three-way valve in the mechanism **72** from the position shown in Figure *9a* to the position shown in Figure *9b*, in which the air from the cylinder can escape to the open air through **79** while the pressure air from the main pipe will be cut off. Now the return springs **77** will drive the cylinders over into their opposite extreme position.

When all of the cylinders have reached this position

the switches on this side will let a current pass through an electro magnet which causes reversing of the three-way valve so that pressure air is again fed to the working cylinder. Otherwise the driving arm with pawl mechanisms is as previously explained.

While the controlling circuits, in the embodiment as shown in Figures 1–9 are electrical, Figure 10 shows the use of hydraulic circuits for this purpose. The arrangement according to Figure 10 corresponds mainly to Figure 1 and the same reference numerals are used for corresponding parts. From the pressure side of the pump a pipe **80** conducts the hydraulic pressure medium to two branch pipes **81** and **82**, which each leads to a control valve on one of the lifting mechanisms. These valves work in a way corresponding to that of the electrical switches shown in Figure 1. Corresponding valves are arranged on all lifting mechanisms and are connected with pipes, thus forming two circuits I' and II'. From the latter lifting mechanism the pipes are again joined to form a single pipe **91**, from which the pressure medium arrives at an actuating valve **92**. In the position shown in the drawing of the valve body **93** in the actuating valve, the pressure medium will enter at the lower end of the redirection valve **18**, through the pipe **94**. Therefore, as soon as the valve in one of the circuits of the lifting mechanism is open for passage of current, the pressure medium will enter at the lower end of the redirection valve **18** and lift the valve **21** to its upper position, in which the pressure medium will enter through the main pipe **20** and cause reverse movement of the arms **8** of the lifting mechanism. At the same time pressure medium through the pipe **95** will enter at the lower end of the actuating valve **92** and lift the valve **93** to its upper position.

When the valves of all the lifting mechanisms are opened for passage of current in the second circuit, the pressure medium will be lead through the pipe **96** by the actuating valve to the upper end of the redirection valve **18**, and cause the redirection of the pressure medium through the main pipe. Simultaneously pressure medium from the pipe **19** through the pipe **97** will enter at the upper end of the actuating valve **92** and cause the valve to change position.

The embodiment of the valves of the lifting mechanisms is most clearly illustrated in Figure 11. Here **83** indicates one to the working cylinder **9** fastened valve cylinder, which is divided into two compartments **84** and **84'**. The compartment **84** has two openings **85** and **86** of which **85** is connected with the pipe **81** or the corresponding pipe leading from a previous valve, while the opening **86** is connected with a pipe leading to the next valve in the circuit. **87** is a valve body which by a spring **88** is urged toward the outside position shown in the drawing, in which position the connection between the openings **85** and **86** is closed. If the cylinder **9** is moved to the left, and thereby also the cylinder **83**, a protrusion **89** on the valve body **87** will touch an abutment **90** on the guiding rails **51** and press the valve body **87** to the right, thus connecting the opening **85** with the opening **86**.

The right part of the valve is made in exactly the same way, and corresponding parts are indicated by similar numerals **84'** to **90'**.

Figure 12 shows a plan for combined pneumatic and hydraulic drive. The drive of the lifting mechanisms is hydraulic as described above, while the control circuits are worked by air under pressure. The arrangement corresponds to that shown in Figure 1, and corresponding parts are indicated with corresponding numerals. **98** indicates a three-way cock of a type known per se, arranged in such a way that a supply of pressure air through a pipe **99** will control cock **98** and cause the redirection of the pressure medium from the pump **15**, alternately to the pipes **19** and **20**. **100** is a compressor which supplies pressure air to the two circuits I'' and II''. The valves **101** may be made in a manner corresponding to that shown in Figure 11.

Figure 13 shows an installation for fully pneumatic drive. The installation mainly corresponds to the installation shown in Figure 12 and differs from this essentially in that the pressure air which is obtained by aid of the compressor **100** is used not only for redirecting the valve **98** by movement of air in the conduit **99** during control of the valves **101**, but also for the drive of the cylinders **9** by supply of the air through the main conduits **19** and **20**.

As may easily be seen, there is fundamentally nothing to prevent the use of pneumatic driving devices where hydraulic devices have been described above, and vice versa. The expression hydraulic in the description as well as in the claims, should therefore be understood to comprise also pneumatic driving devices, when nothing to the contrary is obvious from the wording.

When stating that the embodiment of the ratchet mechanisms of the lifting mechanisms have a to and fro movable part, this expression is meant in its widest scope, so as to comprise also a part which for instance can be moved up and down, the decisive thing being that the part can be moved first in one direction and then in the opposite direction.

