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Stone et al.

[11] **3,791,627**

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[54] **PNEUMATICALLY-OPERATED HOIST WITH AUTOMATIC CONTROL SYSTEM**

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[52] **U.S. Cl.** **254/168,** 254/186, 91/48, 91/449

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

[58] **Field of Search** .. 254/168, 186; 91/449, 35, 48; 294/64 R

[56] **References Cited**

UNITED STATES PATENTS

3,457,837	7/1969	Powell	254/186 R X
3,656,715	4/1972	Powell	254/168
2,939,431	6/1960	Bottje et al.	91/449 X
2,470,566	5/1949	MacConnell	91/35 X
3,552,266	1/1971	Tanenblatt	91/35
3,008,747	11/1961	Lytle	294/64 R

FOREIGN PATENTS OR APPLICATIONS

524,729	8/1940	Great Britain	91/449

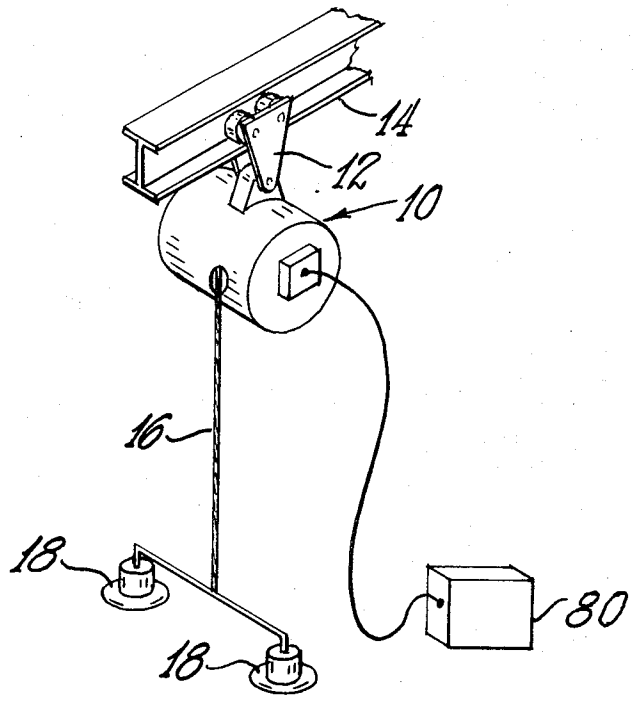
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[57] **ABSTRACT**

A pneumatically-operated hoist is operated through an automatic, pneumatic control system. The operation of the hoist is initiated through an external signal for the pneumatic control system by means of which the hoist is automatically directed through a plurality of sequential steps. The hoist preferably has at least two remotely-positioned bleed elements which are operated through the pneumatic control elements to control the hoist pressure at predetermined values in a manner such that an operator can manipulate a load with the hoist in a desired manner without having to operate any manual controls at all. The control system also is equipped with a bleed element which opens to slowly bleed the hoist in the event of air failure, so that a load carried by the hoist can be safely lowered.

