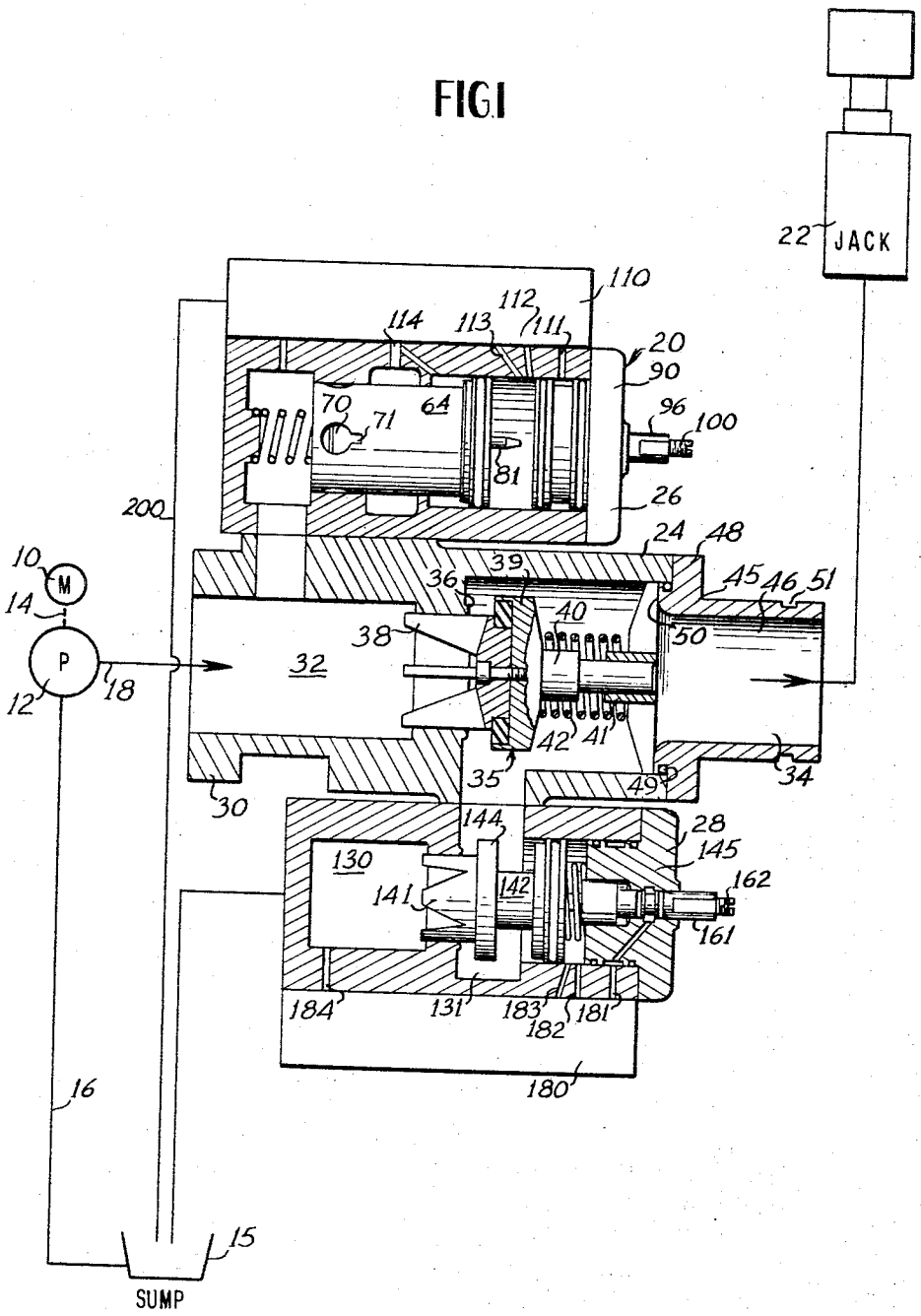
July 11, 1967 B. I. SPRAYBERRY 3,330,110

FLUID FLOW CONTROL SYSTEM

Filed July 6, 1965

3 Sheets-Sheet 1

FIG. 1



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FLUID FLOW CONTROL SYSTEM

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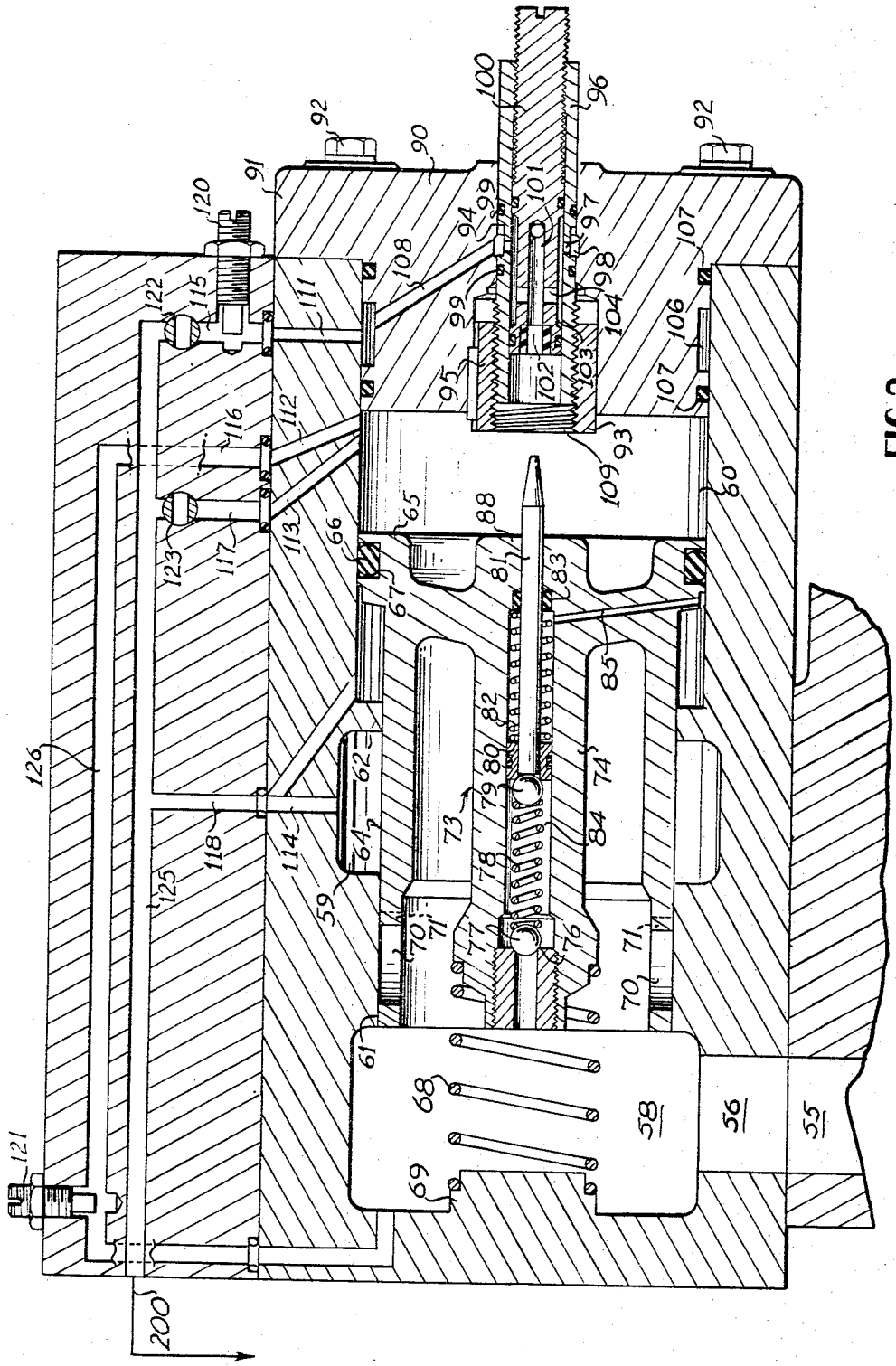


