

March 24, 1964

C. P. KAUFMANN

3,125,819

CONTROL ARRANGEMENT FOR DREDGE LADDER

Filed March 19, 1962

3 Sheets-Sheet 1

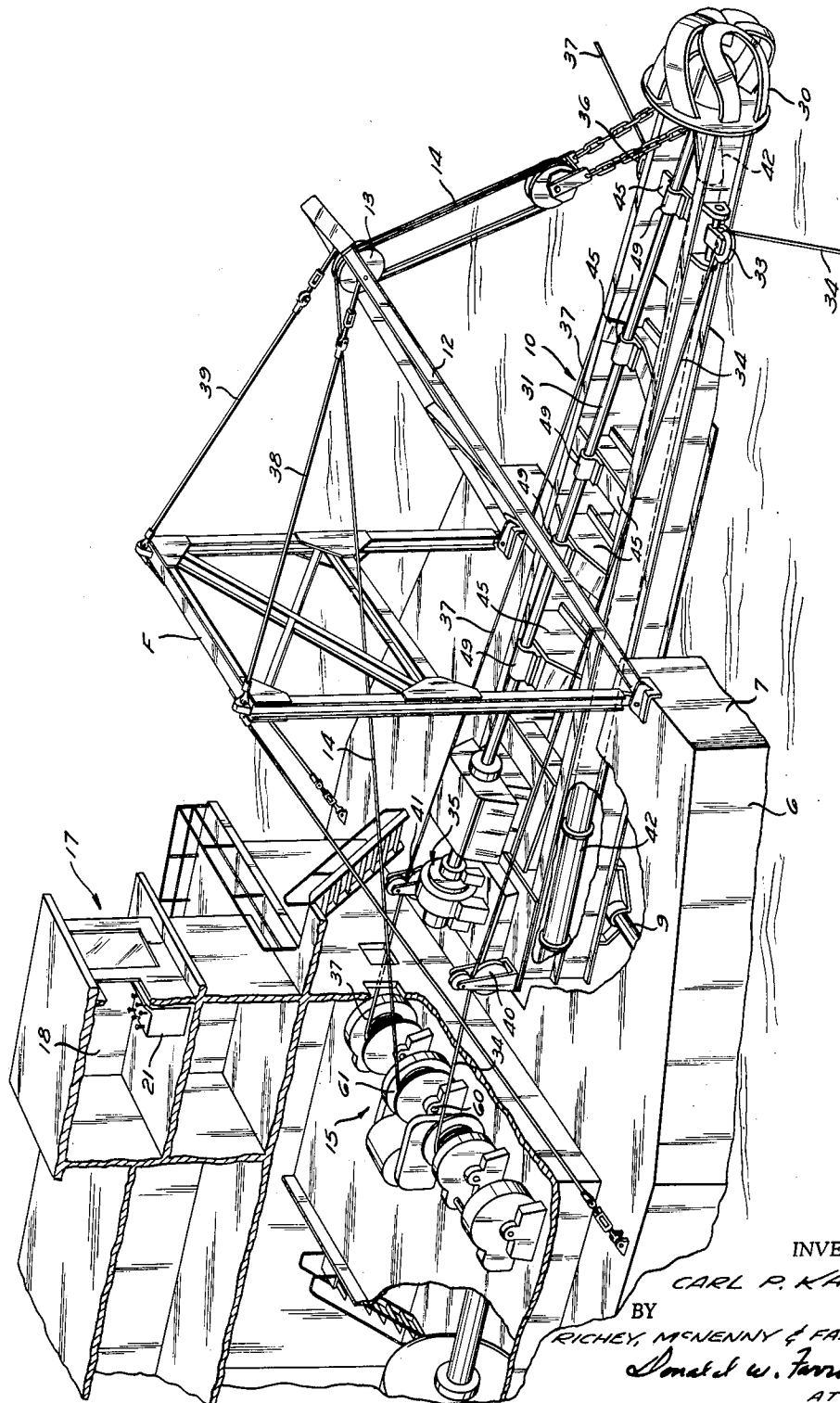


Fig. 1

INVENTOR.