15 Claims, 5 Drawing Figures



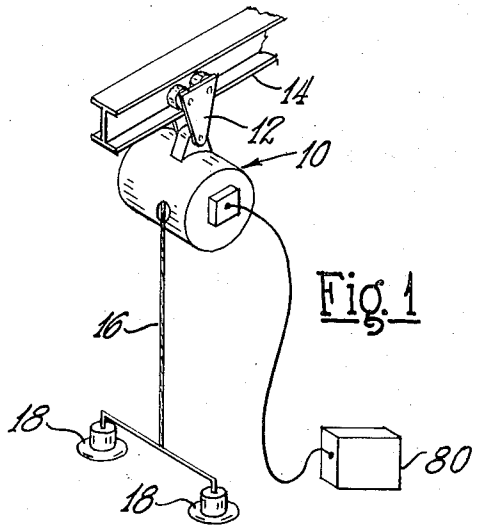


Fig. 1

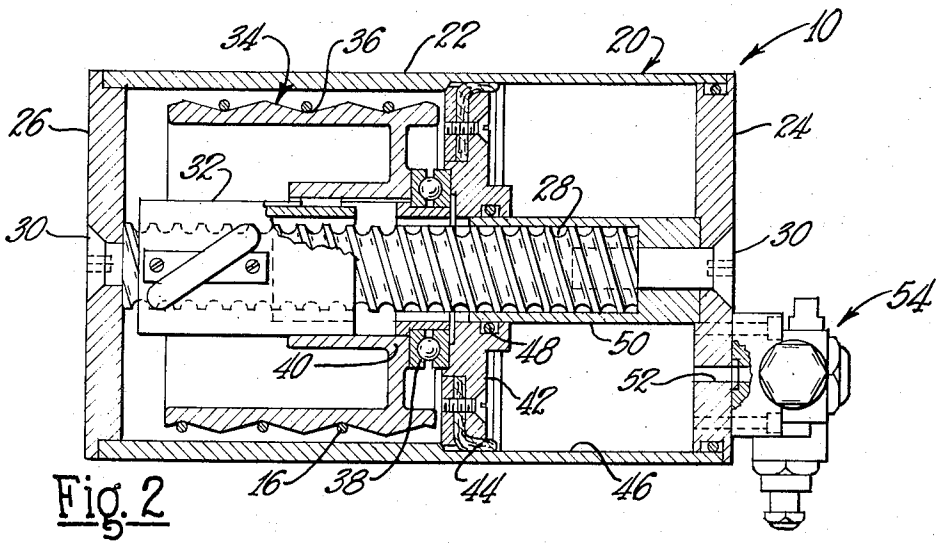


Fig. 2

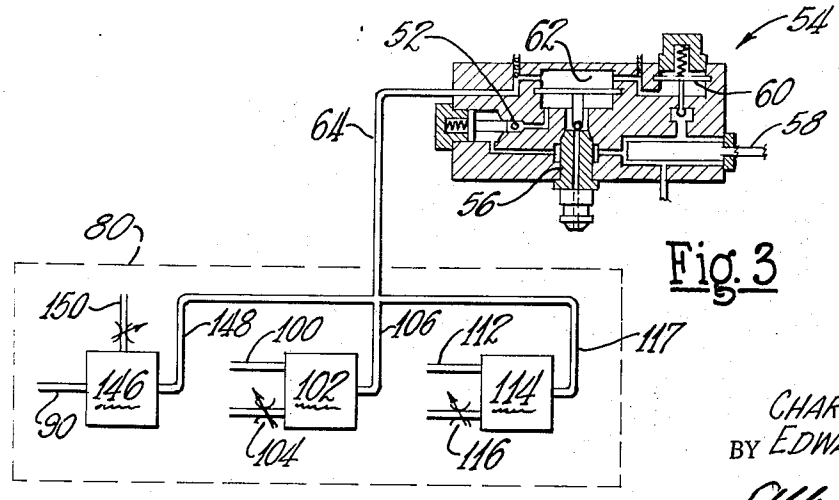


Fig. 3

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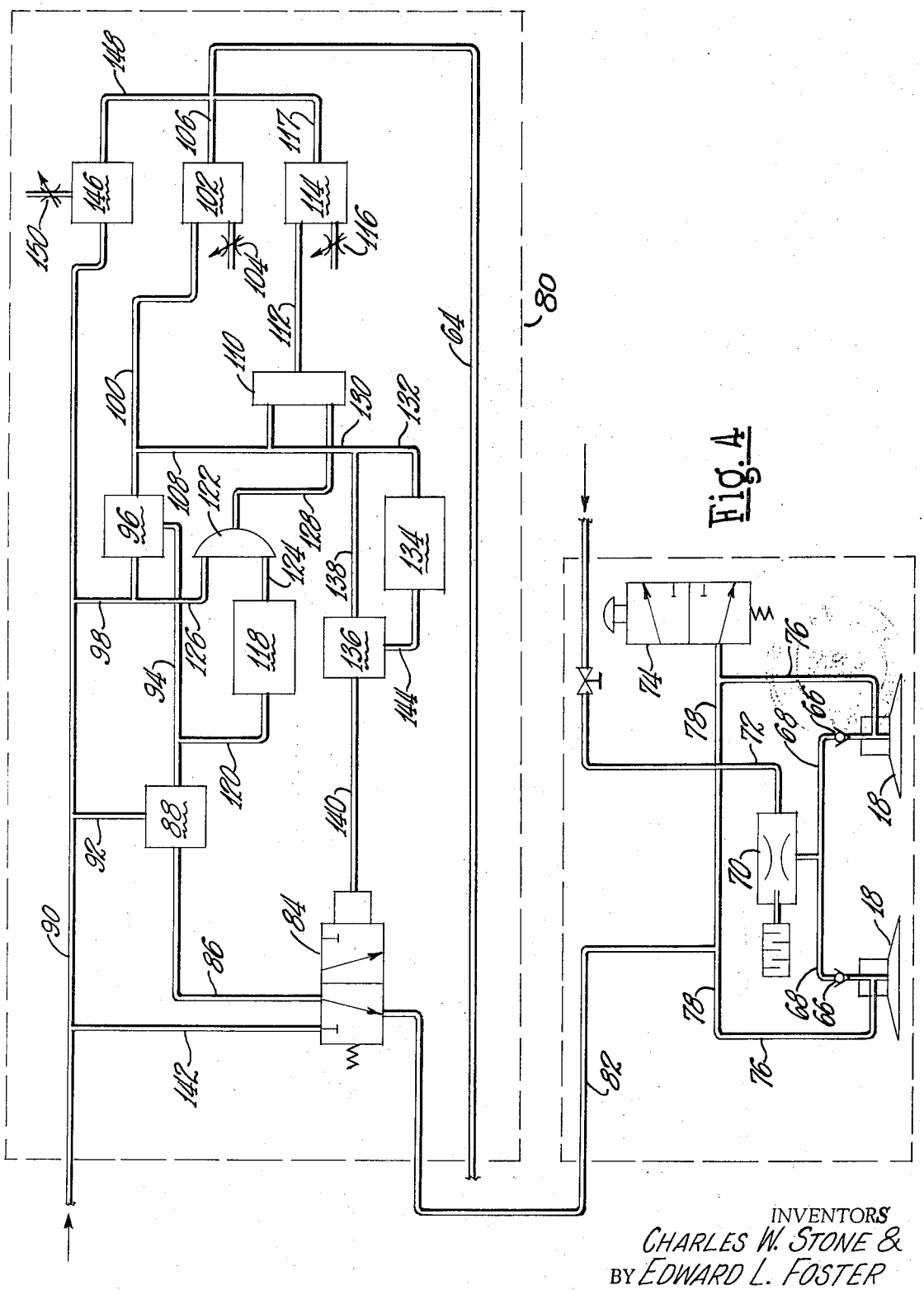


