June 26, 1951 J. B. CASTLE, JR., ET AL 2,558,071

ELECTROHYDRAULIC CONTROL MEANS FOR MACHINES EMPLOYING PLURAL HYDRAULIC MOTORS

Filed May 3, 1946 4 Sheets-Sheet 1

Fig. 1.

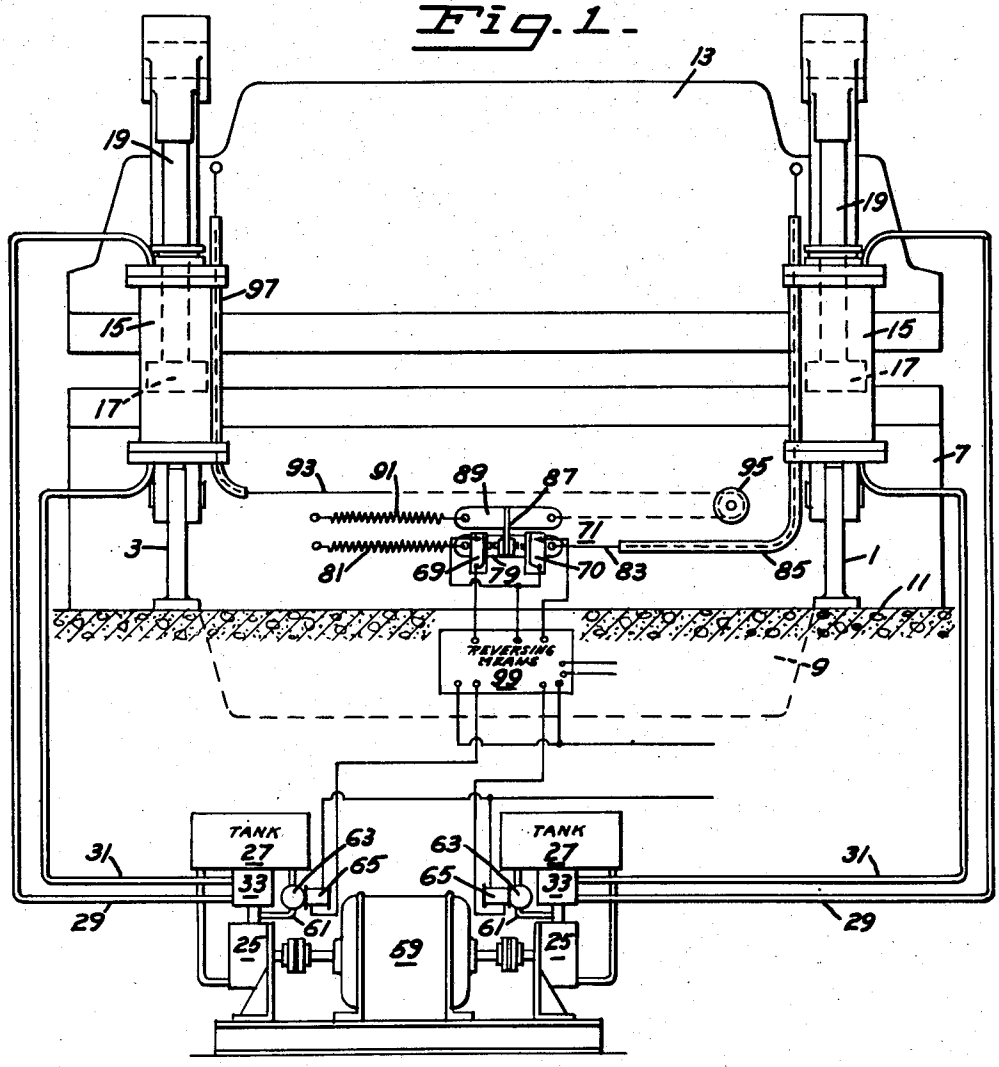
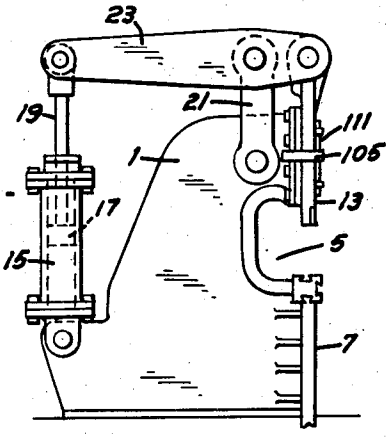


Fig. 2.



