United States Patent

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[54] HOIST AND BALANCING APPARATUS

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[52] **U.S. Cl.** **254/168,** 254/186

[51] **Int. Cl.** **B66d 1/00**

[58] **Field of Search** 254/168, 186

[56] **References Cited**

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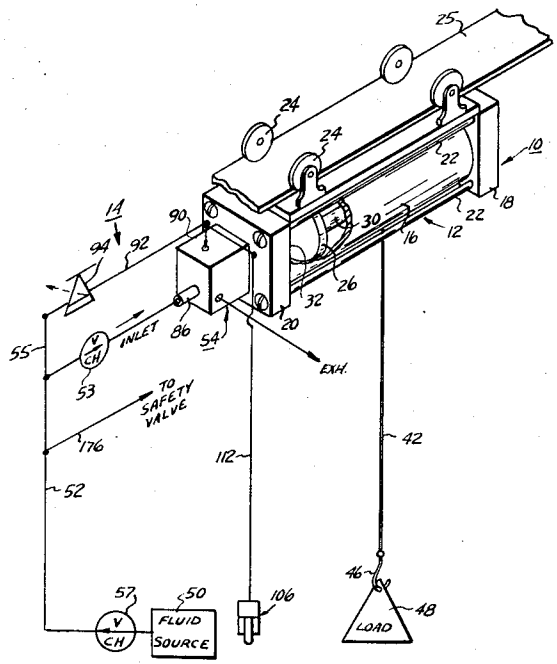
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[57] **ABSTRACT**

A pneumatic hoist having a supported cylinder and a piston in the cylinder, and means for introducing compressed air into the chamber to act on the piston to develop a force for lifting or supporting a load. A pneumatic control system is disclosed for controlling the pressure of compressed air admitted into the chamber and is adapted to selectively introduce air having one of three adjustable predetermined pressures chosen to balance either the weight of the load-attachment means, the combined weight of the load-attachment means and the load, or the weight of a load greater than the combination in order to lower, suspend, or raise the load. A safety valve in the system is arranged to trap the air in the cylinder behind the piston in the event of loss of source pressure so that a suspended load cannot accidentally drop. The control system is actuated by a hand control device which has a built-in safety latch mechanism for tamper-proof operation of the hoist apparatus.

11 Claims, 7 Drawing Figures



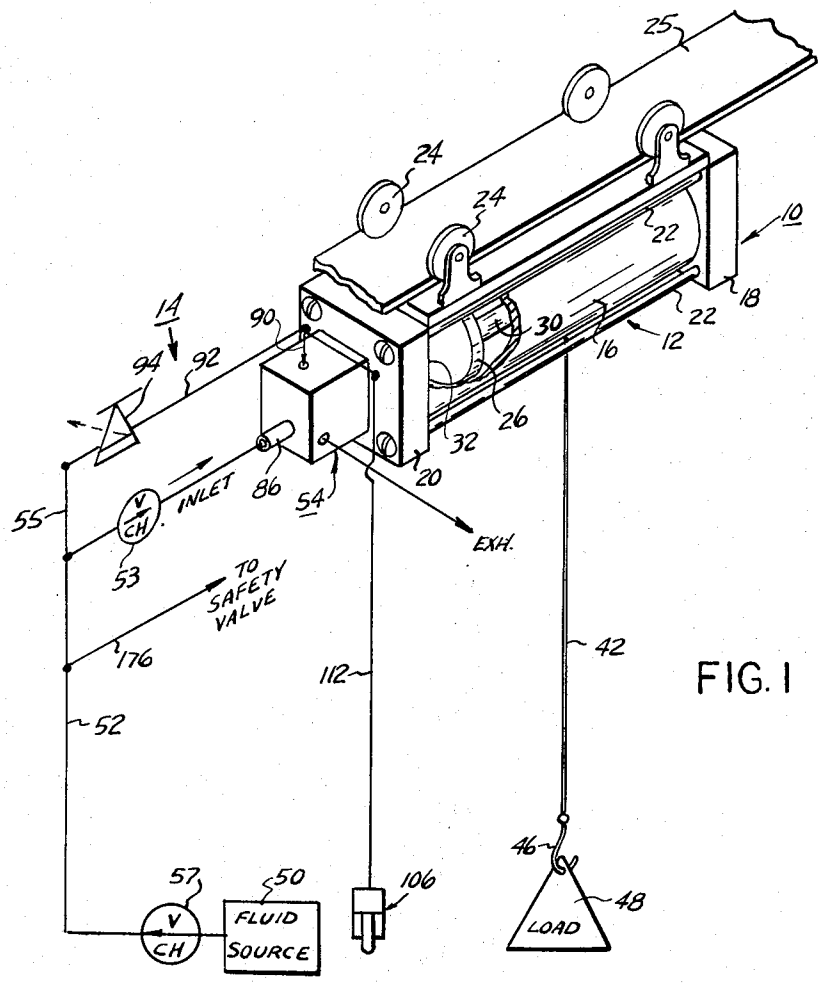
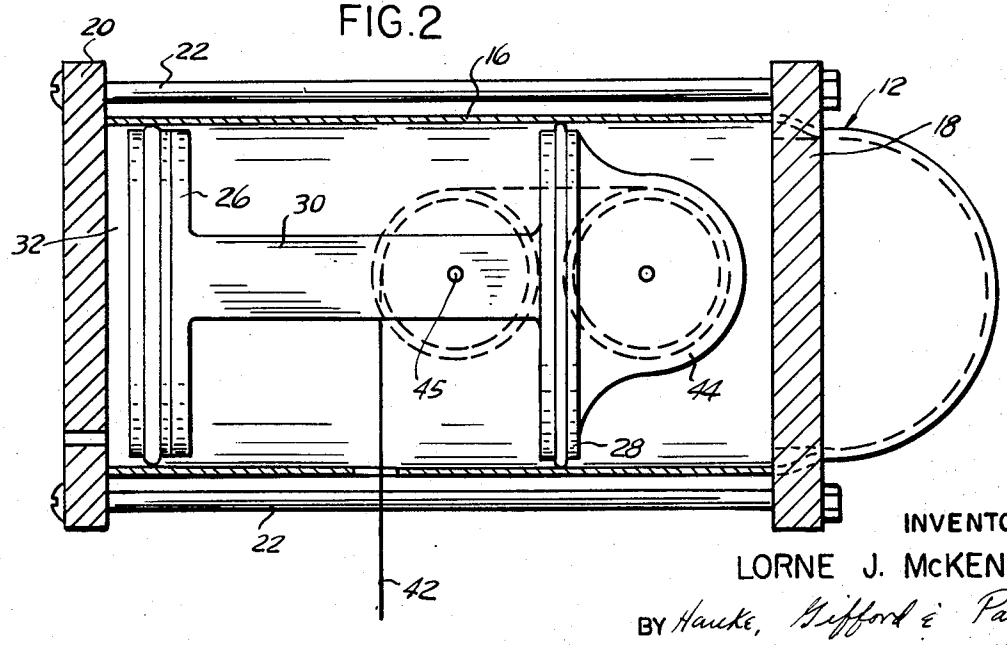


