United States Patent

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[54] **LOAD BALANCER**

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[52] **U.S. Cl.** ....**254/168,** 254/186, 254/189, 254/150 FH

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

[58] **Field of Search**..............254/167, 168, 186, 189, 150 FH

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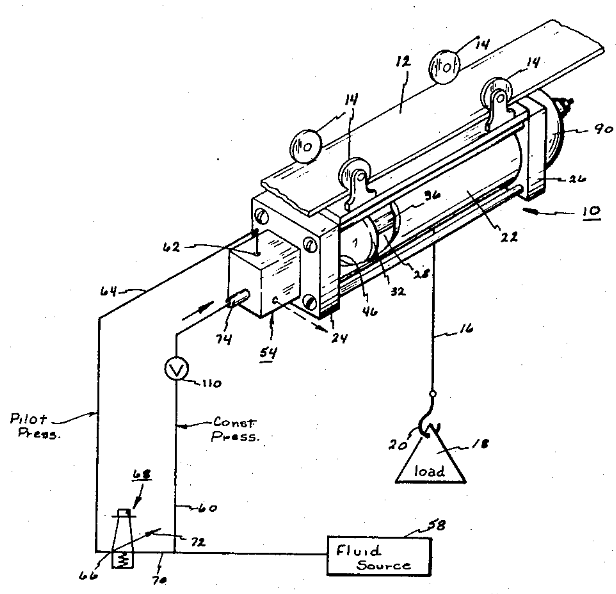
[57] **ABSTRACT**

A pneumatic load balancer having a hoist cylinder adapted for attachment to an overhead support such as a hook, rail, trolley or the like having a piston assembly disposed in the cylinder, a fluid chamber and a lifting cable which is wound around a dual set of pulleys with one end anchored with respect to the cylinder and the other end arranged for attachment to a load. One set of pulleys is fixed against motion near the center of the cylinder and the other set is carried by the piston assembly to reel in or to unwind the cable from the cylinder upon movement of the piston assembly by means of fluid pressure. A pneumatic control system is provided which comprises a monostat in the form a pilot pressure operated fluid pressure regulator having a built-in relief valve and which is fitted to the cylinder inlet and which can be operated either through pilot or mechanical connections to adjust the pressure of fluid available at the inlet of the cylinder in correspondence with the load carried by the cable. Valve means are also provided which are normally open to communicate the fluid chamber with atmosphere and which closes upon an increased pressure in the chamber to thereby dampen upward movement of the cable.