CARL P. KAUFMANN

BY

RICHEY, MCNENNY & FARRINGTON

Donald W. Farrington

ATTORNEYS

March 24, 1964

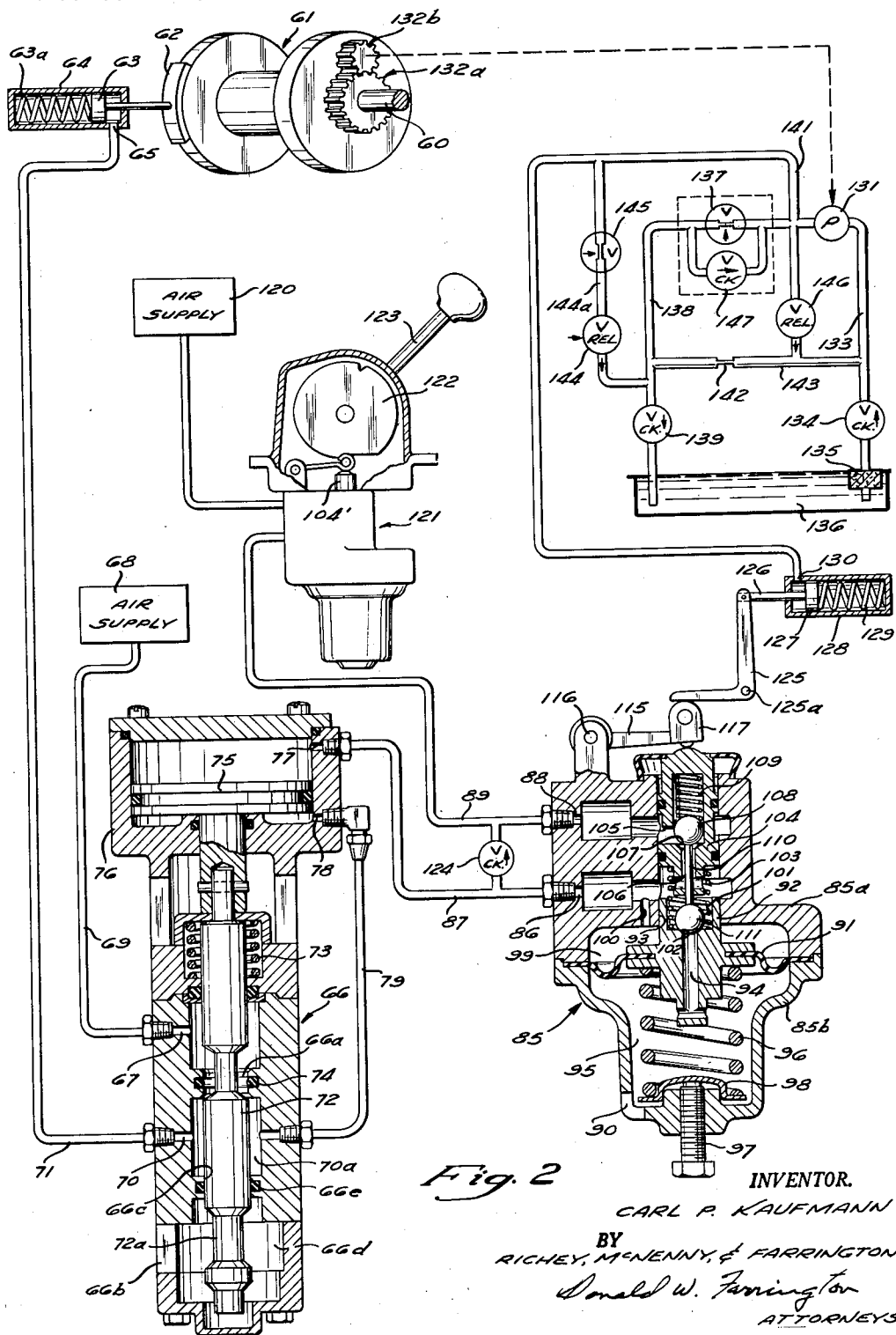
C. P. KAUFMANN

3,125,819

CONTROL ARRANGEMENT FOR DREDGE LADDER

Filed March 19, 1962

3 Sheets-Sheet 2



March 24, 1964

C. P. KAUFMANN

3,125,819

CONTROL ARRANGEMENT FOR DREDGE LADDER

Filed March 19, 1962

3 Sheets-Sheet 3

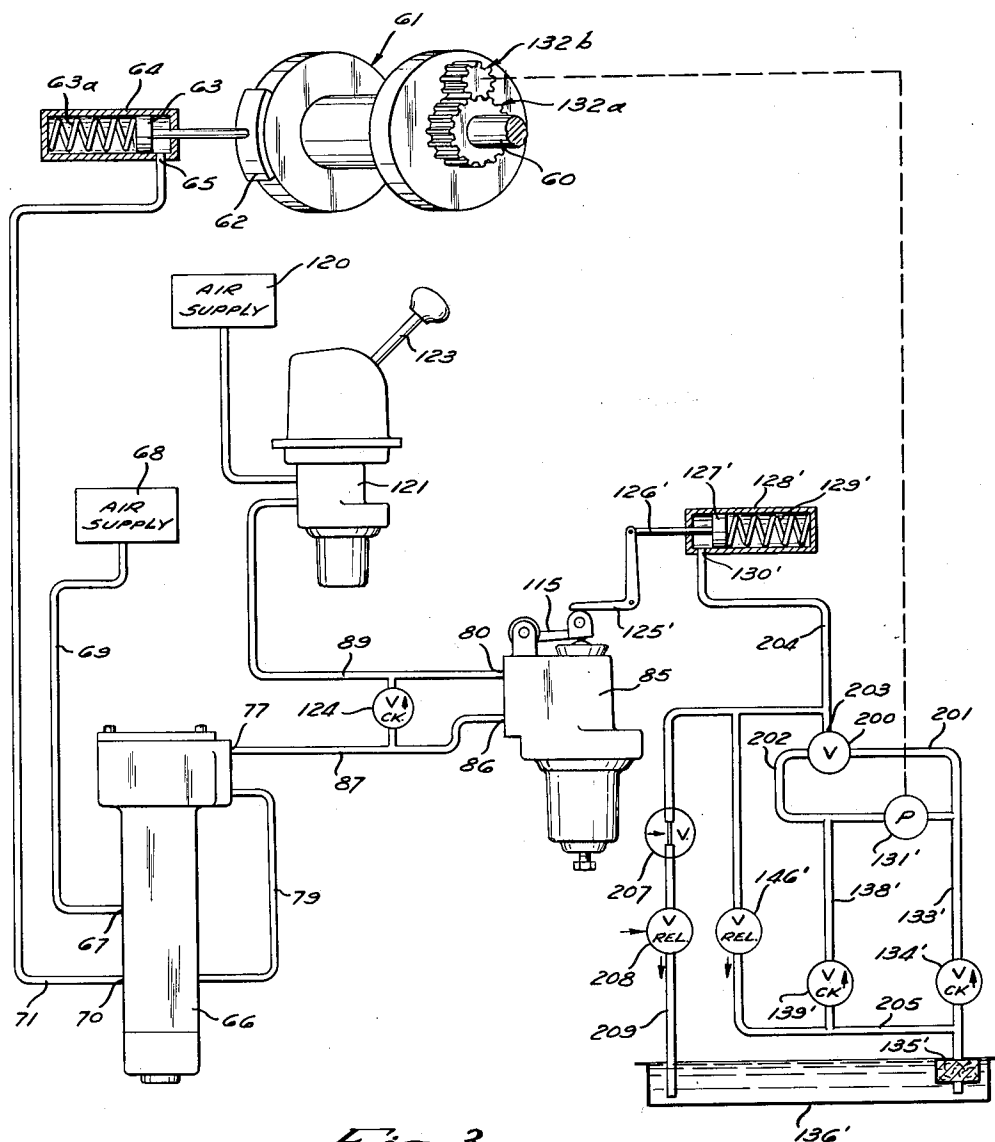


Fig. 3

INVENTOR.

CARL P. KAUFMANN

BY

RICHEY, MCNENNY & FARRINGTON

Donald W. Farrington

ATTORNEYS

1

3,125,819

CONTROL ARRANGEMENT FOR DREDGE LADDER

Carl P. Kaufmann, Baltimore, Md., assignor to Ellicott Machine Corporation, Baltimore, Md., a corporation of Maryland

Filed Mar. 19, 1962, Ser. No. 180,673

12 Claims. (Cl. 37—54)

This invention relates to an arrangement for controlling the lowering of the ladder on a dredge.