FIG. 1

FIG. 2



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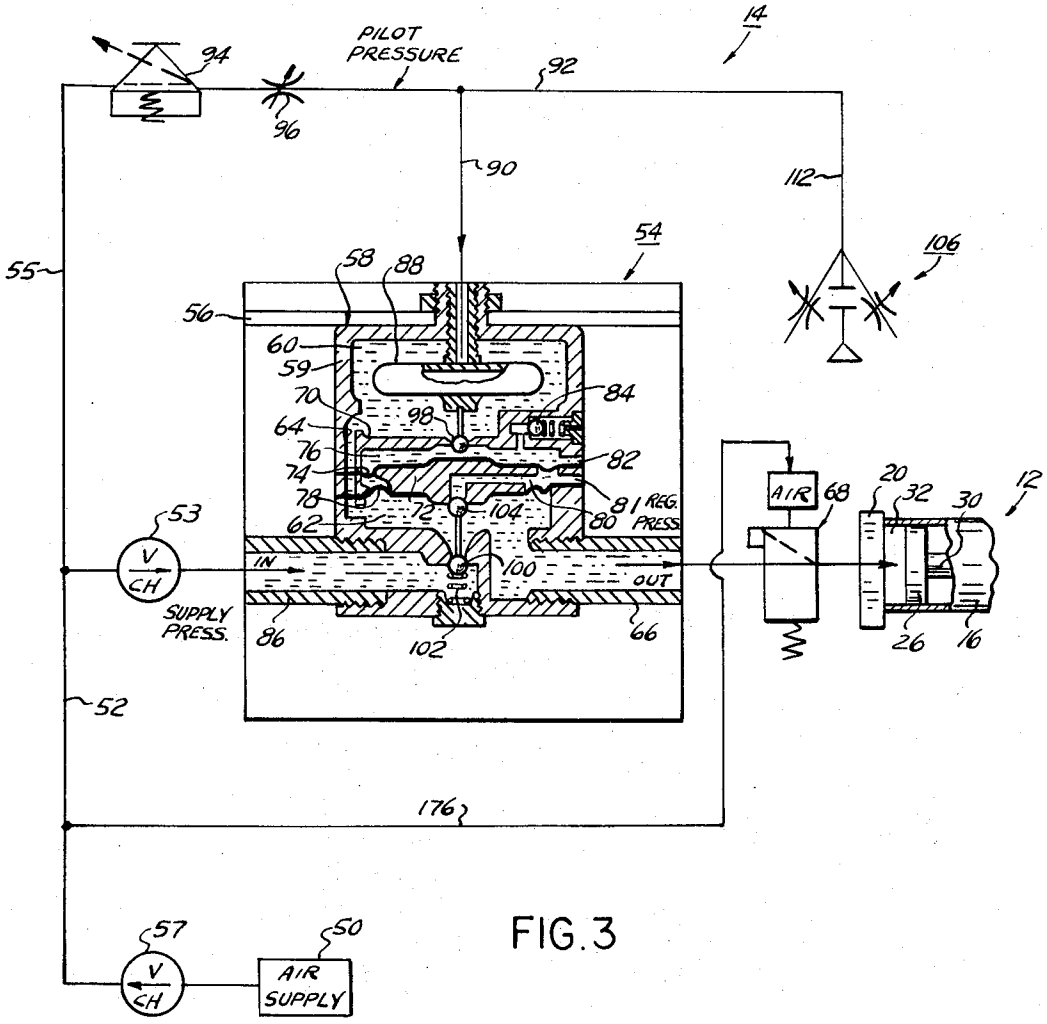


FIG. 3

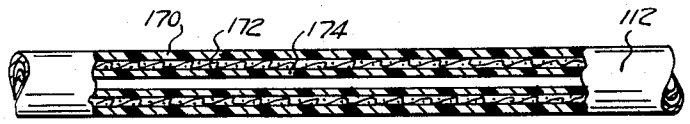


FIG. 7

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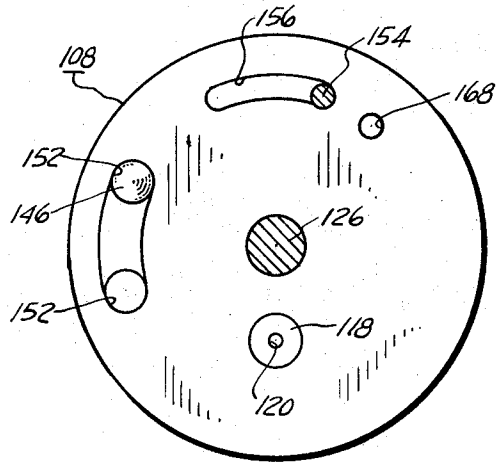