6 Claims, 3 Drawing Figures



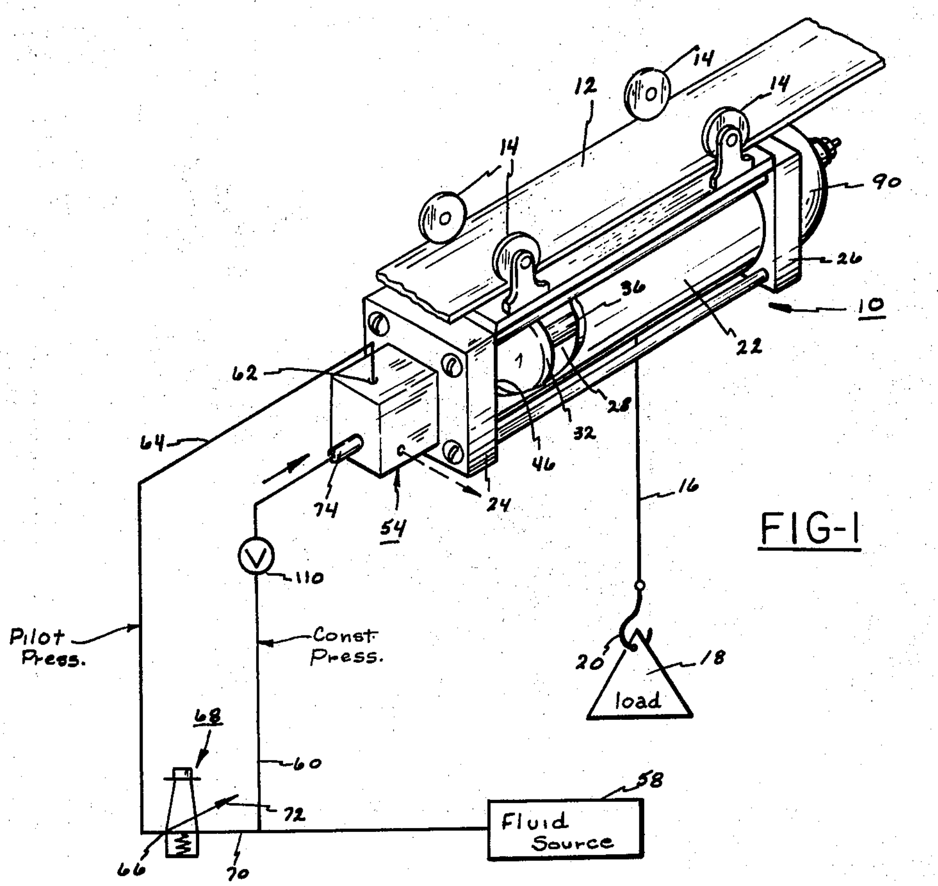


FIG-1

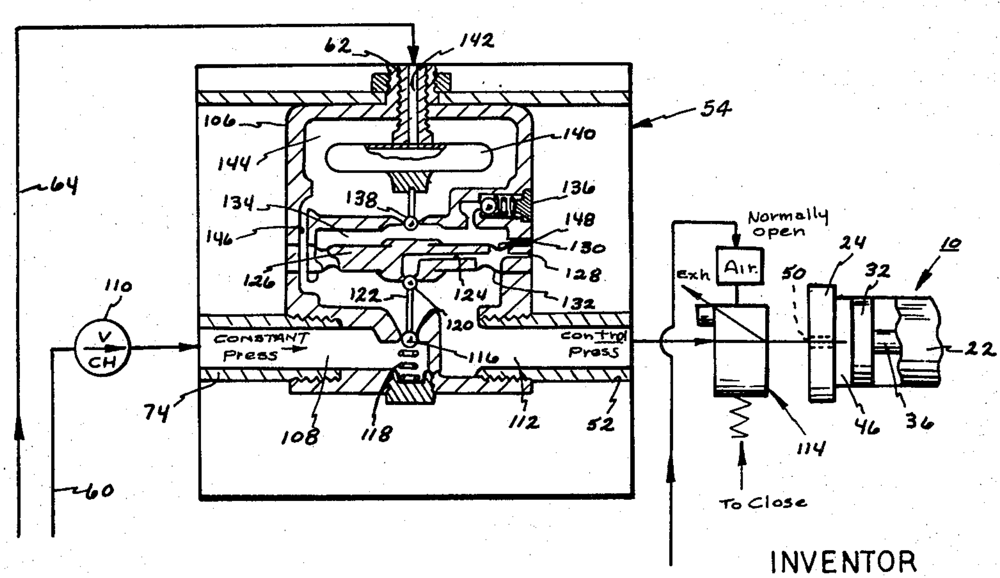


FIG-3

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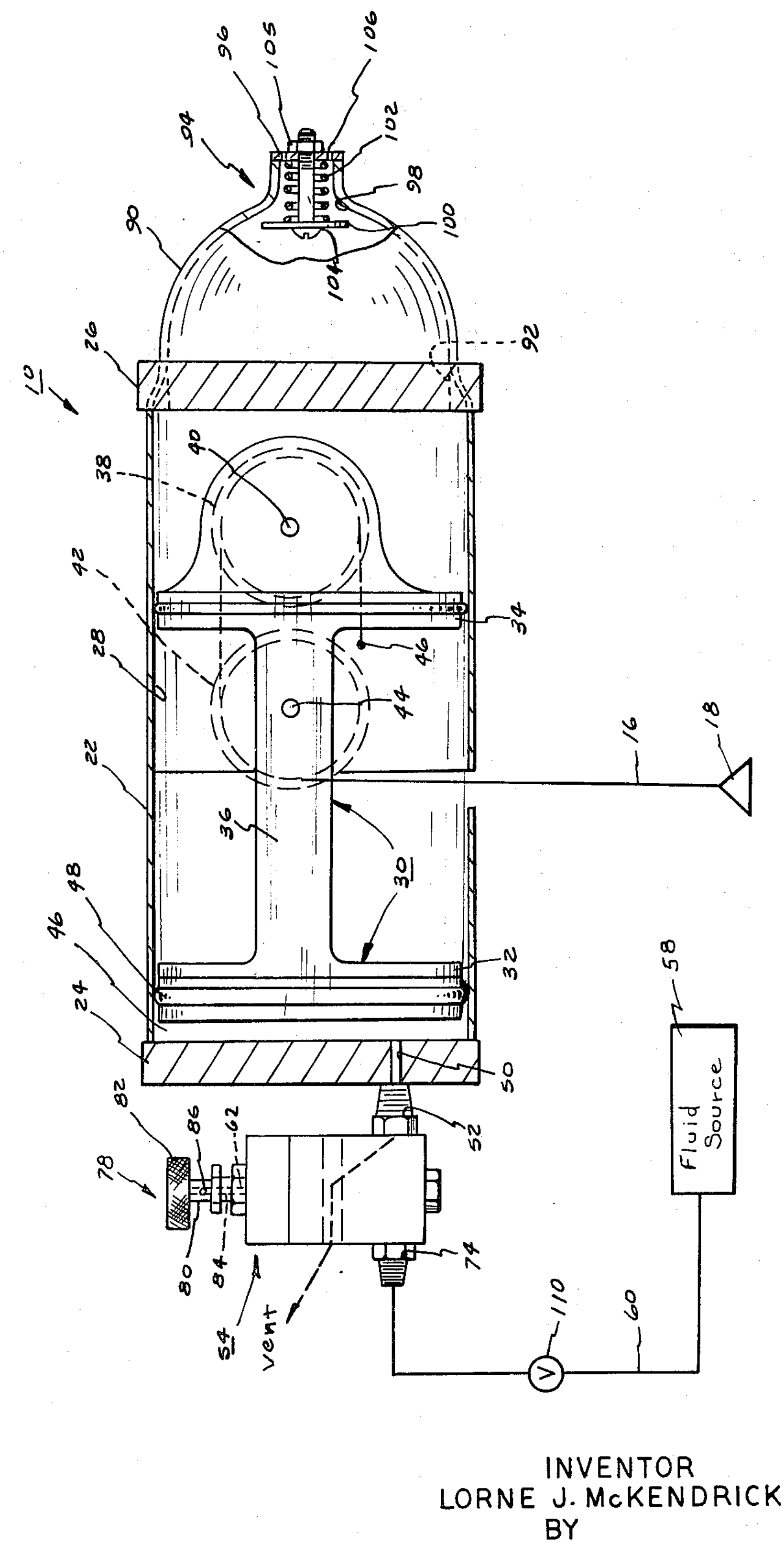
FIG-2



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LOAD BALANCER

BACKGROUND OF THE INVENTION

I. Field of the Invention

The present invention relates to a load balancer and more specifically to a pneumatically operated hoist load balancing device.

II. Description of the Prior Art

Hoist type load balancers are in common use for supporting heavy loads such as workpieces or tools which have to be positioned relative to the work operation and which can not be conveniently manipulated by hand for any extended period of time.

Pneumatically controlled overhead hoist type load balancers are also known which comprise a cylinder having a piston movable therein, a cable drum operably connected to the piston and a cable extending out of the cylinder for attachment to a load. One end of the cylinder and the piston define a pressure chamber which is adapted to be filled with air or other fluid under pressure to move the piston and thereby operate the cable drum to either unreel or windup the cable. Prior devices have also included pressure regulators incorporated in the fluid line of load balancing units to provide different pressures acting on the piston in the cylinder chamber to accommodate loads of different weights. The present invention provides an improvement over these known, pneumatically controlled hoist load balancing devices by providing a simplified hoist mechanism in combination with a pilot pressure regulated, adjustable fluid pressure regulator.