Commonly, dredges are provided with a ladder which is pivoted at its back end to the front end of the dredge hull. The ladder carries a motor-driven cutter at its forward end, as well as a suction pipe extending along its length. The ladder is raised by means of a cable wound around a motor-driven ladder hoist drum on the dredge and is lowered by gravity. The ladder hoist drum is provided with a clutch and a brake.

Prior to the present invention it has been the usual practice for the dredge operator, when lowering the ladder, to manually operate a pneumatic control for the brake intermittently, so that the brake is abruptly released and applied to permit the ladder to lower under its own weight. This abrupt on-and-off operation often results in considerable shock to the hoist cable and drum and to the dredge as a whole. Even when the dredge operator is extremely careful in operating the brake, it requires exceptional skill to control the lowering of the ladder in such a manner that such shock may be avoided. When the ladder is at rest and the brake is applied, the coefficient of static friction is considerably higher than the coefficient of friction when the parts are moving. Accordingly, as soon as the brake is released and the brake drum is in motion the coefficient of friction changes, and unless the brake is applied again, to some extent, the ladder begins to run away. In practice, therefore, it is extremely difficult for the dredge operator to lower the ladder at a substantially continuous, regulated slow speed and to avoid shock due to abrupt on-and-off operation of the brake.

The present invention is directed to a novel control arrangement for the ladder hoist drum on a dredge which enables the ladder to be lowered automatically at a controlled safe speed so as to avoid shock to the dredge. In accordance with the present invention, the ladder hoist drum has its pneumatic control arranged to be normally under the control of a novel fluid-operated governor. When the speed of the ladder hoist drum exceeds a predetermined safe value, the governor causes the brake to be applied in proportion to the speed of the ladder hoist drum so as to reduce the ladder speed to a safe value. The operation of the governor takes place automatically and without requiring the dredge operator's continuing attention.

It is an object of this invention to provide a novel and improved arrangement for controlling the lowering of a dredge ladder.

It is also an object of this invention to provide such a control arrangement which enables the dredge ladder to be lowered at a continuous regulated speed.

Another object of this invention is to provide such a control arrangement which is automatic in its operation and therefore does not require continuing attention by the dredge operator.

Further objects and advantages of this invention will be apparent from the following detailed description of presently-preferred embodiments thereof, which are shown in the accompanying drawings.

In the drawings:

FIGURE 1 is a perspective view of the front end of

2

a dredge on which the present control arrangement may be used;

FIGURE 2 is a schematic diagram showing the pneumatic control for the ladder hoist drum on the dredge and one embodiment of the governor in accordance with the present invention; and

FIGURE 3 is a similar view showing the pneumatic control and different embodiment of the governor in accordance with the present invention.

FIGURE 1 illustrates the front end of a dredge of known design on which the present governor may be incorporated. This dredge has a hull 6 with a forward wall 7. The hull supports the horizontal pivot 9 for the dredge ladder, indicated in its entirety as at 10. An A-frame 12 is mounted on the forward end of hull and the upper end of the A-frame supports the pulley 13 forming a part of the mechanism for raising and lowering the ladder by means of cable 14. The ladder is raised by winding cable 14 on a ladder drum forming a part of the hauling machinery which is indicated in its entirety as at 15.

Preferably the hull 6 is provided with a deck house 17 having an operator's compartment 18 containing the controls at a control stand 21 to be manipulated by the dredge operator.

The dredge ladder 10 is shown as provided with the usual rotary cutter 30 driven by cutter shaft 31 carried on a series of transverse members 45 forming a part of the dredge ladder. The shaft 31 is arranged to be driven by a suitable motor indicated in its entirety at 35. The outer end of the dredge ladder 10 is provided with a starboard pulley 33 at one side to guide an anchor cable 34. A similar port pulley 36 is carried at the outer end of the dredge ladder to guide an anchor cable 37. The anchor cables 34 and 37 are also guided by pulleys 40 and 41 carried at the rear end of the dredge ladder. The anchor cables 34 and 37 are secured to swing drums forming a part of the hauling machinery assembly 15.

The operator, while in the operator's compartment, may observe the condition of the anchor cables 34 and 37 and also may observe the movement of the swing drums in the hauling machinery 15 which are utilized to move the cables 34 and 37. Supporting cables 38 and 39 secured at the apex of the A-frame 12 extend rearwardly therefrom to an upstanding frame F mounted on the front end of the hull.

A suction pipe 42 is carried at the underside of the dredge ladder 10. The suction pipe 42 is provided with a suction mouth which opens to the interior of the cutter 30. Material being dredged and cut loose by the cutter 30 is drawn into the suction mouth and through the suction pipe 42 to the suction pump carried by the dredge.

The transverse ladder members 45 span the longitudinal side members of the ladder 10 and the transverse members 45 carry bearing blocks 49 for the cutter shaft 31.

The hauling and hoisting machinery, which has been indicated in its entirety as at 15, includes a rotatable ladder shaft 60 (FIG. 2) on which is mounted a ladder hoist drum 61. The power unit for the hauling machinery preferably comprises a motor which drives the ladder shaft 60 through a suitable speed reduction arrangement when the ladder is being raised.

When the ladder 10 is lowered (by gravity), the cable 14 unwinds and causes the ladder drum 61 to turn in one direction. Conversely, the ladder is raised when the ladder drum is power driven in the opposite direction so as to wind up the cable 14.

FIG. 2 System

Associated with the ladder drum is a brake 62 of any suitable design. The brake is operated by a piston 63 which is reciprocable in a cylinder 64. Normally, the

3

brake is biased by a spring 63a to a position engaging the ladder drum 61 and holding the latter frictionally against rotation. The brake is released from air is introduced into the cylinder inlet 65 to retract piston 63 against the bias of spring 63a.

