

[54] **CRANE LOAD COMPENSATOR**

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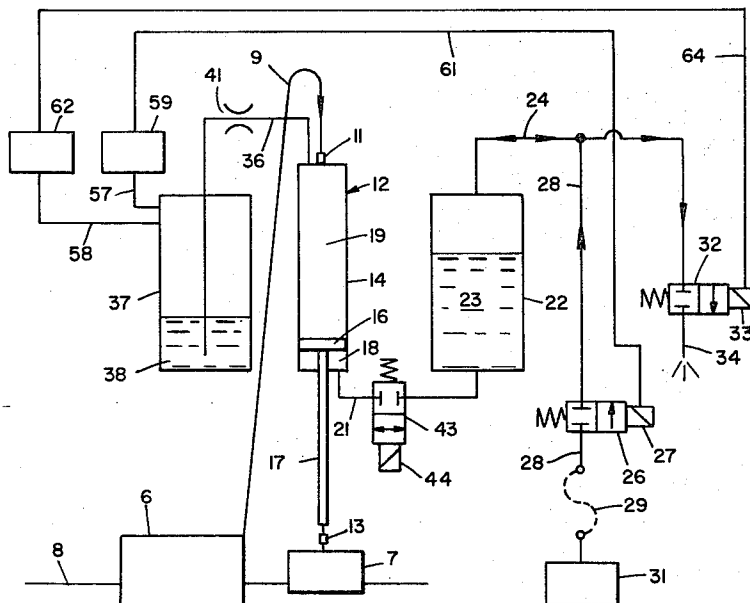
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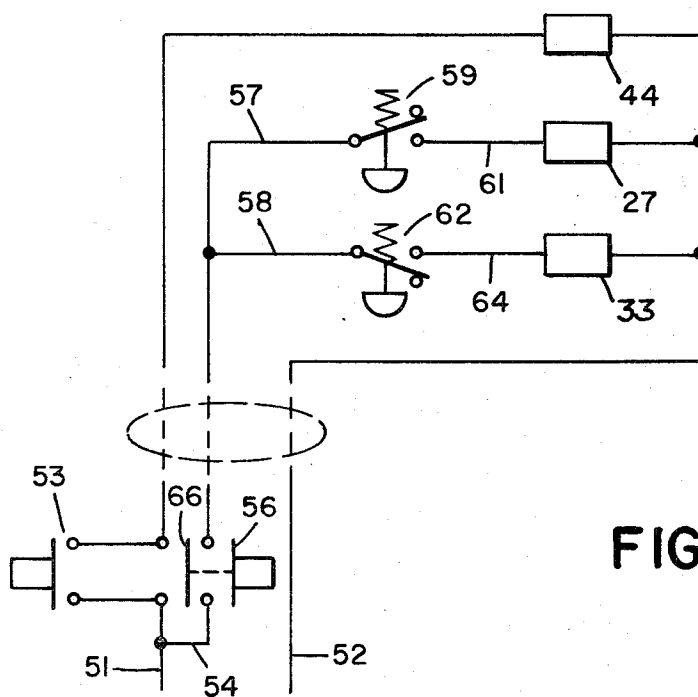
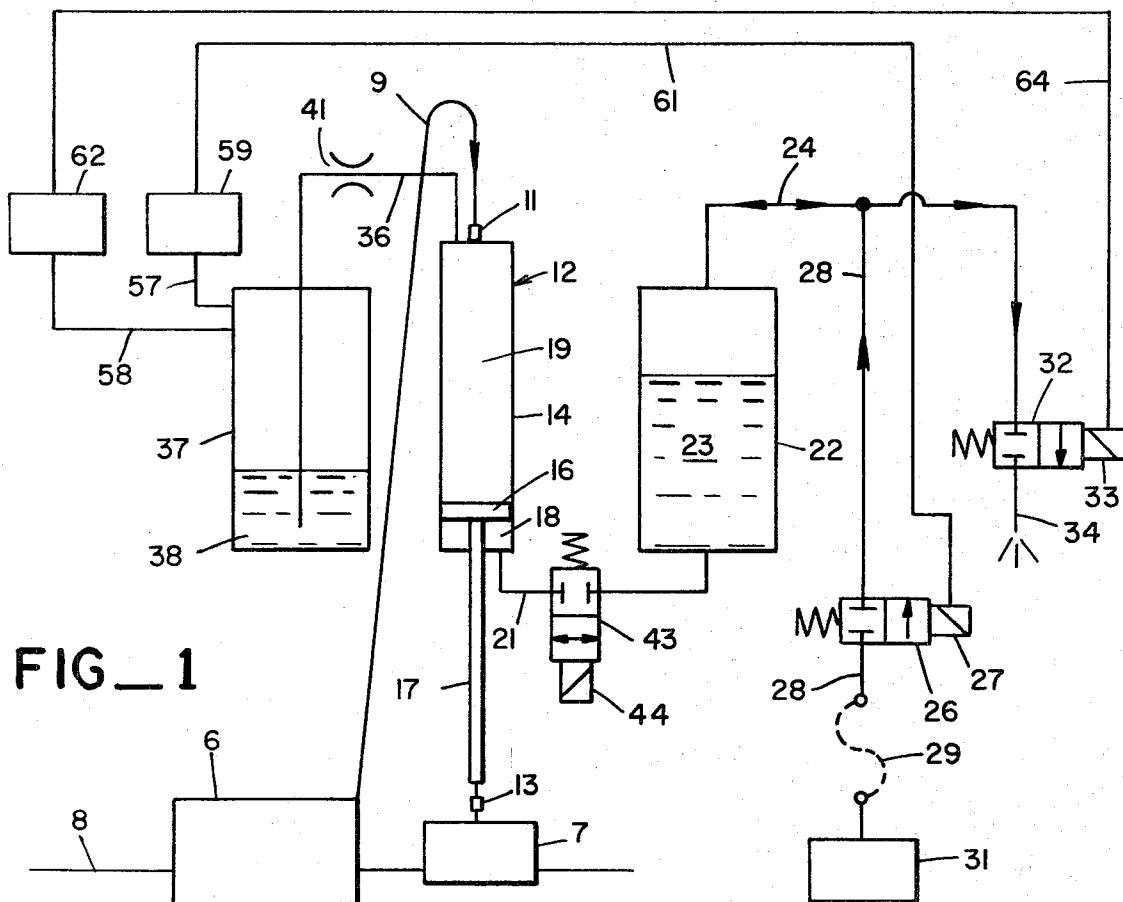
[57] **ABSTRACT**