FIG. 6

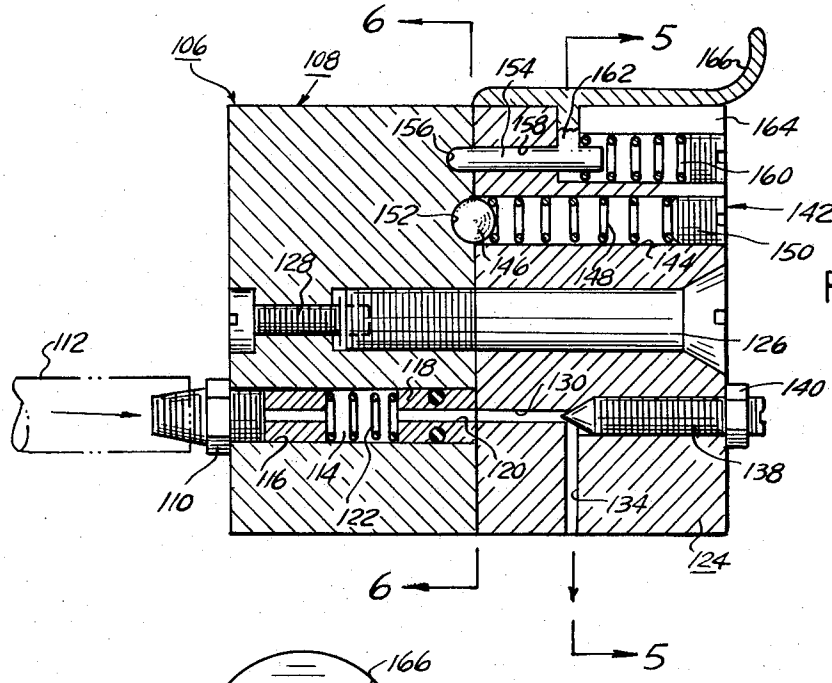


FIG. 4

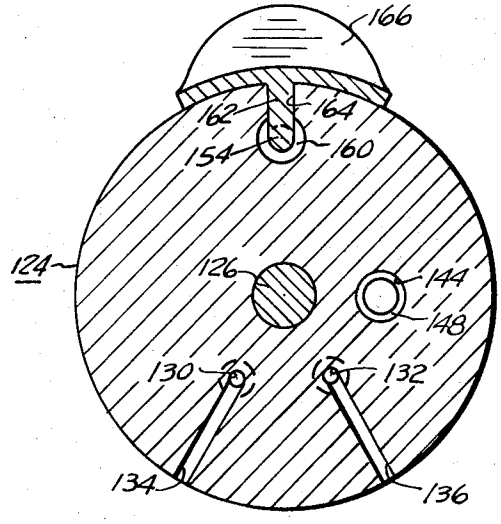


FIG. 5

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HOIST AND BALANCING APPARATUS

REFERENCE TO RELATED APPLICATIONS

The present application is related to my copending applications Ser. No. 733,610 filed May 31, 1968 for "Hoist and Balancing Apparatus," now U.S. Pat. No. 3,537,686 Ser. No. 763,827 filed Sept. 30, 1968, now Pat. No. 3,552,720 for "-Balancing Apparatus for Hoists" and Ser. No. 22,986 filled Mar. 26, 1970, for "Load Balancer."

BACKGROUND OF THE INVENTION

I. Field of the invention

This invention relates to pneumatic hoists adapted to raise, lower and counterbalance a load in a suspended position to permit an operator to manually position a relatively heavy load, and more particularly to a device of this character having a novel control circuit for controlling the pressure of the air admitted into the hoist, a safety valve actuated in the event of loss of air pressure at the source to prevent a suspended load from dropping and novel remote control means for actuating the control circuit.

II. Description of the Prior Art

A fluid operated hoist comprising a supported cylinder having a fluid pressure responsive piston connected to a load which is to be raised or lowered is disclosed in the prior art in British Pat. No. 590,413 and U.S. Pat. No. 2,176,979. In order to add to the raising and lowering functions of such hoists, means have been disclosed in the prior art which adapt the hoist for counterbalancing loads of different predetermined weights. For example, a system employing a first pressure regulating means between the source of the pressurized fluid and the chamber for reducing the source pressure to balance the weight of the load-attachment means, and a second pressure regulating means between the source and the cylinder to reduce the source pressure to balance the combined weight of the attachment means and the load was disclosed in U.S. Pat No. 2,613,903 H. T. Platz.

One purpose of the present invention is to disclose a novel form of pneumatic control circuit for such a hoist which adapts the hoist to counterbalance a plurality of loads of different predetermined weights and to provide a safety valve in such a control circuit to prevent the accidental dropping of a suspended load in the case of a loss of source pressure.

A further purpose of the present invention is to provide an improved hand control unit for actuation of the pneumatic system to raise or lower the load incorporating a tamper-proof safety lock so that the selected raised or lowered position of the load cannot be accidentally changed without releasing the lock first.

SUMMARY OF THE PRESENT INVENTION

The preferred embodiment of the present invention comprises a pneumatic hoist having a cylinder adapted for attachment to an overhead support such as a trolley rail or the like, a pressure responsive piston disposed in the cylinder to form a fluid pressure chamber and a hoist cable which passes around pulleys contained in the cylinder and which are responsive to movement of the piston to take up or unreel the cable, the other end of which is adapted for attachment to a load.

In one form of the hoist mechanism, one set of pulleys is fixed against motion in the center of the cylinder and the other set is carried by a guide piston connected by a pair of piston rods which pass on either side of the fixed set of pulleys to the pressure responsive piston. The admission of compressed air into the chamber forces the piston toward the center of the cylinder so that the movable pulleys carried at the opposite end of the piston separate from the fixed set of pulleys causing the cable to be drawn into the cylinder a distance equal to the piston stroke, multiplied by the number of pulleys. When the piston is moved away from the center of the cylinder, the movable set of pulleys approach the fixed set to allow the cable to lower the load. The present pneumatic pressure control system however is adaptable for use with other known pneumatic hoists.

The control system essentially comprises a pilot operated main control valve disposed in the fluid line between the source of air pressure and the pressure chamber in the cylinder and a safety valve disposed between the main control valve and the pressure chamber.