Fig. 4

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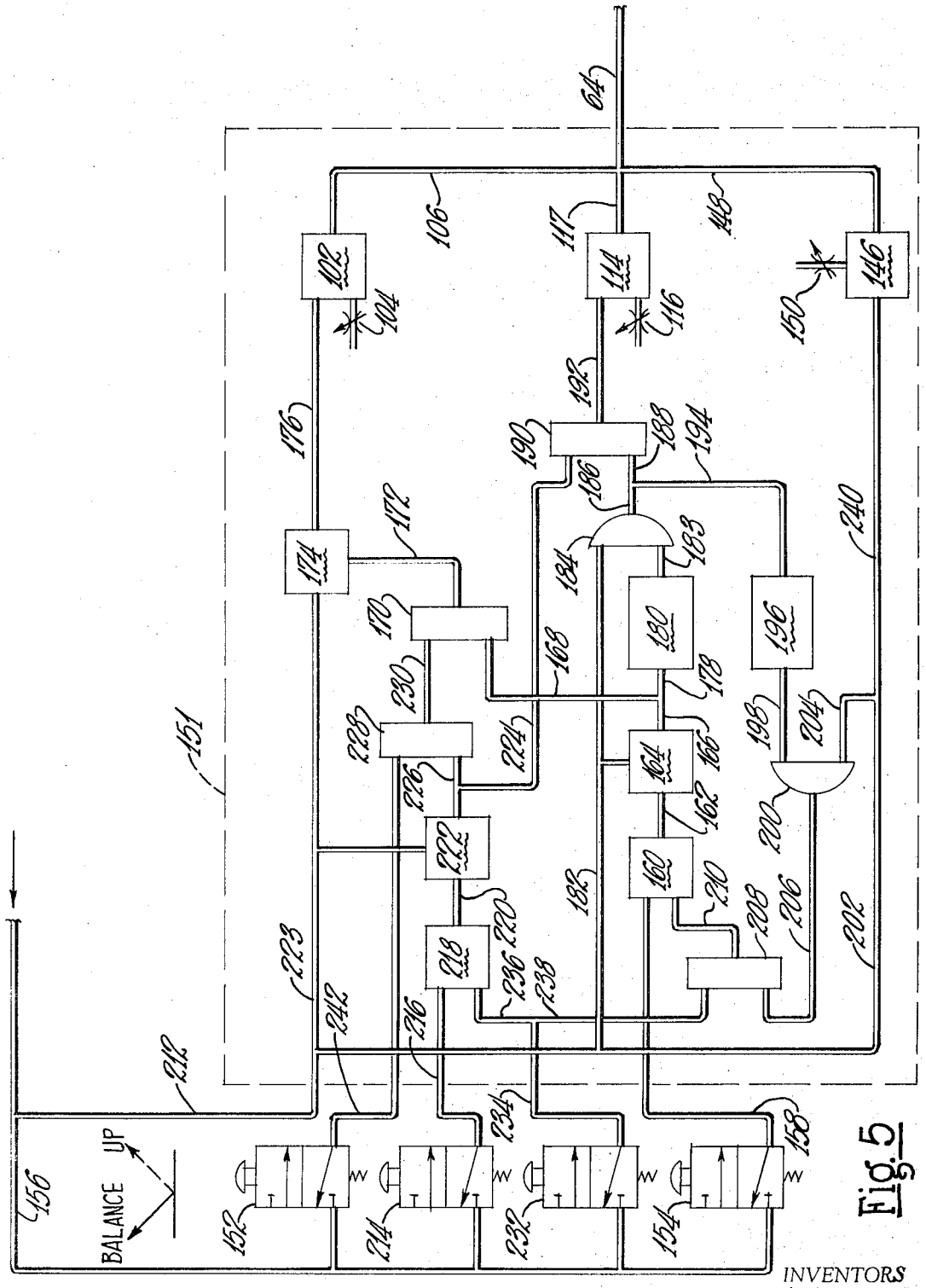


Fig. 5

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PNEUMATICALLY-OPERATED HOIST WITH AUTOMATIC CONTROL SYSTEM

This invention relates to a hoist with an automatic control system and particularly to a pneumatically-operated hoist with a penumatically-operated, automatic control system.