The air pressure at the brake cylinder inlet 65 is under the control of a relay valve 66 of known design. This valve has an inlet port 67 connected to a suitable air pressure source 68 through an inlet line 69. An outlet port 70 in the relay valve is connected through a line 71 to the brake cylinder inlet 65. Between the inlet and outlet ports the valve body presents a cylindrical passage 66a at which is located a resilient O-ring 74. A reciprocable spool valve member 72 controls the fluid communication between the inlet and outlet ports 67 and 70. A spring 73 normally biases the spool valve member 72 to a position (upward from its FIG. 2 position) in which it snugly engages and seals against the O-ring 74 to block the flow of air between inlet and outlet ports 67 and 70.

The valve housing also has an exhaust port 66b located below the outlet port 70. A reduced diameter cylindrical passage 66c connects the outlet chamber 70a in the valve housing to the exhaust chamber 66d. A resilient O-ring 66e is carried by the valve housing at passage 66c. When the valve spool 72 is in the normal (up) position to which it is biased by spring 73, in which it prevents air flow between the inlet port 67 and the outlet port 70, a reduced diameter portion 72a of the valve spool is disposed in passage 66c so that air can flow from the outlet port 70 to the exhaust port 66b.

The large diameter portion of the valve spool 72 is of such a length that it can seal against both O-rings 74 and 66e in one axial position of the valve spool, so as to block the flow of air both from the inlet port 67 to the outlet port 70 and from the outlet port 70 to the exhaust port 66b.

A piston 75 operating in a cylinder 76 is attached to the upper end of the spool valve member 72 in FIG. 2. A control port 77 leads into cylinder 76 above piston 75. Another port 78, which leads into cylinder 76 below piston 75, is connected by means of an external tube 79 to the outlet chamber 70a of the valve.

When air under sufficient pressure is introduced through control port 77 it forces the piston 75 down against the bias exerted by spring 73 to move the spool valve member 72 down to the FIG. 2 position and thereby permit the flow of air under pressure from the source 68 through valve ports 67 and 70 to the brake cylinder inlet 65.

At the same time the valve spool seals against the O-ring 66e to prevent the flow of air to the exhaust port 66b, as shown in FIG. 2. When the pressure at outlet 70 balances the pressure at control port 77 then the spring 73 will return the valve spool 72 to a position sealing against both the O-ring 74 and the O-ring 66e. Therefore, the pressure at control port 77 determines the pressure which will be applied at the brake cylinder inlet 65.

If the pressure at control port 77 is reduced, the valve spool will move upward still farther to connect the outlet port 70 to the exhaust port 66b.

The control pressure at port 77 is under the control of a valve 85 of known design. Valve 85 has an outlet port 86 connected to the control port 77 through a line 87. Valve 85 has an inlet port 88 which receives air under pressure from a line 89. Valve 85 also has an exhaust port 90 leading to the atmosphere.

Valve 85 has a housing or body made up of two members 85a and 85b between which a flexible, resilient diaphragm 91 of rubber-like material is clamped. Attached to diaphragm 91 is a hollow, generally sleeve-like valve member 92 which has its upper end slidably received in a bore 93 in body member 85a. Valve member 92 has an axial passage 94 which opens into an exhaust chamber 95 in body member 85b leading to the atmosphere through exhaust port 90. A coil spring 96 in this chamber biases the diaphragm 91 and slidable valve member 92 upward

4

in FIG. 2. The bias force exerted by this spring is adjustable by means of an adjusting screw 97 engaging beneath a washer 98 on which spring 96 is seated. The body member 85a provides an annular chamber 99 above the diaphragm 91 which communicates with the outlet port 86 through an internal passage 100 formed in body member 85a.

At its upper end the slidable valve member 92 is formed with an enlarged counterbore 101. Valve member 92 presents an upwardly facing valve seat 102 at the juncture between its counterbore 101 and its passage 94.

A coil spring 103 has its lower end seated in the counterbore 101 and its upper end bearing upward against a second slidable valve member 104. Valve member 104 is slidably mounted in the valve body member 85a. Valve member 104 has a lateral port 105 communicating with the inlet port 88, an outlet passage 106 communicating with the outer port 86 and an upwardly facing valve seat 107 between port 105 and passage 106. A ball valve member 108 is biased by a spring 109 to normally engage this valve seat and thereby prevent the flow of air from the valve inlet port 88 to the valve outlet port 86.

A rigid stem 110 is attached to ball valve member 108 and extends down loosely through passage 106. A second ball valve member 111 is attached to the lower end of this stem. Ball valve member 111 is adapted to seat on valve seat 102 to prevent the flow of air from the valve outlet port 86 to the valve exhaust port 90.

In operation, when the valve is in the position shown in FIG. 2, ball valve member 108 is unseated, permitting the flow of air from inlet port 88 to outlet port 86, and valve member 111 is seated to block the outlet port 86 from the exhaust port 90. This condition of the valve is obtained when slidable valve member 104 is moved downward by an externally applied force, as described hereinafter.

When the pressure at the outlet port 86 has increased to the desired value, the pressure in chamber 99 will force diaphragm 91 downward against its spring 96 until a balance is obtained between the opposing forces exerted above and below the diaphragm. When this balanced condition is achieved the spring 109 will seat the upper ball valve member 108 against valve seat 107, cutting off further air flow from inlet 88 to outlet 86.

When the pressure at outlet port 86 is too high, then slidable valve member 104 will be moved upward by spring 103, and the upper ball valve member 108 will be held on its seat 107 by spring 109 and the lower ball valve member 111 will become unseated from its seat 102. Air pressure at the valve outlet 86 is vented through valve passage 94, exhaust chamber 95 and exhaust port 90 to the atmosphere. When the pressure at outlet 86 has decreased to the desired value, the diaphragm 91 will be forced upward by spring 96 to a position in which the opposing forces above and below the diaphragm are balanced. The lower valve seat 102 is held seated against the lower ball valve member 111, thereby preventing further venting of air from the outlet 86 to atmosphere.

The movement of the slidable valve member 104 is under the control of an external lever 115 which is pivotally mounted at 116 on the valve body. At its opposite end the lever carries a follower 117 which engages the outer end of slidable valve member 104. When lever 115 is pivoted clockwise in FIG. 2, it forces valve member 104 downward to increase the air pressure at valve outlet port 86, as described. Conversely, when lever 115 is pivoted counterclockwise in FIG. 2 it permits valve member 104 to move upward, under the action of spring 103, to reduce the air pressure at the valve outlet port 86, as described.