Because the hoist employs positive air pressure in each of its pressurized conditions, the preferred system readily adapts itself to a safety feature for preventing the load from being accidentally dropped upon the occurrence of an abnormal drop in the source pressure, as when a line is ruptured. The safety feature comprises a safety valve connected between the outlet of the main control valve and the inlet of the pressure chamber which is controlled by a pilot connection to the source of the air pressure for sensing an abnormal drop in the air pressure. When such a drop occurs, the safety valve closes before the drop in pressure can be reflected in the output of the main control valve. When the safety valve closes, it traps the air pressure in the pressure chamber behind the piston so that if the hoist is in a balancing condition, the load is locked in a suspended position. This safety feature thereby eliminates the possibility of the operator being injured by a dropped load and obviates the possibility of a load being damaged by accidental dropping.

A pilot air pressure regulator with a built-in relief valve is disposed in such a manner that a sample of supply pressure is available at its inlet. Upon adjustment of the pilot pressure regulator, a regulated pressure signal is provided via its outlet to the pilot air section of the pilot air controlled main control valve. A variable orifice control valve is disposed in the line between the pilot pressure regulator outlet and the pilot control section of the main control valve. The purpose of the variable orifice control valve is to delay the rate of flow of the pilot pressure signal to the pilot section of the main control valve. A flexible composition hose assembly, preferably of reinforced wire-braid construction, is connected to the pilot air operated section of the main control valve and is subjected to a sample of the same pressure as is available to the pilot section of the main control valve as received from the pilot pressure regulator unit.

The opposite end of this hose or air line is affixed to a rotary actuator valve arranged in a convenient hand control unit for operation and control of the hoist by the operator. The hand control unit is constructed so that it provides for two or more positions allowing air pressure supplied to it to pass to the atmosphere at a controlled rate. The rate at which the air pressure escapes is determined by pre-setting of variable orifices placed in each of the connecting passages disposed between the inlet to the hand control unit and the various exhaust outlets, depending on the position of the valve spool in relation to the inlet supply pilot pressure to the hand control unit. In all instances, the hand control unit has one position which positively restricts any flow of air from escaping to the atmosphere.

The improved hand control unit has a safety latch mechanism built in so as to be tamper-proof. Thus, a deliberate release of the latch must be effected in order to change the position of the hand selector control from a low pressure setting to a higher pressure setting. This safety mechanism also guards against shifting the selection from the high pressure position to a lower or near zero pressure setting, unless deliberately actuated. The internal safety lock mechanism is controlled by a finger or thumb switch linked to it and actuatable from an external location conveniently located on the hand control unit.

The hand control unit therefore, depending on the pre-set adjustment of the bleed controls, will directly affect the control signal to the main pressure control valve by varying the magnitude of the signal to the pilot section of the pilot pressure regulator. In the non-bleed or closed position of the hand control unit, the pilot signal line pressure will be at maximum pressure as determined by the setting of the pilot pressure

regulator. This pressure signal will cause the main control valve to respond proportionately to supply sufficient pressure to the piston area of the cylinder to lift the total load attached to the lifting cable. Subsequent selections of the hand control unit to connect the pilot hose to any alternate communication with the atmosphere will reduce the pilot signal to a lesser value. The main control valve will be responsive to this pressure reduction and will react to lower its delivery pressure so that the load will lower at a rate controlled by the orifice size in any one of the bleed connections of the hand control unit as selected.

There are other important advantages inherent in the present improved pneumatic control system. Because the pilot pressure hose of the hand control unit is always vulnerable to being cut or otherwise damaged and since a lesser pressure in this line or a total loss of the air pilot pressure signal, as would be caused by a completely severed line, would cause the load to drop which could cause damage or injury, this hose has been wire reinforced to reduce the liklihood of this occurring.

The internal safety latch incorporated in the hand control unit, which is of a non-tamper nature, removes the tendency for a hoist control operator, as a matter of convenience in operation, to file, grind off or in any other way eliminate the safety latch and to thus make the apparatus unsafe for general use.

As heretofore mentioned, an additional safety valve is disposed between the outlet of the main control valve and the inlet to the hoist cylinder chamber. The safety valve is designed so as not to impair the normal air flow rate through it during normal hoist operations. However, in the event of a sudden air flow rate due to mis-selection of a high control pressure with no load on the hoist lifting cable, or in the event that the load should become accidentally disconnected, the safety valve will restrict the flow rate, thereby causing a significant reduction in the speed of retraction of the cable.

Briefly, the improved pneumatic control system essentially provides a monostat in the form of a remote pilot operated main control valve fitted to the balancing hoist cylinder inlet. Upon attaching the air supply of about 80 psi. to the inlet of a one-way check valve, air pressure is available to the inlet of the monostat or main control valve. Upon attaching a load to the free end of the cable, adjustment of the pilot pressure regulator to increase the regulated output pressure will balance the weight by providing sufficient air pressure over the piston area to support the weight. Upon pulling down on the load, the monostat inlet pressure controlling section will close and a relief section will detect the increase in air pressure within the cylinder chamber of the hoist due to compressing of the trapped air. This increased pressure will cause the relief section of the monostat to open, thus bleeding off the excess pressure and thereby maintaining a continued balancing of the load. This control arrangement, when applied to a hoist concept such as disclosed for instance in the aforementioned copending application Ser. No. 733,610 now U.S. Pat. No. 3,537,686, provides a complete balancing effect over the full cable travel of the balancer unit.

Upon lifting or exerting an upward force on the supported load, the piston will move toward the center section, causing a drop in cylinder pressure. The monostat senses this pressure drop and opens to provide additional air pressure to replenish and maintain the pressure in the chamber, and to thus maintain the load in balance.

Thus, it can be seen that the preferred pneumatic control system adds to the capability and safety of air hoists of the cylinder and piston type. Other advantages of the present invention will readily become apparent to those skilled in the art to which the invention pertains upon reference to the following detailed description.