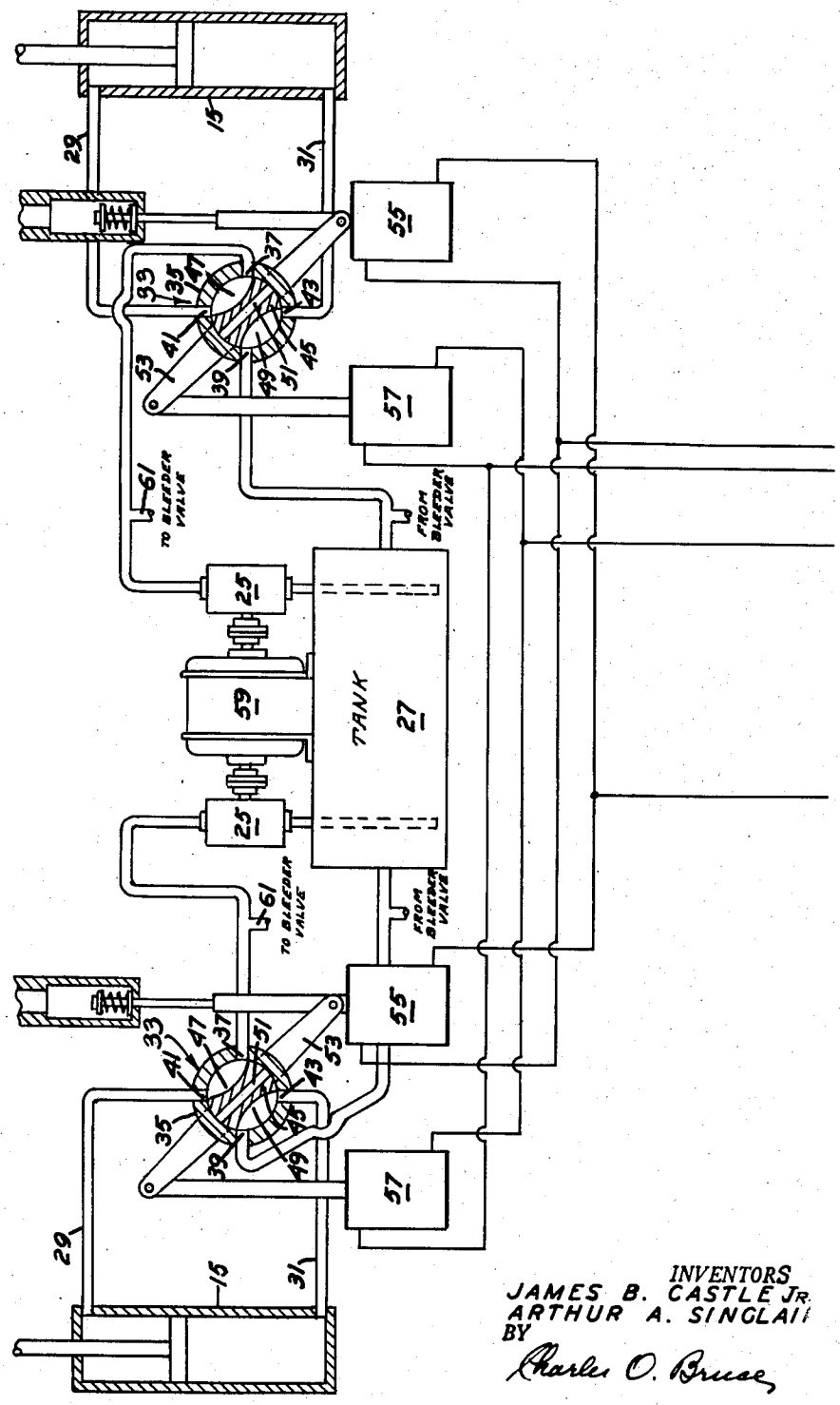
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Fig. 3.



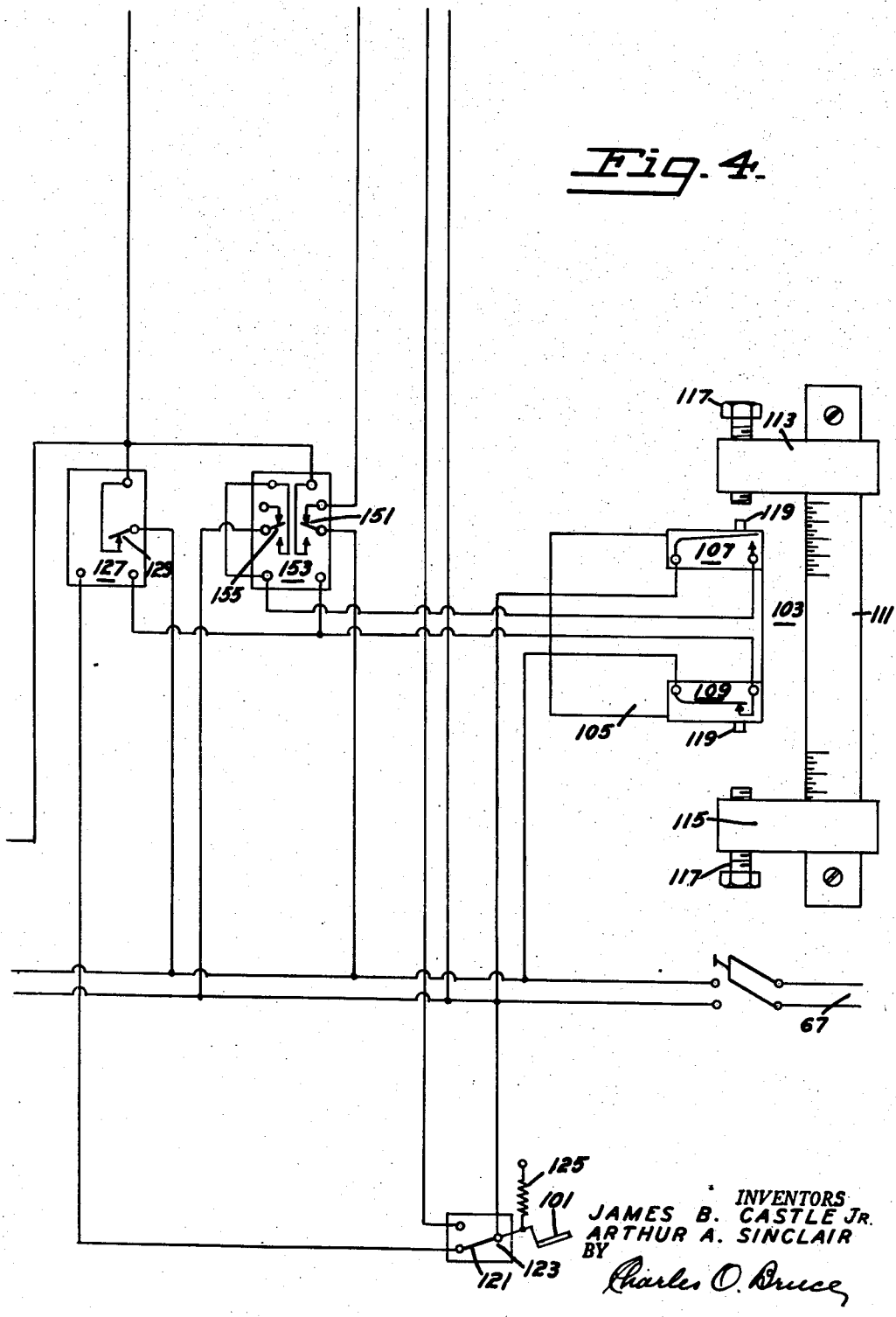
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Fig. 4.