SUMMARY OF THE INVENTION

The preferred embodiment of the present invention comprises a pneumatically controlled load balancer having a cylinder adapted for attachment to an overhead support such as a hook, rail, trolley or the like, and in which is disposed a pressure responsive piston assembly forming a fluid chamber between one end of the piston and one end wall of the cylinder. A load supporting cable is wound around two sets of pulleys with one end of the cable anchored within the cylinder and the other end extending from the cylinder to support a load.

One set of pulleys is fixed against axial motion near the center of the cylinder and the other set of pulleys is attached to and carried by the piston assembly to be moved with the piston assembly toward and away from the fixed pulleys and to thereby reel-in or unwind the cable from the cylinder. The introduction of fluid under pressure into the hoist cylinder chamber forces the piston assembly away from the center of the cylinder so that the pulleys supported at the opposite end of the piston assembly are moved away from the other set of pulleys fixed near the center of the hoist cylinder to raise the load supported at the other end of the cable. When pressure on the fluid is relieved from the hoist cylinder chamber the piston assembly will be moved by the weight on the cable towards the center section of the hoist cylinder to move the set of pulleys carried at the other end of the piston assembly toward the set of pulleys fixed near the center of the hoist cylinder and to thereby unwind the cable.

The improved pneumatic control system comprises essentially a monostat in the form of a pilot pressure operated fluid pressure regulator having a built-in relief valve which is fitted to the inlet of the balancing hoist cylinder chamber and which can either be remotely pilot operated or directly manually operated. Upon attaching a load to the free end of the balancing hoist cable, the selective adjustment of the pilot pressure operated fluid pressure regulator or monostat acts to regulate the fluid pressure so that the balancer can be used to manipulate loads of different weights. Thus, for any given load the pressure is selected to produce a balancing of the load so that the load can be manipulated, including raising and lowering, by hand.

Once the proper adjustment has been selected, the balancer will then act automatically. Pulling down on the load will cause the monostat inlet pressure controlling section to close and the relief section will detect the increase in fluid pressure within the hoist cylinder chamber due to the compression of the trapped fluid therein. This increased pressure, causes the relief section of the monostat to open, thus bleeding off the excess pressure to maintain a continued balancing of the load. The decrease in pressure in the chamber which will be caused as the load is relieved by upward manipulation of the load is sensed by the monostat and opens the inlet to pressure. This control arrangement then provides a complete balancing effect over the full cable travel of the balancer.

Thus the present improved construction of a pressure controlled load balancing system provides a constant and effective load balance regardless of the position of the load throughout the travel of the load balancer support cable. The present improved system is readily adjustable upon a change in load value by means of a simple adjustment. Because of the ability to adjust the pressure over a wide range a single balancer can handle loads of various weights so that a single balancer can be used for many different jobs.

Other objects, advantages and novel features will become apparent by reference to the following description in connection with the accompanying drawings.

DESCRIPTION OF THE DRAWINGS

A preferred embodiment of the improved hoist type load balancer and fluid pressure control is illustrated in the accompanying drawings in which:

FIG. 1 is a partially perspective and partially schematic illustration of one preferred embodiment of the present novel load balancing hoist and improved fluid pressure system and control therefore;

FIG. 2 is a cross section through a load balancing hoist device according to the present invention and schematically illustrating a further embodiment of a fluid pressure control system; and

FIG. 3 is a view partially in cross section and partially schematic illustrating the monostat or fluid pressure regulator embodied in either arrangement of FIG. 1 or FIG. 2.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

With reference to FIG. 1, a pneumatically operated load balancing hoist device generally indicated at **10**, is shown as being transversely movably suspended from an overhead rail or beam **12** by means of trolleys **14**. A cable **16** extends from the hoist device **10** and is adapted to support a load **18** by means of a load attaching hook **20** or the like. The load **18** may be a heavy workpiece intended to be positioned in a machine fixture on an assembly line or it may be a heavy tool or the like to be handled by an operator. Obviously, the load will be of various weights and in instances, would be far too heavy to be handled without the aid of the hoist device **10**.

