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Fisher et al.

[11] **3,799,290**

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[54] **CABLE RESTRAINT FOR MULTI-STAGE PNEUMATIC LIFT ASSEMBLY**

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[51] **Int. Cl.** **E04g 1/22**

[58] **Field of Search** 182/148, 141, 63, 41, 40, 182/19; 52/115, 118, 121

[56] **References Cited**

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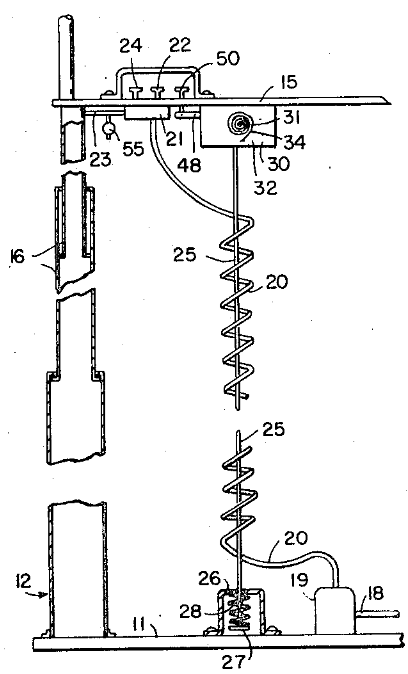
[57] **ABSTRACT**

A pneumatic lift assembly wherein a platform is elevated by applying air under pressure to a telescoping lift cylinder. An inextensible cable is fixed at one end to the base of the assembly and extends up to the platform. When the platform is at any desired height the operator secures the cable to the platform to prevent further upward movement of the platform. Additional pressure can then be applied to the lift cylinder, placing the cable under tension, thereby preventing the platform from thereafter raising or lowering because of variations in loading on the platform. In addition, means are provided to secure the cable to the platform automatically upon sudden upward movement of the platform and thereby prevent dangerous upward surge of the platform in the event normal upward movement of the platform is interrupted and the lift cylinder becomes overpressured.

