# United States Patent [19]

**Bushnell, Jr.**

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[54] **CONTROL SYSTEM FOR MULTI-STAGE LIFT**


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**Related U.S. Application Data**

[63] Continuation-in-part of Ser. No. 889,235, Dec. 30, 1969, abandoned.

[52] **U.S. Cl.**.....**254/93 R**, 91/168, 91/412

[51] **Int. Cl.**.....**B66f 3/24**

[58] **Field of Search**.....254/93 R, 93 L; 91/168, 169, 412, 152–155; 92/51–53



[56] **References Cited**

UNITED STATES PATENTS

| | | | |
|---|---|---|---|
| 332,418 | 12/1885 | Morey | 91/168 |
| 165,472 | 7/1875 | Brickeroff | 91/168 |
| 3,279,755 | 10/1966 | Notenboom et al. | 254/93 R |
| 3,534,659 | 10/1970 | Payson | 91/168 |



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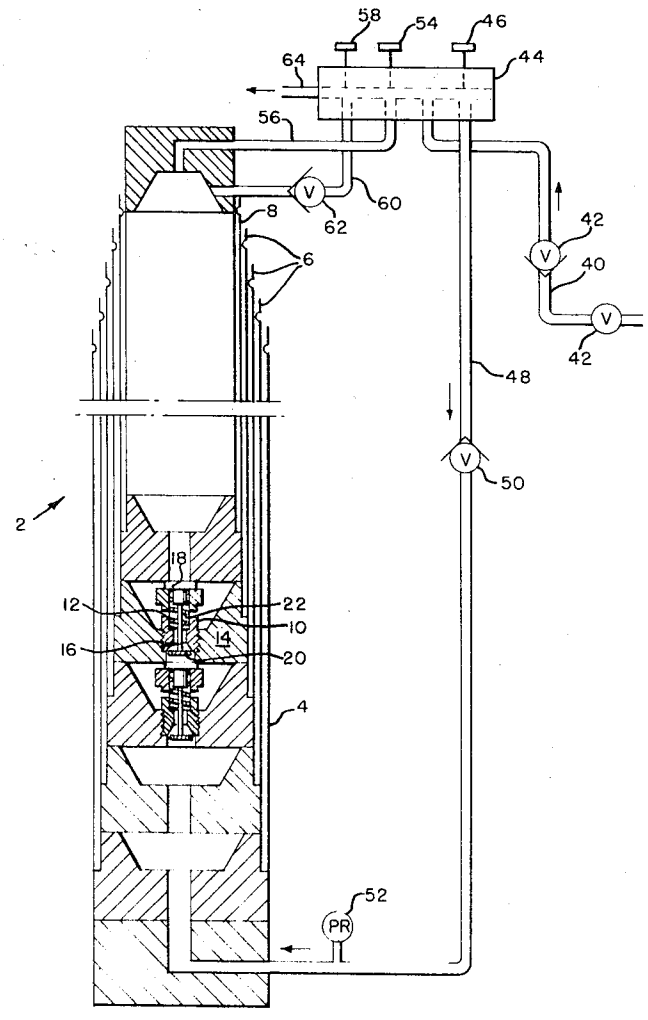
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[57] **ABSTRACT**

A compressible fluid operated multi-stage telescopic hoist for operating to a given load limit. The hoist has a plurality of stages progressing from a base stage of largest cross section to a top stage of smallest cross section. The bottom stage together with a predetermined group of intermediate stages comprises a bottom set of stages and the remainder of the intermediate stages with the top stage comprise a top set of stages. A supply means is interconnected with said stages for selectively supplying a compressible fluid at a predetermined pressure well above the minimum pressure required and the fluid is introduced to the hoist whereby the bottom set of stages is more rigid and at a higher pressure than the superposed column of the top set whenever the hoist assembly is extended beyond said bottom set. The hoist further includes vent means for selectively venting said sets whereby the pressure in the bottom set is maintained at least as high as the pressure at the top set while the hoist assembly is being retracted.