A hoist in accordance with the invention includes a power chamber containing fluid, usually air, under pressure, with the air being compressed as a load is lowered and with the air expanded as the load is raised. This arrangement enables most of the weight of the load to be offset or balanced by the air pressure so that a load of almost any size can be handled by an operator with ease when the pressure in the hoist chamber is adjusted to a predetermined value. The pressure can be increased, if desired, to aid in raising a load, or decreased, to facilitate lowering the load. The pressure in the hoist chamber is regulated by a hoist controller which includes a main regulator and a pilot air regulator. The pressure output of the main regulator is changed by changing the amount of air vented or bled from the pilot air regulator. This venting has heretofore been controlled by a manually-operated handle unit which is manually moved to various bleed or vent settings by the operator. This manipulation has generally required the use of one hand of the operator so that he only has had one free hand available for manipulating the load. A hoist of ths type is discussed more fully in U.S. Pat. No. 3,260,508.

In accordance with the invention, the pneumatically-operated hoist is provided with an automatic control system for bleeding or venting the hoist controller to different degrees and in a predetermined sequence automatically, without any manipulation being required on behalf of the operator. This enables the operator to use both hands to manipulate the load carried by the hoist. Further, since the venting is automatically controlled, there is no time delay involved by the operator in selecting the desired vent position and manually manipulating the vent control to that position.

The hoist with the automatic control system is particularly advantageous where an operator employs the hoist to move loads through predetermined sequences in a repetitive manner. For example, an operator can advantageously use the hoist to move a plurality of loads or objects from one stack to a spaced second stack. The automatic control system can be employed, after receiving a predetermined external signal in a manner to initiate bleeding of the hoist controller to provide maximum pressure in the hoist to aid the operator in lifting the load from the first stack, and then moving it toward the second stack. After a delay, such as can be established by a pneumatic timer, the control system can further vent the hoist controller to reduce the pressure and enable the load to float down, so that the operator can simply guide it to its position on the second stack. The hoist controller can then be more fully vented to just offset the weight of the load-engaging member carried by the hoist cable, so that it can then be moved back to the first stack by the operator. Of course, the sequences and applications of the hoist with the automatic control system according to the invention are subject to wide variations and applications, and the particular control systems set forth herein are only illustrative and not limiting.

The external signal for initiating sequencing of the hoist can be manually operated by the operator or can be automatically operated, as through a pressure change. For example, when a vacuum cup is used to lift the load, a sensing device can initiate operation when a vacuum signal from the vacuum cup of a predetermined value is supplied thereto after the cup has engaged the load.

The automatic control system also includes an additional bleed element which automatically opens to slowly reduce the pressure in the hoist in the event of failure of the main air supply. This enables the hoist load to be slowly lowered rather than being suspended and perhaps being in the way, as well as preventing the possibility of being suddenly dropped and causing injury.

It is, therefore, a principal object of the invention to provide a pneumatically-operated hoist with an automatic control system for sequencing the hoist through a plurality of operations.

Another object of the invention is to provide a pneumatically-operated hoist with a pneumatically-operated control system for controlling pressure in a power chamber of the hoist through a plurality of sequential predetermined values.

A further object of the invention is to provide a hoist with an automatic remote control system and with automatic bleed means for slowly bleeding the hoist and enabling the hoist load to be lowered in the event of air failure.

Other objects and advantages of the invention will be apparent from the following detailed description of preferred embodiments thereof, reference being made to the accompanying drawings, in which:

FIG. 1 is an overall, schematic view in perspective of a hoist embodying the invention, shown mounted on an overhead support and carrying a load;

FIG. 2 is a view in vertical, longitudinal cross section through the hoist of FIG. 1;

FIG. 3 is a schematic view in cross section taken through a controller of the hoist of FIG. 2 and showing certain bleed elements associated therewith;

FIG. 4 is a diagrammatic view of a pneumatic control system for automatically sequencing the hoist, according to the invention; and

FIG. 5 is a diagrammatic view of a modified pneumatic control system for automatically sequencing the hoist, according to the invention.

Referring particularly to FIGS. 1 and 2, a pneumatically-operated hoist 10 is suspended by a trolley or hanger 12 from an overhead support 14. A cable 16 depends from the hoist and carries suitable work-engaging members, shown in the form of vacuum cups 18, in this instance.

Referring more particularly to FIG. 2, the hoist 10 includes a housing 20 comprising a cylindrical side wall 22 and end walls 24 and 26. A ball screw 28 extends longitudinally through the housing and is fastened centrally at its ends to the end walls 24 and 26 by suitable machine screws 30. A ball screw assembly or nut 32 is mounted on the ball screw 28 and moves longitudinally in the housing 20 when turned relative to the ball screw. Cable-carrying means, specifically shown in the form of a cable drum 34, is mounted on the ball screw assembly 32 to rotate and move longitudinally in the housing therewith. The drum 34 has a shallow helical groove 36 which receives the hoist cable 16 when the drum 34 is rotated in a manner to wind the cable thereon. One end of the cable 16 is suitably affixed to

the drum at an end of the helical groove **36** as by a ball being swaged thereon and received in a notch (not shown) of the drum.

