

"LOADING BALANCER"

Background of the invention

The present invention relates to a gravity-free type loading balancer equipped with a jump-preventing mechanism, i.e., a mechanism for preventing a running block having a load, e.g., a heavy article, attached thereto from jumping up when the load is detached from the running block, particularly, to a gravity-free type loading balancer which permits smoothly moving with safety and without fail a heavy article or the like in a good balance to a predetermined position with a small human force in a factory or warehouse, said loading balancer being equipped with a jump-preventing mechanism so as to moderate a sharp impact applied to the loading balancer when the heavy article is detached from the running block.

Japanese Utility Model Disclosure (Kokai) No. 56-6900 discloses a loading balancer equipped with a jump-preventing mechanism. The jump-preventing mechanism included in the loading balancer disclosed in this prior art comprises an equilibrium device of a parallelogrammatic structure. The equilibrium device includes upper and lower horizontal arms whose proximal ends are pivoted to a swingable supporting portion, and a vertical arm pivoted to the distal ends of these horizontal arms. The weight of a load supported by the vertical arm is detected so as to permit the load to be

moved to a predetermined position. The loading balancer also comprises a cylinder mounted to the swingable supporting portion, a hollow rod coupled with a piston arranged within the cylinder, and a solid rod inserted into the hollow rod and having the proximal end fixed to a lower portion of the cylinder. A fluid control device including a bubble plate and a valve flange is mounted to the distal end portion of the solid rod. The bubble plate, which is provided with small holes, is mounted to the tip of the solid rod. On the other hand, the valve flange serves to open or close the small holes made in the bubble plate, is urged by a spring in a direction of opening the small holes, and is coupled with the solid rod such that the sliding range of the valve flange is limited. It should be noted that a fluid chamber partitioned into upper and lower sections by the fluid control device is formed within the hollow rod.

The jump-preventing mechanism of the construction described above serves to prevent the vertical arm from jumping up when the load supported by the vertical arm is detached from the vertical arm.

To reiterate, the jump-preventing device disclosed in the prior art quoted above is constructed such that a hollow rod is coupled with the piston arranged within a cylinder. In this prior art, flow of the fluid within the hollow rod is limited so as to prevent

the piston from being moved rapidly. Clearly, the construction of the jump-preventing mechanism itself is rendered complex. In addition, a hollow rod for exclusive use by the mechanism is required. Further, since it is necessary to use a liquid such oil, a sealing portion is required. It follows that the entire loading balancer is rendered costly.

Summary of the Invention

An object of the present invention, which is intended to solve the above-noted problems inherent in the prior art, is to provide a loading balancer comprising a load response valve mounted to a support member for supporting a load, the load response valve having a sensor function to detect release of the load from the support member and automatically putting a pressure circuit within a control device in a load-free balanced condition, thereby preventing the support member from jumping up.

According to the present invention, there is provided a loading balancer in which a balancing force competing in good balance with sum of the weight of a support member movable in a vertical direction relative to a floor, and the weight of a load attached to the support member, is applied to the support member so as to transfer the load with a small human force, comprising a balance piston operably joined to the support member, a fluid pressure cylinder slidably

housing the balance piston and partitioned into closed chambers by the balance piston, and a control device for supplying a fluid pressure from a fluid pressure source into the closed chambers of the fluid pressure cylinder through a main tubular passageway, the control device including being a main pressure adjusting valve which is arranged within the main tubular passageway and can be controlled by a fluid pressure, a non-load regulator for forming a controlling fluid pressure adapted for the condition that a load is not attached to the support member, a load regulator for forming a controlling fluid pressure adapted for the condition that a predetermined load is attached to the support member, a control pressure selecting valve, connected to the load regulator and the non-load regulator, for supplying the controlling fluid pressure formed by one of the non-load regulator and load regulator to the main pressure adjusting valve, a switching valve interposed between the control pressure selecting valve and the load regulator for performing a switching function depending on the controlling fluid pressure between an open position at which the controlling pressure selecting valve and the load regulator are allowed to communicate with each other and a closed position at which the controlling pressure selecting valve and the load regulator are disconnected from each other, a manual switching valve, which is connected in

series to a control tubular passageway for supplying the controlling fluid pressure to the switching valve, for manually performing the switching function between the open position and the closed position, and a load response valve which is arranged in an open position when a load is attached to the support member and in a closed position when a load is not attached to the support member, wherein the switching valve permits the control pressure selecting valve and the load regulator to communicate with each other when both of the manual switching valve and the load response valve are arranged in open positions so as to permit supply of a predetermined controlling fluid pressure.