14 Claims, 4 Drawing Figures



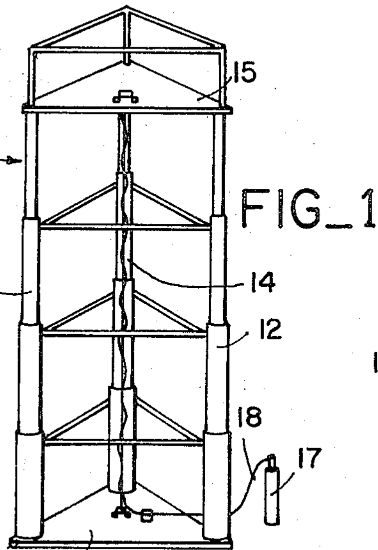


FIG_1

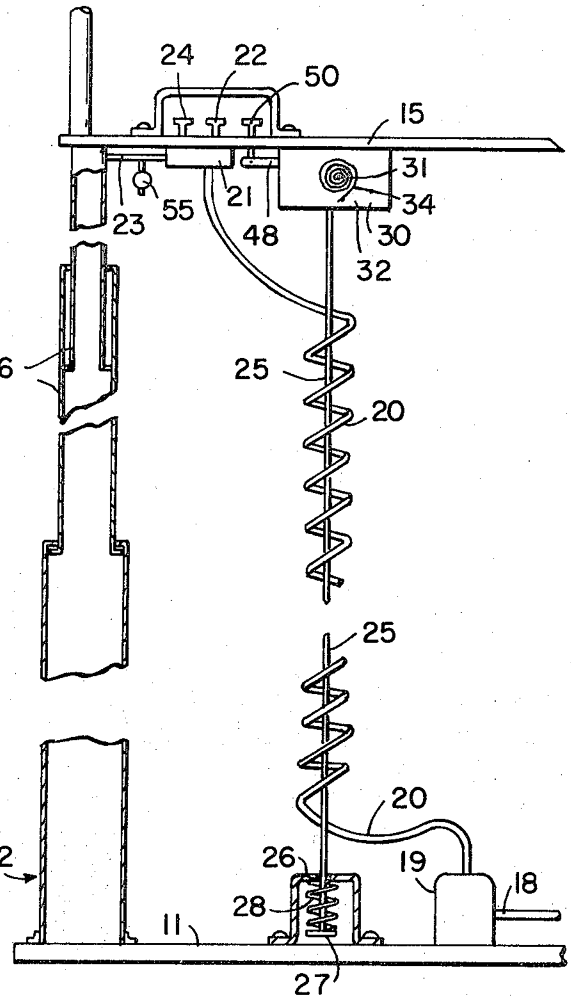


FIG_2

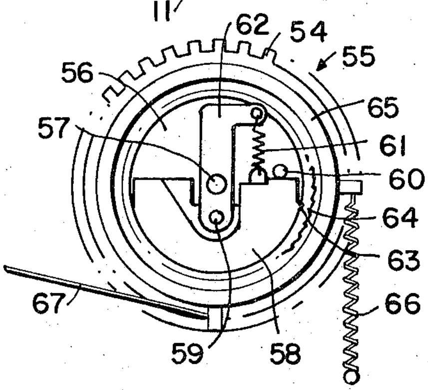


FIG_4

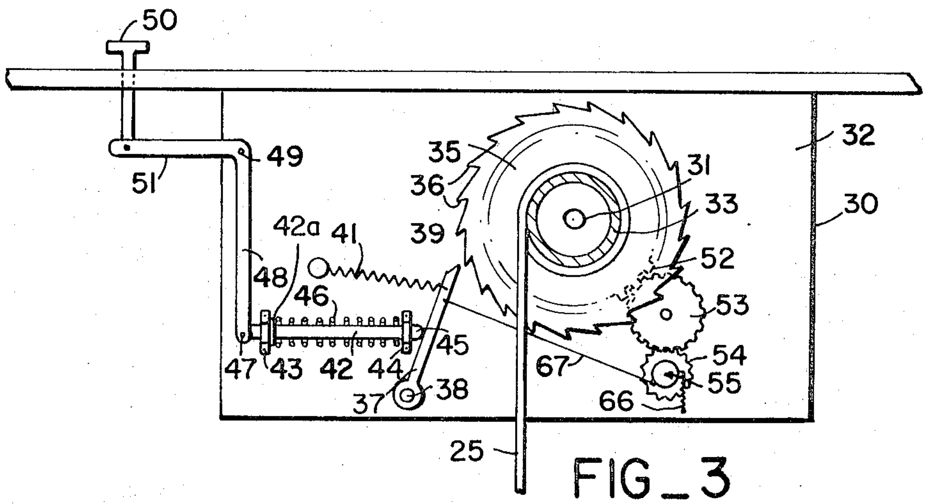


FIG_3

CABLE RESTRAINT FOR MULTI-STAGE PNEUMATIC LIFT ASSEMBLY

BACKGROUND OF THE INVENTION

Pneumatic scaffold systems comprise one or more telescoping lift cylinders which support a work platform on their upper end. In operation, air under pressure is introduced into the cylinders and when the pressure in the cylinders has built up to a sufficient degree to overcome the downward load thereon the lift cylinders begin to extend, carrying the platform upwardly. Continued introduction of pressurized air eventually causes the lift cylinders to extend completely to raise the platform to its maximum height. At such time, additional air under pressure can be forced into the lift cylinders to overpressure them and rigidify the structure.

However, it is often desired to operate the system so that the platform is located at a height less than the maximum possible height. Such location can be easily accomplished by the operator who merely shuts off the flow of pressurized air into the lift cylinders when the platform has reached the desired elevation. At this time the forces in the system are in balance. That is, the upward force on the platform (a function of the air pressure in the lift cylinders over the area on which the air acts upwardly) is equal to the height of the platform, the extended portions of the lift cylinders and the load on the platform (the operator and material thereon). Any variation in scaffold loading will then cause the platform to raise or lower. For example, if the workman on the scaffold is using a wrench to tighten or loosen bolts on the structure alongside of the platform, a downward pull on the wrench will decrease the downward weight on the scaffold. As a consequence, the air pressure in the lift cylinders will cause the platform to rise. Conversely, if the workman pushes up on the wrench, the platform will lower. Similarly, if the workman steps off the platform onto the structure alongside, or if another workman steps from the structure to the platform, the platform will be raised or lowered in accordance with the load variations until the system is again in balance. Also, if two platforms are used, with a bridge therebetween, movement of the workman back and forth on the bridge will cause one platform to rise and the other to lower, thereby tilting the bridge.

