April 9, 1968 C. S. PAPADIA ET AL 3,376,793

HYDRAULIC FLOW REGULATING APPARATUS

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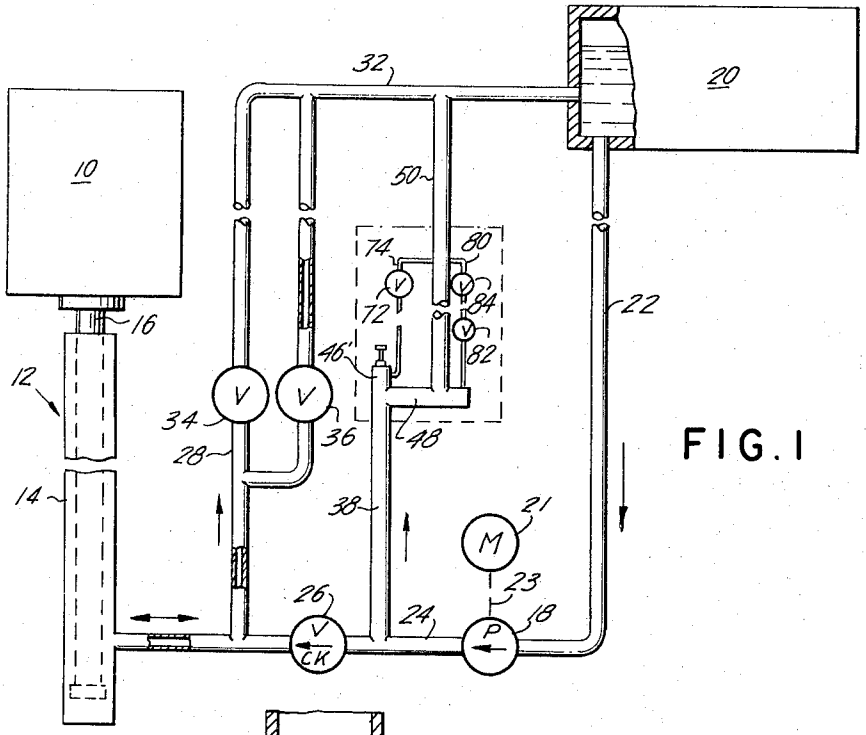