**10 Claims, 5 Drawing Figures**

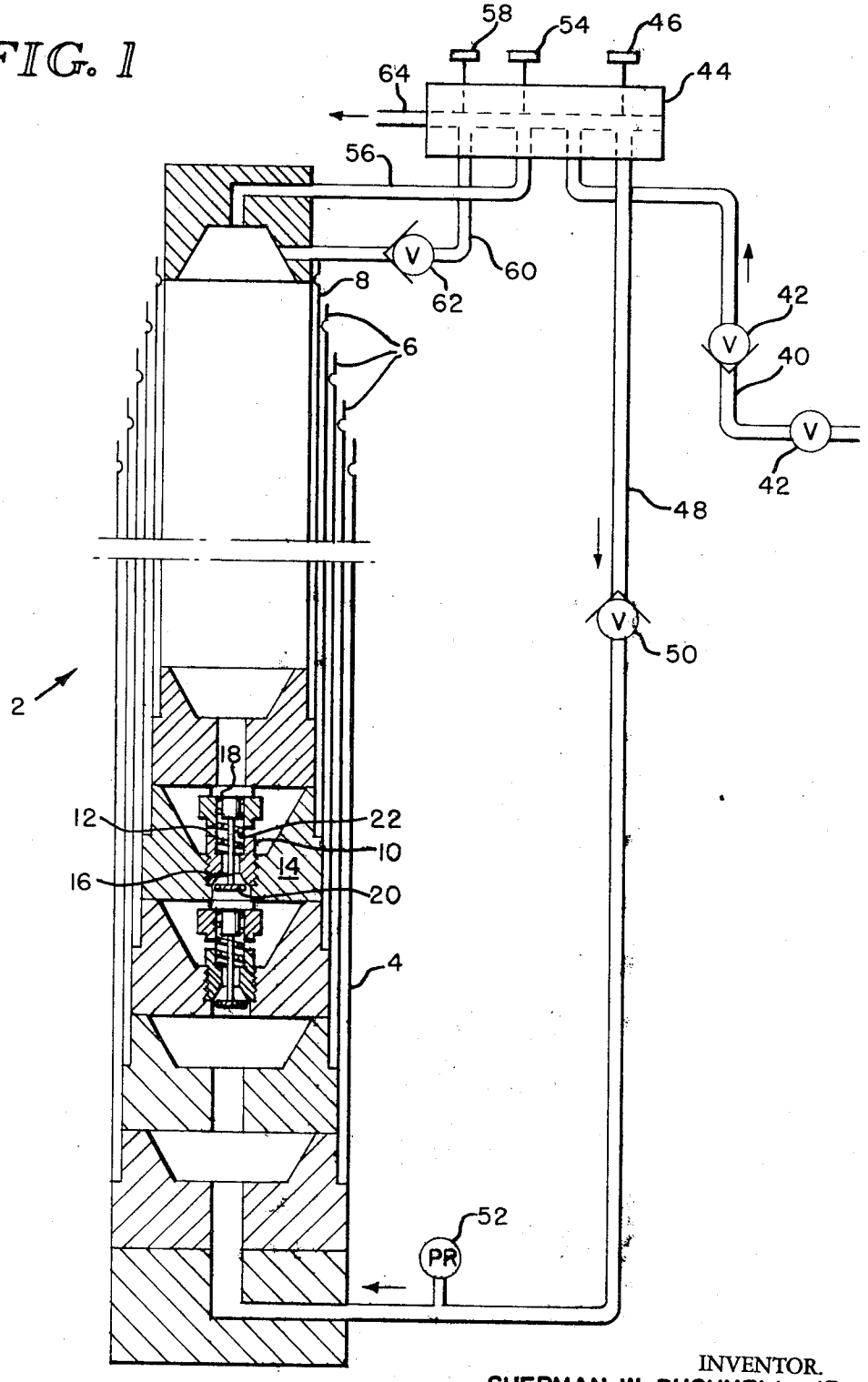


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SHEET 1 OF 2

FIG. 1




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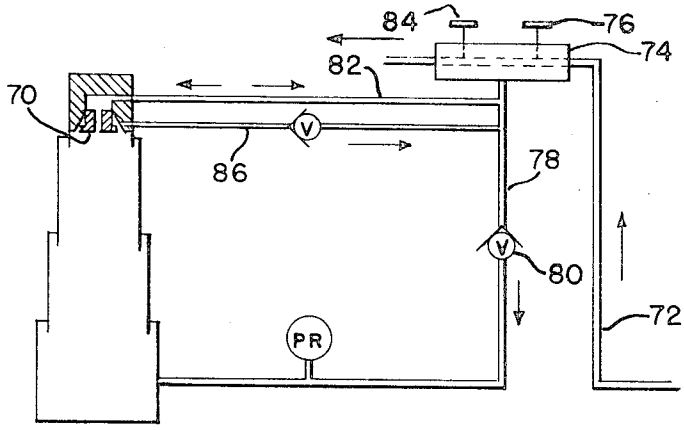