FIG. 2

July 11, 1967 B. I. SPRAYBERRY 3,330,110

FLUID FLOW CONTROL SYSTEM

Filed July 6, 1965 3 Sheets-Sheet 3

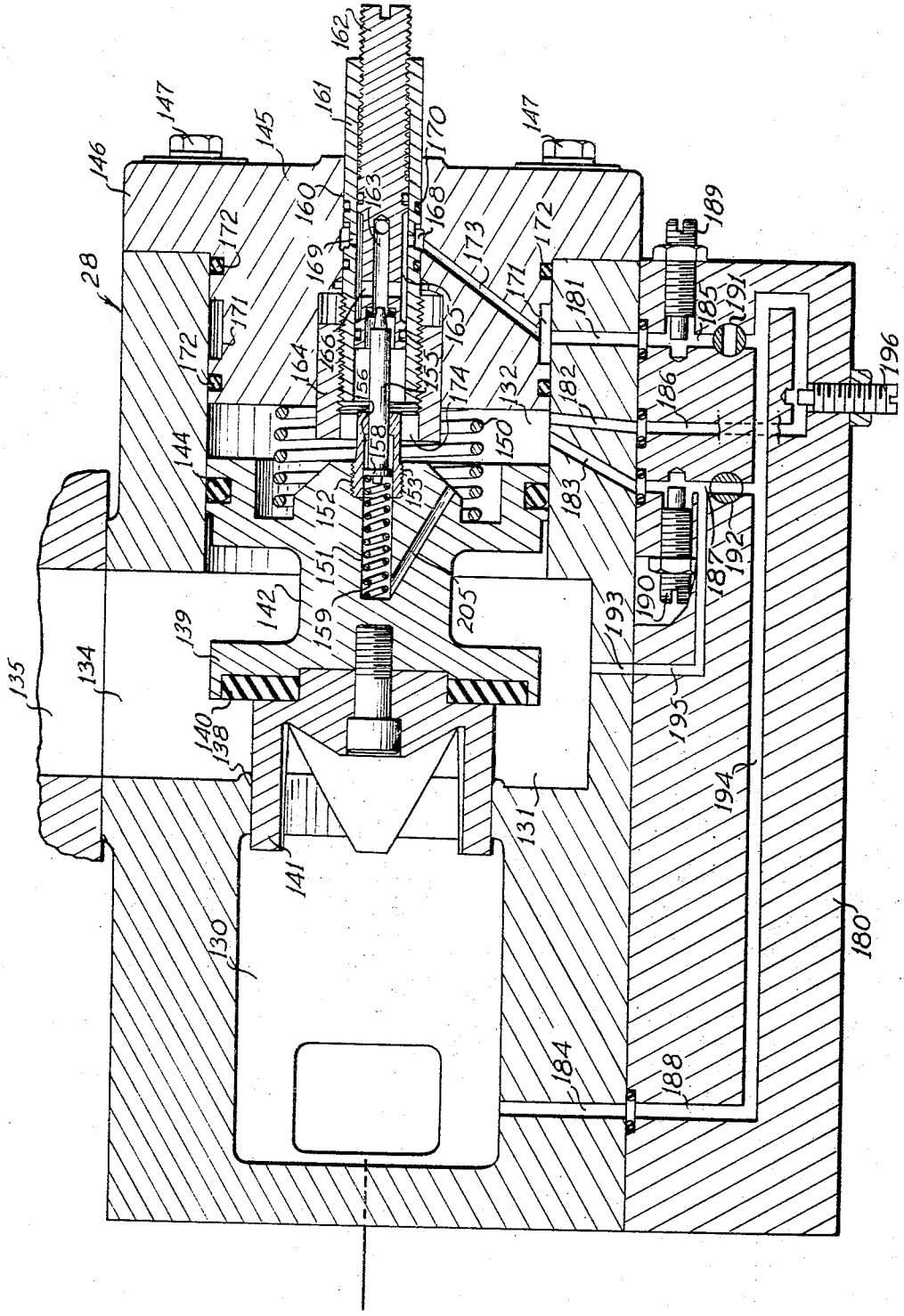


FIG 3

United States Patent Office 3,330,110 Patented July 11, 1967

3,330,110

FLUID FLOW CONTROL SYSTEM

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Filed July 6, 1965, Ser. No. 469,716
17 Claims. (Cl. 60—52)

This invention relates to a fluid flow control system for elevators and the like, and is more particularly directed to a valve mechanism which controls the flow of fluid between the pump and the jack of an elevator system.

In the past, the elevator industry has developed various methods of smoothly accelerating and decelerating elevator cars so that the passengers carried by these cars would not be needlessly and uncomfortably jerked and bumped by the cars at the beginning of and near the end of their movements between floors. The various apparatus developed to perform these functions is quite expensive, and the result has been that a smoothly operating elevator is quite costly. Over the years, however, the industry has endeavored to improve the smooth acceleration and deceleration characteristics in passenger elevator cars while increasing the speed of operation, all at a minimum of cost. However, until the development of this invention, the only successful way in reducing the cost of passenger elevators was to sacrifice the desirable acceleration and deceleration characteristics.