With particular reference to FIG. **2** a preferred construction of a load balancing hoist device **10** comprises a cylinder housing **22** having one end closed by a front end cap **24** and the other end by a rear end cap **26** to thereby define a cylindrical chamber **28**. The chamber **28** is adapted to reciprocably support a dual-piston assembly **30** comprised of a pressure piston **32** and a support piston **34** connected to each other by means of tie rods **36** so as to be movable as a unit. The rear support piston **34** is adapted to support a plurality of pulleys **38** rotatable around a shaft **40**. The pulleys **38** are adapted to retain the inner end of the cable **16** which also extends over a second set of pulleys **42** which are rotatably secured within the chamber **28** on a shaft **44** and which are retained stationary relative to the pulleys **38**. The end of the cable **16** is anchored within the chamber **28** at a point **46** which is located substantially along a line tangent to the pitch diameters of both sets of pulleys **38** and **42**.

Thus, longitudinal movement of the pulleys **38** away from the fixed pulleys **42** causes the cable **16** to be drawn into the cylinder **22** upon movement of the piston assembly **30** towards the right in FIG. 2 to thereby lift the load **18**, and movement of the pulleys **38** caused by movement of the piston assembly **30** in the opposite direction, that is towards the fixed pulleys **42**, permits the cable **16** to be extended from the cylinder **22** to thereby lower the load **18**. The distance the load **18** will be lifted or lowered by the cable **16** is determined by the length of the power stroke of the piston assembly **30** multiplied by the number of fixed and movable pulleys. This construction of a load balancing hoist assembly is conventional and forms no part of the present invention other than in combination with the present improved fluid pressure control system, which will be now described in greater detail.

The front portion of chamber **28** of the cylindrical housing **22** between the front end cap **24** and the pressure piston **32** defines a fluid pressure chamber **46** sealed from the chamber **28** by means of a dynamic seal assembly **48** supported by the piston **32**. The pressure chamber **46** is adapted to be filled with a fluid under pressure through an inlet orifice **50** extending through the end cap **24**. The inlet orifice **50** is connected by means of a fitting **52** to a pilot fluid controlled fluid pressure regulator **54**. The fluid pressure regulator **54** can be directly manually adjusted as illustrated in the embodiment in FIG. 2 or it may be pilot controlled as in the embodiment illustrated in FIG. 1.

Referring again to FIG. 1, the pilot pressure operated fluid pressure regulator **54** is connected by means of an inlet fitting **74** and a conduit **60** to a source of fluid under pressure **58**. In the pilot controlled fluid pressure regulator system as schematically illustrated in FIG. 1 the fluid pressure regulator **54** is further provided with a pilot inlet **62** connected to a flexible pilot pressure conduit or hose **64** which is connected to the outlet side **66** of a remote pilot pressure regulator valve **68** the inlet of which is connected by a fluid conduit **70** to the source of fluid under pressure **58**. The remote pilot regulator valve **68**, as is common has an adjustable pressure relief for exhausting pressure as indicated by the arrow **72** so that upon adjustment of the pilot pressure regulator valve **68** to regulate exhaust, the pilot pressure delivered to the primary fluid pressure regulator **54** can be precisely adjusted.

As shown in detail in FIG. 3, the fluid pressure regulator valve **54** comprises a housing **106** having a lower constant pressure chamber **108** provided with an inlet **74** which is in fluid communication through a one way check valve **110** and conduit **60** with the source of fluid pressure **58** (FIG. 1). The constant pressure chamber **108** is selectively communicable with a regulator pressure chamber **112** which is connected by an outlet **52** and through a normally open safety valve **114** to the inlet **50** of the hoist cylinder pressure chamber **46** to supply that chamber with regulated predetermined fluid pressure at varying magnitudes.