FIG. 2

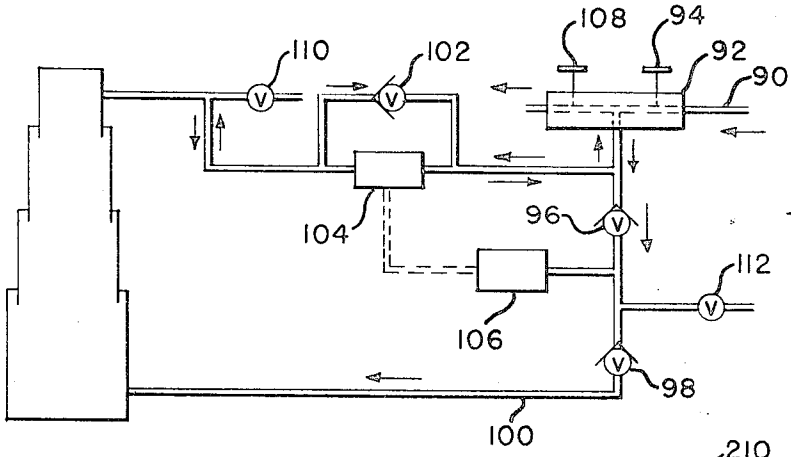



FIG. 3

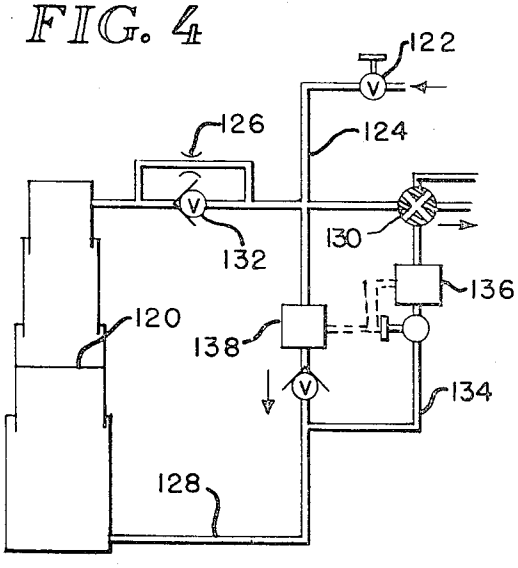



FIG. 4

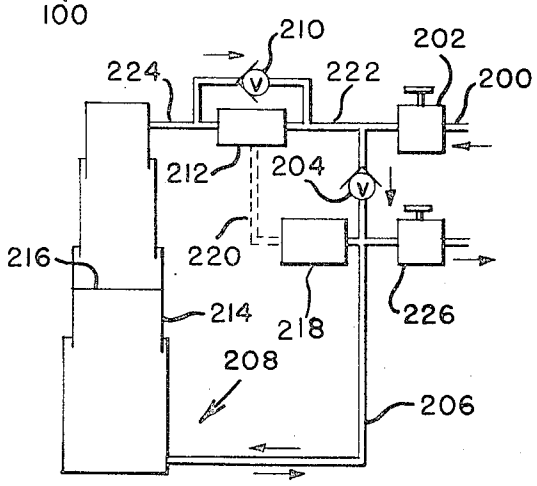



FIG. 5

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# CONTROL SYSTEM FOR MULTI-STAGE LIFT

This application is a Continuation-in-Part of copending U.S. Pat. application Ser. No. 889,235, MULTI-STAGE LIFT, filed Dec. 30, 1969 now abandoned.

## BACKGROUND OF THE INVENTION

Use of multi-stage lifts for elevating personnel, equipment and/or material to great heights for working convenience are well known in the art. The advent of this type of working platform has resolved a large number of problems while introducing new problems.

