

**Aug. 13, 1940.**

**W. FERRIS**

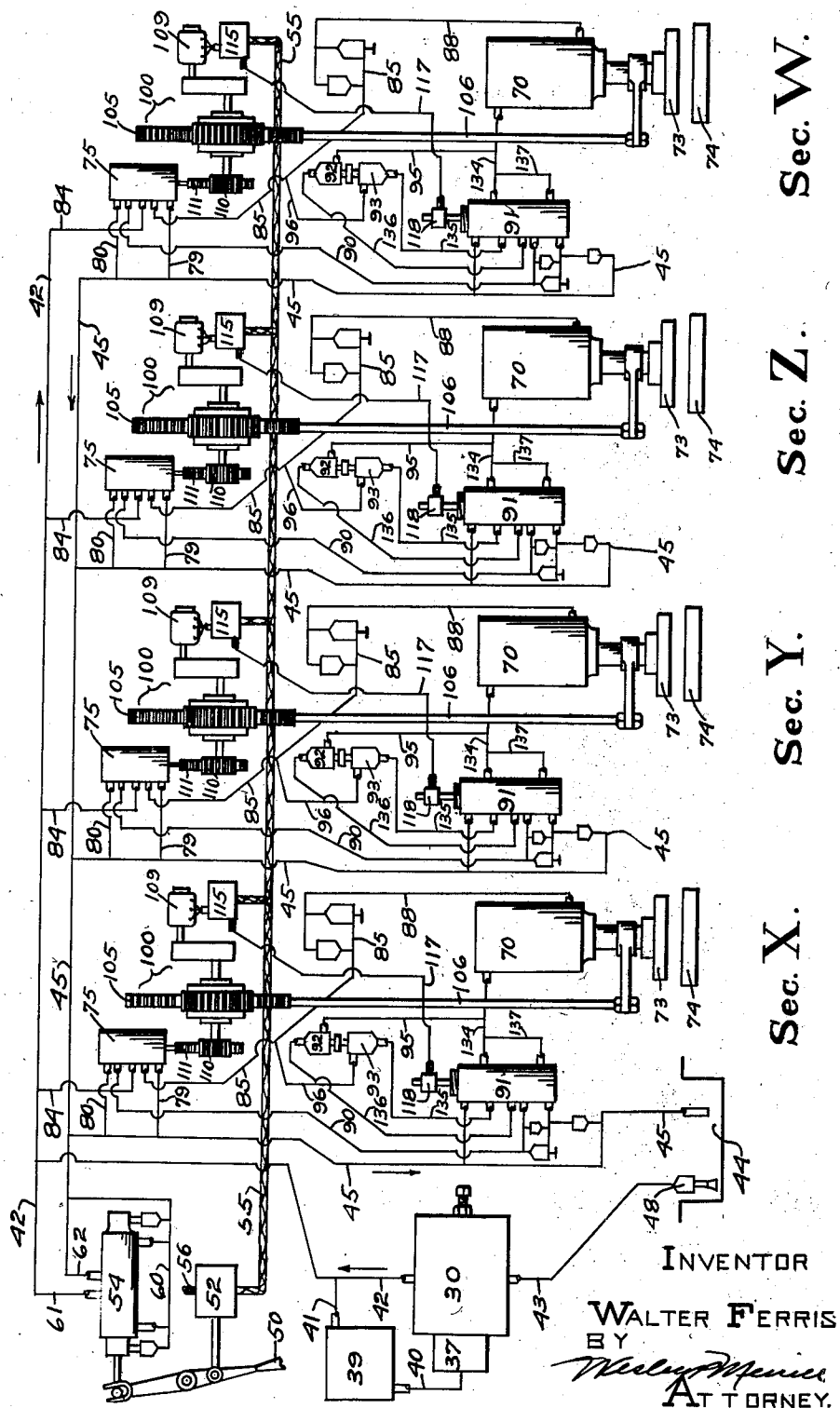
**2,211,692**

## HOLD-DOWN SYSTEM

Original Filed Aug. 3, 1936

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Fig. 1.



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HOLD-DOWN SYSTEM

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Fig. 2.

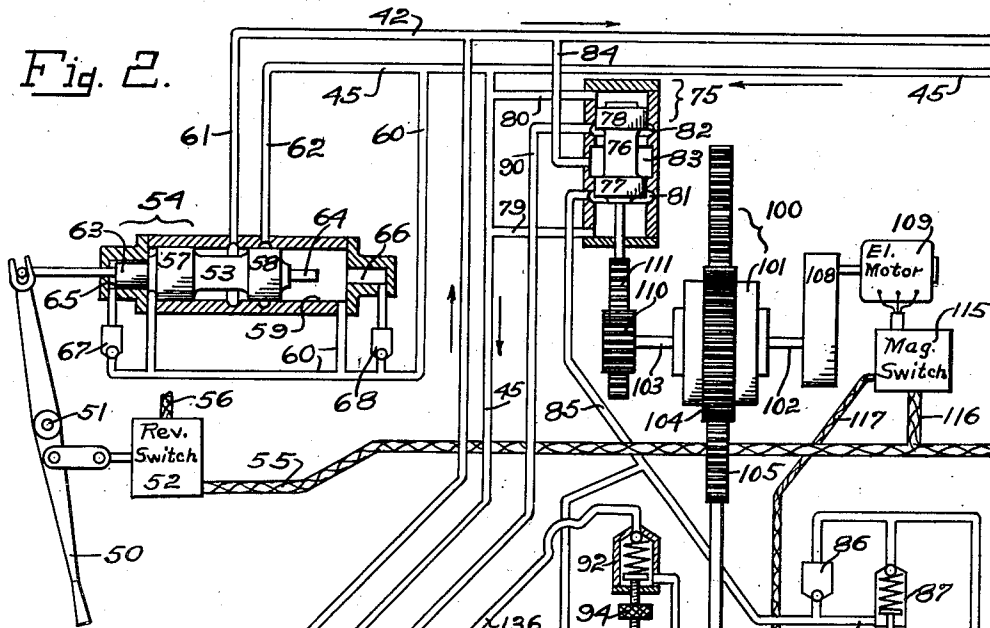
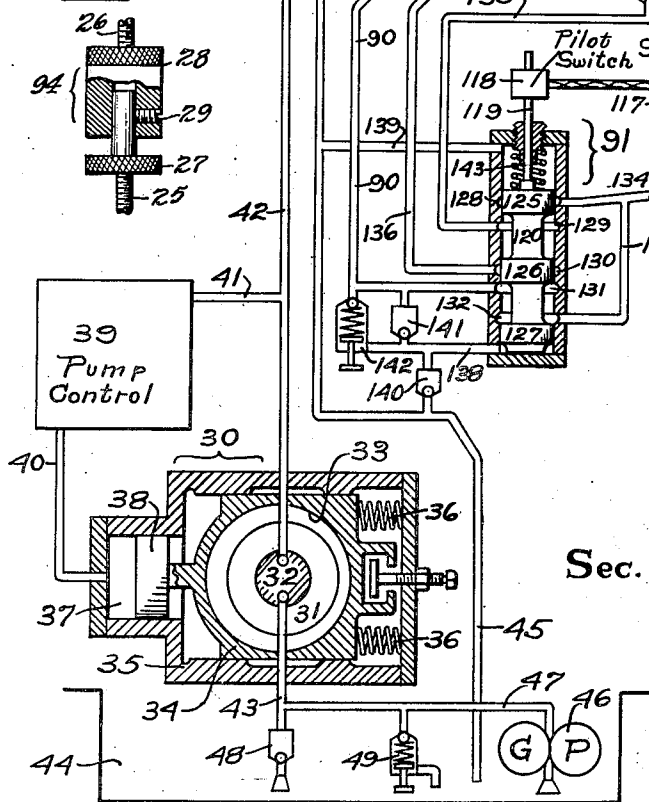
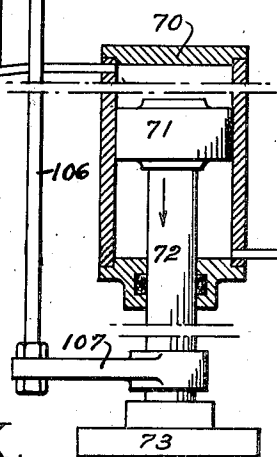