A thrust bearing **38** is located adjacent one end of the drum **34** and bears against a hub portion **40** thereof. The bearing **38** is, in turn, engaged by a piston **42** having a circumferentially-extending seal **44** which contacts the inner surface of the cylindrical wall **22** in gas-tight relationship. The end wall **24** and the right-hand portion of the housing **20** cooperate with the piston **42** to form a variable-volume power chamber **46** to receive air or other suitable fluid for operating the hoist **10.** An O-ring seal **48** is carried by the piston **42** and enables the piston to be supported in slidable but sealing contact with a sleeve **50** mounted on the right end of the ball screw **28.**

When air is supplied under sufficient pressure to the power chamber **46,** the piston **42** is moved toward the left, as viewed in FIG. **2,** and moves the thrust bearing **38,** the ball screw assembly **32,** and the drum **34** in the same direction. During this movement, the ball screw assembly **32** is caused to rotate on the screw **28** and rotates the drum **34** in a manner to wind the cable **16** into the housing **20** and onto the drum to raise the object carried thereby. When the pressure in the power chamber **46** is sufficiently low, the load carried by the cable **16** pulls the cable downwardly and causes the drum **34** to rotate in a manner to move the bearing **38** and the piston **42** toward the right and reduce the volume of the power chamber **46.** This pushes the fluid in the chamber out a passage **52** through which the air is also supplied to the chamber.

The air supplied to the power chamber **46** through the passage **52** is regulated by a controller **54** which is disclosed more fully in U.S. Pat. No. 3,457,837. The controller **54,** shown schematically in FIG. **3,** includes a main regulator **56** which controls the pressure of air supplied from a line **58** to the power chamber **46.** The controller has a pilot air-controlled regulator **60** which, in turn, regulates the pressure output of the main regulator **56** by controlling pressure in a pilot air chamber **62** of the main regulator. The pilot air chamber **62** is also connected with a vent line **64** which can be connected with variable orifices or vents, to be subsequently discussed. The degree of venting through the variable orifices determines the pressure in the pilot air chamber **62,** once the pilot air regulator **60** is adjusted to a particular value; and this, in turn, determines the pressure of the air supplied by the main regulator **56** to the chamber **46** through the passage **52.**

In many instances, the hoist **10** is used in a repetitive manner, to transfer objects or loads from one stack to another, by way of example. In such an instance, the hoist is continuously operated through a series of repetitive steps. To achieve this, the hoist can be automatically regulated by a remote control system so that all the operator need do is direct the work-engaging member of the hoist in the desired manner to engage and dis-engage the objects, with all pressure for the hoist chamber being regulated by the automatic controls.

A remote control system of this nature is shown in FIG. **4.** The vacuum cups **18** are connected through check valves **66** and lines **68** to a throat of a venturi tube **70** to which air is supplied from a suitable source through a line **72.** When air is passing through the line **72,** a vacuum is established at the throat of the venturi tube **70** and a vacuum is established in the vacuum cups **18** when they are engaged with a load or object. When it is desired to release the vacuum cups **18** from the load, a manually-operated valve **74** can be opened to slowly vent the vacuum cups **18** through lines **76** and **78** and to cause blow-off air to be supplied to the cups. These various components can be located adjacent the vacuum cups **18** on a supporting frame for the cups.

An enclosure **80** for the remote control system can be located at any out-of-the-way position. A line **82** connects the line **78** to a three-way valve **84** within the enclosure **80.** This valve is a commercially-available item, obtainable from Numatics, Inc., of Highland Park, Mich., by way of example. If a vacuum of predetermined value is established in the vacuum cups **18,** it is transmitted through the lines **76, 78,** and **82** to the valve **84** and through a line **86** to a "not" amplifier **88.** This element or component, as well as most of the remaining elements to be discussed in FIGS. **4** and **5,** are commercially-available items obtainable from the Aro Corporation of Bryan, Ohio. The details of the "not" amplifier and the "not," "or," "and," "set-reset," "memory," and timing elements discussed below are illustrated in a "Parts Lists and Service Instructions" manual, form 4588, published by that company. Consequently, only the functional results of these elements are discussed. It is to be clearly understood that the specific elements set forth are only examples of means for accomplishing the remote, automatic controlling of hoist in accordance with the invention. All of the elements operate pneumatically so that it is not necessary to have an electrical supply for the control system.

When the amplifier **88** receives a vacuum signal of the predetermined value, it supplies air from a suitable source through lines **90** and **92** and a line **94** to a "not" element **96** receives air from the line **94,** it stops the flow of air through the line **90,** a line **98,** and a line **100** to a "set-reset" bleed element **102.** This element **102** is modified from a standard commercial unit by adding a variable orifice **104** at a vent connection for the element **102.** At this time, the element **102** closes the orifice **104** and stops venting or bleeding of air from the pilot air regulator chamber **62** through the line **64** and a line **106.** The element **102** could bleed air directly from the power chamber **46,** but venting of the pilot air is preferred since less needs to be vented and greater sensitivity can be achieved.

At the same time, air is shut off by the element **96** from a line **108** to an "or" element **110.** This element then shuts off air through a line **112** to a "set-reset" bleed element **114** and bleeding or venting through an added variable orifice **116** from the pilot air regulator through a line **117** is also stopped. The elements **102** and **114** are also used in a different manner than usual because the lines **106** and **117** are used as input rather than output connections and the nuts **104** and **116** are used as output rather than input connections.