Prior to the multi-stage telescoping hoist it was necessary to carry relatively rigid elements, stack or interlock these elements to the point whereat a person could reach a height normally not reached by a ladder. Even in the instance where a ladder could be used of sufficient height the worker was restricted by the relatively small place for resting his feet and further was faced with the necessity of providing a secondary means for lifting material or carrying them up the ladder, a dangerous and energy consuming endeavor.

Some of the early multi-stage lifts, while relieving the worker from the problems hereinabove noted with relation to rigid elements suffered from the drawbacks of being extremely bulky and/or extremely heavy. Further, some of the early hoists were operated by electricity necessitating an interconnecting cord between the mechanism and the supply or alternatively used hydraulics which of necessity required a large reservoir and introduced a great deal of weight inherent therewith.

To obviate the problems introduced by use of electricity or hydraulics, pneumatic lift devices were introduced wherein the pneumatic supply could be provided in a compressed state in a portable tank thereby rendering the platform completely portable and not introducing a great deal of bulk. It is to be understood that when a portable supply of pressurized fluid was used the fluid would be vented to the air when the cylinder was retracted thereby eliminating the need for a storage tank for the used material.

Whereas the use of the telescopic hoist using a compressible gas obviated the problems hereinabove noted it of itself introduced new problems. The compressible gas by its very nature once expanded is again compressible rendering platforms extended to great height and subjected to varying weight to be unstable. The movement of mass on the top of the platform would cause the supporting cylinders to compress beneath the greatest portion of the weight thereby causing the platform to tilt. Further, because the gas is compressible the platform yielded a continuous unstable feeling in the fact that the supporting cylinders tended to be mushy because of the compressability of the supporting gas.

Therefore, it has been deemed desirable to have a multi-stage telescopic platform wherein the lower stages are rendered relatively rigid during use and yet collapsible such that they can be easily stored or transported from place to place. Further, it is desirable that the base or lower stages remain relatively rigid during the entire time the platform is being used as well as during the elevation and retraction stage such that there is no time during which the platform is unstable and unsafe.

With the above noted problems in mind, it is an object of the present invention to provide a means for use



in conjunction with a multi-stage telescoping cylinder assembly which is used to lift a load whereby the pressure in the lower stages can be increased in excess of the actual pressure needed to support the load without causing the partially extended cylinder assembly to continue to elevate. Such over pressurization or supercharging of some stages makes the cylinder stiffer or more rigid and adds great stability to the elevated or extended column.

It is yet another object of the present invention to provide a means whereby the lower stages of the multi-stage telescopic cylinder will be automatically pressurized to a pressure greater than the pressure of the upper stages thereby providing an extremely stable and stiff lower supporting unit.

It is yet another object of the present invention to provide a control system for a multi-stage telescopic hoist wherein the lower stages of each of the telescopic cylinders remains at a charged condition greater than the upper stages during the entire elevation and lowering process.

It is still another object of the present invention to provide a means of retracting or lowering a multi-stage telescopic cylinder assembly while under load whereby the top stage or set of stages retracts first without any pressure reduction in the next or lower stages. By so maintaining the pressure in the lower unretracted stages the elevated or extended column is held stiffer or more rigid thereby adding greater stability to the entire assembly.

Another object of the present invention is to provide an automatic means within the cylinder assembly itself whereby the operator need only have an "up" and "down" control and yet during the raising of the hoist i.e. operation of the "up" control the lower stages will extend first and receive a greater pressure than the upper stages thereby rendering the cylinder stable and during the lowering or "down" operation the reverse will occur i.e. the upper stages will retract first while the lower stages remain in their charged or relatively stable condition.

It is still another object of the present invention to provide a control means whereby the operator may manually extend the lower stages and introduce pressure to the lower stages greater than that required for elevation of the upper stages thereby rendering the lower stages extremely stable and stiff and then the operator may proceed to raise the upper stages resulting in a stable work support. When lowering the platform, the operator will reverse the operation.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic view of the multi-stage telescoping lift of the type for which the hereinafter described control system is adapted to include one of the possible control systems.

FIG. 2 is a schematic view of another control system usable with a telescopic hoist.

FIG. 3 is a schematic view of a totally automatic control system.