FIG. 1

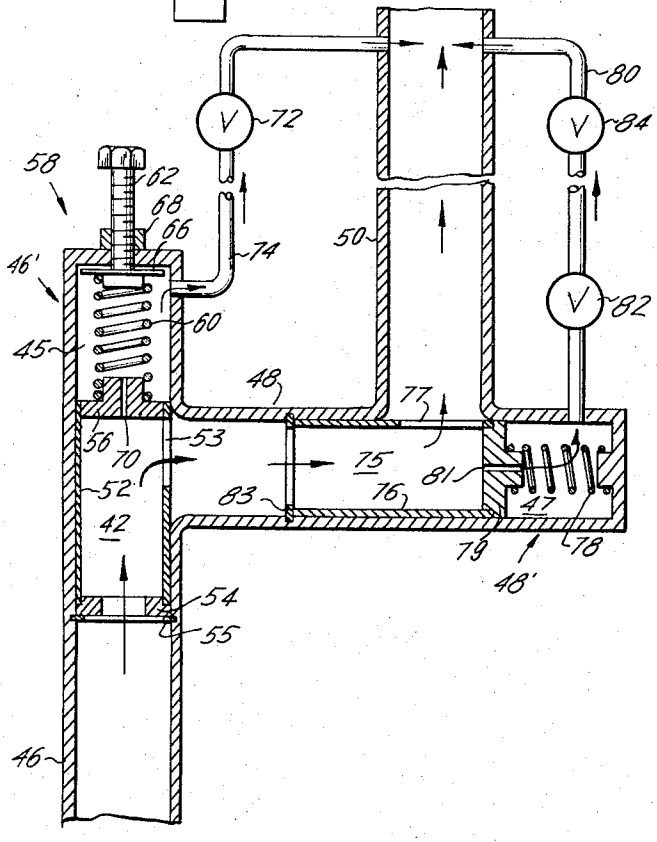


FIG. 2

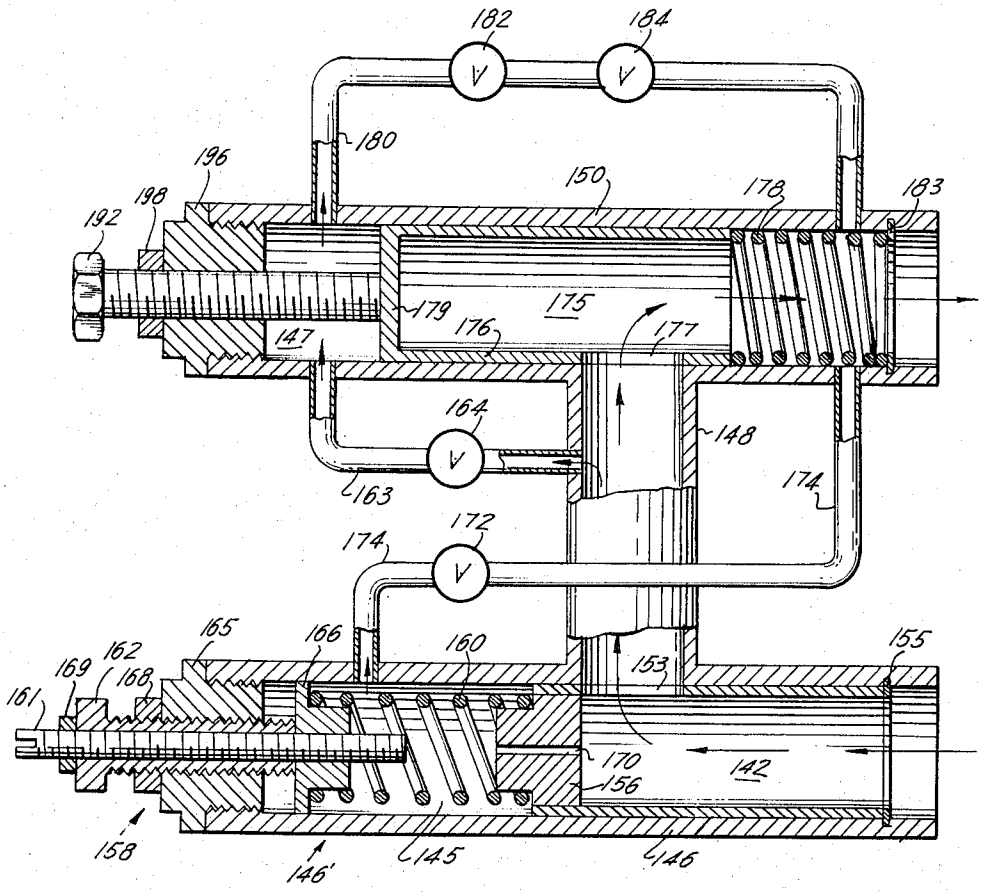
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FIG. 3



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HYDRAULIC FLOW REGULATING APPARATUS

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5 Claims. (Cl. 91—468)

ABSTRACT OF THE DISCLOSURE

Apparatus for reducing the flow of hydraulic fluid through the system as the pressure of the hydraulic fluid is increased as when a load is placed on a platform.

This invention relates to a system for the control of hydraulic mechanisms, and, more specifically, to a control system for the operation of hydraulic elevators wherein there is provided means to facilitate smooth and consistent upward operation regardless of load in the elevator.

The present invention has the advantage of simply and economically utilizing a novel mechanism operating in response to the hydraulic pressure within the system to provide smooth acceleration of an hydraulic elevator from stop to full speed, uniform full upward speed, a smooth transition from full speed to leveling speed, consistent and uniform leveling speed regardless of load in the elevator, and a smooth floating stop. Thus, one of the objects of the present invention is to provide flow regulator means which smoothly adjusts the flow of hydraulic fluid therethrough in inverse proportion to the internal pressure of the system.

A further object is to provide a flow regulator means which provides for uniform and smooth acceleration of an elevator car.

Another object is to provide two flow regulator means in series in combination with suitabe controls to provide uniform acceleration, deceleration, leveling, and stopping of an elevator car.

A still further object is to provide a normally open valve assembly in a system which operates to reduce the flow of fluid therethrough in response to an increase in pressure within the system.

The above and other objects and novel features of the invention will appear more fully from the following description when the same is read in conjunction with the accompanying drawings. It is to be expressly understood, however, that the drawings are not intended to be a definition of the invention but are intended to be illustrated only.

In the drawings wherein like parts are marked alike:

FIGURE 1 is a diagrammatic view of the system as a whole arranged in accordance with the invention.