A crane load compensator for interconnection between a stationary crane and a ship-borne load has a

double acting piston dividing a cylinder into primary and secondary chambers. A first accumulator having liquid in the lower portion thereof and air in the upper portion thereof is connected at the bottom through a first electrically actuated valve to the lower one of the chambers. A second accumulator having liquid in the lower portion and air in the upper portion is connected at the bottom to the other chamber. The first accumulator also has a second electrically actuated valve for supplying air under pressure to it and a third electrically actuated valve for releasing air under pressure therefrom. The second accumulator has a first pressure switch responsive to low air pressure in the second accumulator connected to the second valve and has a second pressure switch responsive to high pressure in the second accumulator connected to the third valve. The pressure of the air is used as a piston position indicator. In addition, the first valve is controlled by a manually operated switch. Also, there is a manually operated switch for placing in circuit the actuators for the second and third air valves. By manipulation of the valves manually and automatically, the load is cushioned and handled carefully despite variations in position between the ship and the crane.

7 Claims, 2 Drawing Figures





CRANE LOAD COMPENSATOR

In the lifting of a load; for example, from a rising and falling ocean barge onto a relatively stationary platform and particularly in reverse for transferring a load from the platform onto the barge, there are various compensating means for making sure that the load is gently handled despite relative movement of the two load bearing devices. Such compensators are particularly in order to keep slack out of the handling lines and to avoid overloading of the handling mechanism. Some of these devices are relatively complex and expensive and some of them have a relatively limited effectiveness and usefulness.

It is therefore an object of the invention to provide a crane load compensator which is quite simple and straightforward yet is effective to provide a cushion for a load during its lifting and landing, particularly in transferring the load between a stationary platform and a movable one.

Another object of the invention is to provide a crane load compensator in which the mechanism involved is comprised generally of relatively inexpensive, standard units.

A further object of the invention is to provide a crane load compensator which positions the load automatically for optimum use of the compensator travel.

Another object of the invention is to provide a crane load compensator in which loads are automatically positioned in a desired fashion despite variations in weight of the different loads.

A further object of the invention is to provide a crane load compensator that can quite readily be controlled and regulated by a relatively unskilled operator.

A further object of the invention is to provide a crane load compensator that can be utilized between a crane hook and a load connection and which requires but little power interconnection.

A further object of the invention is in general to provide an improved crane load compensator.