FIG. 4 is a schematic of another control system wherein a solid piston is used in the telescopic hoist to assure rigidity of the lowermost section at all times.

FIG. 5 is a schematic view of an automatic control system including a solid piston.

## DETAILED DESCRIPTION OF THE DRAWINGS

In brief, the mechanism controlled by the hereinafter described systems comprises a plurality of telescopic cylinders which are connected to a source of compressible fluid whereby the fluid will be introduced into the cylinders causing an entire unit to extend. The cylinders may be used singly or in a grouping and typically may be used to raise a working platform or serve as a lift to raise materials to a convenient height. The intermediate cylinders are substantially closed at the lower ends and the uppermost cylinder and intermediate cylinders serve as pistons to lift the cylinders responsive to the introduction of pressurized fluid into the base cylinder. The pistons of the intermediate cylinders have center openings therethrough for the passage of fluid from one cylinder to the next with the exception of those embodiments shown in FIGS. **4** and **5.**

In some embodiments it is desirable to have air flow between the various cylinders only at predetermined times and therefor a normally closed valve is placed in some of the sections wherein the valve allows passage of fluid under pressure only at predetermined times. Valves which are preferably incorporated in this type of a structure will be described in greater detail hereinafter with respect to the particular systems which incorporate this feature. Suffice it to say at this point that within the arrangements which have intermediate valve members within the cylinders the valve is open when the cylinder section with which it is associated is essentially completely retracted and thereby permit exhaustion of the fluid from the spaces thereabove. On the other hand when the hoist has been extended to the desired height after loading the valve closes to isolate the cylinders from one another.

Referring to the drawings, the present invention is illustrated as applied to a hoist **2** which comprises an elongated tubular base section **4,** a plurality of intermediate tubular sections **6** and an elongated tubular uppermost section **8** all telescopically contained one in another with the base section having the largest diameter and the uppermost having the smallest diameter. Although it is preferable for each of these sections to be cylindrical it is well within the contemplation of the present invention that a particular shape of the tubular sections is a matter of choice.

Although not shown in the present structure the base of the hoist may well be set in a transportable tripod structure and the uppermost section may contain and probably would contain a work support platform such that the hoist may be used for raising men or material to a higher elevation.

As shown in FIG. **1,** the intermediate valve portion which permits air flow therethrough only when the cylinder above is completely lowered or alternatively with pressure from above includes a hollow housing **10** having ports **12** through the sides thereof. The housing **10** is threadably inserted into the base **14** of one of the cylinders and includes a spring biased valve member **16** which extends through the housing to an upper head element **18** and a lower sealing element **20.** The spring **22** continually urges the valve to a sealed condition with the element **20** resting against the housing in a sealing condition. When the cylinder base above the valve is in its lowermost position it will rest upon the head **18** compressing the spring and opening the valve allowing fluid to pass through the valve. However as soon as the next upper cylinder is raised off of the head **18** the spring can expand sealing the valve.

Thus it can be seen when the hoist is being vented the uppermost cylinders will be vented first and as they settle they will open the valve allowing fluid to escape from the next lower cylinder always assuring that a stable base be present. In the normal filling process again it would be desired to have a stable base, the lowermost cylinders would be filled first thus elevating all of the cylinders to the valve portion whereat the normal sequence would be stopped until fluid under pressure was introduced into the top portion. A fluid under pressure introduced to the top portion would cause the uppermost cylinders to raise slightly from the valve structure, however, the pressure in the cylinders would serve, by presenting a force to the upper portion of the sealing element **20,** to compress the spring and allow air to all of the cylinders which have valves. It is to be understood that although there are two valves shown in the present figure it could equally well be one, and two are introduced primarily as a safety factor.