In the loading balancer of the present invention, a load response valve performing a sensor function is arranged within a support member. Even if a heavy article which is attached to the support member inadvertently drops to the floor during transference of the article, the load response valve serves to automatically switch the fluid pressure circuit within the control device included in the loading balancer to a balanced state without load. It follows that the support member is prevented from jumping up when the article attached to the support member drops from the support member, leading to a high safety of the loading balancer.

Additional objects and advantages of the invention

will be set forth in the description which follows, and in part will be obvious from the description, or may be learned by practice of the invention. The objects and advantages of the invention may be realized and obtained by means of the instrumentalities and combinations particularly pointed out in the appended claims.

Brief Description of the Drawings

The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate presently preferred embodiments of the invention, and together with the general description given above and the detailed description of the preferred embodiments given below, serve to explain the principles of the invention.

FIG. 1 shows the construction of an pneumatic type loading balancer according to one embodiment of the present invention;

FIG. 2 is a cross sectional view showing the construction of a support member included in the loading balancer shown in FIG. 1;

FIG. 3 is a cross sectional view showing the construction of a side of a hoist included in the loading balancer shown in FIG. 1;

FIG. 4 is a cross sectional view showing the construction of the hoist included in the loading balancer shown in FIG. 3; and

FIG. 5 is a circuit diagram showing a control device included in the loading balancer shown in FIG. 1.

Detailed Description of the Preferred Embodiments

The accompanying drawings collectively show a loading balancer equipped with a jump-preventing mechanism according to one embodiment of the present invention. As shown in FIG. 1, the loading balancer comprises a support rod 1 which is erected on and fixed to a pedestal 2. An arm 3 is swingably mounted to an upper end portion of the support rod 1. A rail 3a is formed in the arm 3 in a manner to extend in the axial direction of the arm 3. A trolley wheel 4a of a trolley 4 is mounted on the rail 3a such that the trolley 4 is capable of running along the rail 3a. Incidentally, the arm 3 can be made shrinkable, as desired.

A first pulley 5 and a second pulley 6 are attached to the trolley 4. A belt or wire 7, hereinafter referred to as a cable, having one end fixed to the tip of the arm 3 extends downward through the second pulley 6 and, then, extends upward to form a U-shaped configuration. Further, the cable 7 extends through the first pulley 5 so as to be wound up by a drum 17 of a hoist, which is described herein later. A running block 8 is supported by the U-shaped portion of the cable 7. A support member 9 for supporting a heavy

article (load) W is attached to the running block 8.

The support member 9 is capable of performing a sensor function (which is described in detail herein later) for detecting the state that a load is attached to the support member 9 and the state that a load is not attached to the support member 9. Specifically, a ring 24 is detachably mounted to the running block 8 as shown in FIG. 2. A casing 25 is fixed to the ring 24. Also, a guide section 26 of a shaft, which is described herein later, communicating with the inner space of the casing 25 and extending downward is attached to the lower wall of the casing 25. Further, an operating lever 38a of a manual switching valve 38 and a grip 27 are mounted to the circumferential outer surface of the guide section 26.

A shaft 28 is slidably mounted to the guide section 26. A hook 28a attached to the lower end of the shaft 28, with an operating piece 28b being attached to the upper end of the shaft 28. As described herein later, the operating piece 28b serves to operate a load response valve 29 performing a load detecting function. A spring 28c serving to urge the shaft 28 upward is arranged between the operating piece 28b and the bottom surface of the casing 25. Also, a stopper 25a and a sensor rod 29a are mounted to the bottom wall of the casing 25. The stopper 25a extends upward along the outer

circumferential surface of the spring 28c. When the shaft 28 is moved downward, the operating piece 28b is allowed to abut against the sensor rod 29a. If the operating piece 28b is brought into contact with the sensor rod 29a, the load response valve 29 is switched into its open position so as to detect the state that the load is attached to the support member 9.

To be more specific, where a load is not attached to the support member 9, the shaft 28 is held in its upper position shown in FIG. 2 by the urging force of the spring 28c. Where a load is attached to the support member 9, however, the shaft 28 is moved downward against the urging force of the spring 28c until the operating piece 28b mounted to the upper end of the shaft 28 abuts against the stopper 25a. In this step, the operating piece 28b also abuts against the sensor rod 29a extending upward from the bottom wall of the casing 25 so as to detect the state that a load is attached to the support member 9. Further, when the load is dropped downward from the hook 28a, the shaft 28 is moved upward by the urging force of the spring 28c. In this case, the operating piece 28b is moved away from the sensor rod 29a so as to detect the dropping of the load. As a result, the running block 8 and the support member 9 are prevented from jumping up.