With both of the bleeds off, the pressure in the regulator chamber **62** will be at a maximum and the hoist is in a "high load" condition. Under this condition, the controller **54** is adjusted so that air pressure in the hoist chamber **46** will be just sufficient to raise the vacuum cups **18** and the load now engaged therewith. The operator can easily manipulate the load at this time by placing pressure down on it to prevent it from being raised further or by placing pressure up on it to increase the lifting rate. Under this hoist condition, the load is picked up from one stack, by way of example, and can

be moved along a track by the operator to the second stack.

While both of the bleed elements **102** and **114** are closed, a pneumatic timer element **118** is timing, having been actuated by air through a line **120** when the "not" amplifier **88** was actuated. The timer **118** can be adjusted up to a 30-second period, by way of example. When timed out, it supplies air to an "and" element **122** through a line **124,** this element previously having received air through a line **126** directly from the supply. With the element **122** now receiving air signals through both of the lines **124** and **126,** it passes air through an output line **128.** This air is supplied to the element **110** which is thereby caused to supply air through the line **112** to the bleed element **114.** The bleed element **114** now bleeds the chamber **62** through the lines **64** and **117** to reduce the pressure supplied by the main regulator **56** to the hoist chamber **46.** With bleed element **114** open and bleed element **102** still closed, the hoist is under a "low load" condition, at which time the pressure is slightly less than sufficient to balance the vacuum cups **18** and the load carried thereby. By this time, the operator will have moved the object to the second stack and, under the low-load condition, can simply direct the load onto the second stack as it floats down.

With the load deposited on the second stack, the operator pushes the button of the valve **74** which vents the vacuum flow from the vacuum cups **18.** As the vacuum in the cups **18** decreases to a predetermined value, the vacuum signal through the line **82,** the valve **84,** and the line **86** to the amplifier **88** is decreased and it (**88**) closes. Without air through the line **94** to the element **96,** the element supplies air through the lines **98** and **100** to the bleed element **102,** causing it to vent air from the regulator chamber **62** through the variable orifice **104.** With both of the elements **114** and **102** venting air from the regulator chamber, air under minimum pressure is supplied to the hoist chamber **46** and the hoist is then in an "unload" condition. This bleed condition occurs before the vacuum in the cups **18** has dropped sufficiently to separate the cups and the load.

At the same time that the element **102** bleeds, air is supplied by the element **96** through the line **108** and lines **130** and **132** to a timer element **134** and a "not" element **136.** The air through the element **136** and lines **138** and **140** shifts the valve **84** and causes air from the main supply to be directed through a line **142,** the line **82,** the line **78,** and the lines **76** to the vacuum cups **18.** This blow-off air facilitates separation of the vacuum cups **18** from the load. After the timer **134** times out in a very short time, it supplies air to the element **136** through a line **144** which closes the element **136** and shuts off air to the valve **84,** the valve then returning to its original position under the force of a spring. Thus, the valve **84** in in the "blow off" condition for only a brief period of time, as determined by the timer **134.** By the time the blow-off air reaches the vacuum cups **18,** through the line **82,** the bleed valves **102** and **114** will have placed the hoist in the unload condition. This prevents the possibility of the vacuum cups **18** flying up when separated from the load, which could otherwise occur if the hoist were still in the low load condition.

With the bleed valves open and the hoist in the "unload" condition, the operator can then raise the vacuum cups **18,** move them back to the first stack, and lower them into engagement with the next load. When the vacuum cups are then placed against the object, and the valve **74** is again closed, the vacuum is automatically established and the vacuum signal is again supplied to the valve **84** and the element **88.**

In the event of air failure, air is no longer supplied from the main supply through the line **90** to a "not" element **146.** When this air is off, the element **146** bleeds air through the line **64** and a line **148** from the regulator chamber **62** to an adjustable orifice or vent **150.** The air in the regulator is bled slowly through the orifice **150,** causing the pressure in the hoist chamber **46** to slowly drop and causing the load carried by the hoist to slowly lower. This is important to prevent the load from being suspended and perhaps being in the way, and also prevents the possibility of the load suddenly being dropped.

A modified remote control system in an enclosure **151** for the hoist **10** is shown in FIG. **5.** In this instance, the automatic cycle is started by a manually-controlled external signal rather than the automatic signal supplied when the vacuum cups **18** are engaged with the load. Also, the controls of FIG. **5** are provided with manual overrides. Again, these controls can be used to automatically cycle the hoist **10** in a manner to enable an operator to pick up a load from one location or stack, transfer it to a second location or stack, and deposit it at that location.

The controls of FIG. **5** are shown with bleed elements corresponding to those of FIGS. **3** and **4** for clarity and continuity of illustration. The bleed elements of FIG. **5** also operate slightly differently than in the system of FIG. **4.** In that system, with both bleed elements **102** and **114** closed, the hoist is in a high-load condition; with the bleed element **102** closed and bleed element **114** open, the hoist is in a low-load condition; with both of the bleed elements open, the hoist is in an unload condition. With the circuit of FIG. **5,** again with both bleed elements **102** and **114** closed, the hoist is in a high-load condition; with the element **102** closed and the element **114** open, the hoist is in a low-load condition; however, when the element **102** is open and the element **114** is closed, the hoist is in the unload condition. In this latter system, then, both of the elements **102** and **114** do not bleed at the same time.