Having thus described the general operation of the internal valve of the hoist, the system as shown in FIG. **1** will be described in greater detail at this point. As can be seen the fluid under pressure is introduced through line **40** including a valve **42** and it is to be understood that the line **40** may be connected to a portable source of compressed fluid or alternatively may be connected to a relatively fixed source such as a compressor. The fluid passes through line **40** and then through a check valve **42** to a manual control valve **44.** Manual control valve **44** includes a lower section inflation switch **46** which causes fluid to flow through line **48** past check valve **50** and a pressure relief valve **52** into the lowermost section of the lift causing the larger stages of the hoist to expand. Following the expansion of the lower stages to their utmost condition after reaching a predetermined pressure within the cylinders the valve **54** is opened allowing fluid under pressure to pass through line **56** into the uppermost cylinders which then, as noted above will fill all of the cylinders above the intermediate valve as well as those including the intermediate valves. Thus, as can be seen, the entire hoist is elevated and it is in a stable condition. To lower the hoist valve **58** is opened allowing fluid under pressure to flow through line **60** and check valve **62** exhausting the uppermost stages first and as explained hereinabove allowing the settling of the uppermost cylinders to open the intermediate valves thus allowing the entire hoist to be vented through the uppermost portion and to the atmosphere via lines **62** and **64.**

As seen in FIG. **2** there is included another system for controlling the elevation and collapse of the hoist. It is to be understood that in this case the construction of the hoist may well be very similar to that shown in FIG. **1** and will not be described in detail. However, in the particular structure shown there is a restricted flow control valve in the uppermost cylinder. Although shown as part of the uppermost cylinder, the flow control valve could equally well be placed along line **82** whereat it could more conveniently be adjusted or replaced. For simplicity, the flow control valve is shown as one with a restricted orifice, however, it is to be understood that there are a number of valves on the market which could accomplish the same result either singly or in combination with other functions. Thus flow control valve **70** restricts the rate of introduction of the

fluid into the uppermost cylinders such that they expand at a lesser rate than the lowermost cylinders. The fluid under pressure enters the system via line **72** connected to manual control valve **74.** To raise the cylinder the valve member **76** is placed into an open condition allowing air to flow through line **78,** past check valve **80** to the lowermost portion of the hoist as well as through line **82** and through restricted flow valve **70** in the uppermost portion of the hoist. Thus, with the use of one valve element **76** the fluid is introduced into both the lower and uppermost sections of the hoist, however, a much greater volume of fluid is introduced into the lower portion causing it to expand at a far greater rate and reach its desirable rigidity prior to the uppermost cylinders being fully extended. The exhaust of this system is similar to that as described with respect to FIG. **1** in that valve element **84** is opened and the fluid extracted from the uppermost cylinder. In this particular case the fluid is extracted from the uppermost cylinders via line **82** as well as line **86** making a more rapid descent possible.

Referring now to FIG. **3** the hoist is elevated in this particular embodiment by a control system incorporating an adjustable pilot operated pressure transition control valve. Air under pressure is introduced via line **90** to the main control valve **92** whereat the operator depresses the "up" button **94.** Air flows through check valves **96** and **98** to the base of the assembly via line **100** causing the second stage to start extending. Air is prevented from flowing to the top of the cylinder assembly by check valve **102** and normally closed valve **104.** The second stage extends first because of the fact it has the largest diameter and the largest base area. After the second stage is fully extended the next stage to extend will be the one of the next largest base area followed in sequence by the succeeding smaller base area cylinders or stages. The intermediate valve as described with respect to FIG. **1** will prevent those cylinders above the intermediate valve from extending because no air can reach them. As the operator continues to hold the "up" button pressure increases in the lower stages below the intermediate valve as in the hoist hereinabove described. When this pressure reaches the setting on the pressure operated valve **106** the valve will open applying pilot pressure to valve **104** which opens permitting the air supply to feed the top. This is referred to as a pressure transition. Air flows from the top through the uppermost intermediate valves which are held open by weight of the stage above and reaches the upper stages which are extended in sequence until the entire assembly has been fully extended.

To lower the cylinder assembly the operator depresses the down button **108** on the main control valve **92** exhausting air from the top through valve **104,** which is held open by the pilot pressure from valve **106.** Check valve **96** prevents air from exhausting from the bottom thus maintaining full pressure in the lower stages. As pressure is reduced in the upper stages the cylinders settle upon the normally closed valves opening them and allowing pressure to escape to the next lowermost valve until the entire cylindrical assembly is exhausted. It is to be noted in this particular control system that there are two separate exhaust valves **110, 112** for lowering the system in the event that the main control valve **92** should fail and become jammed for some reason.