A hoist 10 is fixed to the upper portion of the support rod 1 by a suitable means. As shown in FIGS. 3

and 4, the hoist 10 comprises a box 11 constituting a hoist body. A chain pin 12 is fixed to the inner surface of the side wall of the box 11. Also, an arcuate guide member 13 is fixed to the inner surface of the upper wall of the box 11. Further, a bearing 14 is mounted to the side wall of the box 11. A shaft 15 extends through the bearing 14. A sprocket 16 is fixed to the inside edge of the shaft 15. On the other hand, the drum 17 referred to previously is fixed to the outside edge of the shaft 15. As described previously, one end of the cable 7 such as a belt or a wire is fixed to the drum 17. The cable 7 extends through the trolley 4 so as to allow the other end of the cable 7 to be fixed to the tip of the arm 3.

A cylinder 18 and a chain-housing container 19 are mounted to the bottom wall of the box 11. Also, a balance piston 20 is slidably arranged within the cylinder 18. A sprocket 22 is rotatably mounted via a bracket 21 to the balance piston 20 arranged within the cylinder 18. A chain 23 having one end fixed to the chain pin 12 is wound about the sprocket 22. Further, the chain 23 is stretched through the sprocket 22 and the sprocket 16 in this order such that the other end of the chain 23 is allowed to fall within the chain-housing container 19.

The cylinder 18 communicates with the box 11. Likewise, the chain-housing container communicates

with the box 11. It follows that the cylinder 18 communicates with the chain-housing container 19 via the box 11. However, the connecting portions among these cylinder 18, box 11 and chain-housing container 19 are made hermetic so as to form hermetic chambers. Further, an air supply port (not shown) is formed above the cylinder 18, and a control device 18a for supplying a compressed air into the hermetic chambers in pulling up a load is mounted to a side wall of the cylinder 18.

FIG. 5 shows the control device 18a. As shown in the drawing, the control device 18a comprises an air pressure source 31 serving to maintain an air pressure of a predetermined range. The control device 18a is connected to the air supply port of the cylinder 18 via a main tubular passageway M. A check valve 32 for preventing back flow of the air stream and a main pressure adjusting valve 33 are mounted to the main tubular passageway M. The main pressure adjusting valve 33 is controlled by a control pressure supplied from a control pressure selecting valve 34 so as to supply an air pressure conforming with the weight of the load supported by the support member 9. Therefore, control tubular passageways P1 and P2 are connected to the control pressure selecting valve 34 such that any one of the control pressures, which is higher, supplied through these passageways P1 and P2 is supplied to the

main pressure adjusting valve 33.

A non-load regulator 36 is mounted to the control tubular passageway P1. On the other hand, a load regulator 37 and a pressure gage 39 are mounted to the control tubular passageway P2. It is possible to manually adjust the pressure set at each of the non-load regulator 36 and the load regulator 37. When the control pressure set at the non-load regulator 36 is supplied to the main pressure adjusting valve 33, a relatively low pressure is supplied from the main tubular passageway M to the cylinder 18 so as to permit the force acting on the balance piston 20 to be balanced with the sum of the weight of the support member 9 under a load-free state and the weight of the running block 8. On the other hand, when the control pressure set at the load regulator 37 is supplied to the main pressure adjusting valve 33, a relatively high pressure is supplied from the main tubular passageway M into the cylinder 18 so as to permit the force acting on the balance piston 20 to be balanced with the sum of the weights of the running block 8, the support member 9 and the load supported by the support member 9. Where the weight of the load is changed, the pressure set at the load regulator 37 is adjusted to conform with the weight of the new load.

Further, a switching valve 35 is mounted to the control tubular passageway P2 so as to open or close

the control tubular passageway P2. The switching valve 35 is controlled by a spring force urging the valve 35 toward the closed position shown in the drawing and by a pressure of a control tubular passageway P3 acting against the spring force. When the pressure of the control tubular passageway P3 exceeds a predetermined value, the switching valve 35 is switched to open the control tubular passageway P2. When the switching valve 35 is switched to its open position, the control pressure set at the load regulator 37 is supplied to the control pressure selecting valve 34.

A manual switching valve 38 and a load response valve 29 are mounted in series to the control tubular passageway P3. The switching between the open position and the closed position of the manual switching valve 38 can be performed by operating the operating lever 38a. On the other hand, the load response valve 29 is switched into its open position when the sensor rod 29a abuts against the operating piece 28b, as described previously. It should be noted that the switching valve 35 mounted to the control tubular passageway P2 is arranged in its open position only when the manual switching valve 38 and the load response valve 29 are both in their open positions. The control device 18a also comprises a muffler 10a mounted to the cylinder 18. An air communication with

the chamber positioned below the piston 20 is made possible by the muffler 10a.