DESCRIPTION OF THE DRAWINGS

The description refers to the accompanying drawings in which like reference characters refer to like parts throughout the several views, and in which:

FIG. **1** is a view showing a preferred air hoist and balancing apparatus and including a schematic representation of an improved pneumatic control system for the hoist and balancing apparatus;

FIG. **2** is a cross-sectional view of the balancer shown in FIG. **1**;

FIG. **3** is a schematic view of a preferred pneumatic control system showing a master pressure regulator valve in cross section and on an enlarged scale;

FIG. **4** is a cross section through the improved hand control unit for the hoist mechanism shown in FIG. **1**;

FIG. **5** is a transverse cross section through the hand control unit shown in FIG. **4** and as seen along line **5** — **5** thereof;

FIG. **6** is another transverse cross section through the hand control unit shown in FIG. **4** and as seen along line **6** — **6** thereof; and

FIG. **7** is a longitudinal cross section through a portion of a preferred pneumatic safety cable for the pilot air pressure line connected between the hand control unit and the main control valve.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Now referring to the drawings, FIGS. **1** and **2** illustrate a representative air hoist and balancing apparatus generally indicated at **10** as comprising an air hoist **12** and a pneumatic control system **14** connected with the air hoist **12**. The hoist comprises an elongated cylinder **16** having an end housing **18** closing one end of the cylinder. A support plate **20** at the other end of the cylinder is connected to the end **18** by rods **22**. Support members **24**, attached to the cylinder **16**, are adapted to support the cylinder on suitable overhead support means, such as a rail **25** or the like, attached to the ceiling of a building to enable the hoist to be moved horizontally. A pressure responsive piston, indicated at **26**, is slidably disposed in the cylinder **16** and is preferably connected to another piston **28** by rod **30** so that the two pistons move together within the cylinder, as more fully disclosed in my aforementioned U.S. Pat. No. 3,537,686.

The edges of the piston **26** are sealingly engaged with the walls of the cylinder **16** to form a fluid pressure chamber **32** between the piston **26** and the support plate **20**.

Motion of the piston **26** away from the support plate **20** is produced by the introduction of compressed air into the chamber **32**. Motion of the piston **26** toward the support plate **20** reduces the volume of the chamber **32**.

A load-supporting cable **42** having one end anchored in the cylinder **16** and wrapped around a set of fixed and movable pulleys **44** and **45** respectively in a manner known in the art has its other end extending through an opening in the cylinder for securement to a hook **46** to form a load-attachment means which is adapted to support a load **48** having a predetermined weight. The cable **42** is arranged so that as the movable pulleys **44** separate from the fixed pulleys **45** by means of movement of the piston **26** the hook **46** is raised toward the cylinder **16** and as the movable pulleys **44** move toward the fixed pulleys **45**, the hook **46** is moved down away from the cylinder **16**. The relative motion between the two sets of pulleys, as more fully described in my aforementioned U.S. Pat. No. 3,537,686, causes the hook **46** on the end of the cable to move a distance which is a function of the stroke of the piston **26** multiplied by the number of pulleys employed.

The load **48**, for purpose of illustration, is described as having a predetermined weight, which is typical in a production line where the hoist **10** is employed for positioning a succession of identical workpieces in a fixture, each of the workpieces having the same weight. The pneumatic control system **14** is adjusted to accommodate this weight and, as illustrated, provides a connection between a source **50** of fluid under pressure, such as compressed air, and the fluid chamber **32** of the cylinder **16**. The control system allows the operator to introduce air into the chamber **32** having a selected one of three predetermined pressures, each of which corresponds to the balancing pressure of a predetermined weight. One of the

predetermined pressures when introduced into the chamber **32** balances the piston **26** and the weight of the hook **46** and cable **42**. A second higher pressure can be selected to balance the combined weight of the hook **46**, the cable **42** and the load **48**. The third or highest pressure is adapted to balance a weight which is in excess of the combined weight of the hook **46**, the cable **42** and the load **48**. A three position hand control **106** is provided for this purpose and will be described in greater detail below.

To achieve the balance control, the control circuit **14** includes a conduit **52** connecting the source **50** and the inlet of the chamber **32** through a main control valve **54** in the conduit of the type which responds to a pneumatic signal by providing a pressure reduction of the source pressure to a pressure corresponding to the signal. A check valve **53** is disposed in the conduit **52** intermediate the source **50** and the control valve **54**.

As can best be seen in FIG. **3**, the monostat or main control valve **54** comprises an outer housing **56** containing an inner housing **58**. The inner housing **58** is provided with an upper pilot control chamber **60** adapted to be in fluid communication with a lower pressure regulating chamber **62** by means of a fluid channel **64**. The lower pressure regulating chamber **62** is adapted to provide a constant controlled regulated fluid pressure by means of suitable valve control mechanism within the housing **58**, which will be presently described, and is provided with an outlet **66** which is in fluid communication with the hoist cylinder pressure chamber **32** through a normally open safety shut-off valve **68**. The upper control chamber **60** and lower pressure regulating chamber **62** are divided by a transverse wall portion **70** extending substantially centrally through the housing **58**. Below the dividing wall portion **70** and spaced therefrom is a float member **72** of substantially smaller diameter than the internal diameter of the housing **58**, and which provides for increases or reductions in the volume of the lower pressure regulating chamber **62**. The float member is provided with an upper diaphragm **74** secured circumferentially to the upper surface of the float member and to the wall **59** of the inner housing **58** so as to provide an extensible pilot pressure chamber **76** between the dividing wall portion **70** and the upper surface of the float member **72** and the upper diaphragm **74**. The opposite lower surface of the float member **72** is also provided with a diaphragm **78** spaced from the upper diaphragm **74** and circumferentially attached to the bottom surface of the float member and to the wall **59** of the inner housing **58** so as to provide a radial exhaust chamber between the diaphragms **74** and **78**. An exhaust vent **81** connects the chamber **80** to the atmosphere.

The pilot pressure chamber **76** is in communication with the atmosphere by means of a bleed orifice **82** extending through the wall **59** of the inner housing **58**. A one-way ball check safety valve **84** is also connected with the chamber **76** and is adapted to bleed off excess fluid pressure from the pilot pressure chamber **76**, if the fluid flow or pressure should exceed the amount which can normally be handled through the bleed orifice **82**. Initially, the upper control chamber **60**, the lower constant pressure regulating chamber **62** and the pilot pressure chamber **76** are all supplied with fluid under pressure from the fluid pressure source **50** through the fluid line **52**, the one-way check valve **53** and an inlet port **86** leading into the inner housing **58**.