Referring now to FIG. **4** there is shown a control system incorporating a single solid piston at the intermediate stage of the lift device to be noted by numeral **120.** The main supply comes through a single control valve **122** and thus pressurizes line **124** introducing the fluid under pressure into the uppermost cylinder via a restricted flow control valve **126** and in the lower stages through an unrestricted line **128** assuring that the lower cylinders below the solid piston are expanded to their fullest extent first. The "down" or exhaust control is a four-way valve **130** which when opened allows exhaust to pass through free flow check valve **132** and directly to the atmosphere. However, to assure that the upper cylinders exhaust first, the exhaust from the lower cylinders is via line **134** which is normally closed by pilot operated valve **136.** Pilot operated valve **136** will not open the exhaust line **134** until the pressure in line **124** drops below a predetermined stage thus opening control valve **138** allowing the pilot pressured to flow to valve **136.** Thus, it can be seen by simply opening the exhaust valve **130** the operator can assure that the upper stages will exhaust to a predetermined lowermost pressure prior to the exhaust of the lower stages again assuring that the lowermost cylinders retain their rigidity and so the uppermost cylinders are retracted for safety.

Referring now in particular to FIG. **5** another embodiment of a telescoping cylinder assembly in accordance with the present invention is shown in the partially elevated pressure transition point. As can be seen in this view, the air under pressure is introduced to the system by supply line **200** and to elevate the operator depresses the two-way valve **202** allowing air under pressure to pass through check valve **204** and then through line **206** to the base of the cylinder assembly **208.** The pressure introduced into the base causes the second cylinder to start extending but air is prevented from flowing through the top of the cylinder assembly by check valve **210** and normally closed valve **212.** The second stage extends first because it has the largest diameter and the largest base area. After the second stage is fully extended the third stage or the next stage with the next largest base area will extend followed by the succeeding stages of next largest base area until the stage denoted **214** in this embodiment is extended. It is to be noted that air cannot reach the upper stages because as noted above check valve **210** and solid piston **216.** The operator continues to depress the "up" valve **202** continually introducing pressure into lower stages below piston **216.** When the pressure in the lower stage reaches the setting on pressure operated valve **218** the valve will open applying pilot pressure through line **220** to valve **212** which opens permitting the air supply to feed to the top stages through line **222** and **224.** This is the pressure transition period. As the air supply to the top of the cylinder assembly next succeeding stages having a large base diameter will extend followed successively by each stage until the entire upper set of stages is extended. Check valve **204** as well as the solid piston **216** prevents higher pressure in the lower stages from reaching the stages above the piston **216.**

To lower the cylinder the operator depresses the "down" valve **226** simultaneously causes air to exhaust from both the top and the bottom stages. Check valve **210** permits air to continue to exhaust from the top after the valve **212** closes due to the loss of pilot pres-

sure which as noted above is controlled by the pressure within the lower stages.

It is to be noted that this particular system has the advantage in the fact that it permits over pressurization or supercharging the lower stages without effecting operation of the remaining upper stages. Further, the solid piston **216** instead of an internal valve as described hereinabove is simpler less costly and eliminates possibility of malfunctioning due to leakage. It is to be noted that the control piston or solid piston **216** could be located at any stage thereby varying in the length of the rigid lower portion. Further, valves **212** and **218** as well as check valve **210** could be replaced by flow control valve or by a restricted orifice system both of which have been described hereinabove. Valve **218** could be eliminated and the pilot line connected directly to valve **212** which could have a spring loaded pilot set to open the desired pressure in the lower stages if this were desired.

Thus it can be seen in each of the systems hereinabove described the hoist is continually in a stable condition that is that the lower stages are extended to a rigid condition during the elevation. They are retained in a rigid condition to the last during the exhaust of the cylinder thereby assuring a continuous stable platform for safety reasons.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

**1.** A compressible fluid-operated multi-stage telescopic hoist for operating up to a given load limit comprising, an extendable and retractable hoist assembly having a plurality of intermediate stages progressing telescopically from a base stage of largest cross section to a top stage of smallest cross section, said base stage together with a bottom group of said intermediate stages comprising a bottom set of stages and the remainder of said intermediate stages together with said top stage comprising a top set of stages, controlled supply means for selectively supplying a compressible fluid to said bottom set via the base stage at a predetermined pressure above the minimum pressure level sufficient for the top stage to meet the given load limit and for selectively supplying a compressible fluid to said top set via the top stage at a pressure at least as high as said minimum level, whereby the column composed of said bottom set is always stiffer than the telescopically superposed column composed of said top set whenever the hoist assembly is extended beyond said bottom set, and vent means for selectively venting said sets such that the pressure in the bottom set is maintained at least as high as the pressure in the top set while the hoist assembly is being retracted.