The loading balancer of the present invention, which is constructed as described above, is operated as follows. In the first step, the non-load regulator 36 is operated so as to set up a balanced state under a load-free condition. Also, the load regulator 37 is operated so as to set up in advance the pressure adapted for the balanced state under the condition that a load is attached to the support member 9. When a load (heavy article) is pulled up for transfer to a desired position, an operator of the loading balancer swings the arm 3 to a desired position and, at the same time, moves the trolley 4 to a position right above the load. Under these conditions, the operating lever 38a is operated so as to arrange the manual switching valve 38 in its open position. Then, the operator moves the hook 28a downward by holding the grip 27 of the support member 9. As a result, the cable 7 is pulled so as to cause the drum 17 to be rotated in a clockwise direction in the drawing of FIG. 1. The drum rotation causes the sprocket 16 to be rotated in a clockwise direction so as to pull up the chain 23 wound about the sprocket 22. Naturally, the sprocket 22 attached to the balance piston 20 is also moved upward while being rotated. In this step, the control pressure adjusted by the non-load regulator acts on the

main pressure adjusting valve 33, with the result that a balanced condition is maintained by a relatively low air pressure acting on the cylinder 18. It follows that the loading balancer can be operated easily.

After the support member 9 is moved downward to a pull-up position of the load, the load is attached to the hook 28a. Then, the support member 9 is moved somewhat upward by manually holding the grip 27. When the operating rod 28b is allowed to abut against the sensor rod 29a, the load response valve 29 is arranged in its open position. In this step, the manual switching valve 38 and the load response valve 29 both mounted to the control tubular passageway P3 are also in their open positions, with the result that the control pressure within the pressure source 31 is allowed to act on the switching valve 35 so as to arrange the switching valve 35 in its open position. As a result, a control pressure is supplied from the pressure source 31 to the control pressure selecting valve 34 through the load regulator 37 mounted to the control tubular passageway P2 and set at a predetermined pressure and the switching valve 35 in its open position, which is also mounted to the control tubular passageway P2. It should be noted that the pressure set at the load regulator 37 is higher than the pressure set at the non-load regulator 36. It follows that the control pressure selecting

valve 34 serves to supply the pressure set at the load regulator 37 to the main pressure adjusting valve 33 as a control pressure. Therefore, the main pressure adjusting valve 33 supplies a relatively high pressure to the cylinder 18 so as to generate within the balance piston 20 a force capable of coping with the sum of the weights of the running block 8, the support member 9 and the load attached to the support member 9.

Under the condition described above, the air pressure set up by the load regulator 37 is in good balance with the weight of the load, making it possible to move the load in a vertical direction by applying a small force to the load. When the load is moved upward to a desired position, the arm 3 is swung to a desired position. Also, the trolley 4 is moved along the rail 3a to the desired position, followed by moving the support member 9 downward to a desired position to cause the load attached to the support member 9 to be brought into contact with the ground. Then, the grip 27 is moved slightly downward against the pull-up force of the cable 7 so as to cause the operating piece 28b to be moved away from the sensor rod 29a. As a result, the control tubular passageways P3 and P2 are closed so as to put the cylinder 18 in a load-free balanced state, thereby detaching the load from the hook 9.

Incidentally, where the load is light in weight,

the grip 27 can be moved downward with a relatively small force so as to move easily the operating piece 28b away from the sensor rod 29a. Where the load is heavy, however, it is difficult to move downward the grip 27 with a small force. In this case, it is necessary to operate the operating lever 38a so as to set up a load-free balanced state. In this fashion, where the load is light in weight, the load-free balanced state can be automatically set up by the load response valve 29 having a sensor function by simply operating the support member 9, making it possible to eliminate the troublesome operation required in the conventional apparatus that a load-free balanced state must be set up by operating a manual operating lever every time it is required to set up the load-free balanced state. On the other hand, where the load is heavy, the operating lever 38a is operated with the load kept in contact with the ground so as to close the manual switching valve 38. As a result, a load-free balanced state is set up, and the load is detached from the support member 9.

Where the load is inadvertently detached from the hook during the operation of transferring the load to a desired position, the shaft 28 of the support member 9 is moved upward by the urging force of the spring 28c so as to move the operating piece 28a away from the sensor rod 29a and, thus, to close the control tubular

passageway P3. As a result, the switching valve 35 is closed so as to put the pilot valve in a load-free balanced state, thereby to prevent the support member 9 from jumping up.