Other objects together with the foregoing are attained in the embodiment of the invention described in the accompanying description and illustrated in the accompanying drawings, in which:

FIG. 1 is a layout diagram showing a crane load compensator pursuant to the invention; and

FIG. 2 is an electric schematic diagram showing the principal electrical connections of the crane load compensator.

In one commercially effective version of the crane load compensator the environment includes a crane base 6 which is stationary. A load 7 is considered to be on a barge or ship floating on a body of water 8 and rises and falls with the motion of the water. Extending upwardly from the crane base 6 is a boom 9 having a hook 11 from which is hung an expansible volume mechanism 12. The other end of the device 12 is provided with a hook 13 connected to the load 7. The mechanism 12 is inclusive of a generally closed hydraulic cylinder 14 supported by the hook 11 and containing a double acting piston 16 on a piston rod 17 to which the hook 13 is connected. The piston 16 divides the cylinder into a lower, primary chamber 18 and an upper, secondary chamber 19.

In accordance with the invention the lower, primary chamber 18 is joined by a conduit 21 to the lower end of a primary accumulator 22 arranged to carry a body

23 of liquid in the lower portion thereof and to contain a quantity of air in the upper portion thereof. The upper part of the primary accumulator has a conduit 24 to convey air. The conduit is branched to connect to a supply valve 26 having an electrically controlled actuator 27 thereon. The valve is interposed in a branch line 28 joined to the conduit 24 and supplied, preferably through a flexible hose 29, from a source 31 of compressed air or other suitable gas under superatmospheric pressure. The conduit 24 extends to an exhaust or discharge valve 32 having an electric actuator 33 thereon and having a discharge 34, preferably leading to the atmosphere.

The secondary chamber 19 of the expansible volume mechanism 12 is provided with a pipe 36 leading into a secondary accumulator 37. In its lower portion the accumulator 37 carries a body 38 of liquid, such as oil, and the pipe 36 is made to extend downwardly through the upper portion of the secondary accumulator and to open into the oil body 38. In the upper portion of the secondary accumulator there is space for air under variable pressure. In the pipe 36 there is a restricted orifice 41 for throttling the flow of liquid through the pipe.

Somewhat comparably, although not exactly so, in the conduit 21 there is a valve 43 having an electric actuator 44 thereon. When the valve 43 is closed there is no flow in the conduit 21 but when the valve 43 is opened there is free flow therethrough.

In order to provide appropriate controls for the various valves, both automatic and manual, there is electric circuitry, as shown in FIG. 2, supplied from an appropriate source of electromotive force. There is a supply conductor 51 and a return conductor 52. The conductor 51 leads through a manually operated switch 53 to the actuator 44 for the valve 43, the return being through the conductor 52. There is a conductor 54 branching from the conductor 51 and extending through a manual switch 56 to a branch 57 and a branch 58. The branch 57 is connected to a pressure actuated switch 59 responsive to a predetermined, relatively low air pressure within the accumulator 37. When such pressure is too low, the switch 59 closes and through a conductor 61 completes a circuit to the actuator 27. This opens the valve 26 and supplies additional compressed air to the top of the primary accumulator 22. Comparably, the branch 58 extends to a pressure actuated switch 62 especially effective when more than a predetermined high pressure exists in the secondary accumulator 37. Excessive high pressure closes the switch 62 making a conductor 64 effective to energize the actuator 33 and open the valve 32. This releases to the atmosphere excess air pressure within the primary accumulator 22.

The normally open switch 56 also has a second switch portion 66 effective when the switch 56 is closed also to close a gap in the conductor 51 parallel to the switch 53. The switch 56 and the switch second portion 66 can be simultaneously opened and closed.

In the operation of this mechanism, in the event a load is to be lifted from the heaving, floating location and then deposited in a stationary position, the operator manually depresses the button and closes the switch 56 and the switch second portion 66. This opens the valve 43 so that there is free hydraulic flow through the conduit 21 between the primary accumulator 22 and the chamber 18. Also, the closure of the switch 56 en-

energizes the branches 57 and 58 so that the pressure switches 59 and 62 are able to operate.

The usual starting condition is with the piston 16 near the bottom of its stroke so that the cushioning action of the expansible volume mechanism 12 is available to a large extent to accommodate upward excursion of the load 7. When the crane tends to lift and assume the load, if the load is relatively heavy, the piston 16 descends, transferring liquid past the valve 43 into the accumulator 22 and inducing liquid flow from the accumulator 37 past the orifice 41 into the upper chamber 19 and so lowering the air pressure in the upper part of the accumulator 37. The air pressure in the upper portion of the secondary accumulator being relatively low, the switch 59 then closes and is effective to actuate the valve 26 to open position. An additional supply of compressed air is transmitted into the top of the primary accumulator 22.