Thus, the present invention provides a method and apparatus for economically controlling the acceleration and deceleration characteristics of an elevator car by allowing the fluid pumped by the elevator pump to be initially bypassed back to the sump when the elevator motor is initially actuated, so that a gradual build-up of pressure can be obtained in the elevator jack which smoothly accelerates the elevator in the upward direction, and which opens slowly to begin bypassing fluid pumped from the elevator pump toward the jack to smoothly decelerate the elevator when approaching the desired floor level; and when traveling in the downward direction a valve is progressively opened to drain fluid from the jack that allows the elevator to smoothly accelerate in its downward direction, and when the elevator car approaches the desired floor level, the valve is progressively moved toward its closed position so the liquid being drained from the jack is restricted through a progressively narrowing aperture whereby the elevator car is decelerated gradually until it reaches a predetermined slow speed just prior to reaching its desired floor level, whereupon the valve is completely closed when the car reaches its desired level.

Accordingly, it is an object of this invention to provide an economical and efficient fluid flow control system for an elevator so that the elevator car is rapidly smoothly accelerated and decelerated when traveling between floors of a building.

Another object of this invention is to provide a method and apparatus for accurately controlling the acceleration and deceleration characteristics of a hydraulic jack.

Another object of this invention is to provide a method and apparatus for accurately controlling the acceleration and deceleration of a reversible hydraulic jack.

Numerous other objects, features and advantages of the present invention will be apparent from consideration of the following specification, taken in conjunction with the accompanying drawing, in which:

FIG. 1 is a partial cross-sectional view of the valve mechanism of the fluid flow control system, with the components outside the valve structure being shown in schematic form.

FIG. 2 is a cross-sectional view of the up start-up and leveling valve mechanism.

FIG. 3 is a cross-sectional view of the lowering down leveling valve mechanism.

Referring now more particularly to the drawing, an electric motor **10** of conventional design is connected to a hydraulic pump **12** by the connection **14**. The pump **12** receives liquid from the sump **15** through the conduit **16** and pumps through the conduit **18** toward the valve mechanism **20**, and ultimately toward the jack **22**.

Main valve

The valve mechanism **20** is composed of three parts, the main valve **24**, the up start-up and leveling valve **26** and the lowering down-leveling valve **28**. The main valve **24** is adapted to be attached to the pump **12** by the flanged portion **30**, and comprises a central channel **32** having an entrance portion **33** and exit portion **34** which are divided by the check valve mechanism **35**.

The check valve mechanism **35** comprises an annular valve seat **36**, a valve guide **38** and a valve disc **39** attached to the guide **38** and arranged to seat on the valve seat **36**. A valve stem **40** is connected to the valve disc **39** on the side opposite from the guide **38** and is slidably received within the guide member **41**. With this arrangement, high pressure of the liquid in the entrance portion **33** and a low pressure in the exit portion **34** of the central channel will cause the check valve mechanism to open to the position shown in FIG. 1 so that the liquid in the entrance portion **33** will flow around the annular valve seat **36**, the valve disc **39**, and past the guide **41** toward the jack **22**. When the pressure differential is reversed, the valve disc **39** will be guided by the guide **38** and the guide **41** so that the valve disc **39** will seat on the valve seat **36** to prevent the liquid from flowing from the jack **22** toward the pump **12**. A return spring **42** is positioned between the guide **41** and the valve disc **39** so that the disc **39** is normally biased by the spring toward its seat **36** so that unless there is a pressure differential across the valve disc **39**, it will remain in its seated position.

The main valve **24** has a discharge closure **45** with a channel **46** therethrough which is coincident with the central channel **32** of the main valve **24**. The discharge closure **45** is attached to the main valve **24** at a flanged portion **48** and an O-ring seal **49** is inserted between the discharge closure and the main valve to prevent leakage therebetween. The discharge closure **45** has an abutment portion **50** that tends to maintain the guide **41** of the check valve mechanism **35** in its proper position. Also, the discharge closure **45** has an annular groove **51** thereabout which functions to receive a clamping means for clamping a resilient conduit onto the closure so that the liquid pumped by the pump **12** through the check valve mechanism can be conveyed to the jack **22**.

Up start-up and leveling valve

The main valve **24** has a conduit **55** in its entrance portion **33** that communicates on the upstream side of the check valve mechanism **35** with the up start-up and leveling valve **26**. The up start-up and leveling valve **26** communicates with the conduit **55** of the main valve **24** through its conduit **56**, and comprises generally a main chamber **58**, a by-pass chamber **59**, and an actuating chamber **60**. The main chamber **58** and the by-pass chamber **59** are separated by an annular valve seat **61**, and the by-pass chamber **59** and the actuating chamber **60** are separated by the annular control spool guide **62**.

A control spool **64** is positioned in the up start-up and leveling valve **26** so that it communicates with all three chambers, main chamber **58**, by-pass chamber **59**, and actuating chamber **60**. The control spool **64** has an annular flange **65** positioned in the actuating chamber **60** which is arranged to slide with relation to the wall of the

chamber and formed so that an O-ring seal **66** is positioned within an annular groove **67** of the flange **65** to seal the actuating chamber **60** from the by-pass chamber **59**. An opening spring **68** is positioned between an abutment **69** in the main chamber **58** and the control spool **64** so that the control spool **64** will be biased toward the right as shown in FIG. 1, in its open position.

The control spool **64** is cylindrically shaped and has a plurality of apertures **70** at its end remote from the annular flange **65**, which apertures **70** are arranged to be sealed on their outer sides by the annular valve seat **61** when the control spool **64** is in the position shown in FIG. 1. When the control spool **64** is partially withdrawn from the annular valve seat **61** toward the right as shown in FIG. 1, it can be seen that the apertures **70** will communicate with the by-pass chamber **59**. Since the conduit **55** of the main valve **24** communicates with the conduit **56** of the up start-up and leveling valve **26**, which in turn communicates with the main chamber **58**, it can be seen that the liquid in the entrance portion **33** of the main valve **24** will communicate through the apertures **70** of the control spool **64** through the interior portion **72** of the control spool and ultimately, the by-pass chamber **59**.

The control spool **64** has a leveling mechanism located centrally thereof. The leveling mechanism **73** comprises a barrel **74** which is coaxial with the control spool **64**, and which has a bottom ball check seat **76**, a bottom ball check valve **77**, a retaining spring **78**, a top ball valve **79**, a compensating piston **80**, a leveling needle **81**, a compensating spring **82**, and an O-ring seal **83**. The bottom ball check valve **77** is arranged to be withdrawn from the check seat **76** by the pressure of the liquid in the main chamber **58** so that a predetermined amount of liquid can enter the chamber behind the check valve **77** to force the compensating piston **80** to the right, as shown in FIG. 2, and force the leveling needle **81** to protrude outwardly, toward the right as shown in FIG. 2, of the barrel **74**. It can be seen that if the leveling needle **81** is forced against the top ball valve **79** that the liquid trapped behind the bottom ball check valve **77** will be allowed to escape past the top ball valve **79** into the compensating spring chamber **84** and out of the valve **74** through the conduit **85**. This, of course, will allow the compensating piston **80** to retain its original position and the leveling needle **81** will be withdrawn into the barrel **74** of the leveling mechanism **73**.