Contained within the upper control chamber **60** is a measuring capsule **88** which is fluidly connected by a conduit **90** to a pilot fluid pressure line **92**, which in turn is in communication with the outlet of a pilot pressure regulator **94**, whose inlet is connected to the fluid supply source **50** by means of an extension **55** of the main pressure line **52**.

A variable orifice control valve **96** is disposed in the line **92** between the pilot pressure regulator **94** and the pilot pressure measuring capsule **88** for the purpose of delaying the rate of flow of the pilot pressure signal from the pilot pressure regulator **94** to the pilot section of the main control valve **54**.

The upper control chamber **60** and the pilot pressure chamber **76** are connected through a valve member **98** which is moved to an open or closed position by movement of the pilot pressure measuring capsule **88** in response to a signal received from the pilot pressure regulator **94**. The lower pressure chamber **62** and the main fluid supply inlet **86** are likewise adapted for selective fluid communication through a supply valve member **100**, which is normally biased into closed position by means of a spring **102**. The supply valve member **100** is interconnected with a relief valve member **104** disposed between the lower pressure regulating chamber **62** and the exhaust chamber **80** to exhaust excess pressure from the pressure regulating chamber **62** upon upward movement of the float member **72**.

It will be seen from FIG. **3** that on downward movement of the float member **72**, the valve **100** will be opened to admit fluid from the fluid supply source **50** into the lower pressure regulating chamber **62** and that since the position of the float member **72** is determined by the signal received in the pilot pressure chamber **76** the supply of fluid through the outlet **66** as controlled by the valves **100** and **104** will be in response to to the signal also. This portion of the control system **14** is disclosed and claimed in copending application Serial No. **22,986** and forms no part of the present invention.

With specific reference to FIGS. **4–6**, the manual control unit **106** of the present invention comprises a first fixed or stationary body portion **108** provided with an inlet fitting **110** adapted to be attached to the pilot pressure line **92** by means of a flexible cable or hose **112**. The inlet fitting **110** is in communication with a pilot pressure chamber **114** provided by a coaxial bore **116** through the fixed body portion **108**. At the inner end of the bore **116**, a sealed valve member **118** is provided which has an axial orifice **120** of predetermined diameter, and which is biased toward the inner end of the inlet bore **116** and against a second body portion **124** by means of a spring **122** disposed within the pilot pressure chamber **114**. The body portion **124** is rotatable relative to the body portion **108** around a pin **126** extending centrally axially through the body portion **124** to be centrally secured against rotation by a lock screw **128** fastened within the body portion **108**.

As can best be seen in FIG. **5**, the body portion **124** is provided with a pair of radially angularly spaced bleed orifices **130** and **132** which are adapted to be selectively brought into alignment with the inlet pressure orifice **120** through the valve member **118** upon respective clockwise or counter-clockwise rotation of the rotatable body portion **124**. The axial bleed orifices **130** and **132** communicate respectively with a radial orifice **134** and **136** which open to the atmosphere. The fluid flow between the axial bleed orifices **130** and **132** and their respective radical orifices **134** and **136** to the atmosphere can be manually adjusted by means of needle valves **138** (FIG. **4**), provided in the rotatable body portion **124**, and which can be screwed in or out to thereby vary the rate of fluid flow between the axial bleed orifices **130** and **132** and their respective radial bleed orifices **134** and **136**. After appropriate initial adjustment of the needle valves **138** as may be required by the particular load lifting operation, the needle valves can be locked in place by the provision of lock nuts **140**.

As can best be seen in FIG. **4**, appropriate coaxial positioning of the bleed orifices **130** or **132** with the pilot pressure orifice **120** is accomplished by the provision of a ball detent means **142**, comprising an aperture **144** provided in the rotatable body portion **124**, and disposed parallel with the central pin **126** and which contains a ball **146** biased by a spring **148** towards the fixed body portion **108**. The spring **148** is retained within the aperture **144** by means of a spring adjusting and retaining screw **150**. The ball **146** is adapted to cooperate with complementary angularly spaced detent recesses **152** (FIG. **6**) provided in the fixed body portion **108** in such relation as to correspond to the spacing between the bleed orifices **130** and **132**. The angle of rotation of the rotatable body portion **124** is normally limited within the angular spacing of the bleed orifices **130** and **132** and the detent

recesses **152** by means of a pin **154**, which is resiliently retained within a radial slot **156** in the fixed body portion **108**. Thus, upon rotation of the rotatable body portion, either clockwise or counter-clockwise, when the pin **154** abuts against either end of the radial slot **156**, the ball **146** will snap into one of the detent recesses **152** to thereby accurately align the pilot pressure orifice **120** with either bleed orifice **130** or **132** to bleed pilot fluid from the pilot line **92** through the control line **112** in an amount as determined by the preadjustment of the respective needle valves **138**.

The resiliently retained pin **154**, in addition to the provision of limiting the rotation of the rotatable body portion **124**, provides a safety latch means by which the rotatable body portion of the manual control unit can be securely locked in an angularly rotated position relative to the fixed body portion **108**, in which neither bleed orifice **130** or **132** is aligned with the pilot pressure orifice **120**, so that fluid flow through the manual control unit **106** is completely blocked. This occurs under full-load, maximum pressure conditions desired for the hoist operation, which causes the main control valve **54** to respond proportionately as determined by the setting of the pilot pressure regulator valve **94** to supply a sufficient pressure over the piston area of the hoist to lift the total load attached to the cable **42**.

The safety mechanism positively locks the hand control in this position so that with a full load being hoisted the control will not be inadvertently shifted to a position which would permit the load to drop. While hand controls with this type of safety feature have been previously provided, unlike the previous hand controls the control unit **106** is constructed so that the safety pin **154** cannot be removed without taking the unit apart. In previous devices the hand control could be easily altered to remove the safety mechanism or to make it inoperable when the operator felt it interfered with the speed at which he wanted to operate the device. This of course led to accidents.