Assume a main control valve **152** is in the "balance" condition, as shown, and a button of an automatic cycle valve **154** is pushed by the operator, after he has engaged the load with any suitable load-engaging hook, vacuum cup, etc. Air is supplied from a main supply and a line **156** through a line **158** to a "set-reset" element **160** which, unlike the elements **102** and **114,** is used in the conventional manner. This element then supplies a signal through a line **162** to a "memory" element **164** which is turned on to supply air through lines **166** and **168** to an "or" element **170.** When this element receives the signal, it supplies air through a line **172** to a "not" element **174** which then shuts off air to a line **176** and the bleed element **102.** The bleed element **114** is also closed at this time. Consequently, the hoist is under a "high-load" condition and the load begins to rise, with the air pressure of the control **54** regulated to slightly exceed the weight of the load and the load-engaging member.

At the same time, air is supplied from the element **164** and the line **166** through a line **178** to a timing element **180** which begins to time out. The element **164** continues to supply air through the line **166** from a line

182 even after the valve 154 is closed. Hence, only a brief push of the valve 154 is necessary to start the cycle.

When the element 180 times out, it supplies air through a line 183 to an "and" element 184. This element is already receiving air through the line 182. Consequently, it supplies air through lines 186 and 188 to an "or" element 190. This element then supplies air through a line 192 to the bleed element 114 which bleeds air from the chamber 62 through the line 64 and the line 117. This places the hoist in the "low-load" condition at which time the pressure is slightly less than sufficient to balance the load and the load-engaging member. The timer 180 is adjusted so that the operator has the load at the second stack by the time it times out. Consequently, the load floats down and is easily controlled by the operator as he moves it to the desired position on the second stack.

When the timer 180 times out, it also causes air to be supplied through the element 184 and the line 186 to a line 194 and a second timing element 196. The element 196 is designed so that when it times out, it supplies air through a line 198 to an "and" element 200. This element is also receiving air through lines 202 and 204 so that it now supplies air through a line 206 to an "or" element 208. The element 208 then supplies air through a pilot line 210 to the "set-reset" element 160. This air causes the element 160 to reset and stop the signal to the element 164 which shuts off to complete a cycle of operation. Shutting off of the "memory" element 164 shuts off air to the element 174. Air is then supplied through the line 176 from a supply line 212 to the bleed element 102 to cause this element to bleed. Air to the elements 180, 184, and 19 is also shut off so that the bleed element 114 stops bleeding. With the element 102 bleeding and the element 114 blocked, the hoist 10 is in the "unload" condition. In this condition, the hoist pressure is just sufficient to balance the load-engaging member of the hoist so that the operator can then easily manipulate it back to the first position, engage another load, and again press the button of the valve 154 for another cycle.

The control system of FIG. 5 is equipped with an over-ride, "down" valve 214. If the load being lowered by the operator were caught on an obstruction, by way of example, it is desirable that the timing element 196 not operate to place the hoist in the "unload" condition. When the valve 214 is temporarily opened by the operator pressing the valve button, air is supplied through a line 216 to a "set-reset" element 218 which also is operated in the conventional manner. A signal is then supplied through a line 220 to a "memory" element 222 which supplies air from a line 223 through a line 224 to the "or" element 190. With the "or" element 190 receiving air through the line 224, it continues to supply air to the element 114, causing it to continue to bleed. Air from the element 222 also is supplied through a line 226 to an "or" element 228 which supplies air through a line 230 to the "or" element 170. This causes air to be supplied through the line 172 to the "not" element 174 and shuts off air to the bleed element 102 so that it does not bleed. Thus, air is continued to the element 174 even when the timer 196 has time out, the "memory" element 164 has been shut off, and the air through the line 168 has similarly been shut off. With the element 102 blocked, and the element 114 bleeding, the hoist stays in the low-load condition until the load can be freed and deposited in the desired location.

When the operator has freed the load from the obstruction and has placed it at the proper position at the second location, he can then press the button of a balance valve 232 which supplies air through a line 234 and a pilot line 236 which resets the element 218. Air is also supplied through a line 238 to the element 208 which supplies air through the pilot line 210 to reset the "set-reset" element 160. Signals to both of the memory elements 164 and 222 are thereby stopped,with the bleed valve 102 then being turned on and the valve 114 being blocked. This places the hoist in the "unload" condition so that the operator can manipulate the load-engaging member to engage another load at the first location, at which time an external signal is generated by closing the valve 154 again.

The system of FIG. 5 also has the emergency bleed "not" element 146 with the vent 150. If the main air should fail, air is no longer supplied through the line 202 and a line 240 to the element 146. Consequently, the vent 150 is opened to bleed the hoist controller through the line 64 and the line 148, thereby enabling the load, if suspended in the air by the hoist, to slowly lower to the ground or other suitable supporting surface. Again, this prevents the load from being in a position in which it may cause obstruction and also prevents it from being in a position where it could cause damage in the event it would suddenly fall. Consequently, this safety bleed is advantageous for all automatic controls.