An end cap **90** is connected to one end of the up start-up and leveling valve **26** by its flanged portion **91** and cap screws **92** so that it forms an end wall of the actuating chamber **60**. The end cap **90** has an aperture **94** located centrally thereof which is aligned with the leveling needle **81** of the control spool **64**. The aperture **94** of the end cap **90** is counter-bored at **95** and an adjustable screw **96** is threaded into the aperture **94**. The adjustable screw **96** is hollow and has a plurality of apertures **97** arranged radially therearound at the approximate midpoint of its length, and an annular groove **98** in the adjustable screw **96** communicates with each of the apertures **97**. An O-ring seal arrangement **99** is positioned on each side of the annular groove **98**. An adjustable nut **93** is positioned in the counter-bored portion **95** of the end cap **90** and adjustably threaded onto the adjustable screw **96**.

A leveling speed screw **100** is threaded into the hollow portion of the adjustable screw **96**. The leveling speed screw **100** has a bore **101** at its interior portion, an exterior annular groove therearound along a portion of the length of the screw occupied by the bore **101**, and a plurality of ports are bored through the leveling speed screw **100** between the bore **101** and the annular groove **103**, whereby the bore **101** communicates with the annular groove **103**.

The end of cap **90** has an annular groove **106** thereabout which communicates with the casing of the up start-up and leveling valve **26**. O-ring seal arrangements **107** are positioned on each side of the annular groove **106**

so that a sealed annular chamber is created by the annular groove **106** and the casing of the up start-up and leveling valve **26**. A conduit **108** is positioned so that it communicates the annular chamber **106** with the aperture **94** in the end cap **90** in the vicinity of the annular groove **98** of the adjustable screw **96**. With this arrangement, it can be seen that a fluid passage is created between the actuating chamber **60** of the up start-up and leveling valve **26**, through the open end of the adjustable screw, through the bore **101** of the leveling speed screw **100**, through the ports **104**, to the grooved portion **103** of the leveling speed screw **100**, through the apertures **97** of the adjustable screw **96**, through the annular groove **98** and through the conduit **108** to the annular chamber **106**.

Since the aperture **94** of the end cap **90** is coaxial with the leveling mechanism **73** of the control spool **64** of the upstart-up and leveling valve **26**, it can be seen that when the control spool **64** is positioned toward the right of FIG. 1 of the drawing, the leveling needle **81** will enter the hollow end of the adjustable screw **95** and the bore **101** of the leveling speed screw **100** to block or partially block, the aforementioned fluid passageway created by the construction of the leveling speed screw, adjustable screw, and end cap. Also, the projection **88** of the control spool **64** will come to rest on the adjustable nut **93**, thereby limiting the movement of the control spool in this direction.

An up start-up manifold **110** is connected to the casing of the up start-up and leveling valve **26**. The casing of the up start-up and leveling valve **26** has conduits **111**, **112**, **113** and **114** communicating therethrough with the conduits **115**, **116**, **117** and **118** of the manifold **110**, respectively. Adjustment screws **120** and **121** are located in the conduits **115** and **116** respectively. The adjustment screws function to determine the effective opening of these conduits and adjustably restrict the flow of liquid therethrough. A solenoid actuated up leveling pilot valve **122** is located in the conduit **115**, and a solenoid actuated unloader pilot relief valve **123** is positioned in the conduit **117**. The conduits **115**, **117** and **118** each communicate with the low pressure conduit **125**, which in turn communicates with the by-pass chamber **59** of the up start-up and leveling valve **26**. The conduit **116** communicates with the pump pressure conduit **126**, which in turn is connected to the main chamber **58**.

Lowering-down leveling valve

The lowering down-leveling valve **28** comprises three chambers; low pressure chamber **130**, main chamber **131** and actuating chamber **132**. A conduit **134** communicates the main chamber **131** with the conduit **135** of the main valve. The conduit **135** of the main valve **24** is located down stream of the check valve mechanism **35** so that the pressure of the liquid entering the main chamber **134** is substantially the same as that in the exit portion **34** of the main valve **24**. The lowering down-leveling valve **28** includes a valve seat **138** that separates the low pressure chamber **130** from the main chamber **131**, and a valve mechanism **139** is located centrally of the lowering down-leveling valve **28**. The valve mechanism **139** has a valve disc **140** which is arranged to seat on the valve seat **138**, and the valve guide **141** is arranged to guide the valve mechanism toward the valve seat **138**. The valve mechanism **139** includes a valve spool **142** which is connected to the valve disc **140** at one end and to an annular flange **144** at its other end. The annular flange **144** has an O-ring seal arrangement therein which is adapted to seal the main chamber **131** of the lowering down-leveling valve **28** from the actuating chamber **132**.

An end cap **145** closes the lowering down-leveling valve **28** at the end, remote from the low pressure chamber **130**, and is connected thereto by the flange portion **146** and the cap screws **147**. A closing spring **150** is positioned between the end cap **145** and the valve spool **142** so as to bias the valve mechanism toward its seated

position to prevent the communication of the liquid between the low pressure chamber **130** of the lowering down leveling valve **28** and the exit portion **34** of the main valve **24**.

The valve spool **142** of the valve mechanism **139** has a central bore **151** which is co-axial with said valve spool **142**. The central bore **151** is counterbored at **152** and a needle guide **153** is threaded therein. A leveling needle **155** is positioned within the central bore **151** and the internal portion of a needle guide **153** and the outward movement thereof is limited by the flanged portion **158** of the needle abutting the flanged portion **156** of the needle guide **153**. A spring **159** is positioned in the central bore **151** and adapted to bear against the flanged portion **158** of the leveling needle **155** to urge the same outwardly of the central bore **151**.

The end cap **145** is centrally bored at **160** in the same manner as the end cap **90** of the up start-up and leveling valve **26**, and an adjustable screw **161** and a leveling speed screw **162**, each essentially of the same configuration as the adjustable screw **96** and the leveling speed screw **100**, respectively, of the up start-up and leveling valve **26** are positioned with the aperture **160** of the end cap **145**. The leveling speed screw **162** is bored at **163**, grooved at **165** and apertured at **166**, all in the same manner as in the leveling speed screw **100** of the up start-up and leveling valve **26**. The adjustable screw **161** is grooved at **168**, apertured at **169**, and sealed at **170** all in the same fashion as the adjustable stop screw **96** of the up start-up and leveling valve **26**. Furthermore, the end cap **145** has an annular groove **171**, sealing means **172** and a conduit **173**, all in the same fashion as the end cap **90** of the up start-up and leveling valve **26**. Accordingly, a fluid passageway is created between the actuating chamber **132** of the lowering down-leveling valve **28** and the annular chamber **171** defined by the casing of the lowering-down leveling valve **28** and the annular groove **171** of the end cap **145** through the passageway formed through the end of the adjustable screw **161**, and bore **163** of the leveling speed screw **162** ports **166** and annular groove **165** of the leveling speed screw **162**, apertures **169** and annular groove **168** of the adjustable screw **161** and the conduit **173** of the end cap **145**.