The extra air pressure then displaces fluid from the body 23 through the open conduit 21 into the lower portion 18 of the cylinder 14 and lifts the piston 16 and correspondingly lifts the load 7. The piston 16 in moving upwardly displaces liquid from the upper chamber 19 of the cylinder through the restricting orifice 41, regulating the rate of displacement, into the bottom of the secondary accumulator 37. The liquid level therein rises. This causes an increase in air pressure in the secondary accumulator. When the secondary air pressure has increased sufficiently the switch 59 is no longer closed but is opened.

Upon a slight further increase in pressure the switch 62 is closed and energizes the valve 32 to release some of the air from the primary accumulator 22 and permit reverse flow of the hydraulic liquid and some sinking of the piston 16. The adjustment of the switches 59 and 62 is such that under normal conditions the piston 16 is brought to the desired position in the cylinder 14 regardless of the load weight so that substantial upward travel of the hook 13 is available to take care of excursions of the load or of the crane or both. The pressure in the secondary accumulator 37 responds to changes in the position of the piston 16. Therefore setting the pressure switches 59 and 62 to alter the pressure in the accumulator 37 also sets or establishes the position of the piston 16. The range of piston positions is made suitable for long-stroke compensation for the expected, variable heaving or lifting of the load as it is being assumed from its barge location.

When the load has been properly assumed or lifted the loading switches 56 and 66 are released. The parts are then left in a dormant, rigidly supporting condition with the valve 43 closed because of de-energization of its actuator 44. There is no further hydraulic adjustment or air transfer. In effect, the structure is locked during traverse or holding and so prevents unwanted oscillations. The closed system retains the load in a good position for usual handling by the crane hook 11 and without springiness.

When it is desired to land the load the operator manually closes the switch 53. This energizes only the solenoid actuator 44 for the valve 43 and interconnects the lower portion 18 of the cylinder 14 with the primary accumulator 22. There is then free flow through the con-

duit 21 and relatively free flow through the pipe 36 so that hydraulic pressure fluid can transfer back and forth between the lower portion of the cylinder 14 and the lower portion of the primary accumulator and also between the lower part of the accumulator 37 and the upper portion of the cylinder 14. Thus, the spring characteristic of the air contained in the accumulator 22 is made available to support the load 7 and thereby greatly diminish landing shocks. The automatic adjustment of the air pressure in the accumulator 22 provides selected spring rates in proportion to each load weight. This provides an effective, wide-ranging cushion for the landing of the load, whether on a stationary support or on another heaving or vertically movable platform. During the landing operation, as in loading, the mechanism operates as a compensator to absorb temporary impulses and to maintain sufficient tension in the load lines so that they cannot become slack.

What is claimed is:

1. A crane load compensator for interconnection between a crane and a load comprising an expansible volume mechanism including a cylinder and a double acting piston thereon defining a primary chamber and a secondary chamber, means for connecting said expansible volume mechanism to said crane and to said load, a first accumulator adapted to contain liquid in the lower portion thereof and air in the upper portion thereof, a second accumulator adapted to contain liquid in the lower portion thereof and air in the upper portion thereof, a first conduit for connecting the lower portion of said first accumulator to said primary chamber, a second conduit for connecting the lower portion of said second accumulator to said secondary chamber, means for supplying air to and releasing air from said first accumulator, means for sensing a predetermined low pressure in the upper portion of said second accumulator, means for sensing a predetermined high pressure in the upper portion of said second accumulator, and means responsive to said sensing means for controlling said air supplying and air releasing means.

2. A device as in claim 1 including a valve in said first conduit, and means for opening and closing said valve.

3. A device as in claim 1 including a restricting orifice in said second conduit.

4. A device as in claim 1 in which said air supplying means is responsive to said low pressure sensing means and said air releasing means is responsive to said high pressure sensing means.

5. A device as in claim 1 including an electric circuit and in which said means for supplying air and releasing air includes valves having electric actuators and said sensing means includes switches for including said actuators in and excluding said actuators from said electric circuit.

6. A device as in claim 5 including a first manual switch for opening said circuit to said actuators.

7. A device as in claim 2 in which said opening and closing means is electrical and including an electric circuit having a second manual switch therein for controlling said circuit to said opening and closing means.

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