In accordance with the present invention the pivotal movement of lever 115, and thus the operation of valve 85, is under the control of a novel governor which is responsive to the speed of the hoist drum 61, as described in detail hereinafter.

5

Valve 85 receives its air supply from a suitable source 120 by way of a manually operated valve 121. Valve 121 essentially similar to valve 85 in construction and mode of operation, and therefore is not shown or described in detail. Valve 121 has a slidable valve member 104' (corresponding to the valve member 104 in valve 85) which is arranged to be operated by a cam 122, which may be turned by a handle 123.

Valve 121 is mounted on the control stand 21 in the operator's compartment 18 on the dredge. By turning the handle 123, the operator may control selectively the air pressure supplied to the inlet port 88 of valve 85.

A check valve 124 is connected in parallel with valve 85 between the air lines 89 and 87. This check valve is arranged to open when the air pressure in line 87 exceeds the air pressure in line 89. The operator of the dredge may apply the brake independent of the governor controlled valve 85, simply by operating valve 121 to reduce the air pressure in line 89. The air pressure in line 87 then exhausts through check valve 124 and line 89 to the exhaust port in valve 121.

Turning now to the novel governor arrangement of the present invention which operates valve 85, the follower 117 on the valve lever 115 is engaged by one leg of a bell crank lever 125 having a fixed pivot 125a. The opposite end of lever 125 is pivotally coupled to a piston shaft 126, which is connected to a piston 127 slidable in a cylinder 128. Piston 127 is normally biased to the left in FIG. 2 by a spring 129, thereby tending to move bell crank lever 125 to its extreme position counterclockwise. This positions valve 85 as shown in FIG. 2, thereby connecting its inlet line 89 to its outlet line 87 and causing air pressure to be applied to the control port 77 of valve 66.

When fluid pressure is applied to the inlet port 130 of cylinder 128, piston 127 is retracted against its spring 129. This causes bell crank lever 125 to pivot clockwise in FIG. 2. Lever 115 pivots counterclockwise, and slidable valve member 104 in valve 85 moves upward, both under the influence of spring 103. The pressure at the control port 77 of valve 66 is reduced and this, in turn, reduces the pressure at the brake cylinder inlet 65 and enables spring 64 to apply the brake to an extent determined by the amount that piston 127 has been retracted.

Cylinder 128 is part of a hydraulic circuit which includes a pump 131 driven from the ladder drum through a speed increasing drive which includes gearing 132a and 132b. With this arrangement, the volume of fluid per unit of time which is pumped by the pump 131 varies with the speed of rotation of the ladder hoist drum gear 132a.

The pump 131 has its inlet line 133 connected through a check valve 134 and a filter 135 to a reservoir 136 containing suitable hydraulic fluid, such as oil. Check valve 134 permits oil to flow only in the direction from the reservoir to the pump.

When the ladder 10 is being lowered at a safe speed, the pump 131 is driven in a direction, and at a speed, such that it discharges fluid under pressure through a return line 138 containing, in series, an adjustable needle valve 137 and a check valve 139, back to the reservoir 136. Check valve 139 passes oil only in the direction from the pump to the reservoir.

The flow rate capacity of the flow restriction provided by needle valve 137 is such that it will pass all of the fluid being pumped without an excessive pressure build-up at the pump outlet as long as the pump speed does not exceed a predetermined safe value. However, when this critical pump speed is exceeded (i.e., when the ladder is being lowered too fast) the volume of fluid being pumped per unit of time will be such that the pressure at the pump outlet ahead of needle valve 137 will build up because valve 137 cannot pass the fluid as fast as it is being pumped by pump 131.

6

The pump outlet is connected to the cylinder inlet 130 through an outlet line 141. Therefore, this pressure build up at the pump outlet causes the pressure at the cylinder inlet 130 to increase correspondingly.

Thus, when the speed of the ladder drum 61, during lowering of the ladder 10, tends to increase above a predetermined safe value, the corresponding speed increase of the pump 131 will cause piston 127 to be retracted to apply the brake 62 by an amount proportional to the drum speed. In this manner the brake 62 need not be fully applied to bring the ladder drum to a complete stop, but is partially applied, just sufficient to reduce the speed to ladder hoist drum 61 to a safe value.

The adjustment of needle valve 137 in the return line determines the speed to which the hydraulically-operated governor will limit the ladder hoist drum 61.

A flow restriction orifice 142 is provided in a bypass line 143 connected between lines 138 and 133 to insure that most of the oil being pumped by pump 131 flows back into reservoir 136 and then through filter 135 back to the pump inlet, instead of by-passing the reservoir and filter by flowing through line 143.

In order to prevent the pressure surge, which occurs when the pump accelerates, from being applied to the cylinder inlet 130, an adjustable relief valve 144 is connected in a relief line 144a between outlet line 141 and the inlet of check valve 139. This pressure surge, if not corrected, would cause the governor to over-correct for the increased ladder hoist drum speed and thereby would tend to cause an on-and-off operation of the brake 62.

An adjustable needle valve 145 is connected in this relief line between outlet line 141 and the inlet of relief valve 144. This needle valve constitutes a flow restriction which provides the necessary back pressure to apply the brake 62 partially (at a higher hoist drum speed than that for which needle valve 137 is set) while relief valve 144 is open in response to this pressure surge. The adjustment of needle valve 145 determines this higher speed at which the brake is partially applied.

Another relief valve 146 is connected between the pump outlet line and its inlet line 133. This valve opens, to protect the pump 131, only if relief valve 144 fails to relieve excess pressure at the pump outlet line 141.

When the ladder 10 is being raised, the pump 131 will be driven in the opposite direction, so that line 138 will be its inlet line and line 133 its return line. At this time the hydraulic fluid is recirculated back to the pump by way of by-pass line 143, flow restriction 142, line 138 and a check valve 147 connected in parallel with the adjustable needle valve 137. Preferably, valves 137 and 147 are incorporated in a combination needle valve and check valve device. When the ladder is being raised the governor for brake 62 does not function. Excessive speed of the ladder hoist drum is not a problem at this time.

Operation

To recapitulate the operation of this system, the adjustable needle valve 137 is pre-set to limit the speed of the ladder hoist drum 61 to a safe value when the ladder is being lowered. The operator of the dredge sets the handle 123 of valve 121 to establish a predetermined air pressure for the control port 77 for valve 66.