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Filed May 3, 1946 4 Sheets-Sheet 4

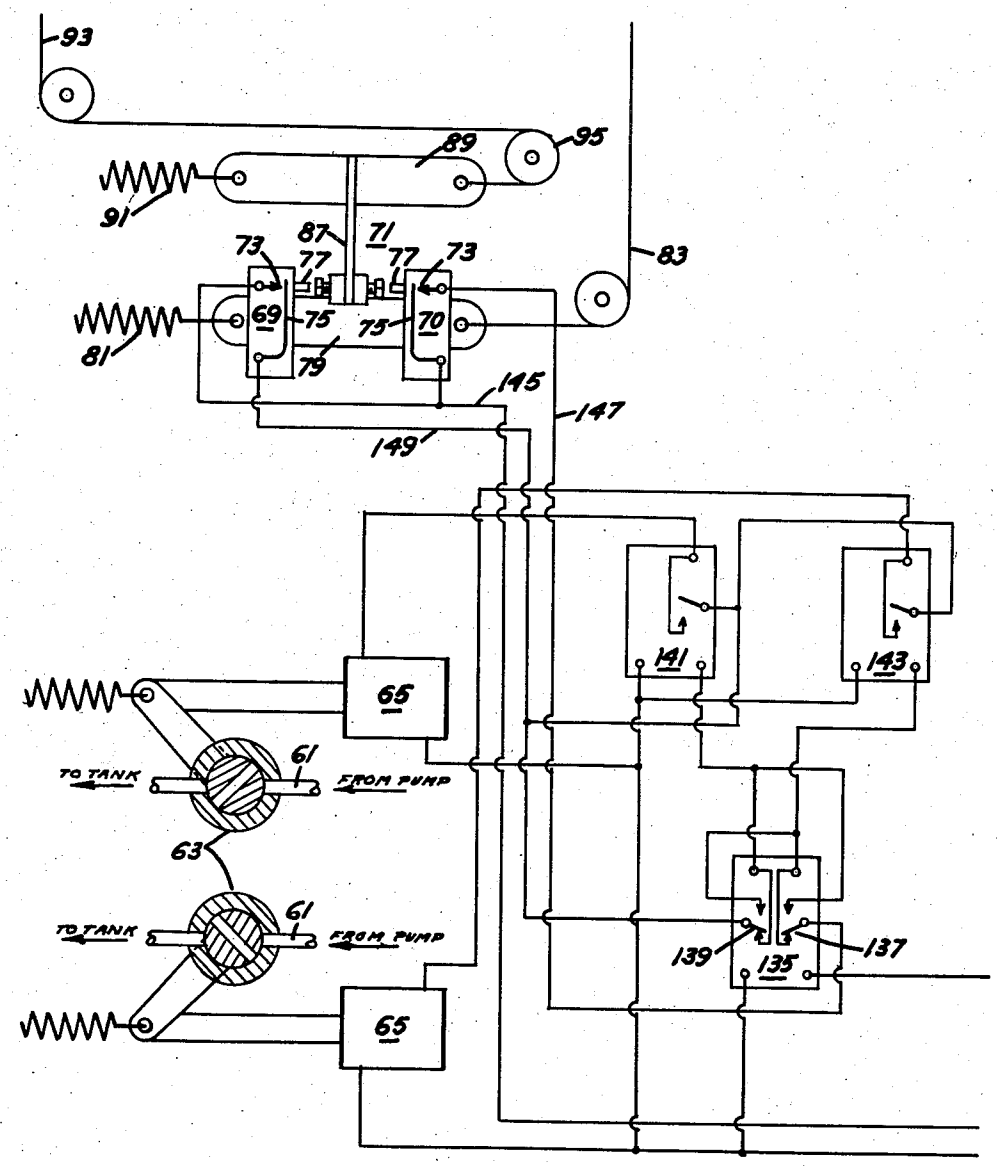


Fig. 5.

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2,558,071

ELECTROHYDRAULIC CONTROL MEANS FOR MACHINES EMPLOYING PLURAL HYDRAULIC MOTORS

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Application May 3, 1946, Serial No. 667,222

16 Claims. (Cl. 60—52)

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Our invention relates to presses, and more particularly to a press brake and apparatus for controlling the movable blade thereof.

Among the objects of our invention are:

(1) To provide a novel and improved press brake or the like;

(2) To provide a novel and improved press brake or the like, wherein equalized movement of the movable blade is assured in the operation of the machine;

(3) To provide in connection with a press brake or the like, novel and improved means for leveling the blade of such machine;

(4) To provide a novel and improved press brake or the like, wherein the stresses developed therein are such as to permit of a relatively light machine doing heavy duty.

Additional objects of our invention will be brought out in the following description of a preferred embodiment of the same, taken in conjunction with the accompanying drawing, wherein—

Figure 1 is a rear elevational view of a press brake of our invention;

Figure 2 is a side elevational view of the machine of Figure 1;

Figures 3, 4 and 5 are related portions of a circuit diagram of the interlinked control circuits, and their relationship to functional components of the machine.

In general, the invention relates to a press brake or the like wherein a pair of cooperating blades of substantial width are brought together to perform an operation, and the invention contemplates not only the incorporation of a system therein which will assure equalized movement of the movable blade of the machine, but also a machine which will withstand excessive stresses with a minimum of built-in weight.