This undesired movement of the platform can be avoided when the platform is fully elevated by overpressurizing the lift cylinders. However, when the platform is to be located at a lesser height, the lift cylinders cannot be overpressured since an increase in pressure would cause the platform to move upwardly.

One of the objects of the invention is to provide a simple means, actuatable by the operator, to lock the platform against upward movement when any desired elevation has been reached. With the platform so locked, the lift cylinders can be overpressured so that the assembly is rigidified and so that variations in loading will not cause platform movement.

Another deficiency of present pneumatic scaffold systems is that a dangerous sudden upward movement of the platform may occur if normal upward movement is temporarily interrupted. For example, a power tool may be carried upwardly with the platform with the electric cord extending to the ground, and the cord may snag something on the ground. If the tool does not pull free from the platform, upward movement of the platform will be stopped. If the workman is not paying attention, air under pressure will continue to be introduced into the lift cylinders until sufficient force is present to part the cord. With this restraint removed, the overpressured lift cylinders will cause a rapid upward surge of the platform with the danger that the workman might be thrown therefrom. Similarly, if the platform hangs up on a projection from the adjacent structure, the platform will surge upwardly after the force developed in the lift cylinders shears off the restraining projection.

It is a further object of the invention to provide a safety device which will automatically sense and stop upward surges of platform movement.

SUMMARY OF THE INVENTION

A substantially inextensible cable is provided which extends from the base of the scaffold up to the platform. In the illustrated embodiment, the cable is secured to the base member and unreels from the platform as the platform is raised. When the platform reaches a desired height, the operator actuates a cable-securing device which secures the platform to the cable and anchors the platform against further upward movement. With the platform so anchored, the operator can cause the lift cylinders to be overpressured, thereby putting the cable under tension. Additional loading on the platform can then be accommodated, up to an amount equal to the amount of initial tension in the cable without causing downward movement of the scaffold. A decrease in platform load will cause an increase in cable tension but the inextensiblility of the cable will prevent upward platform movement.

In addition, a safety device is provided so that the cable is automatically secured to the platform, to anchor against upward platform movement, in the event of an attempted upward surge thereof. In the illustrated embodiment, this safety device is an inertia-sensing device which is responsive to a sudden increase in rate of elevation of the platform, as would occur if the platform sheared off an obstructing projection and which acts to secure the cable to the platform against the upward movement that would otherwise result from the overpressured condition of the lift cylinders.

Other objects and advantages of the invention will become apparent in the course of the following detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings forming a part of this application, and in which like parts are designated by like reference numerals throughout the same,

FIG. 1 is a perspective view of a pneumatic scaffold utilizing the present invention;

FIG. 2 is an elevational view, partly in section, of a portion of the scaffold shown in FIG. 1;

FIG. 3 is an elevational view, partly in section, of the cable-securing means and actuators therefor;

FIG. 4 is a detail view of the inertia-sensing device shown in FIG. 3.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The pneumatic scaffold assembly **10** comprises a base member **11** on which three multi-stage telescoping lift cylinders **12, 13** and **14** are mounted and a platform member **15** supported on the upper ends of the lift cylinders.

Each lift cylinder comprises a plurality of telescopable cylindrical stages **16**, two extendable stages being shown in FIG. **2.** Air under pressure in storage tank **17** passes through conduit **18** to the pressure regulator in housing **19** and then up through the flexible, coiled hose **20** to the valve box **21** mounted on the platform. When depressed, foot pedal **22** operates a valve in the valve box so that the air in hose **20** can flow through conduit **23** to the interior of the lift cylinder **12,** and through similar conduits to the other two lift cylinders. Foot pedal **24** actuates another valve, when the pedal is depressed, to exhaust air from the lift cylinders.