To provide the safety latch, the pin **154** is resiliently slidably retained within an aperture **158** in the rotatable body portion **124** and is spring loaded from the rear by means of a spring **160**. The rear end of the pin **154** adjacent the end of the spring **160** is provided with a nib portion **162** which extends upwardly through a longitudinal slot **164** in the body portion **124** for longitudinal sliding movement therein. The rib portion **162** extends outwardly of the body portion to connect to a thumb grip **166**. The fixed body portion **108**, as seen in FIG. **6**, is additionally provided with a separate pin recess **168** radially aligned with the curvilinear pin slot **156** but angularly spaced therefrom. It can thus be seen that, if the thumb grip **166** is manipulated by movement towards the rear of the rotatable body portion **124** so that the nib portion **162** of the pin **154** is caused to slide within the slot **164** and to thereby move the pin **154** out of the curvilinear slot **156** against the force of the spring **160**, the rotatable body portion **124** can be rotated beyond the angular position normally permitted by the curvilinear slot **156** to cause the lock pin **154** to snap into the separate pin recess **168** under the force of the spring **160**, thereby locking the rotatable body portion **124** against inadvertent or accidental retention. In this position neither of the bleed orifices **130** or **132** in the rotatable body portion **124** will be aligned with the pilot pressure orifice **120** in the fixed body portion **108**, thus completely blocking the fluid flow through the hand control unit **106**. Also in this position, the pilot signal line pressure will be at a maximum as determined by the preadjustment of the pilot pressure regulator **94**. This maximum pilot pressure signal causes operation of the main control valve **54** to supply maximum fluid pressure into the cylinder chamber **32** of the hoist for lifting and supporting the weight attached to the cable **42**. When the thumb grip **166** is actuated to move the lock pin **154** again back into the curvilinear slot **156**, the rotatable body portion **124** can be rotated within the limits of the slot **156** to align either bleed orifice **130** or **132** with the pilot pressure **120** to obtain any selected intermediate pressure position between near zero pressure and the maximum pressure as determined by the adjustment of the needle valves **138**. The amount of pilot air bled through the orifices **130** and **132** causes a signal to be transmitted to the pilot pressure regulator **94**, which transfers the signal to the measuring capsule **88** in the upper control chamber **60** of the main control valve **54** to selectively open the valve **98** between the upper control chamber **60** and the pilot pressure chamber **76** to thereby correspondingly regulate the pressure in the pressure regulating chamber **62**.

With additional reference to FIG. **7**, the flexible hose or conduit **112** connecting the hand control unit **106** to the pilot pressure line **92** is preferably a steel wire reinforced hose and comprises, as particularly seen in cross section in FIG. **7**, an outer elastomer tube **170** which may be of neoprene, rayon or the like, which retains an intermediate tube of steel wire braid **172** for reinforcement of the hose, to which is bonded an inner liner **174** of plastic or elastomer fibers or the like. This construction for the flexible hose **112** is preferred to prevent the hose from being severed or punctured.

Referring back to FIG. **3**, and as briefly mentioned before, a safety shut-off valve **68** is disposed between the main control valve **54** and the cylinder chamber **32** of the hoist. The valve **68** is connected to the fluid supply source **50** by means of a line **176** which normally, that is under normal air pressure or fluid pressure, retains the valve in an open position so as not to restrict the fluid flow between the outlet **66** of the main control valve **54** and the cylinder chamber **32**. However, in the event that the fluid pressure should drop below a safe value, the valve **68** will be forcibly closed by means of a spring a solenoid or other means to thereby block further fluid flow between the main control valve **54** and the cylinder chamber **32** and trapping fluid at a safe pressure within the cylinder chamber **32**, thus preventing sudden movement of the piston **26** which otherwise would cause the load attached to the cable **42** to rapidly drop.

Thus, it can be seen that I have described in detail an improved pneumatic control system for a hoist and balancing unit using positive fluid pressure at all times to raise, lower or balance a load of a predetermined weight. The preferred system has a number of advantages over other systems utilizing a predetermined bleed control where once a positive pressure has been established to support a load and its attachment, the lowering and unloading of the load is accomplished by bleeding some of the pressure to the atmosphere.

By providing the control system with three predetermined balanced pressures that can be admitted into the hoist, the following advantages are available. When the load attachment means alone is in a state of balance, the operator with a slight effort can move the hook up and down through the complete range of the hoist cable travel without operating the hand control unit. After manually lowering the hook to a position where it can be attached to the load, it remains positioned so that it can be attached to the load. After the load has been attached, the hand control unit can be repositioned to the position associated with the highest pressure so that the air pressure behind the piston is sufficient to support as well as raise the load. Normally the difference between the pressure associated with raising the load and the pressure for balancing the load in a suspended position is adjusted or trimmed so that with the higher pressure, due to the inherent friction in the system, the hoist does not raise the load until the operator manually assists in raising the load upward. Once the friction forces in the system has been momentarily overcome, the air pressure is then sufficient to keep the piston moving and the hoist to continue lifting until the operator applies resistance to the load to stop its motion, whereby the inherent friction in the system then holds the load at rest. The hoist will then support the load in this new position until it is moved upwardly again. The load can be lowered by the operator by applying a manual downward force on the load which requires some effort, however, by positioning the remote hand control unit to admit the lowest pressure into the hoist chamber, the load can then be lowered without effort. The system can also be ad-

justed so that the intermediate pressure and the lowest pressure are relatively close so that the load does not automatically commence dropping when the control is shifted from the intermediate pressure to the lowest pressure until the operator applies a slight manual downward force to overcome the inherent friction of the system so that it commences its downward motion.

The control system has a "fail-safe" feature in that if the air pressure at the source drops, the safety valve traps the pressure existing in the hoist chamber at the occurrence of the pressure drop so that the hoist continues to respond to the last signal received by the main control valve. Although under these circumstances the operator is unable to change his selection, he can in fact continue to position the load although he is restricted to the one selection in which the main control valve is in at the occurrence of the failure.