Referring to the drawing for detail, the specific embodiment of our invention as illustrated therein in the form of a press brake, comprises a pair of side plates 1 and 3 formed to provide work-clearance notches 5 in the front edge thereof, the side plates being connected across their front edges below the work-clearance notches, by a lower front stationary blade 7 which is preferably formed with a depending apron 9 adapted for anchoring in the concrete foundation 11 usually provided for the installation of a machine of this type.

An upper front movable blade 13 is slidably mounted in guides on the front edges of the side plates above the work-clearance notches. The opposing edges of the blades are designed

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to carry complementary components of a forming die (not shown).

Pivotally disposed at the rear of each side plate is an hydraulic cylinder 15 enclosing a piston 17 having a piston rod 19 extending upwardly therefrom. At an intermediate point on each side plate between the upper front blade and the hydraulic cylinder, there is pivotally mounted a link 21 adapted to act as a movable fulcrum for a lever 23 having one end pivotally connected to the upper edge of the movable blade and its other end pivotally connected to the piston rod of the associated hydraulic cylinder. Preferably, the fulcrum on each side plate is disposed closer to the movable blade than to the associated hydraulic cylinder to obtain a mechanical advantage whereby the hydraulic cylinder may be of relatively small size, yet capable of transmitting powerful forces to the movable blade in its downward movement toward the lower fixed blade, to accomplish a machine operation.

During this operating stroke of the machine, the stresses developed at the fulcrum mounting are upward. Being applied as they are however, at a location in approximate line with the interior edge of the work clearance notch, a relative light weight side plate can adequately absorb such stresses without buckling or distortion.

Importance must be attached to the pivotal mountings and connections previously indicated, for it is only by reason of these that the arrangement and advantages described are possible.

Each cylinder is part of an independent hydraulic system which, in addition to the hydraulic cylinder 15, includes a pump 25, a tank or reservoir 27, a pair of lines 29 and 31 leading each to one end of the cylinder, and a reversing valve 33 installed in the lines and adapted to interchangeably connect the lines between the discharge of the pump and the reservoir.

Such reversing valve may be of the type schematically illustrated in conjunction with the circuits of Figure 3, and may comprise a valve body 35 having a pair of diametrically disposed openings 37 and 39 for connection to the pump discharge and reservoir respectively, and a second pair of diametrically disposed openings 41 and 43 for connection to the upper and lower ends respectively of a cylinder. An inner rotatable valve member 45 having oppositely disposed concave recesses 47 and 49 and a diametrical passage 51, is affixed axially to the midpoint of a lever 53 normally biased to a neutral position with the passage 51 connecting the pump

to the reservoir or tank. In such position, the lines to the cylinder are valved off.

One end of the lever is connected to the plunger of a solenoid **55** capable when energized, of rotating the valve member in a clockwise direction through sufficient angle to bring the lines **29** and **31** into communication with the pump and reservoir respectively, while the other end of the lever is connected to the plunger of a solenoid **57** capable when energized, of producing counter-clockwise rotation sufficient to bring the lines **29** and **31** into communication with the reservoir and pump respectively, or in other words to effectively reverse the line connections.

The hydraulic system associated with one end of the upper or movable blade is designed to be as closely identical to the hydraulic system associated with the opposite end of the same blade, to realize like operating conditions and, as an aid toward this objective, the pumps are driven from a single motor **59**.

It is of prime importance in a press of this type that both ends of the movable blade should arrive at their destination at the same instant, for should one end arrive an instant prior to the other end, an imperfect operation will result.

In spite of the fact that both hydraulic systems are designed to be as closely identical as it is practical to realize, it has been universally found that in such a system one of the pistons will invariably tend to lead or lag the other and, consequently, we have found it necessary to supplement the supposedly identical hydraulic systems with an equalizer system which will function in response to such unbalance to hold the pistons in line and thereby equalize the rates of movement of one end of the upper blade with respect to the other end thereof.

Such equalizer system which we have illustrated specifically, is electrical in character and functions to adjust the piston pressures in a manner to compensate for unbalance, by bleeding some of the hydraulic fluid from one or the other of the hydraulic systems.

A bleeder passage **61** in each hydraulic system is provided between the discharge of the pump and the reservoir, and such passage includes a normally closed bleeder valve **63** under control of an electrically energizable solenoid **65** associated therewith. Such solenoid is an element of an electrical circuit deriving energy from a common electrical power source **67** and controlled by the operation of a micro-switch **69** or **70** as the case may be, of any conventional design and forming part of a switch assembly **71**.

The particular type of micro-switch illustrated (Figure 5) includes a contact **73** and an armature **75** actuated through the application of a slight pressure to a push pin **77** constituting part of the switch structure.

Both micro-switches **69** and **70** are carried on a link **79** to form a unit, which is floated between a spring **81** anchored at one end under tension, to the rear of the lower fixed blade **7**, and a Bowden wire **83** extending through a fixedly mounted guide tube **85** to a point adjacent the opposite end of the upper movable blade **13**, at which point the Bowden wire is anchored.

Associated with the micro-switches and constituting a component part of the switch assembly **71**, is a switch actuator means in the form of an actuating rod or finger **87** mounted on a similar but independent link **89** which is floated between a spring **91** anchored at one end under tension to the rear of the lower fixed blade, and a Bowden wire **93** passing around a direction-reversing pulley **95** mounted on the rear of the lower fixed blade at the other end thereof, before passing through a fixedly mounted tube **97** at the opposite end of the machine to an anchoring point adjacent that end of the upper blade opposite that at which the first Bowden wire was affixed.

The initial adjustment of the micro-switch assembly is such that the switch actuating rod or finger **87** lies in spaced relationship to the push pins **77** of the micro-switches, thereby causing each micro-switch to be normally in open circuit condition.