A flexible, substantially inextensible cable **25** extends from base member **11** upwardly to the platform member **15,** the cable preferably extending through the center of the coils of hose **20** to ensure that the hose **20** remains within the confines of the scaffold assembly. The cable **25** passes down through an opening in bracket **26,** which is fixed to base member **11,** with the lower end of the cable being fixed to bearing plate **27.** A heavy-duty, shockabsorbing compression spring **28** is confined between the bearing plate **27** and bracket **26.**

The undersurface of platform **15** has mounted thereon a cable reel housing **30** which has a horizontal shaft **31** journaled in opposed walls **32** of the housing. A reel **33** is fixed to shaft **31** for rotation therewith and the upper portion of cable **25** is wound around the reel, the end of the cable being fixed to the reel. A spiral spring **34** is disposed around shaft **31** with one end of the spring being fixed to the shaft and the other end of the spring being fixed to housing wall **32.** A suitable end cap, not shown, is secured to housing wall **32** to enclose spring **34.** As the platform moves upwardly the reel **33** will be pulled in a counterclockwise direction, as viewed in FIG. **3,** unreeling the cable **25** therefrom and winding up spring **34.** On downward movement of the platform, spring **34** will cause clockwise rotation of the reel to wind up the cable thereon and leave no slack therein.

One end of reel **33** has a ratchet wheel **35** fixed thereto, the wheel having a plurality of ratchet teeth **36** spaced around the periphery thereof. Pawl **37,** pivotally mounted at its lower end on pin **38** fixed to housing wall **32** and having an upper end **39** adapted to engage the ratchet teeth **36** is provided to prevent unreeling rotation of reel **33** when engaged therewith. Spring **41** normally biases pawl **37** away from such engagement. Preferably, the engaging surfaces of the teeth and pawl are sloped so that once engaged disengagement cannot occur without some clockwise rotation of the ratchet wheel.

An actuator pin **42** slidably mounted in brackets **43** and **44** is arranged so that the end **45** thereof can push against pawl **37.** Spring **46** confined between pin collar **42***a* and bracket **44** biases the pin to the leftward position shown in FIG. **3.** The left end of pin **42** is pivotally connected at **47** to the lower arm of bell crank **48.** The bell crank is pivotally mounted at **49** to wall **32** and foot pedal **50** extends down through platform **15,** the foot pedal being pivotally connected at **51** to the other arm of bell crank **48.** By this arrangement, depression of foot pedal **50** by the operator causes pin **42** to move pawl **37** over into engagement with the ratchet teeth **36** of reel **33.** When foot pedal **50** is released, spring **46** will move pin **42** to the left, away from pawl **37,** and will raise the foot pedal. The pawl **37** will remain in engagement with the ratchet teeth, however, until there is sufficient clockwise rotation of the ratchet wheel to release the pawl.

Ratchet wheel **35** also has gear teeth **52** formed thereon which engage idler gear **53,** the latter being in meshing engagement with gear **54** which drives the inertia-sensing device **55.** For purposes of illustration, an inertia-sensing device as more fully shown in U.S. Pat. No. 3,450,368 may be used. Such device has a circular plate **56** secured to gear **54** for rotation therewith about an axis **57,** and the plate carrying a semi-circular inertia member **58** which is pivotally mounted thereon at **59.** The inertia member **58** is biased against stop member **60** by spring **61,** stop member **60** being integral with plate **56** and spring **61** being secured to arm **62** which is also fixed relative to plate **56.** At low rates of angular velocity, the inertia member **58** rotates with plate **56** and stays held against stop member **60** by spring **61.** If the angular velocity of plate **56** and the inertia member **58** suddenly increses, the inertia member will pivot in a clockwise direction about its axis **59** so that the inertia member tooth **63** engages the ratchet teeth **64** in the surrounding annular shell **65.** This shell is journaled on but not driven by gear **54,** and is normally biased in a clockwise direction by return spring **66.** As the inertia member tooth **63** engages the ratchet teeth **64,** the shell **65** will be driven in a counterclockwise direction, exerting a force on pull wire **67** to pivot the pawl **37** into engagement with the ratchet teeth **36** on reel **33** to stop unwinding rotation thereof.