While a fluid passageway is created in this manner, it should be noted that movement of the valve mechanism **139** of the lowering-down leveling valve **28** to the right as shown in FIG. 1, will cause the leveling needle **155** to enter the bore **163** of the leveling speed screw **162** and block or partially block the liquid passageway so created. Furthermore, movement of the valve mechanism **139** to the right will cause the portion of the valve spool **142** immediately surrounding the needle guide **153** to abut on adjustable stop nut **164**, similar to that of the up start-up and leveling valve **26**, thus, limiting the movement of the valve mechanism **139** in this direction.

As with the up start-up and leveling valve **26**, a lowering down-leveling valve manifold **180** is connected to the lowering down-leveling valve **28**, and the conduits **181**, **182**, **183**, **184**, and **193** lead from various portions of the lowering down-leveling valve **28** to the conduits **185**, **186**, **187**, **188** and **195** of the lowering down-leveling valve manifold **180**, respectively. Adjustment screws **189** and **190** are located so as to adjustably restrict the conduits **185** and **187**, respectively. A solenoid actuated down leveling pilot valve **191** communicates with the conduit **185**, and a solenoid actuated lowering pilot valve **192** communicates with the conduit **187**, down stream of the juncture of conduit **195** with conduit **187**. The pilot valve **192** is large enough to handle the fluid flowing from both the conduit **195** and conduit **187**. The conduits **185** and **187** also communicate down stream of their respective pilot valves with the low pressure conduit **194**, which in turn communicates with the low pressure chamber **130** through the conduits **188** and **184**. The conduit **186** also communicates with the conduit **194**, which in turn communicates with the low pressure chamber **130**. The adjustment screw **196** which is normally closed, adjustably restricts the flow through the conduit **186**, in order to provide a means of manually opening the valve.

Operation

When the motor **10** is not running, and the pump **12** is not creating a fluid pressure in the line **18**, the return spring **42** of the check valve mechanism **35** in the main valve **24** and the line pressure from the elevator jack will cause the valve mechanism **35** to be closed, the opening spring **68** of the up start-up and leveling valve **26** will cause the control spool **64** to be moved to the right as viewed in FIG. 1 so that the ports **70** will be in their unblocked position and the up start-up and leveling valve **26** will be in its open position, and the closing spring **150** of the lowering down-leveling valve **28** and the line pressure from the elevator jack will cause the valve mechanism **139** to be in its closed position. Thus, when the motor **10** is initially actuated and the pump **12** begins to pump liquid through the conduit **18** into the central channel **32** of the main valve **24**, the liquid will initially be channeled through the opened up start-up and leveling valve **26** to its by-pass chamber **59**, back through the return conduit **200** to the sump **15**.

Up start-up and leveling valve operation

When the motor begins to reach its normal operating speed the pressure created in the conduit **18** will raise the pressure in the conduit **126** so that the liquid will communicate through conduits **126**, **116**, and **112** to flow into the actuating chamber **60** of up start-up and leveling valve **26**. As the liquid pressure builds up in the actuating chamber **60** it forces the control spool **64** against the bias of this opening spring **68** toward the left as shown in FIG. 1 toward its closed position, thus gradually choking off the flow of liquid from the main valve **24** through the up start-up and leveling valve **26**, as the control spool **64** closes the main check valve **39** opens under the pressure of the pump so that the liquid begins to flow to the jack **22** to operate the elevator.

As the control spool **64** approaches its fully closed position the apertures **70** are progressively closed by the annular valve seal **61**, and in order to prevent an abrupt choking off of the flow of fluid through the up start-up and leveling valve **26**, the circular apertures **70** are formed with small key ways **71** which effectively extend the opening of the apertures **70** beyond the limits of their circular configuration so that when the entire circular aperture **70** is covered the key ways **71** will remain in temporary communication with the by-pass chamber **59** so that an abrupt closing is not effected on the system. The control spool **64** subsequently progresses further into its fully closed position and the key ways **71** of the apertures **70** are ultimately withdrawn from communication with the by-pass chamber **59**.

As the control spool **64** of the up start-up and leveling valve **26** moves toward its closed position, the pressure created in the main chamber **58** acts against the bottom ball check valve **77** to cause it to move away from its seat **76**, and a small portion of the liquid in the main chamber **58** enters the chamber of the barrel **74** behind the bottom ball check valve **77**. This increased pressure in the chamber of the barrel **74** causes the compensating piston **80** to move toward the right, as seen in FIGS. 1 and 2, so that the top ball valve **79**, compensating piston **80** and leveling needle **81** are also moved to the right, and the leveling needle is caused to protrude further from the barrel **74** of the control spool **64**. After the control spool **64** is moved to its fully closed position by the liquid in the actuating chamber **60**, and the pressure in the main chamber **58** is equalized with presure behind the compensating piston **80** and the bottom ball check valve **77** will move to its closed position by the retaining

spring 78. Thus, the leveling needle 81 will remain in its projected position until the liquid behind the compensating piston 80 is removed.

As the elevator car approaches the floor desired by its operator, the solenoid actuated up leveling pilot valve 122 located in the up start-up manifold 110 is actuated to open the conduit 115 and allow the liquid in the actuating chamber 60 to flow through the adjustable stop nut 93, leveling speed screw 100, end cap 90 and conduit 111, through the conduit 115 to the low pressure conduit 125, through the conduit 200, back to the sump 15. The adjustment screws 120 and 121 are adjusted so that the flow of liquid to the actuating chamber 60 through the conduit 116 is slower than the flow of the liquid being removed from the actuating chamber 60 through the conduit 115. Thus, the liquid will escape from the actuating chamber 60 at a faster rate than it enters, causing the control spool 64 to move toward its open position.

After the control spool begins movement towards its open position, the leveling needle 81 will enter the open end of the leveling speed screw 100 to partially block the fluid passage therethrough. Thus, the rate of the liquid flowing out of the actuating chamber 60 will be progressively diminished as the leveling needle 81 enters the leveling screw 100 until the liquid flowing out of the chamber 60 is flowing at the same rate as the liquid flowing into the chamber. With this arrangement it can be seen that the control spool 64 will be moved toward its fully opened position only to the extent permitted by the leveling needle 81 as it enters the leveling speed screw 100.