Another "fail-safe" feature of the present invention is the provision of a reinforced flexible hose for the remote hand control unit to lessen or to eliminate the danger of the hose being cut or otherwise damaged.

A third "fail-safe" feature of the present invention is the provision of the safety lock incorporated within the hand control unit to lock the unit in the maximum pressure position to guard against inadvertent or accidental shifting of the maximum positive pressure setting to a lower or near zero pressure setting unless deliberately actuated.

Although I have described only one embodiment of my invention, it is to be understood that various changes and revisions can be made therein without departing from the spirit of the invention as expressed in the scope of the appended claims.

I claim:

1. In a balancing hoist having a pneumatic control system, a hoist, means in said hoist for supporting a cable extending from said hoist adapted to be reeled into and out of said hoist to raise or lower a load attached to the end of said cable, said means comprising an expansible pressure chamber and a piston in said chamber, said chamber being adapted to receive fluid under pressure and said piston being adapted to be moved in one direction upon an increase in pressure in said expansible chamber and in the other direction upon a decrease in pressure in said expansible chamber; a source of fluid under pressure; a first fluid line connecting said source of fluid to said expansible chamber; a pilot pressure controlled main control valve in said first fluid line; a second fluid line between said source of fluid pressure and the inlet of a pilot pressure regulator; a third fluid line connecting the outlet of said pilot pressure regulator with the pilot section of said main control valve for supply of pilot pressure thereto; a fourth fluid line comprising a vent line connected to said pilot pressure regulator; a vent control means connected to the other end of said vent line, said vent control means having at least two positions selectively connectable to said vent line for venting said vent line at rates different from each other, and a third position for blocking said vent line, each of said positions applying a pilot pressure control signal to said pilot pressure regulator of different magnitudes for transmission to said main control valve to thereby selectively vary the pressure supplied to said expansible chamber by said main control valve; said vent control means including a housing having a first body portion secured to said vent line, said first body portion having a pilot pressure inlet orifice aligned and in communication with said vent line, a second body portion secured to said first body portion and rotatable relative thereto, said second body portion having angularly spaced vent means selectively adaptable to be aligned with said pilot pressure inlet orifice of said first body portion in a first and a second position, said second body portion being rotatable to a third position in which neither of said vent means of said second body portion will be aligned with said pilot pressure inlet orifice of said first body portion, said second body portion being provided with means to normally limit rotation of said second body portion relative to said first body portion between said first and second positions and to lock said second body portion in said third position, the improvement comprising said last mentioned means comprising a pin carried within said second body portion; a curvilinear slot provided in said first body portion, biasing means carried by said second body portion for urging said pin into engagement with said curvilinear slot when said second body portion is in either said first or second position, said curvilinear slot being entirely enclosed by said body portions whereby said pin is entirely enclosed by said body portions, said curvilinear slot having an angular dimension corresponding to the angular spacing between said vent means, said pin being provided with means for moving said pin out of said curvilinear slot for rotation of said second body portion to said third position in which neither of said vent means is aligned with said pilot pressure inlet orifice in said first body portion to thereby block fluid flow through said vent control means; and a recess within said first body portion and arcuately spaced from said curvilinear slot, said recess receiving said pin when said second body portion is moved to said third position to lock said second body portion in said third position, said biasing means urging said pin into said recess when said second body is in said third position.

2. The pneumatic control system as defined in claim 1 further comprising flow control means disposed in said third fluid line between said pilot pressure regulator and said main control valve to delay the transmission of pilot pressure signal from said pilot pressure regulator to the pilot section of said main control valve.

3. The pneumatic control system as defined in claim 1 the further provision of a one-way check valve disposed between said source of fluid under pressure and said main control valve to prevent back flow of fluid from said main control valve to said source of fluid pressure.

4. The pneumatic control system as defined in claim 1, a check valve provided in said first fluid line adapted to close the supply of fluid to said main control valve upon an increase in fluid flow beyond the predetermined normal operating flow.

5. The pneumatic control system as defined in claim 1, the further provision of a safety shut-off valve disposed between said main control valve and said expansible chamber, said safety shut-off valve having a valve operating member connected to said source of fluid under pressure to thereby maintain said valve in an open position for free communication of fluid between said main control valve and said expansible chamber, and means to close said safety shut-off valve upon a decrease in fluid pressure at said source of fluid under pressure below a predetermined value.

6. The control system as defined in claim 1, said vent means of said second body portion comprising bleed orifices to bleed pilot pressure to the atmosphere to thereby produce a signal transmitted to the pilot pressure regulator to cause said main control valve to change the pressure supplied to said expansible pressure chamber.

7. The control system as defined in claim 6, the flow through said bleed orifices being manually adjustable to obtain a first pressure setting of low magnitude and a second pressure setting of a higher magnitude.

8. The control system as defined in claim 1, the second body portion being provided with resilient detent means adapted to cooperate with angularly spaced recesses provided in said first body portion spaced a distance equal to the distance between said bleed orifices to accurately selectively align either of said bleed orifices with the pilot pressure inlet orifice of said first body portion.

9. The control system as defined in claim 1, said first body portion being provided with a recess angularly spaced from said curvilinear slot adapted to receive said pin when said second body portion is rotated to said third position to thereby positively lock said second body portion against rotation.

10. The control system as defined in claim 9, said pin being resiliently forced into engagement within said locking recess of said first body portion and provided with a grip means extending outwardly of said second body portion to move said pin out of said locking recess.

11. The control system as defined in claim 1, said vent line comprising a flexible reinforced wire braided hose.

* * * * *

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,675,899 Dated July 11, 1972

Inventor(s) Lorne J. McKendrick

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

IN THE SPECIFICATION

Col. 1, line 38, after "2,613,903" insert --to-- .

IN THE CLAIMS

Claim 8, line 1, "1" should be --6-- ;

Claim 10, "9" should be --1-- .

Signed and sealed this 27th day of February 1973.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents

FORM PO-1050 (10-69)

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