As the platform is elevated under normal conditions, the reel **33** will unwind and will drive the inertia-sensing gear **54** at a faster but relatively constant speed. If the upward movement of the platform is interrupted the reel will stop. If the pressure in the lift cylinders builds up, then when the obstruction is removed the platform will attempt to surge upwardly. This in turn will cause reel **33** to start to unwind at a rapid rate which in turn will cause the inertia-sensing device **55** to actuate the pawl **37** and lock the reel against further unwinding rotation. A subsequent clockwise, or winding, rotation of the reel will allow the inertia sensor to reset by springs **61** and **66,** and will allow spring **41** to pivot the pawl **37** out of engagement with ratchet teeth **36.**

In operation, with the lift cylinders fully contracted so that the platform is at its lowest elevation, the workman will climb onto the platform and will actuate the foot pedal **22** to elevate the platform. Gas under pressure will be introduced into the lift cylinders, and when the pressure has built up to a sufficient degree the lift cylinders will begin to extend. As the platform rises, the cable **25** will unreel from reel **33,** the cable being maintained in a slack-free condition by reel spring **34.** The workman will maintain the foot pedal **22** depressed until the platform reaches the desired elevation. At this point foot pedal **50** is depressed, causing pawl **37** to move into engagement with the ratchet teeth **36** and stop upward platform movement. Continual depression of foot pedal **22** admits further flow of pressurized air into the lift cylinders to begin the overpressurization thereof. When the lift cylinders have been sufficiently overpressured, the foot pedal **22** is released. If desired, a pressure relief valve **55** may be used to provide an audio signal to the operator indicating that the pressure in the lift cylinders has built up to the desired degree of overpressure.

With the lift cylinders in their overpressured condition, the cable **25** will be held under tension. Any lessening of loading on the platform, as for example by the workman stepping off the platform onto the adjacent structure, will simply cause an increase in tension in the cable **25** but the platform will remain stationary. Conversely, any increase in loading will cause a corresponding reduction in cable tension. However, as long as the increased loading is insufficient to reduce the cable tension to zero, the platform will remain at the desired elevation.

When it is desired to lower th platform, the workman simply depresses the foot pedal **24** to bleed air from the lift cylinders. As the overpressured air is bled therefrom the cable tension gradually decreases. After the overpressure condition has been relieved, the lift cylinders begin to contract, carrying the platform downwardly. Reel spring **34** now causes the reel to rotate to wind the cable on the reel. As soon as there is sufficient winding rotation, pawl **37** will be pulled to the left by spring **41**. As the platform continues to descend, the reel **33** will continue to take up the cable so that it remains slack-free. At any time the operator may stop the descent of the platform when it reaches another desired elevation. Depression of the foot pedal **50** will then lock the scaffold against upward movement at this new height and the workman can then again overpressure the lift cylinders to stabilize the platform for work operations.

Similarly, if the workman wishes to return the platform to a higher work elevation, he depresses the foot pedal **24** to bleed off the overpressure in the lift cylinders until the pressure is reduced to a point wherein there is a sufficient downward movement of the platform to reduce the pawl **37**. The platform may now be moved upwardly by depressing the foot pedal **22**.

As may be seen, once the platform has been locked against upward movement and the lift cylinders have been overpressured, the workman cannot elevate the platform to a higher position without first bleeding off the overpressure condition in the lift cylinders. Thus the workman is protected against sudden upward surge of the platform as would result from an overpressure condition in the normal operation of the scaffold.