Since both the by-pass adjusting screw 96 and the leveling speed screw 100 are adjustable, they can be inserted into the end cap 90 and adjusted to any preselected position so that the leveling needle 81 will enter and block the fluid communicating therethrough at a preselected position, whereby the extent of a movement of the control spool is selectively adjustable.

After the control spool 64 is moved to its partially opened position, as described above, the elevator car will continue to slowly move to the level preselected by its operator until the preselected level is reached, and the solenoid actuated unloader pilot relief valve 123 and the off switch (not shown) of the motor 10 are actuated simultaneously so that the pump 12 stops and the conduit 117 leading from the actuating chamber 60 of the up start-up and leveling valve 26 is opened to drain the fluid remaining in the actuating chamber back to the sump 15, at the same time the main valve assembly 35 is moving to its closed position so that it is just cracked and closes when the pressure flow stops. Thus, the control spool 64 will be urged to its full opened position by the opening spring 68 and the liquid pressure remaining in the central channel 32 of the main valve 24 will be by-passed back to the sump 15 through the up start-up and leveling valve 26, and the leveling needle 81 will be forced against the bore 101 of the leveling speed screw 100 so that it will cause the top ball valve 79 to be removed from the compensating piston 80 and allow the liquid trapped in the chamber of the valve 74 to flow through the compensating spring chamber 84 and through the conduit 85 to a low pressure area, whereupon the leveling needle 81 will be repositioned to its withdrawn position inside the valve 74 by the compensating spring 82.

Lowering down leveling valve operation

When the elevator car is to be moved in a downward direction, the liquid that was formerly forced to the jack 22 to move the elevator car in an upward direction will be allowed to flow out of the jack. It can be seen that the liquid communicating with the jack 22 through the main valve 24 on the down stream side of the check valve mechanism 35 will be free to communicate with the lowering down-leveling valve 28 through the conduits 134 and 135. In order to allow the liquid to flow from the jack 22 through the lowering down-leveling valve 28 back to the sump 15 the solenoid actuated lowering pilot valve 192 in the lowering down-leveling valve manifold 180 which has a capacity large enough to exhaust fluid through both conduits 187 and 195 are opened so that the liquid pressure in the actuating chamber 132 behind the valve mechanism 139 is reduced and the pressure in the main chamber 131, which is the same as the pressure in the main chamber 131, which is the same as the pressure on the jack 22, will cause the valve mechanism 139 to move to its opened position, towards the right as viewed in FIG. 1. Since the seat 138 of the valve mechanism 139 defines an aperture leading to the low-pressure chamber 130 that is smaller in area than the area of the actuating chamber 132, the liquid pressure in the main chamber has a larger surface in the flanged portion 144 of the valve spool 142 to act on than in the valve disc 139. Thus, the liquid pressure in the main chamber exerts a force toward the right on the valve spool 142, as viewed in FIG. 1. The reduction of the pressure in the actuating chamber 132 causes a total pressure differential across the valve mechanism (the pressure against the flanged portion 144 of the valve spool minus the pressure of the liquid in the actuating chamber 132 minus the force of the closing spring 150 plus the pressure of the liquid in the low pressure chamber 130) to move the valve mechanism to its opened position, thereby allowing the liquid to flow from the jack 22 to the low pressure chamber 130, back to the sump 15 through the conduit 204, thereby lowering the elevator car.

As the valve mechanism 139 is positioned in its fully opened position the portion of the valve spool 142 immediately surrounding the needle guide 153 will abut the adjustable stop nut 164 and the leveling needle 155 will abut the edge of the bore 163 of the leveling speed screw 162. The leveling speed screw 162 is adjusted to a position where it will come into contact with the leveling needle 155 before the valve spool 142 abuts the adjustable stop screw 161 and the spring 159 will allow the leveling needle to be retracted inside the needle guide 153 and central bore 151. Any liquid trapped in the central bore 151 behind the flanged portion 158 of the leveling needle 155 will be allowed to escape through the conduit 205 leading from the central bore 151 to the actuating chamber 132.

As the elevator car travels in a downward direction and approaches the level desired by its operator the solenoid actuated lowering pilot valve 192 is deactuated so that it closes the conduit 187 and the solenoid actuated down-leveling pilot valve 191 is actuated so that it opens the conduit 185. The actuation of the valves 191 and 192 in this manner is simultaneous. The pressure of the fluid from the jack 22 is continuously communicated through the main valve 24, main chamber 131 of the lowering down-leveling valve 28, its conduit 193, conduits 195 and 187 of the lowering down-leveling manifold 180, through the conduit 183 to the actuating chamber. Accordingly, when the lowering pilot valve 192 is deactuated so that the conduit 187 is closed, the pressure is allowed to build up in the actuating chamber 132 behind the valve mechanism 139, thus, causing the valve mechanism to begin movement toward its closed position.

As the valve mechanism 139 moves toward its closed position, it will allow the leveling needle 155 to remain projected into the leveling speed screw 162 under the bias of the spring 159 until the flanged portion 158 of the leveling needle comes in contact with the flanged portion 156 of the needle guide 153, whereupon the leveling needle begins to withdraw from the bore 163 of the leveling speed screw 162. As the leveling needle withdraws from the leveling speed screw 162 a fluid passageway is opened between the actuating chamber 132, through the leveling speed screw 162, by-pass ad-

justing screw **161**, conduit **173** of the end cap **145**, annular chamber **171**, and the conduits **181**, **185**, **194**, **188**, and **184** to the low pressure chamber **130**. This allows the liquid flowing into the actuating chamber **132** to begin to be exhausted from the actuating chamber, and continued movement of the valve mechanism **139** toward its closed position will further withdraw the leveling needle **155** from the adjustable stop screw **161** and the leveling speed screw **162** until the flow of liquid into the actuating chamber **132** is equal to the flow of liquid being exhausted from the actuating chamber **132**, whereupon the valve mechanism **139** stops its movement toward its closed position. Thus, the flow of liquid from the jack through the main valve **24**, past the valve mechanism **139**, is gradually choked off so that the jack is progressively decelerated.

When the elevator car reaches the level desired by its operator, the solenoid actuated down leveling pilot valve **191** is deactuated so that the valve **191** is closed to stop the flow of liquid from the actuating chamber **132** through the adjustable stop screw **161** and the leveling speed screw **162**, whereupon the liquid flowing through the conduit **195** from the main chamber **131** to the actuating chamber **132** causes the valve mechanism **139** to move to the left as viewed in FIG. 1, until it is completely seated on the valve seat **138**, thereby stopping the flow of liquid through the lowering down-leveling valve **28**, and further operation of the jack **22** and elevator car.