When the hoist is not to be used for awhile, the main valve 152 is moved to the "up" position. Air is then supplied through a line 242 to the elements 228 and 170 and to the element 174, shutting off air to the bleed element 104 and preventing bleeding. The bleed valve 114 will also be blocked at this time. Consequently, the hoist will be in its maximum pressure position causing the load-engaging member thereof to be raised to its maximum position, with or without a load thereon, and thus be out of the way for storage. In practice, the valve 152 is in a relatively inaccessible location as compared to the valves 214, 232, and 154 so that it cannot be inadvertently manipulated so as to accidentally cause the hook to fly up.

It will thus be seen from the above examples that an automatic control system according to the invention enables a hoist to be cycled through a predetermined sequence automatically when subject to an external signal. This signal can be manually generated, as in the system of FIG. 5, or automatically generated, as in the system of FIG. 4. The system is preferably equipped with at least two bleeding elements which are automatically controlled. In some instances, however, more than two bleed valves are desired and in some systems in accordance with the invention, a large number of such bleed elements are used, depending on the particular automatic application to which the invention is applied. Further, the system is preferably supplied with an additional bleed element which automatically bleeds the hoist controller in the event of failure of the main air supply, to enable any load suspended by the hoist to be slowly and safely lowered to a support.

Various modifications of the above described embodiments of the invention will be apparent to those skilled in the art, and it is to be understood that such modifications can be made without departing from the

scope of the invention, if they are within the spirit and the tenor of the accompanying claims.

We claim:

1. In combination, a pneumatically-operated hoist comprising a housing, means carrying a cable within said housing and adapted to raise the cable when moved in one direction in said housing and to lower the cable when moved in the opposite direction in said housing, means forming a power chamber in said housing and effective to move said cable-carrying means in said one direction when pressure in said chamber is at least equal to a predetermined amount, said cable-carrying means moving in said opposite direction when the pressure in said chamber is below the predetermined amount, when a given load is carried by the cable, controller means for supplying gas to said chamber, a bleed line communicating with said controller means and extending away from said hoist, at least two automatically-operated bleed elements communicating with said bleed line, and control means for opening and closing said bleed elements in a predetermined sequence for regulating said controller means to supply gas to said power chamber at at least three different pressures to enable loads to be moved up and down without any manual manipulation of said control means and bleed elements.

2. The combination according to claim 1 characterized further by an emergency bleed element, and means for bleeding said emergency bleed element when the main gas supply is off.

3. The combination according to claim 1 wherein said control means for actuating said bleed elements includes at least one pneumatic timing element.

4. The combination according to claim 1 characterized by means for establishing an external signal effective to initiate operation of said control means for said bleed elements.

5. The combination according to claim 4 characterized further by said external signal means being manually operated.

6. The combination according to claim 4 characterized further by said external signal means includes said hoist cable having a vacuum cup for engaging a load, means for establishing a vacuum in said cup when engaged with the load, and means connecting said cup with a component responsive to the vacuum for initiating operation of said control means.

7. In combination, a pneumatically-operated hoist comprising a housing, means carrying a cable within said housing and adapted to raise the cable when moved in one direction in said housing and to lower the cable when moved in the opposite direction in said housing, means forming a power chamber in said housing, a piston associated with said power chamber and movable with said cable-carrying means according to the pressure in said power chamber, bleed means connected with said hoist and effective to control the pressure in said power chamber according to the degree of bleeding of fluid by said bleed means, means associated with said bleed means for changing the degree of bleeding, and pneumatic control means for actuating said bleed means in a predetermined sequence, whereby the pressure in said power chamber is controlled at different values in a predetermined sequence without any manual manipulation of said bleed means.

8. The combination according to claim 7 characterized further by additional bleed means for automatically reducing the pressure in said power chamber when the main gas supply is off.

9. The combination according to claim 7 wherein said control means includes at least one pneumatic timing element.

10. The combination according to claim 7 characterized by means for establishing an external signal effective to initiate operation of said control means.

11. The combination according to claim 10 characterized further by said external signal means being manually operated.

12. The combination according to claim 10 characterized further by said external signal means includes means for effecting a pressure change.

13. The combination according to claim 1 characterized further by said control means actuates said bleed elements so that both of said elements are closed, one of said elements is open, and both of said elements are open.

14. The combination according to claim 1 characterized by one of the three pressures being at least equal to said predetermined amount, another of said pressures being below said predetermined amount, and the third of said pressures being at an amount between the other two of said pressures.

15. The combination according to claim 7 characterized further by said bleed means includes at least two automatically-operated bleed valves, and said pneumatic control means actuates said bleed valves to cause pressure in said chamber to be at any of three different values in the predetermined sequence.

* * * * *

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,791,627 Dated February 12, 1974

Inventor(s) Charles W. Stone and Edward L. Foster

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

Column 4, line 35, after "96" insert -- . When the "not" element 96--.

Column 7, line 34, change "19" to --190--.

Column 7, line 64, change "time" to --timed--.

Signed and sealed this 21st day of May 1974.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents

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