As the ladder 10 is being lowered, valve 85 will be open (connecting its inlet 88 to its outlet 86) so long as the ladder hoist drum speed does not exceed the safe value determined by needle valve 137. Consequently, the air pressure at the control port 77 for valve 66 causes the latter to be maintained open (connecting its inlet 67 to its outlet 70) and the air pressure at brake cylinder inlet 65 will maintain the ladder hoist drum brake 62 released.

When the ladder hoist drum speed tends to exceed the safe value for which needle valve 137 is pre-set, increased hydraulic pressure will be applied to cylinder port 130, retracting piston 127. The latter acts through bell crank

lever 125 and valve lever 115 to close valve 85 sufficiently to reduce the air pressure at the control port 77 of valve 66. The latter valve closes sufficiently to reduce the air pressure at port 65 of the brake cylinder 64, permitting spring 63a to apply the brake 62 enough to reduce the ladder hoist drum speed down to the safe value.

It will be noted that this braking action takes place automatically in response to the speed of the ladder hoist drum and does not require any attention or action on the part of the dredge operator.

Any momentary surges of hydraulic pressure in the governor are normally taken care of by the relief valve 144, as described.

At any time the dredge operator can disconnect the governor and apply the brake 62 fully to stop the ladder, simply by operating the handle 123 of valve 121 to connect the latter's outlet line 89 to exhaust. This connects the control port 77 of valve 66 to exhaust through check valve 124, releasing the air pressure at the brake cylinder inlet port 65 and enabling spring 63a to apply the brake fully.

When the ladder is being raised the hydraulic governor is ineffective to control its speed. The dredge operator can release and apply the brake by manipulating the handle 123 of valve 121.

FIG. 3 System

FIGURE 3 shows an alternative embodiment of the present invention which has a simplified hydraulic governor adapted to limit the ladder hoist drum speed in either direction (i.e., whether lowering or raising the ladder).

The ladder hoist drum, its brake, the various air valves and the other elements of the pneumatic control system are given the same reference numerals as in the FIG. 2 system, since these elements may be the same. Elements of the hydraulic governor which remain the same as in the FIG. 2 system are given the same reference numerals, with a "prime" superscript added.

In the FIG. 3 governor a pressure-operated shuttle valve 200 of known design is connected in parallel with the pump 131'. Two different fluid lines 201 and 202 connect the opposite sides of pump 131' to two different inlets of the shuttle valve. The single outlet 203 of this valve is connected to an outlet line 204 leading to the cylinder port 130'. Depending upon the direction in which pump 131' is driven, its output pressure is applied through either line 201 or line 202 to the shuttle valve 200 and thence through the shuttle valve outlet 203 to outlet line 204.

Check valve 139' is connected so that the flow direction through it is from the reservoir to the pump. The inlet side of check valve 139' is connected through a fluid line 205 to the filter 135' ahead of check valve 134'.

Relief valve 146' is connected between the pump output line 204 and line 205.

An adjustable needle valve 207 and an adjustable relief valve 208 are connected in series in the return line extending from the outlet line 204 back to the reservoir 136'.

In the operation of this system, when the speed of pump 131' (in either direction) is below a predetermined value, the hydraulic fluid being pumped is passed through the flow restriction provided by needle valve 207 and through relief valve 208 back to the reservoir. The fluid pressure at the cylinder inlet 130' will be insufficient to retract the piston 127'. Therefore, as in the FIG. 2 system, the brake 62 will be released.

If the pump speed increases above this predetermined value, in response to an increase in the speed of the ladder hoist drum 61 above a safe value, the needle valve 207 will be unable to pass the hydraulic fluid as fast as the pump 131' is delivering it. Consequently, the pressure in the outlet line 204 will increase and piston 127' will be retracted to the extent necessary to apply the brake 62 enough to slow down the ladder hoist drum 61 to a safe speed.

While two presently-preferred embodiments of this invention have been shown and described, it is to be understood that various modifications, omissions and refinements which differ from the disclosed embodiments may be adopted without departing from the spirit and scope of the invention.

What is claimed is:

1. In combination with a dredge having a ladder mounted to be raised and lowered, a power-operated ladder hoist drum rotatable in one direction when the ladder is being lowered and rotatable in the opposite direction to raise the ladder, a brake for said ladder hoist drum, control means connected to control the application of said brake, and a governor controlling the operation of said control means, said governor comprising a movable pressure responsive member operatively coupled to said control means to release the brake upon movement of said member in one direction and to apply the brake upon movement of said member in the opposite direction, spring means biasing said member in said one direction, and means for applying fluid pressure against said member to move the latter in said opposite direction, said last-mentioned means comprising a source of hydraulic fluid, a pump connected to said source to pump fluid therefrom, means coupling said ladder hoist drum to said pump to drive the pump in a direction and at a speed determined by the direction and speed of rotation of said drum, a fluid return line connected to the pump outlet to pass fluid from the pump when said drum is being rotated to lower the ladder, a flow restriction in said return line, and an outlet line connected between said pump outlet and said movable pressure responsive member for applying fluid pressure against the latter to move the latter in said opposite direction when the pump is being driven at a speed to pump hydraulic fluid faster than the same can be passed by said flow restriction.

2. In combination with a dredge having a ladder mounted to be raised and lowered, a power-operated ladder hoist drum rotatable in one direction when the ladder is being lowered and rotatable in the opposite direction to raise the ladder, a brake for said ladder hoist drum, pneumatic control means connected to control the application of said brake, and a governor controlling the operation of said pneumatic control means, said governor comprising a movable pressure responsive member operatively coupled to said pneumatic control means to release the brake upon movement of said member in one direction and to apply the brake upon movement of said member in the opposite direction, spring means biasing said member in said one direction, and means for applying fluid pressure against said member to move the latter in said opposite direction, said last-mentioned means comprising a source of hydraulic fluid, a pump connected to said source to pump fluid therefrom, means coupling said ladder hoist drum to said pump to drive the pump in a direction and at a speed determined by the direction and speed of rotation of said drum, a fluid return line connected to the pump outlet to pass fluid from the pump when said drum is being rotated to lower the ladder, an adjustable needle valve providing a flow restriction in said return line, and an outlet line connected between said pump outlet and said movable pressure responsive member for applying fluid pressure against the latter to move the latter in said opposite direction when the pump is being driven at a speed such that it pumps hydraulic fluid faster than the same can be passed by said flow restriction.