As the upper blade **13** is lowered to perform a machine operation, both floating components of the micro-switch assembly will move in the direction of pull exerted by their respective tensioning springs. The movement of one of these floating components will, of course, be under control of one end of the movable blade while the other floating component of the assembly will be under control of the opposite end of the movable blade. Consequently, as long as both ends of the movable blade travel at the same instantaneous velocity or rate and maintain symmetry of movement, the relationship of the actuating rod or finger with respect to the micro-switches will be maintained, and the micro-switches will remain in open circuit condition. Under these conditions, the hydraulic systems are functioning properly and will not be disturbed.

On the other hand, any departure from the above relationship in the movement of the upper blade, will produce a relative movement between the floating components of the micro-switch assembly, with the result that one or the other of the armatures will be urged into circuit closing engagement with its associated contact. That hydraulic system which is responsible for the more rapid movement of the one end of the upper blade will have its bleeder valve opened and for such brief interval of time only as is necessary to reestablish the equalized movement of both ends of the blade in question, and this will of course be followed by an instantaneous reestablishment of the neutral position of the actuating rod and consequent deenergization of the pertinent electrical circuit. The corrective changes are for all practical purposes instantaneous, an accomplishment due in large measure to the sensitivity of the conventional type micro-switch used, and the rapid drop in hydraulic pressure permitted by the bleeding from the system of a very minute portion of the liquid.

On the return stroke of the upper blade to its initial starting position, it is just as essential that equalized travel be maintained to assure proper starting conditions for the subsequent down stroke. Inasmuch as the corrective factors for the up stroke should be the reverse of those on the down stroke, a circuit reversing means **99** is installed in the circuit between the micro-switch assembly and the bleeder valve solenoids, and is made responsive to controlled operation of the machine.

Such controlled operation entails a foot controlled pedal **101** for initiating movement of the upper blade through application of power to electrically controlled circuits, and a micro-switch gauge **103** for disconnecting such power at either end of a stroke, in addition to energizing a reversing circuit for both the hydraulic systems and the bleeder valve solenoid circuits.

The micro-switch gauge includes a bracket **105**

mounted adjacent the front edge of one of the side plates 1 or 3 and carrying an upper micro-switch 107 of a normally open type and a lower micro-switch 109 of a normally closed type. Mounted on the upper blade and at approximately the level of the switch bracket, is a switch actuator including a calibrated strip 111 having adjustably affixed thereto a pair of arms 113 and 115, the upper one extending laterally to a point above the upper micro-switch 107 while the lower arm extends laterally to a point below the lower micro-switch 109. Each laterally extending arm carries an adjustment bolt 117 in line with the push pin 119 of the associated micro-switch, the arms and associated bolts being so disposed that the upper micro-switch will be actuated at the desired lower limit of the down stroke of the blade, while the lower switch will be actuated at the desired upper limit of the up stroke of the blade.

The foot control pedal actuates the armature 121 of a two-way switch 123, and is normally biased by a spring 125 to an up position. The foot switch armature is normally connected to one side of the power source 67, and in the up position of the foot pedal, it effects a connection from that side of the power source through the winding of a relay 127 and the normally closed micro-switch 109 back to the other side of the power source, to thereby energize the aforementioned relay. This relay in its deenergized condition is of the normally open contact type and having but a single pair of circuit closing contacts 129, and when energized, serves to close a circuit from one side of the power source through corresponding solenoids 55 which determine the flow of fluid from the pumps 25 to the upper ends of the respective cylinders 15, and thereby bring about the upstroke of the upper blade.

During the period of this upward stroke of the blade, during which interval of time the contacts 129 of the relay 127 remain closed, a circuit is established from the power source through the winding of a reversing relay 135 by way of these contacts 129. This relay carries a pair of armatures 137 and 139, each adapted to effect connection between one or another of a pair of contacts, depending on the condition of the relay.

The reversing relay is associated with the micro-switch assembly 71 of the compensating circuit, and serves to cause energization of one or the other of a pair of like relays 141 and 143, each of which has a single pair of contacts adapted to close the circuit through one of the bleeder valve solenoids 65.

The circuits involve a common connection 145 from one of the contacts of each of the micro-switches 69 and 70 to one side of the power circuit, and a separate connection 147 or 149 respectively from the remaining contact of each micro-switch to one of the armatures 137 and 139 respectively of the reversing relay 135.

Corresponding contacts associated with each of the armatures are connected to different ones of the similar relays 141 and 143, and accordingly these relays will be energized to the exclusion of one another, depending upon which of the micro-switches in the switch assembly happens to be actuated.

Which of these relays 141 and 143 becomes energized, will in turn determine which of the bleeder valve solenoids 65 becomes energized. The reversing relay 135, therefore, will interchange these relays 141 and 143 for the up and down strokes of the blade, so that on the upstrokes, one of the micro-switches of the switch assembly will upon closing, cause energization of one of the bleeder valve solenoids, whereas on the downstroke of the blade, the same micro-switch will cause the other bleeder valve solenoid to become energized.

When the blade reaches the upper limit of its travel, opening of micro-switch 109 occurs, which breaks the circuit through the winding of relay 127 to open its contacts and deenergize the upstroke solenoids 55. In this position, the machine comes to rest, for the down-stroke solenoids 57 can only be energized when the foot pedal 101 is depressed.

Therefore, to initiate a downward stroke of the blade, the operator will put pressure on the foot pedal to the extent of making contact between the foot lever and the upper contact of the foot switch, whereby to energize the downstroke solenoids 57 through normally closed contacts 151 of a relay 153 of a type similar to that of the reversing relay 135 previously described.

The winding of this relay is connected to the source of power through each of the micro-switches 107 and 109, associated with the gauge 103, but inasmuch as the upper micro-switch 107 is of the normally open type, the relay will not be energized until this particular micro-switch is closed, which occurs at the lower extremity of the downstroke of the blade.