FIGURE 2 is a detailed cross-sectional view of the flow regulator assembly portion of the system shown in FIGURE 1.

FIGURE 3 is a detailed cross-sectional view of an alternate embodiment of the flow regulator assembly.

Referring now to FIGURE 1 of the drawings, an elevator **10** is arranged to be raised and lowered by hydraulic jack **12**. Jack **12** comprises a cylinder **14** with piston **16** concentrically mounted therein and projecting from the upper end thereof and mounting the elevator **10** in a conventional manner. A constant volume displacement pump **18** which is driven by suitable means such as motor **21** and shaft **22** is adapted to supply fluid under pressure to the jack **12**. The inlet of pump **18** is provided with hydraulic fluid through conduit **22** from tank **20**. Pump **18** forces the hydraulic fluid from reservoir **20** to jack

12 through conduit **24** which is provided with a check valve **26** intermediate pump **18** and jack **12**.

Conduits **28**, **30**, **32** are provided intermediate jack **12** and check valve **26** for the return of hydraulic fluid from jack **12** to reservoir **20**. Conduits **28**, **30** are provided with lowering valves **34**, **36** respectively which operate in conduits **28**, **30** to recycle hydraulic fluid to reservoir **20** during downward movement of said elevator.

A bypass line **38** is provided intermediate pump **18** and check valve **26**, and is provided with bypass valve assembly **40** described in more detail hereinafter with reference to FIGURE 2. Bypass line **38** in conjunction with bypass valve assembly **40** operates, in accordance with the requirements of the system, to divert all or a portion of the output of pump **18** directly to reservoir **20**.

Referring now to FIGURE 2, bypass line **38** is divided into three conduit sections **46**, **48**, **50** arranged at right angles to each other. Conduit sections **46**, **48**, **50** are sequentially arranged to allow a continuous flow therethrough. Flow adjustment means **42** is provided in conduit section **46** and constitutes a load compensating valve adapted to decrease the rate of flow of hydraulic fluid therethrough upon an increase in pressure within the hydraulic system such as would be caused by an increase of the load in an elevator. Load compensating valve **42** comprises a sliding plunger **52** adapted to reciprocate with close tolerances within the bore of conduit **46**. Orifice **53** is provided in the wall of plunger **52** to permit flow from conduit section **46** into conduit section **48**, and is provided with a flow reducing annular member **54** affixed thereto at the upstream end thereof. The downstream end of reciprocating plunger **52** is closed by bulkhead **56**. Reciprocating plunger **52** tends, because of the normal pressure of the hydraulic fluid against bulkhead **56**, to reciprocate into the chamber **45** formed by extension **46'** of conduit section **46**. This tendency is counteracted by a suitable tensioning means such as means **58** which is comprised of spring **60** and bolt **62**, screwed into threaded hole **64** in extension **46'** of conduit section **46**. Bolt **62** is adapted to adjust the tension of spring **60** through plate **66**, and said adjusting bolt **62** is adapted to be locked in place by lock nut **68**.

Chamber **45** in extension **46'** communicates with conduit section **50** through conduit **74** which is provided with a suitable normally closed valve such as solenoid valve **72**. A relatively small diameter aperture **70** of predetermined size is provided in bulkhead **56** to permit the flow of hydraulic fluid therethrough when valve **72** in conduit **74** is opened. When valve **72** in conduit **74** opens hydraulic fluid flows from conduit section **46**, through aperture **74** and valve **72** and into conduit section **50**; whereby, when said valve **72** is opened, the pressure within chamber **45** is diminished so that the internal hydraulic pressure within the system can force said plunger **52** into chamber **45** causing the orifice **53** in plunger **52** to be at least partially obturated by the wall of extension **46'** thereby decreasing the flow of hydraulic fluid through said aperture **53** upon an increase of the hydraulic pressure within the system as a whole.

Flow adjustment means **75** is similar in construction to means **42** described above but differs in function therefrom. Flow adjustment means **75** is positioned in conduit section **48** and is comprised of plunger **76** having an orifice **77**. Plunger **76** is biased into a normally open position with reference to conduit section **50** by suitable tensioning means such as spring **78**. Spring **78** is positioned within chamber **47** formed by extension **48'** of conduit section **48** and abuts against bulkhead **79** of plunger **76**. Bulkhead **79** is provided with an aperture **81** to allow the flow of hydraulic fluid therethrough. Chamber **47** is in communication with conduit section **50** of conduit **38** through conduit **80** which is provided

with an adjustment valve 82 and a suitable automatically controlled valve such as solenoid valve 84.