Fig. 6.



Sec. X.



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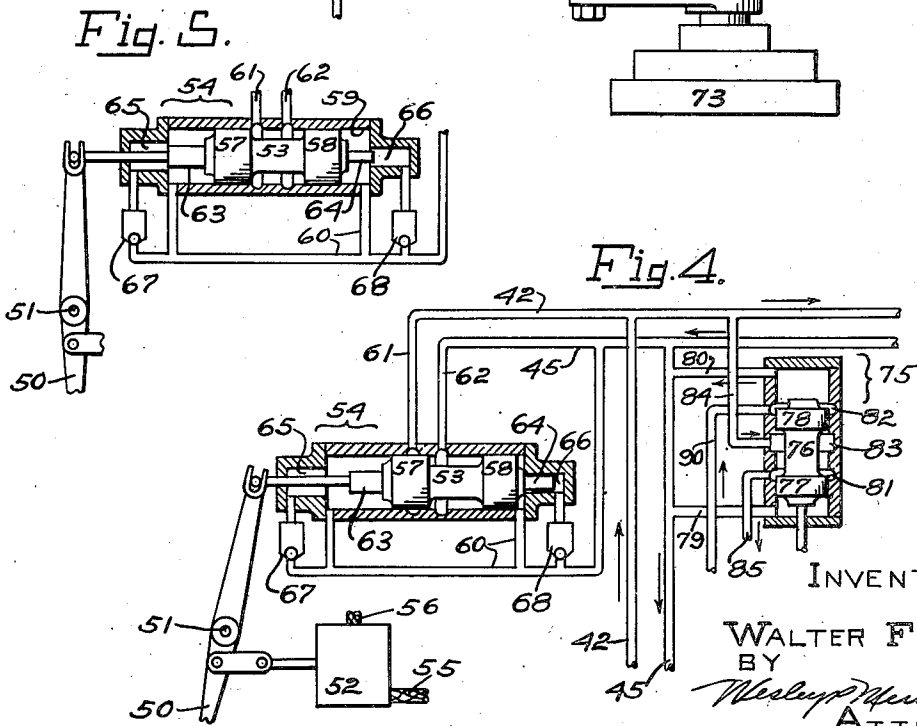
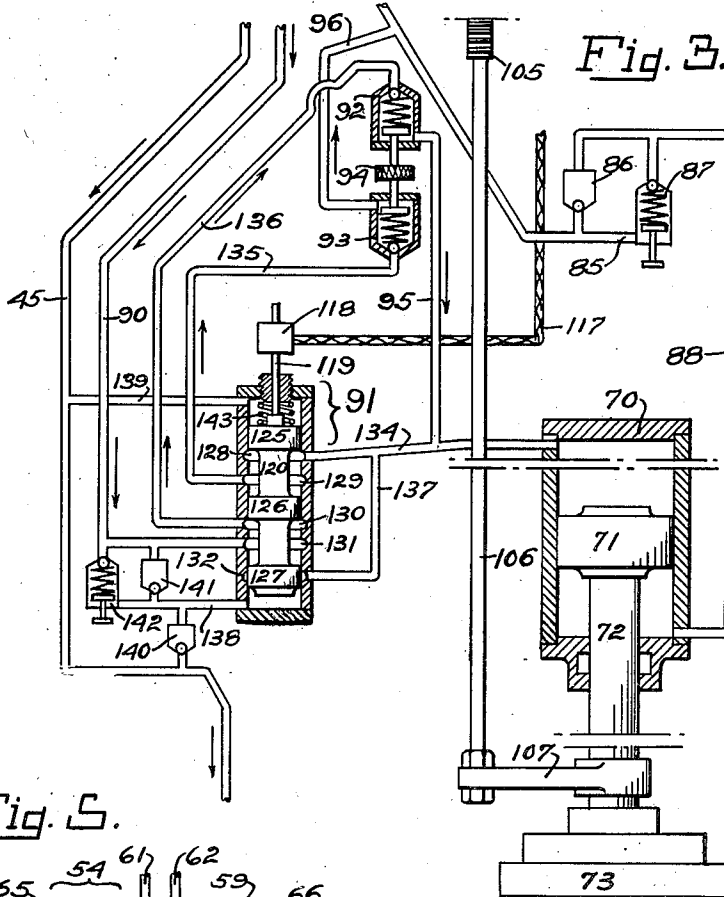
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HOLD-DOWN SYSTEM

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3 Sheets-Sheet 3



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## UNITED STATES PATENT OFFICE

2,211,692

## HOLD-DOWN SYSTEM

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Original application August 3, 1936, Serial No. 94,034. Divided and this application August 25, 1938, Serial No. 226,793

15 Claims. (Cl. 60—52)

This application is a division of application Serial No. 94,034 filed August 3, 1936 and now abandoned.

The invention relates to hydraulic mechanisms of the type having a plurality of reciprocating hydraulic motors for exerting holding or pressing forces at spaced apart points.

An object of the invention is to provide a mechanism of this character in which a plurality of reciprocating hydraulic motors are operated by motive liquid supplied thereto from a single source and controlled by mechanism which enables each motor to operate at high speed until it is exerting a holding or pressing force and then to automatically maintain the holding or pressing force within narrow limits without affecting the operation of or the force exerted by any other of the motors.