When this point is reached, however, the circuit through the winding of relay 153 is completed and the solenoid becomes energized and opens the circuits to the downstroke solenoids 57, and in so doing connects the upstroke solenoids in circuit across the power source, and starts the blade in reverse, which immediately re-opens micro-switch 107 and would normally break the circuits to the upstroke solenoids.

This is precluded, however, by the establishment of a holding circuit through the second armature 155 on the relay and such holding circuit will include the lower normally closed micro-switch 109, and shunt out the now open micro-switch 107. Such holding circuit will continue to energize the relay 153 until the normally closed micro-switch 109 is actuated to open condition at the extremity of the upward stroke of the blade, at which time the machine comes to a halt.

At such time as the machine comes to a halt, neither the downstroke nor upstroke solenoids are energized and consequently the spring bias on the valves 33 are permitted to restore the valves to their neutral positions wherein the pumps are disconnected from the cylinders 15 and pump directly into the reservoir or tank or in other words, idle.

Thus it has been shown how the blade leveling system of the invention can function to maintain symmetry of movement of the blade from one end to the other, both on the upstroke as well as the downstroke, and how the necessary reversal of the leveling circuits is accomplished at the proper times through cooperation with the circuits for controlling machine operation.

Therefore, while we have disclosed our invention in its preferred form and in considerable detail, the same is subject to modification and alteration without departing from the underlying principles and we, accordingly, do not desire to be limited in our protection to the specific details illustrated and described except as may be necessitated by the appended claims.

We claim:

1. In a machine wherein a pair of cooperating members of substantial width are brought together to perform an operation of said machine, means for controlling the forward and reverse stroke of one of said members, said means including a separate hydraulic drive system for each end of said member and involving a cylinder and included piston in drive connection to said member, a reversing valve in each of said hydraulic systems for determining the forward or reverse direction of movement of said member, and a control system for determining the operating conditions of said valves; means for equalizing the movement of said member during both its forward and reverse strokes, said means being responsive to a departure from equalized movement of said member for bleeding one or the other of said hydraulic systems until equalized movement of said member is reestablished, and involving a normally closed solenoid-operated valve in shunt with each of said cylinders, an electrical energizing circuit for each of said valves including a switch, and means for selectively actuating one of said switches in accordance with the end of said element which advances ahead of the other; and means for reversing the association of said valves relative to said switches on reverse strokes of said member.

2. In a machine wherein a pair of cooperating members of substantial width are brought toward each other to perform an operation of said machine, one of said members having a piston at each end to drive the same; a hydraulic system for each of said pistons, each said hydraulic system comprising a pump, a cylinder enclosing one of said pistons, a fluid circuit between said pump and cylinder, a pump driving motor in drive connection to the pump of each hydraulic system; and means responsive to the relative advance of any one of said pistons during movement of said member, for effectively disconnecting operating pressure from the associated cylinder, said means including a low resistance passageway by-passing said cylinder, and a normally closed valve blocking said passageway and adapted for instantaneous opening upon occurrence of the relative advance of such piston.

3. In a machine wherein a pair of cooperating members of substantial width are brought toward each other to perform an operation of said machine, a piston at each end of one of said members and operatively connected thereto to drive said member; a hydraulic system for each of said pistons, each said hydraulic system comprising a pump, a cylinder enclosing one of said pistons, a fluid circuit connecting the output of said pump to one end of said cylinder and the other end of said cylinder to the input of said pump, and means responsive to a slight relative advance of any one of said pistons during movement of said member for substantially instantaneously removing the hydraulic pressure from said piston, said means including a low resistance passageway connecting the output of said pump to the input thereof, a normally closed solenoid-controlled valve in said passageway adapted, when energized, to unblock said passageway and permit the same to carry the discharge from said pump, a plurality of micro-switches corresponding in number to the number of such pistons, each of said micro-switches being connected in circuit with one of said solenoid-controlled valves.

4. In a machine wherein a pair of cooperating members of substantial width are brought toward each other to perform an operation of said machine, a piston at each end of one of said members and operatively connected thereto to drive said member; a hydraulic system for each of said pistons, each said hydraulic system comprising a pump, a cylinder enclosing one of said pistons, a fluid circuit connecting the output of said pump to one end of said cylinder and the other end of said cylinder to the input of said pump; and means responsive to a slight relative advance of any one of said pistons during movement of said member for substantially instantaneously removing the hydraulic pressure from said piston, said means including a low resistance passageway connecting the output of said pump to the input thereof, a normally closed solenoid-controlled valve in said passageway adapted, when energized, to unblock said passageway and permit the same to carry the discharge from said pump, a plurality of normally open micro-switches corresponding in number to the number of such pistons, each of said micro-switches being connected in circuit with one of said solenoid-controlled valves, and means for selectively closing that micro-switch whose associated solenoid-controlled valve is in the hydraulic system of the advanced piston.

5. In a machine wherein a pair of cooperating members of substantial width are brought toward each other to perform an operation of said machine; means for establishing a forward and return stroke of one of said members, said means including a separate hydraulic drive system for each end of said member and involving pump means, a cylinder having a piston therein operatively connected to said member, a reservoir, and a hydraulic line from said pump means to said cylinder and a hydraulic line from said cylinder to said reservoir and from said reservoir to said pump means; and means for equalizing the movement of both ends of said member during its forward movement toward said other member, said means including a normally closed valve in each of said hydraulic systems in by-pass relationship to the cylinder therein, and means responsive to a relative advance between one end of said member and the opposite end thereof for opening the valve associated with the advanced end of said member.

6. In a machine wherein a pair of cooperating members of substantial width are brought toward each other to perform an operation of said machine; means for establishing a forward and return stroke of one of said members, said means including a separate hydraulic drive system for each end of said member and involving pump means, a cylinder having a piston therein connected to said member, a reservoir, a hydraulic line from said pump means to said cylinder and a hydraulic return line from said cylinder to said reservoir, control means involving circuit make-and-break means responsive to forward movement of said member at its desired forward limit of travel for reversing said hydraulic line connections to said cylinder; means for equalizing the movement of both ends of said member during its forward movement toward said other member; and means upon the completion of such forward movement as determined by said control means, for reversing said movement equalizing means to render said movement equalizing means also effective on the return movement of said member.