The trolley 4 and the hoist 10 are included in the loading balancer shown in the accompanying drawings. However, it is possible to use other members performing similar functions in place of these trolley and hoist. Also, the cable 10 used in the embodiment shown in the drawings consists of a belt or a wire. However, another member such as a rope can be used as the cable 10. Further, wheels such as casters can be mounted together with a brake to the pedestal 2, as required. Further, the support rod 1 can be made movable in a vertical direction, as required. Still further, the arm 3 can be made swingable by, for example, an electric power.

The technical idea of the present invention can be worked in various other fashions within the technical scope of the present invention. Of course, the embodiment shown in the accompanying drawings is simply intended to exemplify the loading balancer of the present invention and should not be interpreted limitatively.

Additional advantages and modifications will readily occur to those skilled in the art. Therefore, the invention in its broader aspects is not limited to

the specific details, and representative embodiments shown and described herein. Accordingly, various modifications may be made without departing from the spirit or scope of the general inventive concept as defined by the appended claims and their equivalents.



Claims:

1. A loading balancer in which a balancing force competing in good balance with sum of the weight of a support member movable in a vertical direction relative to a floor, and the weight of a load attached to said support member, is applied to the support member so as to transfer the load with a small human force, comprising:

a balance piston operably joined to the support member;

a fluid pressure cylinder slidably housing said balance piston and partitioned into closed chambers by the balance piston; and

a control device for supplying a fluid pressure from a fluid pressure source into said closed chambers of the fluid pressure cylinder through a main tubular passageway, said control device including:

a main pressure adjusting valve which is arranged within said main tubular passageway and can be controlled by a fluid pressure, a non-load regulator for forming a controlling fluid pressure adapted for the condition that a load is not attached to the support member, a load regulator for forming a controlling fluid pressure adapted for the condition that a predetermined load is attached to the support member,

a control pressure selecting valve, connected to the load regulator and to the non-load regulator, for



supplying the controlling fluid pressure formed by one of said non-load regulator and load regulator to said main pressure adjusting valve;

a switching valve interposed between the control pressure selecting valve and the load regulator for performing a switching function depending on the controlling fluid pressure between an open position at which the controlling pressure selecting valve and the load regulator are allowed to communicate with each other and a closed position at which the controlling pressure selecting valve and the load regulator are disconnected from each other;

a manual switching valve, which is connected in series to a control tubular passageway for supplying the controlling fluid pressure to the switching valve, for manually performing the switching function between said open position and said closed position; and

a load response valve which is arranged in an open position when a load is attached to the support member and in a closed position when a load is not attached to the support member;

wherein the switching valve permits the control pressure selecting valve and the load regulator to communicate with each other when both of the manual switching valve and the load response valve are arranged in open positions so as to permit supply of a predetermined controlling fluid pressure.



2. The loading balancer according to claim 1, wherein each of said manual switching valve and the load response valve is formed of a three-way-two-position switching valve.

3. The loading balancer according to claim 1, wherein said support member comprises a shaft joined to a load, a casing slidably housing the shaft, a spring arranged within the casing for urging the shaft in a direction opposite to the acting direction of the weight of the load, and a sensor rod which is operated when the shaft is moved against the urging force of the spring, and said load response valve is switched between its open position and closed position by the sensor rod.

4. The loading balancer according to claim 1, wherein said manual operating valve includes an operating lever mounted to the support member, said operating lever being operated by an operator to perform switching between an open position and a closed position of the manual operating valve.

5. The loading balancer according to claim 1, wherein said cylinder has a hermetically closed chamber partitioned by a balance piston and communicating with the outer air through a muffler.

6. The loading balancer according to claim 1, wherein said cylinder is operated by an air pressure.

7. The loading balancer according to claim 1,



further comprising:

a horizontal arm swingably supported by a support rod erected from a floor;

a hoist swingable together with said horizontal arm and having a drum;

a trolley movable along the horizontal arm;

a cable having one end fixed to the horizontal arm, the other end fixed to the drum of said hoist, and an intermediate portion extending through said trolley and hanging downward;

a running block supported by the intermediate portion of said cable and having said support member attached thereto; and

connecting means for connecting said balance piston and the drum so as to rotate the drum when said connecting means is moved within the cylinder.

8. The loading balancer according to claim 7, wherein said connecting means includes sprockets mounted to the piston and the drum, respectively, and a chain wound about each of these sprockets.

9. A loading balancer, substantially as hereinbefore described with reference to the accompanying drawings.