**2.** A hoist according to claim **1** in which said top set is always internally separated from communication with said bottom set by divider means, and in which said vent means is arranged to vent said top set via said top stage and to vent said bottom set via said bottom stage.

**3.** A hoist according to claim **2** in which said vent means is arranged to vent said top and bottom sets simultaneously.

**4.** A hoist according to claim **1** in which said controlled supply means includes normally closed valve means controlling the supply of fluid to said top set, said valve means being adapted to open responsive to full extension of said bottom set at said predetermined pressure.

**5.** A hoist according to claim **4** in which said vent means includes a check valve bypassing said valve means in a flow direction opposite that through the valve means.

**6.** A hoist according to claim **1** in which said vent means is arranged and adapted to vent said top set via said top stage and to vent said bottom set via the top set after the top set is substantially retracted.

**7.** A hoist according to claim **6** in which said sets are internally separated by a divider means and said vent means includes a normally closed valve in said divider means and means in said top set for opening said valve responsive to a substantial retraction of said top set whereby said bottom set can then vent through said top set.

**8.** A compressible fluid-operated multi-stage telescopic hoist for operating up to a given load limit comprising, an extendable and retractable hoist assembly having a plurality of intermediate stages progressing telescopically from a base stage of largest cross section to a top stage of smallest cross section, said base stage together with a bottom group of said intermediate stages comprising a bottom set of stages and the remainder of said intermediate stages together with said top stage comprising a top set of stages, controlled supply means for selectively supplying a compressible fluid to said bottom set via the base stage at a supply pressure well above the minimum pressure level sufficient for the top stage to meet the given load limit and for selectively supplying a compressible fluid to said top set via the top stage at a pressure at least as high as said minimum level and only when said bottom set is in a fully extended condition, and vent means for selectively venting said sets such that the pressure in the bottom set is maintained at said supply pressure while the top set is being retracted, whereby the column composed of said bottom set is always stiffer than the telescopically superposed column composed of said top set whenever the hoist assembly is extended to a height greater than the fully extended height of said bottom set.

**9.** A compressible fluid-operated multi-stage telescopic hoist for operating up to a given load limit comprising, an extendable and retractable hoist assembly having a plurality of intermediate stages progressing telescopically from a base stage of largest cross section to a top stage of smallest cross section, said base stage together with a bottom group of said intermediate stages comprising a bottom set of stages and the remainder of said intermediate stages together with said top stage comprising a top set of stages, supply means for supplying a compressible fluid to said hoist assembly at a supply pressure well above the minimum level sufficient for the top stage to meet the given load limit, first supply control means for selectively conducting the supplied fluid to said bottom set via the base stage, second supply control means operating responsive to a fully extended condition of said first set at said supply pressure for conducting the supplied fluid to said top set via the top stage, and vent means for selectively venting said sets through said top stage such that the top set is substantially fully retracted before venting of the bottom set is commenced, whereby the column composed of said bottom set is always stiffer than the telescopically superposed column composed of said top

set whenever the hoist assembly is extended beyond said bottom set.

**10.** A compressible fluid-operated multi-stage telescopic hoist for operating up to a given load limit comprising; an extendible and retractable hoist assembly having a plurality of intermediate stages progressing telescopically from a base stage of largest cross section to a top stage of smallest cross section, said base stage together with a bottom group of said intermediate stages comprising a bottom set of stages and the remainder of said intermediate stages together with said top stage comprising a top set of stages, controlled supply means for simultaneously supplying a compressible fluid to said bottom set and to said top set via both the base stage and the top stage whereby the pressure in the bottom set is increased above the pressure level sufficient for the uppermost stage to meet the upper limit, whereby the column composed of said bottom set is always stiffer than the telescopically superposed column composed of said top set whenever the hoist assembly is extended beyond said bottom set.

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