7. In a machine wherein a pair of cooperating members of substantial width are brought to-

ward each other to perform an operation of said machine; means for establishing a forward and return stroke of one of said members, said means including a separate hydraulic drive system for each end of said member and involving pump means, a cylinder having a piston therein operatively connected to said member, a reservoir, and a hydraulic line from said pump means to said cylinder and a hydraulic line from said cylinder to said reservoir and from said reservoir to said pump means; means for equalizing the movement of both ends of said member during its forward movement toward said other member, said means including a normally closed valve in each of said hydraulic systems in by-pass relationship to the cylinder therein, means responsive to a relative advance of one end of said member relative to the other for opening the valve associated with that end of said member; and means for reversing the association of said valves and said advance responsive means during the return movement of said member to render said movement equalizing means also effective on such return movement.

8. In a machine wherein a pair of cooperating members of substantial width are brought toward each other to perform an operation of said machine, and a piston is located at each end of one of said members; a hydraulic system for each of said pistons, each said hydraulic system comprising a pump, a cylinder enclosing one of said pistons, a fluid line connecting the output of said pump to one end of said cylinder and the other end of said cylinder to the input of said pump, and valve means for reversing the fluid line connections between said pump and cylinder to determine the forward and return movements of said member, said valve means including means for determining a static condition of said member; and means for controlling the operating positions of said reversing valve means to determine the start and finish points in the stroke of such member with respect to the other member of said pair, said means involving a bracket mounted on a stationary portion of said machine, a pair of switches mounted in vertically spaced relationship on said bracket, an electrical control circuit interconnecting said reversing valve means and said switches, and switch actuation means mounted on said controlled member for movement therewith in a path occupied by said switches, said switch actuator means including an actuator element above the upper of said switches and an actuator element below the lower of said switches.

9. In a machine wherein a pair of cooperating members of substantial width are brought toward each other to perform an operation of said machine, and a piston is located at each end of one of said members to drive the same; a hydraulic system for each of said pistons, each said hydraulic system comprising a pump, a cylinder enclosing one of said pistons, a fluid line connecting the output of said pump to one end of said cylinder and the other end of said cylinder to the input of said pump, and valve means for reversing the fluid line connections between said pump and cylinder to determine the forward and return movements of said member, said valve means including means for determining a static condition of said member; and means for controlling the operating positions of said reversing valve means to determine the start and finish points in the stroke of such member with respect to the other member of said pair, said means involving a bracket mounted on a stationary portion of said machine, a pair of micro-switches mounted in vertically spaced relationship on said bracket, an electrical control circuit interconnecting said reversing valve means and said switches, and switch actuation means mounted on said controlled member for movement therewith in a path occupied by said micro-switches, said switch actuator means including an actuator element above the upper of said micro-switches and an actuator element below the lower of said micro-switches and means for adjusting the spacing between each of said actuator elements and its associated switch.

10. In a machine wherein a pair of cooperating members of substantial width are brought toward each other to perform an operation of said machine, and a piston is located at each end of one of said members to drive the same; a hydraulic system for each of said pistons, each said hydraulic system comprising a pump, a cylinder enclosing one of said pistons, a fluid line connecting the output of said pump to one end of said cylinder and the other end of said cylinder to the input of said pump, and valve means for reversing the fluid line connections between said pump and cylinder to determine the forward and return movements of said member, said valve means including means for determining a static condition of said member; means for controlling the operating positions of said reversing valve means to determine the start and finish points in the stroke of such member with respect to the other member of said pair, said means involving a bracket mounted on a stationary portion of said machine, a pair of micro-switches mounted in vertically spaced relationship on said bracket, an electrical control circuit interconnecting said reversing valve means and said switches, and switch actuation means mounted on said controlled member for movement therewith in a path occupied by said micro-switches, said switch actuator means including an actuator element above the upper of said micro-switches and an actuator element below the lower of said micro-switches and means for adjusting the spacing between each of said actuator elements and its associated switch; and means for equalizing the movement of both ends of said controlled member during its movement toward said other member, said means including a normally closed solenoid controlled valve in each of said hydraulic systems in by-pass relationship to the cylinder in such system, and means responsive to a relative advance between one end of said controlled member and the opposite end thereof for opening the valve associated with said advanced end.

11. In a machine wherein a pair of cooperating members of substantial width are brought toward each other to perform an operation of said machine, and a piston is located at each end of one of said members to drive the same; a hydraulic system for each of said pistons, each said hydraulic system comprising a pump, a cylinder enclosing one of said pistons, a fluid line connecting the output of said pump to one end of said cylinder and the other end of said cylinder to the input of said pump, and valve means for reversing the fluid line connections between said pump and cylinder to determine the forward and return movements of said member, said valve means including means normally biasing the same to an intermediate neutral position; means for controlling the operating positions of said reversing valve means to determine the start and

finish points in the stroke of such member with respect to the other member of said pair, said means involving a bracket mounted on a stationary portion of said machine, a pair of micro-switches mounted in vertically spaced relationship on said bracket, an electrical control circuit interconnecting said reversing valve means and said switches, and switch actuation means mounted on said controlled member for movement therewith in a path occupied by said micro-switches, said switch actuator means including an actuator element above the upper of said micro-switches and an actuator element below the lower of said micro-switches and means for adjusting the spacing between each of said actuator elements and its associated switch; means for equalizing the movement of both ends of said controlled member during its movement toward said other member, said means including a normally closed solenoid controlled valve in each of said hydraulic systems in by-pass relationship to the cylinder in such system, means responsive to a relative advance between one end of said controlled member and the opposite end thereof for opening the valve associated with said advanced end; and means for reversing the association of said solenoid controlled valves and said advance responsive means during the return movement of said controlled member to render said movement equalizing means also effective on such return movement.