Another object is to provide a control which will cause the pistons of a plurality of reciprocating hydraulic motors to move in unison.

Other and more specific objects and advantages will appear from the description hereinafter given of a hold-down system in which the invention is embodied, the system being shown schematically in accompanying drawings in which the views are as follows:

Fig. 1 is a diagram showing the hydraulic circuit and the functional relations of the several parts of a hold-down press having four sections each of which includes a reciprocating hydraulic motor for operating a pressing member or platen.

Fig. 2 is a diagram showing on a larger scale one section of the press with the valves thereof in positions to direct liquid to the hydraulic motor to advance the platen at high speed.

Fig. 3 is a view of part of the mechanism shown in Fig. 2 but with the parts in the positions occupied when a holding pressure is being maintained in the cylinder of the motor.

Fig. 4 is a view showing the by-pass and reversing valves in the positions occupied to effect reversal of the hydraulic motor.

Fig. 5 is a view showing the by-pass valve in position to by-pass the pump and thereby stop the press.

Fig. 6 is a detail view.

For the purpose of illustration the invention has been shown applied to a press having four sections X, Y, Z and W but it is equally applicable to a press having a different number of sections. Since the press frame and the details of construction form no part of the present invention, the same have been omitted from the drawings in order to avoid complicating the views, it being

sufficient to state that the hydraulic motors and the control elements are suitably fixed in stationary positions.

Liquid for operating the press is supplied by a pump 30 which has the characteristics of delivering liquid at a predetermined maximum rate until pump pressure reaches a predetermined maximum and then automatically reducing its stroke until it is delivering just sufficient liquid to maintain that maximum pressure substantially constant. Pump 30 may be of the general type shown in Patent No. 2,074,068, and it may be provided with a control of the type shown in Patent No. 2,080,810.

Since pump 30 and its control are fully illustrated and described in the above patents, only a brief description thereof will be given herein. The pump has its pistons and cylinders arranged in a rotatable cylinder barrel 31 which is journaled upon a stationary valve shaft or pintle 32 through which liquid flows to and from the cylinders. The pump pistons are reciprocated by having the outer ends thereof in contact with an annular reaction surface 33 shown as being arranged upon the inside of a slide block or thrust member 34 which is closely fitted in the pump casing 35 and shiftable therein transverse to the cylinder barrel axis to vary pump displacement. In practice, however, reaction surface 33 is formed in a thrust member which is arranged within slide block 34 and rotatively supported thereby. Slide block 34 is urged in a direction to increase pump displacement by two springs 36 and is adapted to be moved in the opposite direction to decrease pump displacement by liquid supplied to a cylinder 37 which is carried by casing 35 and has a piston 38 fitted therein and connected to slide block 34.

Liquid for operating piston 38 is supplied by the pump itself under the control of a control mechanism 39 which is connected by a channel 40 to cylinder 37 and by a channel 41 to a supply channel 42 through which pump 30 delivers liquid to all four sections of the press. Control mechanism 39 has not been shown in detail as it is fully illustrated and described in Patent No. 2,080,810. It is deemed sufficient to state herein that control mechanism 39 permits liquid to escape from cylinder 37 when pump pressure is below a predetermined maximum so that springs 36 can shift slide block 34 toward the left to increase pump displacement, and that it permits liquid to flow from channel 42 into cylinder 37 and shift slide block 34 toward the right to decrease pump displacement upon pump pressure

exceeding a predetermined maximum. When cylinder barrel 31 is rotated and the axis of reaction surface 33 is offset from the axis of cylinder barrel 31, pump 30 will discharge liquid into supply channel 42 and be supplied with liquid through an intake channel 43 from a reservoir 44 to which liquid is returned from the circuit through a return channel 45.

Pump 30 may draw its entire supply of liquid from reservoir 44 through channel 43 or the liquid required by pump 30 may be supplied in whole or in part by an auxiliary pump such as a gear pump 46 which draws liquid from reservoir 44 and delivers it through a channel 47 into channel 43 in which case channel 43 is provided with a check valve 48 to prevent liquid from escaping through the open end thereof and channel 47 has connected thereto a relief valve 49 through which liquid discharged by gear pump 46 in excess of requirements is exhausted, particularly when pump 30 is delivering only sufficient liquid to maintain a holding pressure in the system.

For the purpose of illustration, the press has been shown provided with a hand operated control lever 50 by means of which the press may be started, stopped or reversed. Lever 50 is pivoted intermediate its ends upon a stationary pivot 51 and is connected to a reversing switch 52 and to the plunger 53 of a by-pass valve 54 so that it may operate switch 52 and by-pass valve 54 simultaneously.

Reversing switch 52, which functions to reverse certain control motors to be presently described, is connected to those motors by suitable conductors arranged in a conduit 55 and to a power source (not shown) by suitable conductors arranged in a conduit 56.

Plunger 53 of by-pass valve 54 is provided with two spaced apart heads or pistons 57 and 58 which are closely fitted in a bore 59 formed in the valve casing. Bore 59 is connected at both of its ends to return channel 45 by a branched channel 60 and it is connected intermediate its ends to channels 42 and 45, respectively, by two channels 61 and 62.

When plunger 53 is in either of its end positions as shown in Figs. 2 and 4, one or the other of channels 61 and 62 is blocked by one or the other of pistons 57 and 58 so that pump 30 may deliver liquid to the hold-down motors to be presently described and, when it moves from one end position to the other end position, channels 61 and 62 are momentarily in communication with each other, as shown in Fig. 5, so that the liquid discharged by pump 30 is momentarily bypassed through channels 42 and 61, bore 59 and channels 62 and 45 to reservoir 44 and the pressure in channel 42 momentarily drops to a very low value for a purpose to be presently explained.

In order to limit the speed at which plunger 53 may be moved near the limit of its movement in either direction, valve 54 is provided with a dashpot on each end thereof. As shown, plunger 53 has dashpot plungers 63 and 64 arranged upon opposite ends thereof and adapted, respectively, to enter dashpots 65 and 66 arranged at opposite ends of bore 59 and carried by the by-pass valve casing. Dashpots 65 and 66 are connected, respectively, to channel 60 through check valves 67 and 68, which permit liquid to flow from channel 60 into the dashpots but prevent liquid from escaping from the dashpots into channel 60.

The arrangement is such that liquid may flow freely from one end of bore 59 to the other end

thereof through channel 60 and from channel 60 into the rear dashpot during the entire movement of plunger 53 in either direction. Consequently, plunger 53 may be moved at high speed far enough to open communication between channels 61 and 62 and then the forward dashpot plunger will enter the other dashpot and decelerate plunger 53 sufficiently to maintain communication between channels 61 and 62 long enough to permit the pressure in channel 42 to drop to a very low value.

The liquid supplied by pump 30 through channel 42 is employed to operate a plurality of hydraulic motors which may be of the same size or of different sizes and controlled by substantially identical control mechanisms. Since each motor and its control mechanism functions independently of any other motor and the control mechanism thereof, each motor and its control mechanism may be considered as an independent press section and the press may be divided into as many such sections as there are motors, four being shown and indicated by the reference letters X, Y, Z, and W.

Since the four sections are substantially identical, details of section X only have been shown and a description of that section will suffice for all sections, corresponding parts of the other sections having been indicated by corresponding reference characters.

Referring now more particularly to Fig. 2, section X contains a hydraulic motor consisting primarily of a stationary cylinder 70 and a piston 71 which is fitted in cylinder 70 and connected by a piston rod 72 to a pressure member or platen 73. The motor may press platen 73 against a stationary die block or abutment 74 or urge it toward abutment 74 to press therebetween the material to be operated upon.

The direction of movement of piston 71 is controlled by a reversing valve 75 the plunger 76 of which has two spaced apart heads or pistons 77 and 78 formed thereon and closely fitted in the valve casing to control the flow of liquid there-through. The reversing valve casing is connected at its extreme ends by two channels 79 and 80 to return channel 45, and it is provided intermediate its ends with two distributing ports 81 and 82 and with an inlet port 83 which is arranged between the two distributing ports and connected to supply channel 42 by a channel 84.

Port 81 communicates with one end of a channel 85 the other end of which is connected through a check valve 86 and a resistance valve 87 to one end of a channel 88 the other end of which is connected to the lower end of cylinder 70. Check valve 86 permits liquid to flow freely to the lower end of cylinder 70 to raise piston 71, but it forces liquid ejected from the lower end of the cylinder 70 to flow through resistance valve 87 which offers a low resistance to the flow of liquid therethrough and thereby prevents piston 71 from moving downward when the press is idle.

Port 82 is connected by a channel 90 to a pressure responsive valve 91 which either directs liquid freely to the upper end of cylinder 70 to move piston 71 downward or directs liquid thereto to maintain a holding pressure therein through a pressure control valve consisting primarily of two oppositely opening resistance valves 92 and 93.

In practice, the two resistance valves are arranged in alignment in a single casing or in connected casings and are adjusted by a single element but, for the purpose of illustration, they

have been shown as being separate and provided with a common adjusting member 94 rotation of which in one direction will increase the tension of the spring in valve 92 and decrease the tension of the spring in valve 93, thereby increasing the pressure required to open valve 92 and decreasing the pressure required to open valve 93, while rotation of member 94 in the opposite direction will decrease the tension of the spring in valve 92 and increase the tension of the spring in valve 93, thereby decreasing the pressure required to open valve 92 and increasing the pressure required to open valve 93. Therefore, the sum of the resistances of the two valves remains constant.

In order that the springs of resistance valves 92 and 93 may be individually adjusted, member 94 is shown in Fig. 6 as being provided with two separate adjusting screws 25 and 26 which are threaded, respectively, through the casings of valves 92 and 93 and into contact with the springs therein.

Screw 25 has a nut 27 fixed thereon near its outer or upper end and that part of the screw beyond nut 27 is unthreaded and fitted in the bore of a hollow nut 28 which is fixed upon the outer or lower end of screw 26. Nuts 27 and 28 may be fixed for simultaneous rotation by means of a set screw 29 threaded through the wall of nut 28 into contact with the unthreaded portion of screw 25.

When screw 29 is loosened, adjusting screws 25 and 26 may be turned independently of each other to individually adjust the resistances of valves 92 and 93, respectively. Then by tightening set screw 29, nuts 27 and 28 will be fastened together so that rotation of one will cause rotation of the other and thereby cause the resistances of valves 92 and 93 to be simultaneously varied inversely to each other when member 94 is rotated.

Valve 92 is adjusted to open at a pressure equal to the difference between pump pressure and the maximum pressure desired in the upper end of cylinder 70 and valve 93 is adjusted to open at a pressure slightly greater than the maximum pressure desired in the upper end of cylinder 70. The inlets of valves 92 and 93 are connected to valve 91 by channels to be presently described, the outlet of valve 92 is connected to a channel 95, and the outlet of valve 93 is connected to channel 95 by a channel 96.

In order that hydraulic motor 70—71 may be operated at predetermined speeds, reversing valve 75 functions as a follow-up valve under the joint control of piston 71 and a constant speed element, as by means of a differential 100 having one leg connected to piston 71, its second leg connected to a constant speed element and its third leg connected to plunger 76 of valve 75.

As shown, differential 100 is provided with a casing 101 and two shafts 102 and 103 which represent the three legs of the differential. Casing 101 has a ring gear 104 fixed thereon and in mesh with a rack 105 which is connected by a rod 106 to an arm 107 fastened to piston rod 72. Shaft 102 is connected through a reduction gear 108 to a reversible constant speed electric motor 109, and shaft 103 has fastened thereon a gear 110 which meshes with a rack 111 connected to the stem of reversing valve plunger 76.

The arrangement is such that, when pump 30 is operating, electric motor 109 when energized will operate differential 100 to move reversing valve plunger 76 in a direction to permit liquid

to enter cylinder 70 and move piston 71 which, through rod 72, arm 107, rod 106 and rack 105 will operate differential 100 to move reversing valve plunger 76 in a direction to stop delivery of liquid to cylinder 70. Consequently, if piston 71 tends to move in either direction faster than the rate prescribed by the speed of electric motor 109, it will automatically operate valve 75 to reduce the rate of delivery of liquid to cylinder 70 and thereby reduce the speed of piston 71.

Conversely, if piston 71 should move slower than the prescribed speed, it would permit electric motor 109 to operate differential 100 to open valve 75 wider so that more liquid could flow to cylinder 70 and thereby accelerate piston 71. The speed of electric motor 109 thus determines the speed of piston 71 at all times regardless of the direction of movement.

The speed of piston 71 may be varied by varying the speed ratio between electric motor 109 and rack 111. This may be accomplished by either varying the speed of electric motor 109 or by varying the gear ratio between electric motor 109 and rack 111 as by varying the ratio of reduction gear 108. Therefore, if the speed ratio between electric motor 109 and rack 111 is the same in all sections of the press, all of the hydraulic motors 70—71 will be operated at the same speed and, if this speed ratio is different in different sections, the hydraulic motors 70—71 will operate at different speeds but those speeds will remain proportional to each other.

Electric motor 109 is adapted to be reversed by means of reversing switch 52 and it is adapted to be started and stopped by means of a magnetic switch 115 through which it is connected, by means of conductors arranged in a conduit 116, to the conductors arranged in conduit 55.

Magnetic switch 115 has its operating mechanism connected, by means of conductors arranged in a conduit 117, to a pilot switch 118 which is arranged at the end of valve 91 and has its operating member 119 connected to the plunger 120 thereof so that switch 118 will be opened or closed when valve 91 is operated.

Valve plunger 120 is provided with three spaced apart heads or pistons 125, 126 and 127 which are closely fitted in the bore of the valve casing to control communication between five ports 128, 129, 130, 131 and 132 which are formed in the wall of the bore.

Port 128 is connected by a channel 134 to the upper end of cylinder 70, port 129 is connected by a channel 135 to the inlet of resistance valve 93, port 130 is connected by a channel 136 to the inlet of resistance valve 92, port 131 has channel 90 connected thereto, and port 132 is connected by a channel 137 to channel 134 intermediate the ends thereof. Channel 95 is also connected to channel 134 intermediate the ends thereof.

The casing of valve 91 is connected at the extreme lower end of its bore to one end of a channel 138 and at the upper end of its bore to one end of a channel 139 the other end of which is connected to return channel 45 intermediate the ends thereof. Channel 138 is connected to return channel 45 through a check valve 140 and to channel 90 through a check valve 141 and a resistance valve 142. Check valve 140 permits liquid to be drawn into channel 138 from return channel 45 but prevents it from flowing in the opposite direction. Check valve 141 permits liquid to flow from channel 138 into channel 90 but prevents its flowing in the opposite direction

except through resistance valve 142 which is adjusted to open at a predetermined pressure.

The arrangement is such that, when the pressure in channel 90 exceeds a predetermined value, liquid will break through resistance valve 142, flow through channel 138 to the lower end of the valve casing and exert sufficient force on the lower face of piston 127 to move valve 120 upward against the resistance of a spring 143 which is arranged in the upper end of the valve casing to move valve 120 downward when the pressure below piston 127 drops to a low value.

#### Operation

Assuming that the speed ratio between electric motor 109 and rack 111 is the same in all press sections, that pump 30 and electric motors 109 are operating and that the several parts are in the positions shown in Fig. 2, the press will operate as follows:

Pump 30 will deliver liquid into channel 42 and this liquid will flow to each section through channels 42 and 84, valve 75, channel 90, valve 91 and channels 137 and 134 to the upper end of cylinder 70 and force piston 71 downward. Piston 71 will eject liquid from the lower end of cylinder 70 through channel 88, resistance valve 87, channel 85, valve 75 and channels 79 and 45 into reservoir 44.

In each section, electric motor 109 will tend to open valve 75 wider and piston 71 will tend to close it, as previously explained, so that the opening through valve 75 remains substantially the same. Valve 75 thus throttles the flow of liquid to cylinder 70 and permits only sufficient liquid to flow therethrough to move piston 71 at the desired speed. Consequently, all of the hydraulic motors 70-71 are operated simultaneously and the operation of one is not affected by the operation of any other.

When further downward movement of platen 73 is arrested by abutment 74 and piston 71 is causing platen 73 to exert a predetermined force against abutment 74 or against any material therebetween, the pressure in channel 90 will rise sufficiently to permit liquid to break through resistance valve 142 and then flow through channel 138 to the lower end of valve 91 and raise its plunger 120 to the position shown in Fig. 3.

As plunger 120 moves upward, it will eject liquid from the upper end of the valve casing through channel 139 into return channel 45 and near its upper limit it will operate pilot switch 118 which will cause magnetic switch 115 to open and stop motor 109, thereby causing reversing valve plunger 76 to remain stationary for the reason that piston 71 has stalled. At the same time, plunger 120 will close port 132 and open ports 128 and 130.

Closing port 132 and opening port 130 will prevent the pressure in channel 90 from extending to the upper end of cylinder 70 except through channel 136 and resistance valve 92. Since there is no flow of liquid through valve 75 at this time, the throttling effect of valve 75 will be eliminated and the pressure in channels 90 and 136 will rise until it equals the pressure in supply channel 42.

As the pressure in channel 136 rises, resistance valve 92 will open and pressure will extend there-through and through channels 95 and 134 to the upper end of cylinder 70, thereby causing to be exerted upon piston 71 a pressure equal to the difference between the pressure in channel 42

and the pressure required to open resistance valve 92.

If the pressure in channel 42 should increase sufficiently or if the upward force acting on pressure member 73 should increase and thereby increase the pressure in the upper end of cylinder 70 above the predetermined value, resistance valve 92 would open and permit liquid to escape from cylinder 70 through channel 134, valve 91, channel 135, resistance valve 93, channels 96 and 85, valve 75 and channel 79 into return channel 45 until the pressure in cylinder 70 was reduced to the predetermined value.

Valve 75 may be open wider at this time than when piston 71 is moving downward due to a very slight delay between the stalling of piston 71 and the stopping of motor 109 but such a widening of the valve opening will have no effect upon the operation of any other press section for the reason that only enough liquid may be delivered to cylinder 70 to maintain therein a pressure equal to the difference between pump pressure and the pressure required to open resistance valve 92. Consequently, if one hydraulic motor stalls before any of the other hydraulic motors stall, such other motors will continue to operate at their predetermined speeds until they stall and then the control mechanisms thereof will operate to enable pump 30 to maintain individual holding pressures in the cylinders 70 thereof.

As previously explained, pump control 39 causes pump 30 to deliver liquid at a maximum rate until pump pressure reaches a predetermined maximum and to then reduce its displacement until it is delivering just sufficient liquid to maintain that maximum pressure constant, that the resistance valve 92 of each section is so adjusted that its closing pressure is equal to the difference between pump pressure and the maximum pressure required in the cylinder 70 of that section, and that the relief valve 93 in each section is adjusted to open at a pressure higher than the maximum pressure required in the cylinder 70 of that section, it being obvious that pump 30 cannot create a pressure greater than the pressure required to open both of valves 92 and 93 in any one section.

For example, if pump pressure is 1000# per square inch and it is desired that the pressure created in the cylinder 70 of one section be limited to 900# per square inch, the valve 92 in that section is adjusted to have a closing pressure of 100# per square inch and the associated valve 93 is adjusted to open at about 910# per square inch. If the valves 92 and 93 of a second section are adjusted to have resistances of 200 and 810# per square inch respectively, pump 30 will create a pressure of 800# per square inch in the cylinder 70 of the second section without affecting the pressure in the cylinder 70 of any other section. If the valves 92 and 93 of a third section are adjusted to have resistances of 400 and 900# per square inch respectively, pump 30 will create a maximum pressure of 600# per square inch in the cylinder 70 of the third section and the piston 71 thereof will be able to resist an upward force 50% greater than the downward force exerted thereon by the liquid.

When it is desired to raise the platens, the operator will swing hand lever 50 toward the left and thereby move valve plunger 53 from the position shown in Fig. 2 to the position shown in Fig. 4. Plunger 53 will move rapidly until it opens communication between channels 61 and 62 and then dashpot plunger 64 will enter dashpot

66 and cause plunger 53 to move slowly so that channels 61 and 62 are in communication, as shown in Fig. 5, long enough to destroy the pressure in channels 42, 84 and 90 and thereby permit spring 143 to move plunger 120 of valve 91 downward to the position shown in Fig. 2.

Plunger 120 will eject liquid from the lower end of the valve casing through channel 138 and check valve 141 into channel 90 and, as it approaches the limit of its downward movement, it operates pilot switch 118 which causes magnetic switch 115 to close so that motor 109 will be energized when switch 52 is closed.

When lever 50 has been swung to the position shown in Fig. 4, valve plunger 53 will have closed communication between channels 61 and 62, so that pump 30 can create pressure in channel 42, and then will have closed switch 52 so that motors 109 are energized but are operated in a direction opposite to that in which they were operating when pistons 71 were being moved downward.

In each section, motor 109 will move reversing valve plunger 76 downward to open port 81 to port 83 and to open port 82 to channel 80 as shown in Fig. 4. Then liquid from channel 42 may flow through channel 84, valve 75, channel 85, check valve 86 and channel 88 to the lower end of cylinder 70 and move piston 71 upward. Piston 71 will eject liquid from the upper end of cylinder 70 through channels 134 and 137, valve 91, channel 90, valve 75 and channels 80 and 45 into reservoir 44.

If all of the pistons 71 should rise high enough to stall, pump pressure would rise to the predetermined maximum and pump 30 would reduce its stroke until it is delivering just sufficient liquid to maintain that maximum pressure constant. However, before pistons 71 stall, the operator may swing lever 50 to the position shown in Fig. 5 to open channel 61 to channel 62 and then the pump would be bypassed and the press remain idle.

The operator may then restart the press by swinging lever 50 to the position shown in Fig. 2 in which position channel 62 is blocked, so that pump 30 can create pressure in channel 42, and switch 52 is closed so that motors 109 are caused to operate in a direction to move valve plunger 76 upward to admit liquid to the upper ends of cylinders 70. Pistons 71 will then move downward and move valve plunger 76 downward until just sufficient liquid is being delivered to cylinders 70 to advance pistons 71 at the desired speeds as previously explained.

The invention herein set forth is susceptible of various modifications and adaptations without departing from the scope thereof as hereafter claimed.

The invention is herein claimed as follows:

1. A hydraulic press, comprising a source of motive liquid having a pressure above a predetermined value and a plurality of press units operated by liquid from said source, each of said units including a stationary cylinder, a piston fitted in said cylinder, a valve for directing liquid from said source to one end or the other of said cylinder and for controlling the rate at which liquid is delivered thereto, a standard speed element, means responsive to any variation in the speed of said piston relative to the speed of said element for adjusting said valve to vary the flow of liquid to said cylinder and thereby correct such variation in the speed of said piston, means for maintaining the working pressure in said cylinder within narrow limits, and means responsive to the

working pressure in said cylinder reaching a predetermined maximum for rendering the last mentioned means effective and simultaneously stopping said standard speed element.

2. A hydraulic press, comprising a source of motive liquid having a pressure above a predetermined value and a plurality of press units operated by liquid from said source, each of said units including a stationary cylinder, a piston fitted in said cylinder, a valve for directing liquid from said source to one end or the other of said cylinder and for controlling the rate at which liquid is delivered thereto, a standard speed element, means responsive to any variation in the speed of said piston relative to the speed of said element for adjusting said valve to vary the flow of liquid to said cylinder and thereby correct such variation in the speed of said piston, pressure control means adapted when effective to prevent the pressure in said cylinder exceeding a predetermined maximum and to cause a drop in pressure between said cylinder and said valve, a second valve for controlling said pressure control means and normally rendering said pressure control means ineffective, and means responsive to the working pressure in said cylinder reaching a predetermined maximum for shifting said second valve to thereby render said pressure control means effective.

3. A hydraulic press, comprising a source of motive liquid having a pressure above a predetermined value and a plurality of press units operated by liquid from said source, each of said units including a stationary cylinder, a piston fitted in said cylinder, a valve for directing liquid from said source to one end or the other of said cylinder and for controlling the rate at which liquid is delivered thereto, a standard speed element, means responsive to any variation in the speed of said piston relative to the speed of said element for adjusting said valve to vary the flow of liquid to said cylinder and thereby correct such variation in the speed of said piston, pressure control means adapted when effective to prevent the pressure in said cylinder exceeding a predetermined maximum and to cause a drop in pressure between said cylinder and said valve, a second valve for controlling said pressure control means and normally rendering said pressure control means ineffective, means responsive to the working pressure in said cylinder reaching a predetermined maximum for shifting said second valve to thereby render said pressure control means effective, and means operated substantially in unison with said second valve for stopping said standard speed element.

4. A hydraulic press, comprising a source of motive liquid having a pressure above a predetermined value, a plurality of press units operated by liquid from such source; each of said units including a stationary cylinder, a piston fitted in said cylinder, a valve for directing liquid to opposite ends of said cylinder alternatively to advance and retract said piston and for controlling the rate at which liquid is delivered to said cylinder to thereby control the speed of said piston, a standard speed element, means responsive to any variation in the speed of said piston relative to the speed of said element for adjusting said valve to vary the flow of liquid to said cylinder and thereby correct the variation in piston speed, pressure control means adapted when effective to prevent the pressure in said cylinder exceeding a predetermined maximum and to cause a drop in pressure between said cylinder and said

valve, a second valve for controlling said pressure control means and spring biased to a position to render said pressure control means ineffective, and means responsive to the working pressure in said cylinder reaching a predetermined maximum for shifting said second valve to render said pressure control means effective; means for reducing the pressure at said source to thereby permit said second valve to shift to a position to render the pressure control means ineffective, means for reversing the standard speed elements in all of said units, and means for operating said pressure reducing means and said reversing means simultaneously.

5. A hydraulic press, comprising a source of motive liquid having a pressure above a predetermined value, a plurality of press units operated by liquid from such source; each of said units including a stationary cylinder, a piston fitted in said cylinder, a valve for directing liquid to opposite ends of said cylinder alternatively to advance and retract said piston and for controlling the rate at which liquid is delivered to said cylinder to thereby control the speed of said piston, a standard speed element, means responsive to any variation in the speed of said piston relative to the speed of said element for adjusting said valve to vary the flow of liquid to said cylinder and thereby correct the variation in piston speed, pressure control means adapted when effective to prevent the pressure in said cylinder exceeding a predetermined maximum and to cause a drop in pressure between said cylinder and said valve, a second valve for controlling said pressure control means and spring biased to a position to render said pressure control means ineffective, means responsive to the working pressure in said cylinder reaching a predetermined maximum for shifting said second valve to render said pressure control means effective, and means operative in unison with said second valve for stopping said standard speed element; means for reducing the pressure at said source to thereby permit said second valve to shift to a position to render said pressure control means ineffective, means for reversing the standard speed elements in all of said units, and means for operating said pressure reducing means and said reversing means simultaneously.

6. A hydraulic press, comprising a source of motive liquid having a pressure above a predetermined value, a plurality of press units operated by liquid from such source; each of said units including a stationary cylinder, a piston fitted in said cylinder, a valve for directing liquid to opposite ends of said cylinder alternatively to advance and retract said piston and for controlling the rate at which liquid is delivered to said cylinder to thereby control the speed of said piston, an electric standard speed element, means responsive to any variation in the speed of said piston relative to the speed of said element for adjusting said valve to vary the flow of liquid to said cylinder and thereby correct the variation in piston speed, pressure control means adapted when effective to prevent the pressure in said cylinder exceeding a predetermined maximum and to cause a drop in pressure between said cylinder and said valve, a second valve for controlling said pressure control means and spring biased to a position to render said pressure control means ineffective, means responsive to the working pressure in said cylinder reaching a predetermined maximum for shifting said second valve to render said pressure control means effective, a mag-

netic switch for controlling said speed element, and a pilot switch operated in response to movement of said second valve for causing said magnetic switch to stop said element upon said second valve rendering said pressure control means ineffective; means for reducing the pressure at said source to thereby permit said second valve to shift to a position to render said pressure control means ineffective, a reversing switch for reversing the standard speed elements in all said units, and means for operating said pressure reducing means and said reversing switch simultaneously.

7. A hold-down system, comprising a source of motive liquid having a pressure above a predetermined value and a plurality of hydraulically actuated hold-down units operated by liquid supplied thereto from said source, each of said units including a cylinder having a power end and a retraction end, a piston fitted in said cylinder, a first control valve for directing liquid to opposite ends of said cylinder alternatively to advance and retract said piston and for controlling the rate at which liquid is delivered to said cylinder to control the speed of said piston, a substantially constant speed element, a differential having one leg thereof driven from said constant speed element and a second leg thereof driven by motion imparted thereto from said piston whereby any variation in the speed of said piston relative to the speed of said element causes rotation of the third leg of said differential, means responsive to rotation of the third leg of said differential for shifting said valve to vary the rate of delivery of liquid to said cylinder to thereby maintain the speed of said piston proportional to the speed of said element, a resistance valve connected to the power end of said cylinder for causing a drop in the pressure of the liquid delivered thereto, a relief valve for limiting the pressure in the power end of said cylinder, and a second control valve operable either to permit the liquid passing through said first control valve to flow freely to the power end of said cylinder or to direct said liquid thereto through said resistance valve.

8. A hold-down system, comprising a source of motive liquid having a pressure above a predetermined value and a plurality of hydraulically actuated hold-down units operated by liquid supplied thereto from said source, each of said units including a cylinder having a power end and a retraction end, a piston fitted in said cylinder, a first control valve for directing liquid to opposite ends of said cylinder alternatively to advance and retract said piston and for controlling the rate at which liquid is delivered to said cylinder to control the speed of said piston, a substantially constant speed element, a differential having one leg thereof driven from said constant speed element and a second leg thereof driven by motion imparted thereto from said piston whereby any variation in the speed of said piston relative to the speed of said element causes rotation of the third leg of said differential, means responsive to rotation of the third leg of said differential for shifting said valve to vary the rate of delivery of liquid to said cylinder to thereby maintain the speed of said piston proportional to the speed of said element, a resistance valve connected to the power end of said cylinder for causing a drop in the pressure of the liquid delivered thereto, a relief valve for limiting the pressure in the power end of said cylinder, a second control valve operable either to permit the liquid passing through said first control valve to flow freely to the power end of said cylinder or to direct said liquid there-

to through said resistance valve, and means for reversing said constant speed element to thereby reverse said piston.

9. A hold-down system, comprising a source of motive liquid having a pressure above a predetermined value and a plurality of hydraulically actuated hold-down units operated by liquid supplied thereto from said source, each of said units including a cylinder having a power end and a retraction end, a piston fitted in said cylinder, a first control valve for directing liquid to opposite ends of said cylinder alternatively to advance and retract said piston and for controlling the rate at which liquid is delivered to said cylinder to control the speed of said piston, a substantially constant speed element, a differential having one leg thereof driven from said constant speed element and a second leg thereof driven by motion imparted thereto from said piston whereby any variation in the speed of said piston relative to the speed of said element causes rotation of the third leg of said differential, means responsive to rotation of the third leg of said differential for shifting said valve to vary the rate of delivery of liquid to said cylinder to thereby maintain the speed of said piston proportional to the speed of said element, a resistance valve connected to the power end of said cylinder for causing a drop in the pressure of the liquid delivered thereto, a relief valve for limiting the pressure in the power end of said cylinder, a second control valve operable either to permit the liquid passing through said first control valve to flow freely to the power end of said cylinder or to direct said liquid thereto through said resistance valve, and means responsive to the stalling of said piston for stopping said constant speed element.

10. A hold-down system, comprising a source of motive liquid having a pressure above a predetermined value and a plurality of hydraulically actuated hold-down units operated by liquid supplied thereto from said source, each of said units including a cylinder having a power end and a retraction end, a piston fitted in said cylinder, a first control valve for directing liquid to opposite ends of said cylinder alternatively to advance and retract said piston and for controlling the rate at which liquid is delivered to said cylinder to control the speed of said piston, a substantially constant speed element, a differential having one leg thereof driven from said constant speed element and a second leg thereof driven by motion imparted thereto from said piston whereby any variation in the speed of said piston relative to the speed of said element causes rotation of the third leg of said differential, means responsive to rotation of the third leg of said differential for shifting said valve to vary the rate of delivery of liquid to said cylinder to thereby maintain the speed of said piston proportional to the speed of said element, a resistance valve connected to the power end of said cylinder for causing a drop in the pressure of the liquid delivered thereto, a relief valve for limiting the pressure in the power end of said cylinder, a second control valve operable either to permit the liquid passing through said first control valve to flow freely to the power end of said cylinder or to direct said liquid thereto through said resistance valve, means for reversing said constant speed element to thereby reverse said piston, and means responsive to the stalling of said piston for stopping said element.

11. A hold-down system, comprising a source of motive liquid having a pressure above a pre-

determined value and a plurality of hydraulically actuated hold-down units operated by liquid supplied thereto from said source, each of said units including a cylinder having a power end and a retraction end, a piston fitted in said cylinder, a first control valve for directing liquid to opposite ends of said cylinder alternatively to advance and retract said piston and for controlling the rate at which liquid is delivered to said cylinder to control the speed of said piston, a substantially constant speed element, a differential having one leg thereof driven from said constant speed element and a second leg thereof driven by motion imparted thereto from said piston whereby any variation in the speed of said piston relative to the speed of said element causes rotation of the third leg of said differential, means responsive to rotation of the third leg of said differential for shifting said valve to vary the rate of delivery of liquid to said cylinder to thereby maintain the speed of said piston proportional to the speed of said element, a resistance valve connected to the power end of said cylinder for causing a drop in the pressure of the liquid delivered thereto, a relief valve for limiting the pressure in the power end of said cylinder, a second valve for controlling the delivery of liquid to the power end of said cylinder and normally permitting the liquid passing through said first control valve to flow freely thereto, and means responsive to said piston stalling at the end of its advance movement for operating said second control valve to cause it to direct said liquid to the power end of said cylinder through said resistance valve.

12. A hold-down system, comprising a source of motive liquid having a pressure above a predetermined value and a plurality of hydraulically actuated hold-down units operated by liquid supplied thereto from said source, each of said units including a cylinder having a power end and a retraction end, a piston fitted in said cylinder, a first control valve for directing liquid to opposite ends of said cylinder alternatively to advance and retract said piston and for controlling the rate at which liquid is delivered to said cylinder to control the speed of said piston, a substantially constant speed element, a differential having one leg thereof driven from said constant speed element and a second leg thereof driven by motion imparted thereto from said piston whereby any variation in the speed of said piston relative to the speed of said element causes rotation of the third leg of said differential, means responsive to rotation of the third leg of said differential for shifting said valve to vary the rate of delivery of liquid to said cylinder to thereby maintain the speed of said piston proportional to the speed of said element, means for reversing said constant speed element to thereby reverse said piston, a resistance valve connected to the power end of said cylinder for causing a drop in the pressure of the liquid delivered thereto, a relief valve for limiting the pressure in the power end of said cylinder, a second valve for controlling the delivery of liquid to the power end of said cylinder and normally permitting the liquid passing through said first control valve to flow freely thereto, and means responsive to said piston stalling at the end of its advance movement for operating said second control valve to cause it to direct said liquid to the power end of said cylinder through said resistance valve.

13. A hold-down system, comprising a source of motive liquid having a pressure above a pre-

terminated value and a plurality of hydraulically actuated hold-down units operated by liquid supplied thereto from said source, each of said units including a cylinder having a power end and a retraction end, a piston fitted in said cylinder, a first control valve for directing liquid to opposite ends of said cylinder alternatively to advance and retract said piston and for controlling the rate at which liquid is delivered to said cylinder to control the speed of said piston, a substantially constant speed element, a differential having one leg thereof driven from said constant speed element and a second leg thereof driven by motion imparted thereto from said piston whereby any variation in the speed of said piston relative to the speed of said element causes rotation of the third leg of said differential, means responsive to rotation of the third leg of said differential for shifting said valve to vary the rate of delivery of liquid to said cylinder to thereby maintain the speed of said piston proportional to the speed of said element, means responsive to the stalling of said piston for stopping said constant speed element, a resistance valve connected to the power end of said cylinder for causing a drop in the pressure of the liquid delivered thereto, a relief valve for limiting the pressure in the power end of said cylinder, a second valve for controlling the delivery of liquid to the power end of said cylinder and normally permitting the liquid passing through said first control valve to flow freely thereto, and means responsive to said piston stalling at the end of its advance movement for operating said second control valve to cause it to direct said liquid to the power end of said cylinder through said resistance valve.

14. A hold-down system, comprising a source of motive liquid having a pressure above a predetermined value and a plurality of hydraulically actuated hold-down units operated by liquid supplied thereto from said source, each of said units including a cylinder having a power end and a retraction end, a piston fitted in said cylinder, a first control valve for directing liquid to opposite ends of said cylinder alternatively to advance and retract said piston and for controlling the rate at which liquid is delivered to said cylinder to control the speed of said piston, a substantially constant speed element, a differential having one leg thereof driven from said constant speed element and a second leg thereof driven by motion imparted thereto from said piston whereby any variation in the speed of said piston relative to the speed of said element causes rotation of the third leg of said differential, means responsive to rotation of the third leg of said differential for shifting said valve to vary the rate of delivery of liquid to said cylinder to thereby maintain the speed of said piston proportional to the speed

of said element, means for reversing said constant speed element to thereby reverse said piston, means responsive to said piston stalling for stopping said constant speed element, a resistance valve connected to the power end of said cylinder for causing a drop in the pressure of the liquid delivered thereto, a relief valve for limiting the pressure in the power end of said cylinder, a second valve for controlling the delivery of liquid to the power end of said cylinder and normally permitting the liquid passing through said first control valve to flow freely thereto, and means responsive to said piston stalling at the end of its advance movement for operating said second control valve to cause it to direct said liquid to the power end of said cylinder through said resistance valve.

15. A hold-down system, comprising a pump adapted to deliver motive liquid at a pressure above a predetermined value and a plurality of hydraulically actuated hold-down units operated by liquid supplied thereto from said pump, each of said units including a cylinder having a power end and a retraction end, a piston fitted in said cylinder, a first control valve for directing liquid to opposite ends of said cylinder alternatively to advance and retract said piston and for controlling the rate at which liquid is delivered to said cylinder to control the speed of said piston, a substantially constant speed element, a differential having one leg thereof driven from said constant speed element and a second leg thereof driven by motion imparted thereto from said piston whereby any variation in the speed of said piston relative to the speed of said element causes rotation of the third leg of said differential, means responsive to rotation of the third leg of said differential for shifting said valve to vary the rate of delivery of liquid to said cylinder to thereby maintain the speed of said piston proportional to the speed of said element, a resistance valve connected to the power end of said cylinder for causing a drop in the pressure of the liquid delivered thereto, a relief valve for limiting the pressure in the power end of said cylinder, a second control valve operable either to permit the liquid passing through said first control valve to flow freely to the power end of said cylinder or to direct said liquid thereto through said resistance valve, means responsive to said piston stalling at the end of its advance movement for operating said second control valve to cause it to direct liquid to the power end of said cylinder through said resistance valve, means for reducing pump pressure to a low value, and means operable in unison with said pressure reducing means for reversing the constant speed elements of all of said units simultaneously.

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