I claim:

1. Apparatus for lifting sliding shutterings for use in building concrete structures comprising a plurality of climbing rods, a plurality of yokes slidably mounted on said rods, a plurality of sliding shutterings carried by said yokes arranged to form concrete for a structure, means between each of said yokes and said climbing rods for moving said yokes upwardly on said climbing rods, said moving means operating with a reciprocating motion, actuating means operable by fluid pressure, supply means supplying fluid pressure for reciprocating said actuating means, reversible valve means for directing fluid pressure for reciprocating said actuating means, said valve means positioned between the fluid pressure supply means and said actuating means, control means controlling the reversal of said valve means positioned at the opposite ends of the reciprocating motion of each of said moving means and actuated by said actuating means, the control means at corresponding ends of said reciprocating motion of said moving means being connected in series, whereby all of the said control means at one end of the reciprocating movement of said moving means must be actuated to reverse said valve means and direct fluid pressure to reciprocate said actuating means.

2. Apparatus as claimed in claim 1 in which said control means comprises a plurality of electric switches, one positioned at each end of the reciprocating motion of each of said moving means and actuated by the said fluid pressure operable actuating means, switches at corresponding ends of the reciprocating motion of each of said moving means connected in series, a solenoid positioned at each end of said valve means, one solenoid connected to one series of switches and the other connected to the other series, and a source of electrical energy between the solenoids and the series of switches, whereby when all switches in the series at one end of the reciprocating motion of said moving means are actuated, the solenoid connected thereto is energized to reverse the valve means to direct fluid pressure to reciprocate said actuating means.

3. Apparatus as claimed in claim 1 in which said control means comprises a plurality of control valves one at each end of the reciprocating motion of each of said moving means and opened by said fluid pressure operable actuating means, the valves at corresponding ends of the reciprocating motion of each of said moving means connected in series, said fluid pressure supply means supplying fluid under pressure to one end of each of said series of valves, the other end of said series of valves being connected to said valve means for reversing said valve

means, an actuating valve between said series of valves and said valve means for controlling the supply of pressure to said valve means, said actuating valve being moved to admit pressure to said valve means by fluid pressure from said fluid pressure supply through said valve means, whereby when all of the control valves in the series of valves at one end of the reciprocating motion of said moving means are open fluid pressure through the series of open control valves reverses said valve means to direct fluid pressure to reciprocate said actuating means and to reverse the actuating valve.

4. Apparatus as claimed in claim 1 in which said control means comprises a plurality of control valves one at each end of the reciprocating motion of each of said moving means and opened by said fluid pressure operable actuating means, the valves at corresponding ends of the reciprocating motion of each of said moving means connected in series, a source of pneumatic supply connected to one end of each of said series of valves, the other end being connected to said valve means for reversing said valve means, a 3-way cock between said series of valves and said valve means for controlling the supply of pneumatic pressure to said valve means, whereby when all the control valves in the series of valves at one end of the reciprocating motion of said moving means are open, pneumatic pressure through the series of open control valves reverses the valve means to direct fluid pressure to reciprocate said actuating means.

5. Apparatus as claimed in claim 1 in which said actuating means comprises a pair of vertical guides on said yoke on opposite sides of said climbing rod, a fluid pressure actuated piston and cylinder mechanism guided for vertical movement relative to said guides, said mechanism being attached to said moving means for reciprocating said moving means, a source of fluid pressure to which said piston and cylinder mechanism is connected, and valve means between said source of fluid pressure for governing the supply of fluid pressure for actuating said piston and cylinder mechanism for reciprocating said moving means.

6. Apparatus as claimed in claim 5 in which said piston and cylinder mechanism comprise a guide rod mounted between said guides, a piston fixed centrally on said rod, a cylinder slidably mounted on said piston and attached to said reciprocating moving means, said cylinder extending an equal distance on either side of said piston when said moving means is in a position halfway between the extremes of its reciprocating motion, the opposite ends of said cylinder being connected to said source of fluid pressure, and said valve means comprising a valve for directing fluid pressure to one end of said cylinder and then to the other, whereby when the fluid pressure is alternately supplied to opposite ends of said cylinder, the cylinder slides on said piston to reciprocate said moving means.

7. Apparatus as claimed in claim 5 in which the piston and cylinder mechanism comprise a cylinder support mounted between said guides, a cylinder mounted on said support with its midpoint at a point halfway between the extremes of reciprocal motion of said moving means, a piston slidably mounted in said cylinder and attached to said reciprocating moving means, the opposite ends of said cylinder being connected to the source of fluid pressure, and said valve means comprising a valve for directing fluid pressure to one end of said cylinder and then to the other, whereby when the pressure is alternately supplied to the opposite ends of said cylinder, the piston slides in said cylinder to reciprocate said moving means.

8. Apparatus as claimed in claim 5 in which the piston and cylinder mechanism comprises a guide rod mounted between said guides, a piston fixed centrally on said rod, a cylinder slidably mounted on said piston and attached to said reciprocating moving means, said cylinder extending an equal distance on either side of said piston when said moving means is in a position halfway between the extremes of reciprocal motion of said moving means, one end of said piston open to the atmosphere and the opposite end connected to said source of fluid pressure, valve means between the source of fluid pressure and said cylinder for directing fluid pressure to said cylinder intermittently, and spring means on said rod on the side of said cylinder which is connected to the source of fluid pressure, said spring means urging said cylinder in the direction of the other extremity of the reciprocating motion of said moving means.

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