12. In a machine wherein a pair of cooperating members of substantial width are brought together to perform an operation of said machine, a system for assuring equalized approach of both ends of one of said members toward the other member, said system including a switch assembly comprising a pair of micro-switches mounted for movement as a unit and means associated therewith and responsive to movement relative to said micro-switches for establishing an electrical circuit through one of said switches in accordance with such relative direction of movement, means for moving said circuit-establishing means in accordance with movement of one end of said afore-mentioned member, means for simultaneously moving said micro-switches as a unit in the same direction as said circuit-establishing means in accordance with corresponding movement of the other end of said aforementioned member, said circuit-establishing means and micro-switches being initially adjusted to normally maintain open circuit conditions only so long as both ends of said aforementioned member move at the same instantaneous rates, and means responsive to establishing of a circuit through one of said switches, occasioned by a relative change in instantaneous rates between the ends of said member, for adjusting the instantaneous rate of travel of one of the ends of said aforementioned member in a direction to reestablish the open circuit condition of such micro-switch.

13. In a machine having a movable member of substantial length, means for assuring equalized movement of said member at both ends, said means comprising a switch assembly including two relatively movable components, one of said components embodying a pair of spaced circuit-closing elements, said other component constituting a circuit actuator, means supporting said first component for movement in accordance with movement of one end of said member, means supporting said circuit actuator for independent movement between said spaced circuit closing elements in accordance with movement of the other end of said member, said circuit actuator being normally in spaced relationship to each of said circuit-closing elements during equalized travel of said member but adapted to actuate one or the other of said circuit-closing elements in response to unequalized movement of said member, and means responsive to the closing of one or the other of said circuit-closing devices for reestablishing equalized movement of said member.

14. In a machine wherein a pair of cooperating members of substantial width are brought toward each other to perform an operation of said machine, a hydraulic system for driving at each end of one of said members, each such hydraulic system comprising a pump, a cylinder having a piston in drive connection to an end of said member, a fluid line connection from the output of said pump to one end of said cylinder and the other end of said cylinder to the input of said pump, means for interchanging fluid line connections between said pump and said cylinder to determine the forward and return movement of such member, means adapted to interconnect the output of said pump to its input for rendering ineffective such aforesaid fluid line connections between pump and cylinder and together with the other corresponding hydraulic circuit means, establishing a static condition of said member, means for equalizing the movement of the ends of said member during its forward movement, means actuable by an operator during a static condition of said member for establishing flow of fluid to an end of each cylinder to initiate a forward movement of said member, means responsive to movement of such member at its desired forward limit of travel for reversing the prevailing fluid line connections between pump and cylinder in each of said hydraulic circuits to automatically halt said forward movement and initiate a return movement of said member, and means responsive to the return movement of said member at its desired limit of travel in such return direction, for controlling said interconnecting means to create a fluid connection between the output and input of the pump in each hydraulic system to establish a static condition of said member in the absence of actuation of said operator actuable means.

15. In a machine wherein a pair of cooperating members of substantial width are brought toward each other to perform an operation of said machine, a hydraulic system for driving at each end of one of said members, each such hydraulic system comprising a pump, a cylinder having a piston in drive connection to an end of said member, a fluid line connection from the output of said pump to one end of said cylinder and the other end of said cylinder to the input of said pump, means for interchanging fluid line connections between said pump and said cylinder to determine the forward and return movement of such member, means adapted to interconnect the output of said pump to its input for rendering ineffective such aforesaid fluid line connections between pump and cylinder and together with the other corresponding hydraulic circuit means, establishing a static condition of said member, means for equalizing the movement of both ends of said member during its forward movement, means actuable by an operator during a static condition of said member for establishing flow of fluid to an end of each cylinder to initiate a forward movement of said member, means respon-

sive to movement of such member at its desired forward limit of travel for reversing the prevailing fluid line connections between pump and cylinder in each of said hydraulic circuits to automatically halt said forward movement and initiate a return movement of said member, means responsive to the return movement of said member at its desired limit of travel in such return direction, for controlling said interconnecting means to create a fluid connection between the output and input of the pump in each hydraulic system to establish a static condition of said member in the absence of actuation of said operator actuable means, and means for adjusting the point of response of said forward movement responsive means to shift the forward limit of travel of said member.

16. In a machine wherein a pair of cooperating members of substantial width are brought toward each other to perform an operation of said machine, a hydraulic system for driving at each end of one of said members, each such hydraulic system comprising a pump, a cylinder having a piston in drive connection to an end of said member, a fluid line connection from the output of said pump to one end of said cylinder and the other end of said cylinder to the input of said pump, means for interchanging fluid line connections between said pump and said cylinder to determine the forward and return movement of such member, means adapted to interconnect the output of said pump to its input for rendering ineffective such aforesaid fluid line connections between pump and cylinder and together with the other corresponding hydraulic circuit means, establishing a static condition of said member, means for equalizing the movement of the ends of said member during its forward movement, means actuable by an operator during a static condition of said member for establishing flow of fluid to an end of each cylinder to initiate a forward movement of said member, means responsive to movement of such member at its desired forward limit of travel for reversing the prevailing fluid line connections between pump and cylinder in each of said hydraulic circuits to automatically halt said forward movement and initiate a return movement of said member, means responsive to the return movement of said member at its desired limit of travel in such return direction, for controlling said interconnecting means to create a fluid connection between the output and input of the pump in each hydraulic system to establish a static condition of said member in the absence of actuation of said operator actuable means, means for adjusting the point of response of said forward movement responsive means to shift the forward limit of travel of said member, and means for adjusting the point of response of said return movement responsive means to determine the starting position of said member with respect to the work to be operated on.

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