It can be seen that the configuration of the guide **141** of the valve mechanism **139** is such that the valve will function to initially open with a small opening and then gradually build into a large opening for large volume liquid flow and close with a gradual closing function, so that when either opening or closing the valve will not cause the flow of liquid therethrough to surge.

The adjustment screw **190** is adjusted so that the flow of liquid through the conduit **183** is not too rapid to cause the valve mechanism **139** to suddenly move to the right to start the elevator down with a jerk. Lowering pilot valve **192** has enough capacity to handle both the pressure flow through both conduits **195** and **187**. The rate of flow through conduit **187** is adjusted by means of adjustment screw **190**.

When lowering pilot valve **192** is closed, the flow continues in by adjusting screw **190** through conduit **183** but down-leveling pilot valve **191** is actuated so that even though the leveling needle **155** is projected into the fluid passageway through the leveling speed screw **162** some oil starts to flow out through conduit **163**, **166**, **165**, **169**, **168**, **173**, **171**, **181**, by adjusting screw **189**, **185**, through down-leveling pilot valve **191**, **199**, **188**, **184** to to the low pressure chamber **130**.

It will be obvious to those skilled in the art that many variations may be made in the embodiments chosen for the purpose of illustrating the present invention without departing from the scope thereof as defined by the appended claims.

I claim:

1. Apparatus for controlling the movement of an elevator car, comprising:

(A) a motor,

(B) a pump having an inlet and an outlet connected to said motor,

(C) a valve mechanism associated with said pump, said valve mechanism comprising:

(1) a main valve comprising:

(a) a casing having an inlet connected to the outlet of said pump,

(b) a check valve mechanism,

(c) a first by-pass outlet upstream of said check valve mechanism,

(d) a second by-pass outlet downstream of said check valve mechanism,

(e) a discharge outlet downstream of said check valve mechanism,

(2) an up start-up and leveling valve mechanism, comprising:

(a) a casing having an inlet connected to said first by-pass outlet and an outlet,

(b) a valve positionable between said inlet and said outlet to control the flow of fluid therebetween,

(c) spring means biasing said valve toward its open position,

(d) an actuating chamber,

(e) means continuously communicating said pump outlet with said actuating chamber so that fluid flows from said pump to said actuating chamber at a predetermined rate to close said valve,

(f) first means for selectively communicating said actuating chamber with said pump inlet so that fluid flows from said actuating chamber toward said pump at a rate greater than said predetermined rate to open said valve,

(g) second means for selectively communicating said actuating chamber with said pump inlet so that fluid flows from said actuating chamber toward said pump at a rate greater than said predetermined rate to open said valve,

(h) restricting means carried by said valve for restricting the flow of fluid through said second means so that when said valve is in a predetermined partially open position the flow of fluid through said second means is equal to the flow of fluid through said continuously communicating means,

(3) a lowering down-leveling valve mechanism, comprising:

(a) a casing having an inlet connected to said second by-pass outlet and an outlet,

(b) a valve positionable between said inlet and said outlet to control the flow of fluid therebetween,

(c) spring means biasing said valve toward its closed position,

(d) an actuating chamber,

(e) means continuously communicating said main valve discharge outlet with said actuating chamber so that fluid flows from said main valve discharge outlet to said actuating chamber at a predetermined rate to close said valve,

(f) first means for selectively communicating said actuating chamber with said pump inlet so that fluid flows from said actuating chamber toward said pump at a rate greater than said predetermined rate to open said valve,

(g) second means for selectively communicating said actuating chamber with said pump inlet so that fluid flows from said actuating chamber toward said pump at a rate greater than said predetermined rate to open said valve,

(h) restricting means carried by said valve for restricting the flow of fluid through said second means so that when said valve is in a predetermined, partially open position the flow of fluid through said second means is equal to the flow of fluid through said continuously communicating means,

(D) a jack communicating with said discharge outlet of said main valve, and

(E) an elevator car operatively connected to said jack.

2. An apparatus of the type for controlling fluid flow

to an elevator jack having a motor, a pump, a sump, a jack and a main valve mechanism between said pump and said jack whereby fluid is pumped from said sump through said valve to said jack, the combination therewith of an up start-up and leveling valve comprising:

(A) a casing having a main chamber, an actuating chamber and a by-pass chamber,

(B) an inlet to said main chamber communicating with the upstream side of said main valve mechanism,

(C) an outlet from said by-pass chamber communicating with said sump,

(D) a control spool positionable between said inlet and said outlet to close and open fluid communication therebetween,

(1) said control spool extending into said actuating chamber,

(E) a spring means biasing said control spool into said actuating chamber to open said valve,

(F) means for communicating the output of said pump with said actuating chamber,

(G) first selectively actuatable means for communicating said actuating chamber with said sump,

(H) second selectively actuatable means for communicating said actuating chamber with said sump,

(I) means associated with said control spool for limiting the rate of communication of said second selectively actuatable means.

3. An apparatus of the type for controlling the flow of a fluid having a check valve mechanism with an inlet and an outlet upstream of a check valve and at least one outlet downstream of said check valve, the combination therewith of a valve mechanism having an inlet communicating with said up stream outlet and an outlet, a control spool for opening and closing communication between the inlet and outlet of said valve mechanism, means for biasing said control spool toward its open position, said control spool defining an actuating area, a source of fluid pressure for communicating with said actuating area to move said control spool toward its closed position, means for communicating said actuating area with a source of low pressure, a leveling needle carried by said control spool and adapted to be actuated by said source of fluid pressure so as to project outwardly of said control spool to limit said means for communicating, and means for deactuating said leveling needle.

4. The invention as set forth in claim 3 and further comprising means for selectively adjusting the distance between said leveling needle and said means for communicating when said control spool is in its closed position.

5. The invention as set forth in claim 3 and further comprising adjustably positionable means for limiting the movement of said valve spool toward its open position.

6. An apparatus of the type for controlling the flow of a fluid comprising a source of fluid pressure, fluid conduit, a check valve in said fluid conduit to maintain unidirectional flow of fluid therethrough, and a by-pass valve upstream of said check valve for by-passing fluid away from said check valve, the improvement in said combination of said by-pass valve having a spring means for constantly biasing said by-pass valve in an open position, an actuating area defined by said by-pass valve, means for communicating a source of fluid pressure to said actuating area to close said valve, means for communicating a low pressure source with said actuating area to allow said valve to open, a restricting means carried by said by-pass valve, means for projecting and maintaining said restricting means toward said second mentioned means for communicating to restrict fluid communication.