In operation, the valve assembly 40 provides for simple, smooth, and uniform acceleration by gradually closing off the bypass line 38 between conduit 24 and reservoir 20 thereby forcing a gradually increasing flow of hydraulic fluid to the jack 12. Valve assembly 40 continues to restrict flow through bypass line 38 until such flow is completely shut off at which time the elevator 10 will rise at full speed. The action described above is accomplished by energizing the normally closed pilot solenoid valve 84 to the open position. As valve 84, opens, the hydraulic fluid, under pressure with the chamber 47, is forced through aperture 79 and line 80 into conduit section 50. As the pressure within chamber 47 is thereby reduced a pressure differential develops betwen the hydraulic fluid within conduit section 48 and that in chamber 47, whereby plunger 76 is forced into chamber 47. As plunger 76 moves into chamber 47 the orifice 77, which in open position has the ability of passing the full capacity of pump 18, is gradually closed.

The rate of acceleration may be controlled or adjusted by changing the setting of adjustment valve 82 which controls the rate of change of pressure within chamber 47. When orifice 77 has fully closed due to the pressure differential referred to hereinabove the bypass line 38 is effectively closed whereby the entire output from constant displacement pump 18 is passed into jack 12 forcing elevator 10 upward at full speed.

When the elevator reaches a predetermined distance from the floor at which it is to stop, solenoid valve 84 is de-energized whereby said valve closes thereby causing an increase in the hydraulic pressure within conduit 80 and chamber 47. As the hydraulic pressure within chamber 47 increases and approaches the pressure within conduit 48 biasing means 78 forces plunger 76 into its nearly normally open position. The movement of sliding member 76 into open position is slow and continuous whereby the size of opening 77 is gradually increased causing the speed of the elevator 10 to smoothly diminish due to the passage of a slowly increasing amount of hydraulic fluid through bypass line 38 into hydraulic fluid reservoir tank 20. The rate of deceleration is controlled by the diameter of aperture 81 in bulkhead 79. Movement of plunger 76 into conduit section 48 is limited by stop 83 positioned to allow opening 77 to completely open.

In order to provide smooth acceleration at the time the elevator car starts its upward movement it is important that the aperture 77 be sufficiently large that the full capacity of the pump can be passed therethrough. When the valve 75 again opens during deceleration, the aperture 77 will again be capable of passing the full capacity of the pump. This, however, is undesirable and would ordinarily cause the car to stall. The function of valve 42 described hereinabove is to provent such stalling and to provide a consistent leveling speed during the leveling of the car at a floor as it moves upwardly.

Upon reaching a predetermined distance from the floor at which the elevator is to stop, the normally closed solenoid valve 72 is energized to open position simultaneously with the de-energizing of solenoid valve 84 described above. This allows hydraulic fluid to flow from chamber 45 in extension 46' through line 74. Upon the escape of hydraulic fluid from chamber 45 a pressure differential is created on opposite sides of bulkhead 56 thereby causing the plunger 52 to reciprocate into extension 46'. The movement of plunger 52 compensates for varying loads in the elevator by causing the size of opening 53 to be reduced a predetermined amount in accordance with the presetting of tensioning means 58, which determines the amount of force provided by spring 60. The amount of hydraulic fluid that passes through opening 53 in any given time is constant because when valve 72 is open the size of opening 53 varies in inverse proportion to the hydraulic pressure within the system. The action of valves 42 and 75 is simultaneous thereby assuring a smooth changeover from high speed to low speed.

Upon reaching the chosen floor, pilot solenoid valve 72 is de-energized thereby allowing said valve to close which results in termination of the passage of fluid from chamber 45. The hydraulic pressure on opposite sides of bulkhead 56 then slowly equalizes allowing spring 60 to force plunger 52 out of extension 46'. The speed at which plunger 52 leaves extension 46' is controlled by the size of opening 70, and accordingly opening 53 slowly enlarges allowing additional hydraulic fluid to be bypassed therethrough whereby the elevator car comes to a smooth floating stop as the full capacity of the pump is bypassed through line 38. A timer is provided to keep the pump running until the elevator comes to a full stop. The movement of plunger 52 from extension 46' into conduit 46 is limited by stop means 55 provided in conduit 46.