A valve **116** is positioned intermediate the constant pressure chamber **108** and the regulator pressure chamber **112** and is normally retained in a closed position by fluid pressure and a spring **118**. Valve **116** is provided with a relief valve **120** connected thereto by a stem **122** so the valves **116** and **120** act together to control the pressure within the regulator chamber **112** depending upon the opened or closed position of the valve members **116, 120**. The relief valve **120** normally closes an exhaust passage **124** provided in an intermediate floating spacer member **126** for exhausting air from the chamber **112** to the atmosphere through an orifice **128**. The spacer member **126** is supported by a lower and upper diaphragm **130** and **132** respectively and separates the regulator chamber **112** from a pilot pressure chamber **134**. The pilot pressure chamber **134** is normally closed by a valve **138** connected to a pilot fluid pressure measuring capsule **140** the interior of which is fluid connected by an inlet passage **142** provided in an inlet fitting **62** at the top of the housing **106** to fluid line **64** which is connected to the outlet **66** of the pilot pressure regulator **68** (FIG. 1). The measuring capsule **140** is disposed within a control chamber **144** which is in open fluid communication with the regulator chamber **112** by means of a passage **146** provided in the side wall of the housing **106** so as to maintain substantially equal fluid pressure in both chambers **112** and **144**.

Normally, the inlet valve **116** is maintained in closed position by fluid pressure in the constant pressure chamber **108** in addition to the force of the spring **118**. Small movement of the measuring capsule **140** downwardly in the control chamber **144** as caused by admission of pilot fluid to the interior of the capsule **40** causes the pilot valve **138** to open to establish fluid communication between the control chamber **144** and the pilot chamber **134**. The increased pressure in the pilot chamber **134** acts on the upper diaphragm **130** with excess pressure being vented to the atmosphere through a vent **148**. Pressure on the diaphragm **130** is excess of that in the chamber **112** produces downward movement of the spacer member **126** and the inlet valve **116** to admit fluid in metered amounts from the constant pressure chamber **108** to the regulator chamber **112** until pressure across the diaphragms **130** and **132** equalizes. Excess pressure acts on the lower diaphragm **132** to move the floating spacer member **126** away from the relief valve **120** to open the chamber **112** to the vent orifice **128**. At the same time the spring **118** forces the inlet valve **116** into closed position to interrupt fluid communication between chambers **108** and **112**. The increased pressure in the regulator chamber **112** is also transmitted through the passage **146** to the control chamber **144** to act on the measuring capsule **140** to close the pilot valve **138** to again interrupt fluid communication between the control chamber **144** and the pilot chamber **134**. In this way regulated pressure is delivered to the hoist chamber **46** in response to a signal from the pilot pressure regulator **68**. The pressure of the fluid delivered to the inlet **62** will determine the pressure delivered to the hoist chamber **46** and at any setting of the pilot pressure regulator **62** an increase in pressure in the hoist chamber **46**, as caused by movement of the piston **32** to the left (FIG. **2**) to raise the load will override the pilot pressure regulator **68** and the pressure will be exhausted. A decrease in pressure in the hoist chamber **46** as caused by lifting the load will permit the pilot pressure to move the spacer member **126** downwardly to open the chamber **108** to the chamber **112** and thereby increase the pressure in the hoist chamber **46**.