7. A fluid flow control valve for smoothly and gradually opening and closing a by-pass line so as to smoothly and graduallly accelerate and decelerate the flow of fluid through a main line, said control valve comprising a substantially cylindrically shaped control spool having flow ports near one end, and an annular flange at the end remote from said one end, spring means associated with said annular flange to bias said control spool toward its open position, said remote end of said spool defining an actuating chamber, a first fluid conduit communicating with said actuating chamber, a second fluid conduit communicating with said actuating chamber, a leveling needle carried centrally of and projecting from said spool, means for introducting and maintaining fluid within said control spool to further project said leveling needle from said control spool whereby said leveling needle limits the flow of fluid through said second fluid conduit, and means for partially retracting said leveling needle within said control spool.

8. Valve mechanism of the type for controlling the flow of a fluid from an elevator jack to an area of low pressure, said mechanism comprising a valve spool positionable in a fluid flow conduit to block the flow of fluid therethrough, spring means biasing said valve spool toward its closed position, said valve spool having a first pressure surface of a given area arranged so that fluid pressure thereon forces said valve spool toward its open position, said valve spool having a second pressure surface of an area larger than said given area and arranged so that fluid pressure thereon forces said valve spool toward its closed position, first communicating means for constantly communicating fluid pressure from said elevator jack to said first pressure surface, second communicating means for selectively communicating fluid pressure from said elevator jack to said second pressure surface, third communicating means for selectively communicating said second pressure surface with said area of low pressure, restricting means carried by said valve spool for limiting the fluid flow through said third communicating means.

9. The invention set forth in claim 8 and further comprising resilient means enabling said restricting means to be forced inside said valve spool.

10. The invention set forth in claim 8 and further comprising means for selectively adjusting the distance between said restricting means and said third communicating means when said valve is closed.

11. The invention as set forth in claim 8 and further comprising adjustably positionable means for limiting the movement of said valve spool toward its open position.

12. Apparatus for controlling the flow of a fluid comprising a valve housing, a check valve in said valve housing, duct means defining an inlet opening and an outlet opening upstream of said check valve and at least one outlet opening downstream of said check valve; a bypass valve including an inlet opening communicating with the upstream outlet opening of said check valve, an outlet opening, and a pressure chamber, a valve spool positioned in said bypass valve and movable to separate said inlet opening and outlet opening of said bypass valve from one another, first duct means leading from said pressure chamber for communicating with a source of high fluid pressure, second duct means leading from said pressure chamber for communication with a source of low fluid pressure, a flow blocking member carried by said valve spool and projecting from said control spool toward said second duct means, said valve spool being movable to communicate said inlet opening with said outlet opening and to project said flow blocking member at least partially into said second duct means.

13. Apparatus for controlling the flow of fluid toward and away from a high pressure zone comprising

a main valve housing including an inlet for connection to the outlet of a fluid pump, a check valve in said housing, a first outlet upstream of said check valve, a second outlet downstream of said check valve, and a third outlet downstream of said check valve for communication with the zone of high pressure,

a first bypass valve including an inlet connected to the first outlet of said main valve housing, an outlet for communication with the inlet of the fluid pump, and

a pressure chamber including a first aperture communicating with the inlet of said first bypass valve and an outlet aperture for communication with the inlet of the pump, a control spool disposed in said first bypass valve and responsive to fluid pressure in its pressure chamber to selectively separate and communicate the inlet and the outlet of said first bypass valve, and blockage means carried by said control spool to at least partially block said outlet aperture of said pressure chamber when the inlet and outlet of said first bypass valve communicate with each other,

a second bypass valve including an inlet opening connected to the second outlet of said main valve housing, an outlet opening for communication with the inlet of the pump, and a pressure chamber including first and second outlet apertures for communication with the inlet of the pump, a control spool disposed in said second bypass valve and responsive to fluid pressure in its pressure chamber to selectively separate and communicate the inlet opening and the outlet opening of said second bypass valve, and blockage means carried by said control spool of said second bypass valve to at least partially block one of said outlet apertures of said pressure chamber of said second bypass valve when the inlet and outlet openings of said second bypass valve communicate with each other.

14. Fluid flow control apparatus comprising a pump, a motor, main valve means including an inlet connected to the outlet of said pump and an outlet connected to said motor, a bypass valve including a housing defining a first chamber communicating with the inlet of said main valve and the outlet of said pump, a bypass chamber communicating with the inlet of said pump, and a pressure chamber, a valve control spool disposed in said housing and spring biased toward a position wherein said first and bypass chambers in open communication with each other, open conduit means communicating said first chamber with said pressure chamber, said housing defining aperture means opening outwardly from said pressure chamber, said valve control spool including needle means movably carried therewith and extending outwardly therefrom into said pressure chamber toward said aperture means, whereby said needle means extends at least partially into said aperture means when said valve control spool is positioned to allow communication between said first chamber and said bypass chamber.

15. Apparatus for controlling fluid flow to an elevator jack comprising a fluid supply, a source of fluid pressure, and a control mechanism controlling the flow of fluid between said source of fluid pressure and said jack, said control mechanism comprising a valve including a valve spool for opening and closing communication between said source of fluid pressure and said fluid supply, said valve

spool including a pressure surface, first duct means for communicating said source of fluid pressure with said pressure surface of said valve spool to urge said valve spool toward its closed position, second duct means for communicating said pressure surface of said valve spool with said fluid supply to allow said valve spool to move toward its closed position, means carried by and movable with said valve spool for limiting the flow of fluid through said second duct means.

16. Apparatus for controlling fluid flow to an elevator jack comprising a fluid supply, a source of fluid pressure communication with the fluid supply, and a control mechanism controlling the flow of fluid between said source of fluid pressure and said jack, said control mechanism comprising a valve including a valve spool for opening and closing communication between said jack and said fluid supply, said valve spool including a pressure surface, first duct means for communicating said jack with said pressure surface of said valve spool to urge said valve spool toward its closed position, second duct means for communicating said pressure surface of said valve spool with said fluid supply to allow said valve spool to move toward its closed position, means carried by and movable with said valve spool for limiting the flow of fluid through said second duct means.

17. Apparatus of the type for controlling fluid flow to an elevator jack having a motor driven pump, a sump communicating with the inlet of said pump, a main valve mechanism communicating with the outlet of said pump, and a jack communicating with said main valve mechanism, the combination therewith of a bypass valve comprising an inlet communicating with the outlet of said pump and an outlet communicating with said sump, a valve element, a pressure chamber disposed adjacent said valve element, first duct means for communicating a source of high pressure fluid with said pressure chamber upon initial operation of said pump to move said valve element to a position blocking communication between the inlet and the outlet of said valve, second duct means for communicating said pressure chamber to a source of low pressure fluid, means carried by said valve element for at least partially blocking said second duct means.

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