A ring 54 is affixed to plunger 52 at the lower end thereof to eliminate any fluctuation in the amount of hydraulic fluid bypassed through line 38 during the momentary drop in internal pressure when the speed is changed. Ring 54 eliminates any dip in elevator car speed as the elevator is slowing down and allows the transition from high speed to low speed to be smooth and gradual. The velocity of the hydraulic fluid passing through ring 54 will hold the piston 52 in its proper place during the transient dip in pressure at the moment of slowdown.

Referring now to the embodiment shown in FIGURE 3, bypass line 38 is divided into three conduit sections 146, 148, 150 arranged at right angles to each other. Conduit sections 146, 148, 150 are sequentially arranged to allow a continuous flow therethrough. Flow adjustment means 142 is provided in conduit section 146 and constitutes a load compensating valve adapted to decrease the rate of flow of hydraulic fluid therethrough upon an increase in pressure within the hydraulic system in the manner described with reference to valve 42 of FIGURE 2. Load compensating valve 142 comprises a sliding plunger 152 adapted to reciprocate with close tolerances within the bore of conduit 146. Orifice 153 is provided in the wall of plunger 152 to permit flow from conduit section 146 into conduit section 148. The downstream end of reciprocating plunger 152 is closed by bulkhead 156. Reciprocating plunger 152 tends, because of the normal pressure of the hydraulic fluid against bulkhead 156, to reciprocate into the chamber 145 formed by extension 146' of conduit section 146. This tendency is counteracted by a suitable tensioning means such as means 158 which is comprised of spring 160 and bolt 162, screwed into cap 165 which closes the end of extension 146' of conduit section 146. Bolt 162 is adapted to adjust the tension of spring 160 through plate 166, and said adjusting bolt 162 is adapted to be locked in place by lock nut 168. A threaded bore is provided in bolt 162 into which rod 161 is threaded. Rod 161 is used to establish and adjust the minimum opening of orifice 153.

Chamber 145 in extension 146' communicates with conduit section 150 through conduit 174 which is provided with a suitable normally closed valve such as solenoid valve 172. A relatively small diameter aperture 170 of predetermined size is provided in bulkhead 156 to permit the flow of hydraulic fluid therethrough when valve 172 in conduit 174 is opened to allow hydraulic fluid to flow from conduit section 146, through conduit 174 into conduit section 150; whereby, when said valve 172 is opened, the pressure within chamber 45 is diminished so that the internal hydraulic pressure within the system can force said plunger 152 into chamber 145 causing the orifice 153 in plunger 152 to be at least partially obturated by the wall of extension 146' thereby decreasing the flow of hydraulic fluid through said aperture 153 upon an increase of the hydraulic pressure within the system as a whole.

Flow adjustment means 175 (FIGURE 3) is positioned in conduit section 150 and is comprised of plunger 176

having an orifice **177**. Plunger **176** is biased into a normally open position with reference to conduit section **148** by suitable tensioning means such as spring **178**. Spring **178** is positioned within conduit section **150** and abuts against ring **183**. A chamber is formed by extension **150'** of conduit section **150** in which there is provided adjustable means **192** to control the maximum opening of orifice **177** for flow control. Means **192** may suitably comprise a bolt which abuts against bulkhead **179** of plunger **176**. Bolt **192** will advantageously be adjustably threaded into the closure **196** of extension **150'** of conduit section **150** and locked in place by lock nut **198**. Chamber **150'** is in communication with a portion of conduit section **150** downstream of flow adjustment means **175** through conduit **180** which is provided with an adjustment valve **182** and a suitable automatically controlled valve such as solenoid valve **184**. Chamber **150'** is also in communication with conduit section **148** upstream of flow adjustment means **175** through conduit section **163** and adjustment valve **164**.

The embodiment shown in FIGURE 3 provides for smooth and uniform acceleration by gradually closing off the bypass line **38** between conduit **24** and reservoir **20** (see FIGURE 1) thereby forcing a gradually increasing flow of hydraulic fluid to the jack **12**. The action described above is accomplished by admitting hydraulic fluid, under pressure into chamber **147**, through conduit **163** and adjustment valve **164** as the pressure increases in conduit section **148**. As the pressure within chamber **147** is thereby increased a pressure differential develops between the hydraulic fluid within conduit section **150** and that in chamber **147** whereby plunger **176** is forced out of chamber **147** in a downstream direction. As plunger **176** moves downstream the orifice **177**, which in open position has the ability of passing the full capacity of pump **18**, is gradually closed. When this orifice is fully closed the elevator will be at full speed since the entire output of the pump will go to jack **12**. The rate of acceleration is controlled by adjustment of valve **164**.

When the elevator reaches a predetermined distance from the floor at which it is to stop pilot solenoid valve **184** is energized allowing the oil from chamber **147** to pass through line **180** in greater quantity than it is entering through line **163**. Plunger **176** will then return to its former position thereby gradually opening orifice **177** thus causing the elevator to decelerate. Spring **178** aids in returning the plunger **176** to the open position. The rate of deceleration is controlled by adjustment valve **182**.

In order to provide smooth acceleration at the time the elevator car starts its upward movement it is important that the aperture **177** be sufficiently large that the full capacity of the pump can be passed therethrough. When the valve **175** again opens during deceleration, the aperture **177** will again be capable of passing the full capacity of the pump. This, however, is undesirable and would ordinarily cause the car to stall. The function of valve **142** described hereinabove is to prevent such stalling and to provide a consistent leveling speed during the leveling of the car at a floor as it moves upwardly.

Upon starting and full speed traveling of the elevator in the upward direction flow regulating means **142** has no effect because it passes more oil than flow regulating means **175** thereby allowing means **175** to control the acceleration and full speed traveling of the elevator. Either at or before the elevator reaches the slow down point, a predetermined distance from the floor at which the elevator is to stop, pilot solenoid valve **172** is energized. This allows oil to escape from chamber **145** through conduit **174**. Plunger **152** will then move back causing orifice **153** to be reduced to desired opening for upward leveling speed. Spring **160** compensates for the varying loads on the elevator by controlling the size of orifice **153**. The number of gallons per minute passing through orifice **153** as will be constant because the size of orifice **153** varies inversely proportional to the pump pressure. The action of flow regulating means **142**, **175** is overlapping thereby assuring a smooth changeover from high speed to low speed.

Upon reaching the floor, pilot solenoid valve **172** is deenergized. This closes conduit **174** causing the pressure to equalize in chamber **145** and conduit section **146**. When the pressure is equalized spring **160** will return plunger **152** to the fully open position. This causes the car to come to a floating smooth stop because the full output of the pump is passed. The speed of opening for the stop is controlled by the size of opening **170**. A timer is provided to keep the pump running until the elevator comes to a full stop. Adjustment screw **162** controls the tension of spring **160** and threaded rod **161** establishes the minimum opening of orifice **153** to prevent a complete shutoff due to overloading or excessively high pressure.

It will be understood that various changes in the details and arrangement of parts which have been herein described and illustrated in order to explain the nature of the invention may be made by those skilled in the art within the principle and scope of the invention as expressed in the appended claims.

We claim:

1. A hydraulic control system comprising, in combination: a cylinder; a piston slideable in said cylinder; a load carrying platform adapted to be moved by said piston; a source of hydraulic fluid; means to transmit hydraulic fluid from said source to said cylinder to act on said piston to raise the latter; bypass means from said means to transmit hydraulic fluid between said source and said cylinder to permit diversion of hydraulic fluid from said cylinder during upward acceleration and deceleration of said load carrying platform; and a flow regulator assembly in said bypass means to regulate the quantity of hydraulic fluid being diverted; said flow regulator assembly comprising: a first conduit section having an inlet and an outlet, a sliding member in said first conduit section adapted to close said outlet at least partially, said sliding member comprising, as an integral unit, an annular member adapted to slide in close proximity to said first conduit section the upstream end thereof being open to admit hydraulic fluid thereto, and a bulkhead closing the downstream end of said annular member, an opening in said annular member to allow passage of hydraulic fluid from said sliding member to said outlet and into a second conduit section through an inlet thereof, biasing means tending to force said sliding member in an upstream direction, and means contiguous to said opening, adapted at least partially to obturate said opening upon reciprocation of said sliding member in a downstream direction in response to an excess of pressure within said sliding member over the force of said biasing means, an aperture in said bulkhead to allow the passage of fluid therethrough into a chamber, means to pass said fluid from said chamber to a downstream portion of said bypass means, valve means in said means to pass, and means to selectively open and close said valve means; an outlet opening in said second conduit section to allow the passage of fluid into a third conduit section, a sliding member in said second conduit section adapted to close the outlet opening thereof at least partially, the sliding member in said second conduit section comprising, as an integral unit, a member adapted to slide in close proximity to said shell the upstream end thereof being open to admit hydraulic fluid thereto, a bulkhead at the downstream end thereof, an opening therein to allow passage of fluid to the outlet of said second conduit section, biasing means tending to force the sliding member in the second conduit section in an upstream direction, and means contiguous to said opening adapted to obturate said opening at least partially upon reciprocation of said sliding member in a downstream direction in response to an excess of pressure within said sliding member over the force of said biasing means in said second conduit section, an aperture in said bulkhead to allow the passage of fluid therethrough into a chamber, means to flow hydraulic fluid from said chamber to a

downstream portion of said bypass means, valve means in said means to flow hydraulic fluid, and means to selectively open and close said valve means.

2. The apparatus of claim 1 wherein said biasing means for the sliding member in said first conduit section comprises an adjustable mechanical tensioning device in combination with hydraulic fluid in said chamber which causes increased pressure therein when the valve means in said means to pass is closed.

3. The apparatus of claim 1 wherein there is provided an additional valve means in said means to flow hydraulic fluid, said valve being adjustable to vary the effective diameter of said means to flow hydraulic fluid whereby the rate of acceleration of said load carrying platform may be adjusted.

4. The apparatus of claim 1 wherein a ring is affixed to the upstream end of the sliding member in said first conduit section to reduce the effective diameter of said sliding member whereby there is eliminated any fluctuation in the amount of hydraulic fluid passed through said bypass means caused by a momentary drop in pressure with the system.

5. A hydraulic control system comprising, in combination: a cylinder; a piston slideable in said cylinder; a load carrying platform adapted to be moved by said piston; a source of hydraulic fluid; means to transmit hydraulic fluid from said source to said cylinder to act on said piston to raise the latter; bypass means from said means to transmit between said source and said cylinder to permit diversion of hydraulic fluid from said cylinder during upward acceleration and deceleration of said load carrying platform; and a flow regulator assembly in said bypass means to regulate the quantity of hydraulic fluid being diverted; said flow regulator assembly comprising: a first conduit section having an inlet and an outlet, a sliding member in said first conduit section adapted to close said outlet at least partially, said sliding member comprising, as an integral unit, an annular member adapted to slide in close proximity to said first conduit section the upstream end thereof being open to admit hydraulic fluid thereto, and a bulkhead closing the downstream end of said annular member, an opening in said annular member to allow passage of hydraulic fluid from said sliding member to said outlet and into a second conduit section through an inlet thereof, biasing means tending to force said sliding member in an upstream direction, and means contiguous to said opening, adapted at least partially to obturate said opening upon reciprocation of said sliding member in a downstream direction in response to an excess of pressure within said sliding member over the force of said biasing means, an aperture in said bulkhead to allow the passage of fluid therethrough into a chamber, means to pass said fluid from said chamber to a downstream portion of said bypass means, valve means in said means to pass, and means to selectively open and close said valve means; an outlet opening in said second conduit section to allow the passage of fluid into a third conduit section, a sliding member in said third conduit section adapted to close said outlet opening in said second conduit section in proportion to the fluid pressure at the inlet; said sliding member comprising as an integral unit, an annular member adapted to reciprocate in close proximity to said shell, an opening in said annular member to allow the entrance of hydraulic thereto, a bulkhead at one end of said annular member, an opening at the other end thereof to allow the exit of hydraulic fluid therefrom; biasing means tending to force said sliding member in one direction; means contiguous to the opening in said annular member adapted at least partially to obturate said opening upon reciprocation of said sliding member in a direction opposite the direction of force of said biasing means; means forming a chamber beyond said bulkhead; means to pass hydraulic fluid into said chamber from said second conduit section; means to pass hydraulic fluid from said chamber to a downstream portion of said bypass means, and valve means in said last named means.

References Cited

UNITED STATES PATENTS

1,904,204	4/1933	Delery	137—505.13
2,386,051	10/1945	Kempton	137—505.13
2,858,842	11/1958	Reis	137—108
2,872,939	2/1959	Terry	137—504
2,969,091	1/1961	Wolff	251—30
3,001,367	9/1961	Bartholomew	137—108
3,020,891	2/1962	Joseph	91—449
3,125,319	3/1964	Arbogast et al.	91—468
3,188,047	6/1965	Criffield	251—33
3,296,797	1/1967	Tlusty	91—468
3,302,531	2/1967	Arbogast et al.	91—446

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