Referring again to FIG. 2 for a description of the fluid pressure regulator valve **54** provided with a manual control, the regulator **54** has its inlet **74** directly connected through a one-way check valve **110** and a conduit **60** to the source of fluid under pressure **58**. The pilot pressure inlet **62** in the embodiment in FIG. 2 is provided with a manual adjusting mechanism **78** providing a valve rod **80** fluidly connected to the inlet **62** and which is rotatable by means of a knurled hand wheel **82** to adjust venting of fluid from the capsule **140** (FIG. 3) and in this way provide means for adjusting the balancer to accommodate different loads. The valve rod **80** is provided with an axial passage **84** connecting the pilot section of the pressure regulator **54** with the atmosphere by means of suitable orifices **86**. The axial passage **84** and the orifices **86** are comparable to the inlet **62** and pilot line **64** in FIG. 3 and are in fluid communication with the floatable pilot pressure measuring capsule **140** within the fluid pressure regulator valve **54**, as shown in FIG. 3 and described above so that movement of the capsule as caused by changes in pressure in chamber **144** produces a regulating of pressure applied to the fluid pressure chamber **46** in the hoist housing cylinder **22** substantially as described with respect to the embodiment of FIGS. 1 and 3.

Thus, from the foregoing description it will be obvious that, upon attaching a load to the free end of the cable **16**, direct manual or remotely controlled adjustment of the pilot pressure operated fluid pressure regulator **54** to increase the regulator output pressure supplied to the fluid pressure chamber **46** of the hoist cylinder **22** will balance a load by the provision of sufficient fluid pressure over the dynamic piston area of the pressure piston **32** to maintain the piston in a "balanced" condition. The adjustment permits loads of different weights to be balanced and once the proper adjustment has been made the supplying of air of sufficient pressure to maintain the balancing will be automatically produced by the pressure regulator **54**.

Upon pulling down on the load, the increased pressure caused by the load acting upon the piston to move it to the left (FIG. 2) will act upon the diaphragm **132** (FIG. 3) to move the member **126** upwardly. This causes valve **116** to close and **120** to open. Opening valve **120** permits bleeding of excess air pressure through the orifice **148** so that balance of the load is maintained as it is moved downwardly.

Manual movement of the load upwardly decreases pressure in chamber **112** permitting member **126** to be moved downwardly by pilot pressure to thereby close valve **120** and to cause valve **116** to be opened to open chamber **112** to pressure chamber **108** to thereby increase pressure in the cylinder chamber to maintain balancing of the load as it is moved upwardly.

Referring again to FIG. **2**, the cylinder **22** is provided with an extension **90** secured to the rear end cap **26** and forming an extension of the chamber **98**. Cap **26** is provided with an appropriate aperture **92** of such dimensions as to allow the pulleys **38** to move into the extension **90** during rearward movement of the piston assembly **30**. Centrally, the extension **90** is provided with a check valve assembly **94** contained within an opening **96** forming a valve seat **98** for cooperation with a valve plate **100**. The valve plate **100** is normally resiliently biased away from the valve seat **98** and against the head of a bolt **104** supporting the valve plate by means of a spring **102** supported within the opening **96**. The bolt **104** forms a guide for the valve plate **100** and a nut **105** tightened against a perforated plate **106** maintains the bolt **104** and valve plate **100** in position. The arrangement of the check valve assembly **94** in the extension **90** is adapted to control the raising or wind-up speed of the cable **16** relative to the lifting of the load **18** and to dampen the rearward movement of the piston assembly **30** upon an increase of pressure in the fluid pressure chamber **46**. Thus, as seen in FIG. **2**, when the piston assembly **30** is moved rearwardly, that is towards the right in FIG. **2**, by means of an increase in pressure in the pressure chamber **46**, the valve plate **100** will be forced from its normally open position toward a closed position against the valve seat **98** to thereby trap a certain amount of atmospheric pressure within the rear end of the cylinder chamber **28**. The rearward movement of the piston assembly **30** and the raising or winding-up of the cable **16** is thus dampened by the check valve assembly **94** to prevent a sudden rearward movement of the piston assembly **30** upon an increase of pressure in the pressure chamber **46** when, for instance, the load is removed from the cable **16**. Upon unwinding of the cable **16** from the cylinder **22** for lowering of the load **18** by means of a decreased pressure in the fluid pressure chamber **46**, causing movement of the piston assembly **30** towards the left in FIG. **2**, a suction force will be created in the rear portion of the cylinder chamber **28** and in the extension **90**, and the spring **102** then will move the plate to an open position to thereby admit atmospheric pressure into the extension **90** behind the piston portion **34** to facilitate movement of the piston assembly **30**.