In addition, the inertia-sensing device **55** will protect the workman against sudden upward surges in the event of abnormal operating conditions. If the lift cylinders are extending and the platform hangs up on an obstruction, air under pressure will continue to build up in the lift cylinders if the workman does not release the foot pedal **22**. Eventually, the pressure in the lift cylinders may build up to a degree whereby the obstruction may be sheared off, releasing the platform for further upward movement. The initial upward movement of the platform will cause a rapid unwinding rotation of reel **33** which will be transmitted to the inertia device which in turn will pull pawl **37** into engagement with the ratchet teeth on the reel to stop the unwinding rotation of the reel. Instead of suddenly rising several feet, upward travel of the platform will be stopped in a matter of inches. The shock of the sudden stop will be absorbed by spring **28**. In order to continue the upward travel, the workman must depress the foot pedal **24** to bleed off the overpressure and allow the platform to descend sufficiently so that the pawl **37** can be released by spring **41**. Depression of foot pedal **22** will now again allow normal elevation of the platform.

Mounting the cable reel on the platform is advantageous since it enables a direct mechanical connection from the foot pedal **50** to the pawl **37**. However, if desired, the cable could be anchored at its end to the platform and the cable reel mechanism could be mounted on the base, with a remote control mechanism being used to actuate the pawl from the platform.

Having thus described our invention, we claim:

1. A pneumatic lift assembly comprising:

a base member,

a platform member,

lift cylinder means mounted on said base member and supporting said platform on its upper end, said lift cylinder means comprising telescoping rigid cylinders and being vertically extensible upon introduction of a gas under pressure thereinto,

means for supplying gas to said lift cylinder means at a pressure sufficient to cause extension of said lift cylinder means and capable of supplying gas at a pressure substantially greater than that necessary to cause full extension of said lift cylinder means,

a substantially inextensible cable extending from said base member to said platform member and having one end thereof secured to one of said members,

means mounted on the other of said members and operable upon demand for securing said cable to said other member prior to full extension of said lift cylinder means to prevent further upward movement of said platform member relative to said base member.

2. A pneumatic lift assembly as set forth in claim **1** and further including means for preventing release of said cable-securing means when the pressure in said lift cylinder means is in excess of that required to elevate said platform.

3. A pneumatic lift assembly as set forth in claim **1** and further including means actuatable by personnel using said assembly for opertaing said cable-securing means.

4. A pneumatic lift assembly as set forth in claim **1** and further including means responsive to sudden upward movement of said platform member for operating said cable-securing means.

5. A pneumatic lift assembly as set forth in claim **4** and further including shock-absorbing spring means securing said one end of said cable to said one member.

6. A pneumatic lift assembly as set forth in claim **1** and further including:

means actuatable by personnel using said assembly for operating said cable-securing means, and

means responsive to sudden upward movement of said platform for operating said cable-securing means,

said personnel actuatable means and said movement-responsive means each being independently capable of operating said cable-securing means.

7. A pneumatic lift assembly as set forth in claim **1** and further including a rotatable reel carried by said other member, said cable being wound around said reel, said reel being rotatable in one direction to unwind cable therefrom as said platform member moves upwardly, and spring means for rotating said reel in the opposite direction to wind said cable upon said reel as said platform member moves downwardly.

8. A pneumatic lift assembly as set forth in claim **7** wherein said cable-securing means is operable to lock said reel against rotation in said one direction.

9. A pneumatic lift assembly as set forth in claim **8** and further including means actuable by personnel using said assembly for operating said cable-securing means.

10. A pneumatic lift assembly as set forth in claim **9** wherein said one end of said cable is secured to said base member, said reel is carried by said platform member and wherein said personnel actuable means is mounted on said platform member.

11. A pneumatic lift assembly as set forth in claim **8** and further including means responsive to sudden upward movement of said platform member for operating said cable-securing means.

12. A pneumatic lift assembly as set forth in claim **8** and further including means responsive to sudden increase in speed of rotation of said reel in said one direction for operating said cable-securing means.

13. A pneumatic lift assembly as set forth in claim **8** and further including:

means actuable by personnel using said assembly for operating said cable-securing means, and

means responsive to sudden upward movement of said platform member for operating said cable-securing means,

said personnel actuable means and said movement responsive means each being independently capable of operating said cable-securing means.

14. A pneumatic lift assembly as set forth in claim **13,** wherein said reel, said personnel actuable means and said motion-responsive means are all mounted on said platform member.

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