3. In combination with a dredge having a ladder mounted to be raised and lowered, a power-operated ladder hoist drum rotatable in one direction when the ladder is being lowered and rotatable in the opposite direction to raise the ladder, a brake for said ladder hoist drum, pneumatic control means connected to control the application of said brake, and a governor controlling the operation of said pneumatic control means, said governor

9

comprising a movable pressure responsive member operatively coupled to said pneumatic control means to release the brake upon movement of said member in one direction and to apply the brake upon movement of said member in the opposite direction, spring means biasing said member in said one direction, and means for applying fluid pressure against said member to move the latter in said opposite direction, said last-mentioned means comprising a source of hydraulic fluid, a pump connected to said source to pump fluid therefrom, means coupling said ladder hoist drum to said pump to drive the pump in a direction and at a speed determined by the direction and speed of rotation of said drum, a fluid return line connected to the pump outlet to pass fluid from the pump when said drum is being rotated to lower the ladder, a flow restriction in said return line, an outlet line connected between said pump outlet and said movable pressure responsive member for applying fluid pressure against the latter to move the latter in said opposite direction when the pump is being driven at a speed such that it pumps hydraulic fluid faster than the same can be passed by said flow restriction, a relief line connected between said outlet line and said reservoir, and a relief valve in said relief line operative to relieve pressure surges in said outlet line.

4. In combination with a dredge having a ladder mounted to be raised and lowered, a power-operated ladder hoist drum rotatable in one direction when the ladder is being lowered and rotatable in the opposite direction to raise the ladder, a brake for said ladder hoist drum, pneumatic control means connected to control the application of said brake, and a governor controlling the operation of said pneumatic control means, said governor comprising a movable pressure responsive member operatively coupled to said pneumatic control means to release the brake upon movement of said member in one direction and to apply the brake upon movement of said member in the opposite direction, spring means biasing said member in said one direction, and means for applying fluid pressure against said member to move the latter in said opposite direction, said last-mentioned means comprising a source of hydraulic fluid, a pump connected to said source to pump fluid therefrom, means coupling said ladder hoist drum to said pump to drive the pump in a direction and at a speed determined by the direction and speed of rotation of said drum, a fluid return line connected to one side of the pump to pass fluid from the pump when said drum is being rotated to lower the ladder, a flow restriction in said return line, an outlet line connected between said side of the pump and said movable pressure responsive member for applying fluid pressure against the latter to move the latter in said opposite direction when the pump is being driven at a speed such that it pumps hydraulic fluid faster than the same can be passed by said flow restriction, a relief line connected between said outlet line and said reservoir, a relief valve in said relief line operative to relieve pressure surges in said outlet line, and a flow restriction in said relief line between said outlet line and said relief valve.

5. In combination with a dredge having a ladder mounted to be raised and lowered, a power-operated ladder hoist drum rotatable in one direction when the ladder is being lowered and rotatable in the opposite direction to raise the ladder, a brake for said ladder hoist drum, pneumatic control means connected to control the application of said brake, and a governor controlling the operation of said pneumatic control means, said governor comprising a movable pressure responsive member operatively coupled to said pneumatic control means to release the brake upon movement of said member in one direction and to apply the brake upon movement of said member in the opposite direction, spring means biasing said member in said one direction, and means for applying fluid pressure against said member to move the latter in said opposite direction, said last-mentioned means comprising a source of hydraulic fluid, a pump connected

10

to said source to pump fluid therefrom, means coupling said ladder hoist drum to said pump to drive the pump in a direction and at a speed determined by the direction and speed of rotation of said drum, a fluid return line connected to one side of the pump to pass fluid from the pump when said drum is being rotated to lower the ladder, an adjustable flow restriction in said return line, an outlet line connected between said one side of the pump and said movable pressure responsive member for applying fluid pressure against the latter to move the latter in said opposite direction when the pump is being driven at a speed such that it pumps hydraulic fluid faster than the same can be passed by said flow restriction, a relief line connected between said outlet line and said reservoir, an adjustable relief valve in said relief line operative to relieve pressure surges in said outlet line, and an adjustable flow restriction in said relief line between said outlet line and said relief valve.

6. In combination with a dredge having a ladder mounted to be raised and lowered, a power-operated ladder hoist drum rotatable in one direction when the ladder is being lowered and rotatable in the opposite direction to raise the ladder, a brake for said ladder hoist drum, pneumatic control means connected to control the application of said brake, and a governor controlling the operation of said pneumatic control means, said governor comprising a movable pressure responsive member operatively coupled to said pneumatic control means to release the brake upon movement of said member in one direction and to apply the brake upon movement of said member in the opposite direction, spring means biasing said member in said one direction, and means for applying fluid pressure against said member to move the latter in said opposite direction, said last-mentioned means comprising a source of hydraulic fluid, a pump, means coupling said ladder hoist drum to said pump to drive the pump in a direction and at a speed determined by the direction and speed of rotation of said drum, an inlet fluid line extending from said reservoir to the side of the pump which is the inlet side when said drum is being rotated to lower the ladder, a first check valve in said inlet line operative to pass fluid only in the direction from the reservoir, a return line connected to the opposite side of the pump to pass fluid from the pump back to the reservoir when said drum is being rotated to lower the ladder, a second check valve in said return line operative to pass fluid only in the direction to the reservoir, a flow restriction in said return line ahead of said second check valve, an outlet line connected between said opposite side of the pump and said movable pressure responsive member for applying fluid pressure against the latter to move the latter in said opposite direction when the pump is being driven at a speed effective to pump hydraulic fluid faster than the same can flow through said flow restriction in the return line, a third check valve connected in parallel with said flow restriction in said return line and operative to pass fluid only in the direction from the reservoir toward the pump, a bypass line extending from said return line ahead of said second check valve therein to said inlet line behind said first check valve therein, a second flow restriction in said bypass line, and a relief valve connected between said outlet and inlet lines in parallel with said pump and operative to pass fluid only in a direction from said outlet line to said inlet line.

7. In combination with a dredge having a ladder mounted to be raised and lowered, a power-operated ladder hoist drum rotatable in one direction when the ladder is being lowered and rotatable in the opposite direction to raise the ladder, a brake for said ladder hoist drum, pneumatic control means connected to control the application of said brake, and a governor controlling the operation of said pneumatic control means, said governor comprising a movable pressure responsive member operatively coupled to said pneumatic control means to release the brake upon movement of said member in one direc-

tion and to apply the brake upon movement of said member in the opposite direction, spring means biasing said member in said one direction, and means for applying fluid pressure against said member to move the latter in said opposite direction, said last-mentioned means comprising a source of hydraulic fluid, a pump connected to said source to pump fluid therefrom, means coupling said ladder hoist drum to said pump to drive the pump in a direction and at a speed determined by the direction and speed of rotation of said drum, an inlet fluid line extending from said reservoir to the side of the pump which is the inlet side when said drum is being rotated to lower the ladder, a first check valve in said inlet line operative to pass fluid only in the direction from the reservoir, a return line connected to the opposite side of the pump to pass fluid from the pump to the reservoir when said drum is being rotated to lower the ladder, a second check valve in said return line operative to pass fluid only in the direction to the reservoir, a first adjustable needle valve in said return line ahead of said second check valve, an outlet line connected between said opposite side of the pump and said movable pressure responsive member for applying fluid pressure against the latter to move the latter in said opposite direction when the pump is being driven at a speed effective to pump hydraulic fluid faster than the same can flow through said needle valve, a third check valve connected in parallel with said needle valve in the return line and operative to pass fluid only in the direction from the reservoir toward the pump, a bypass line extending from said return line ahead of said second check valve therein to said inlet line behind said first check valve therein, a flow restriction in said bypass line, a relief valve connected between said outlet and inlet lines in parallel with said pump and operative to pass fluid only in a direction from said outlet line to said inlet line, a relief line connected between said outlet line and said reservoir, a second adjustable relief valve in said relief line operative to relieve pressure surges in said outlet line, and a second adjustable needle valve in said relief line ahead of said last-mentioned relief valve.

8. In combination with a dredge having a ladder mounted to be raised and lowered, a power-operated ladder hoist drum rotatable in one direction when the ladder is being lowered and rotatable in the opposite direction to raise the ladder, a brake for said ladder hoist drum, pneumatic control means connected to control the application of said brake, and a fluid-operated governor controlling the operation of said pneumatic control means, said governor comprising a movable pressure responsive member operatively coupled to said pneumatic control means to release the brake upon movement of said member in one direction and to apply the brake upon movement of said member in the opposite direction, spring means biasing said member in said one direction, and means for applying fluid pressure against said member to move the latter in said opposite direction, said last-mentioned means comprising a source of hydraulic fluid, a pump connected to said source to pump fluid therefrom, means coupling said ladder hoist drum to said pump to drive the pump in a direction and at a speed determined by the direction and speed of rotation of said drum, a pair of inlet fluid lines extending from said reservoir to opposite sides of said pump, check valves in said fluid lines, a pressure responsive valve having a pair of inlets connected respectively to the opposite sides of said pump and having an outlet, a return line extending from said valve outlet back to the reservoir, a flow restriction and a relief valve in said return line, an outlet line extending from said valve outlet to said movable pressure responsive member for applying fluid pressure against the latter to move the latter in said opposite direction when the pump is being driven at a speed effective to pump hydraulic fluid faster than the same can flow through said

flow restriction in said return line, and an additional relief valve connected between said valve outlet and said reservoir.

9. In combination a dredge, a ladder pivoted on said dredge for raising and lowering movement, hoist means connected to raise and lower said ladder, a brake connected to said hoist means normally applying sufficient braking force to prevent lowering of said ladder, power means connected to release said brake to a degree producing a braking force which is an inverse function of a control signal, separate manual and automatic means connected in series with said power means providing said control signal, said manual means producing a control signal having a value manually controlled, said automatic means being responsive to the rate of lowering movement of said ladder and reducing the value of said control signal when the rate of lowering movement of said ladder exceeds a predetermined rate.

10. In combination a dredge, a ladder on said dredge mounted for raising and lowering movement, a brake operatively connected to said ladder normally applying sufficiently braking force to prevent lowering of said ladder, pressure responsive means connected to said brake operable to reduce the braking force as an inverse function of a control pressure, a source of fluid pressure, manual and automatic controls connected in series between said source and pressure responsive means operable to supply said control pressure to said pressure responsive means, said manual control being operable to produce a control pressure variable manually by an operator, and said automatic control being responsive to the rate of lowering of said ladder and operating to reduce said control pressure when the rate of lowering of said ladder exceeds a predetermined rate.

11. In combination a dredge, a ladder mounted on said dredge for raising and lowering movement, a brake operatively connected to said ladder normally applying sufficient braking force to prevent lowering of said ladder, a pressure responsive brake release actuator connected to said brake operable by a control pressure to reduce said braking force as a control pressure increases, a source of fluid pressure, manual and automatic control valves operatively connected in series between said source and brake release actuator operable to supply said control pressure to said brake release actuator, said manual control valve being operable to produce said control pressure variable manually by an operator, and said automatic control valve being responsive to the rate of lowering of said ladder operating to reduce said control pressure when the rate of lowering of said ladder exceeds a predetermined rate.

12. In combination a dredge having a ladder, power means for raising and lowering said ladder, a brake connected to said power means normally applying sufficient braking force to prevent lowering of said ladder, a pressure responsive brake actuator connected to said brake operable by a control pressure to produce a braking force which is an inverse function of said control pressure, a source of fluid pressure, manual and automatic control means connected in series between said source and said brake actuator operable to supply said control pressure to said brake actuator, pump means connected to produce a predetermined hydraulic pressure in response to operation of said power means at a predetermined rate, said manual control means being operable to produce a control pressure variable manually by an operator, and said automatic control means connected to said pump means and operating to reduce said control pressure when said hydraulic pressure exceeds a predetermined value.

References Cited in the file of this patent

UNITED STATES PATENTS

2,461,311	Cushing	Feb. 8, 1949
2,714,943	Whaley	Aug. 9, 1955