Thus, it will be seen from the foregoing description in connection with the drawings that an improved fluid flow control system for a fluid pressure operated hoist mechanism has been provided including a fluid pressure regulator valve operable to compensate for various fluid pressure conditions caused by the weight balanced by the hoist and by the weight being lowered and raised so as to maintain the weight of the load in balance at all times.

Additionally, atmospheric pressure responsive valve means has been provided which functions to dampen the movement of the hoist piston upon a sudden decrease in load such as caused by removing the weight supported by the hoist to produce a sudden increase in fluid pressure against the piston in the hoist chamber.

Although only two preferred embodiments have been shown and described herein, it is obvious that various modifications may be made without departing from the spirit and essential characteristics of the present invention as defined by the scope of the appended claims.

I claim:

1. In combination, a pneumatically operated hoist having a hoist housing, a piston assembly movable in said housing, a first set of pulleys fixed within said housing, a second set of pulleys within the housing supported by said assembly for movement therewith towards and away from said first set of pulleys, a cable wound around said first and said second set of pulleys having one end anchored in said housing, the other end of said cable extending out from said housing for attachment to and support of a load therein, a fluid pressure chamber defined between the front end of said piston assembly and one end of said housing, means supplying said fluid pressure chamber with fluid under pressure to move said piston assembly and said second set of pulleys towards or away from said first set of pulleys, said means comprising a fluid pressure regulator valve, said valve having an inlet connected with a source of fluid pressure and an outlet connected with said fluid pressure chamber of said hoist, a normally closed first valve intermediate said inlet and said outlet, a normally closed relief valve connected with said first valve and operable when opened to relieve pressure from said outlet, a floating spacer member movable between a first position opening said first valve and a second position opening said relief valve, said spacer member being subjected to outlet pressure on one side and pilot pressure responsive means regulating pressure to the opposite side of said spacer member, said pilot pressure responsive means comprising a control chamber connected with said outlet, a capsule disposed within said control chamber with its interior connected to a pressure line extending between said capsule and said source and having a pilot regulator valve therein to provide a source of pilot pressure in said chamber, and a second valve connected with said capsule and operable to regulate pressure from said control chamber to side of said spacer member opposite said outlet pressure whereby an increase in pilot pressure or a decrease in outlet pressure opens said second valve to deliver pressure fluid to said opposite side of spacer member to cause said first valve to open and an increase in outlet pressure moves said spacer member to a position opening said relief valve and said hoist is converted to a balancer.

2. The device as defined in claim **1** and including means carried by said housing to dampen the movement of said piston assembly rearwardly upon a sudden increase in pressure within said pressure chamber.

3. The load balancing device as defined in claim **2**, in which said last mentioned means comprises said housing being provided with a rearwardly extending end portion, said end portion having an aperture to provide for the movement of said pulleys supported by said piston assembly into said end portion, said end portion comprising a compensating chamber provided with a one-way check valve normally biased in an open position to communicate said end portion with atmosphere but operable upon an increase to close to thereby dampen the movement of said piston assembly in a direction away from said fixed set of pulleys.

4. The device as defined in claim **3**, said valve comprising an opening in said housing, a stem extending through said opening having an enlarged head portion disposed inwardly of said housing, said enlarged head portion supporting a valve plate on said stem having a larger diameter than said opening, a plate disposed at the other end of said stem outwardly of said housing and overlying said opening, and fastening means securing said valve plate in position.

5. In the device as defined in claim **4**, in which the inner end of said opening defines a valve seat in said valve plate being adapted to cooperate with said valve seat to close said opening.

6. In the device as defined in claim **5**, spring means disposed in said opening around said stem to normally bias said valve plate away from said valve seat.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,669,411 Dated June 13, 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:

Column 1, line 53, after "cylinder to", insert --thereby cause the cable to be drawn into the hoist cylinder to--.

Signed and sealed this 26th day of September 1972.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents