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[54] **LOADING BALANCER**

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Nov. 17, 1970 Japan 45/100750

[52] **U.S. Cl.** ..... **212/35 R,** 212/59

[51] **Int. Cl.** **B66c 23/54**

[58] **Field of Search** 212/35, 59

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[57] **ABSTRACT**

A loading balancer including a pivotal intermediate arm and accompanying main-and auxiliary pressure cylinders wherein changes in the position of the hoisted load in the vertical plane are mechanically converted into corresponding changes in the turning moment about the pivotal point of the intermediate shaft and such changes in the moment are automatically balanced by corresponding changes in the pressure forces provided by the pressure cylinders upon sensing said changes in the moment.

6 Claims, 7 Drawing Figures

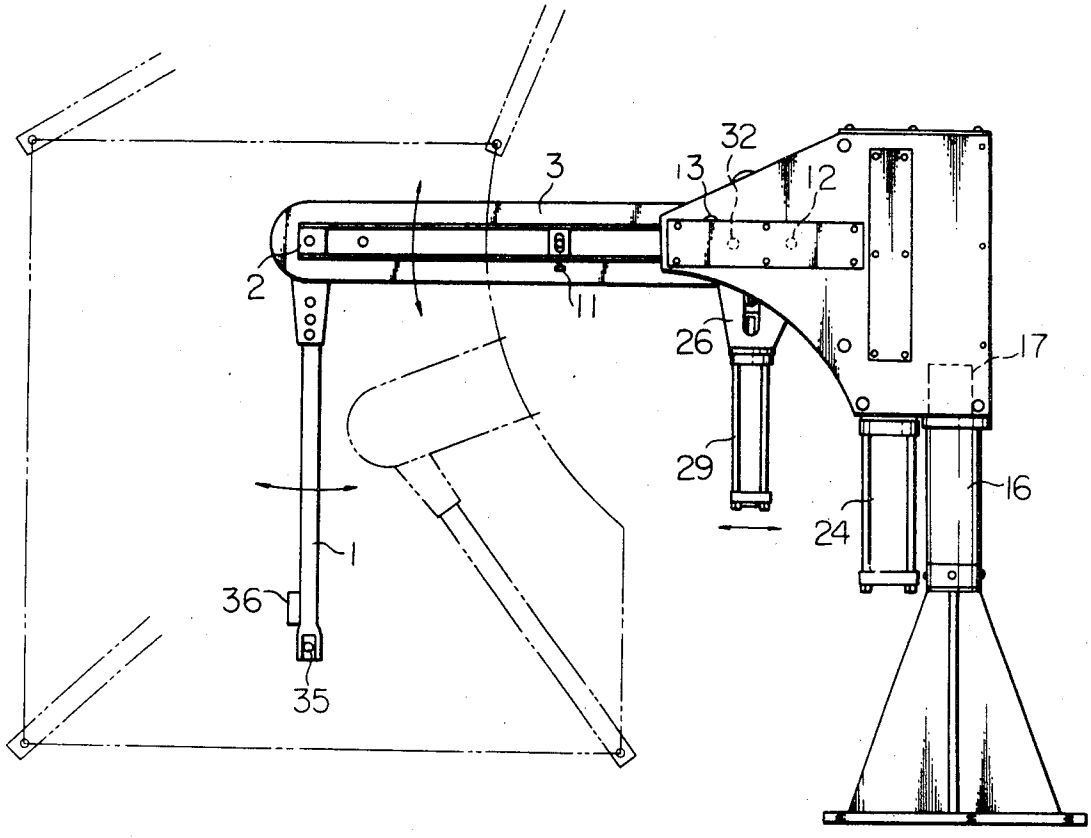
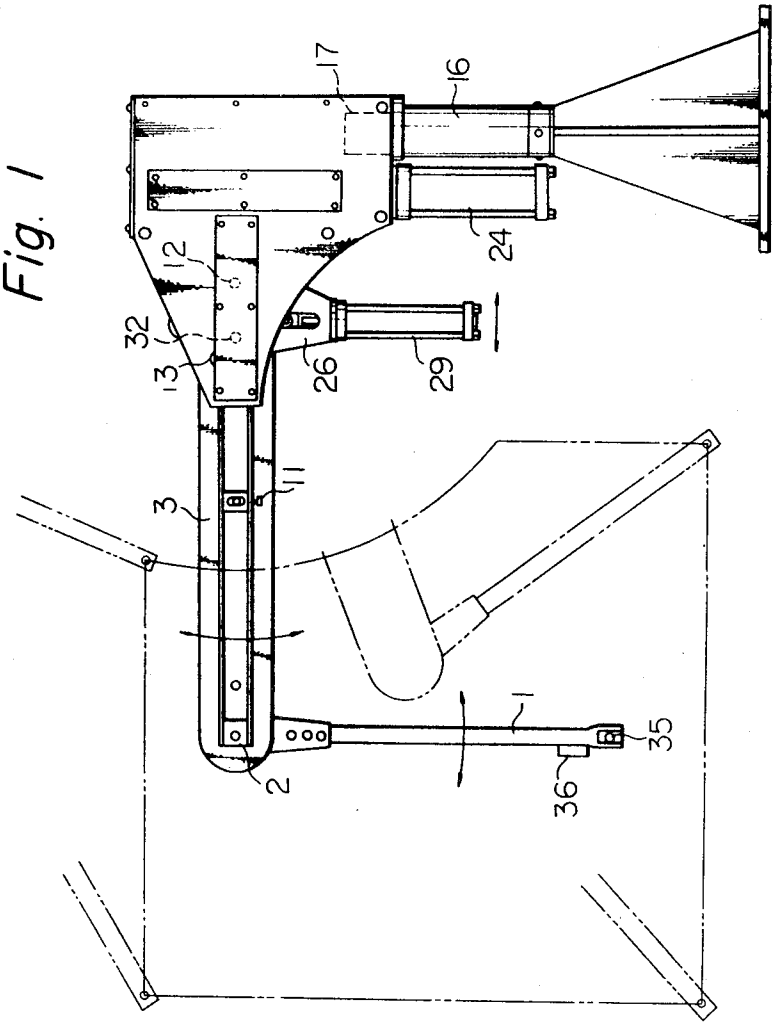


Fig. 1



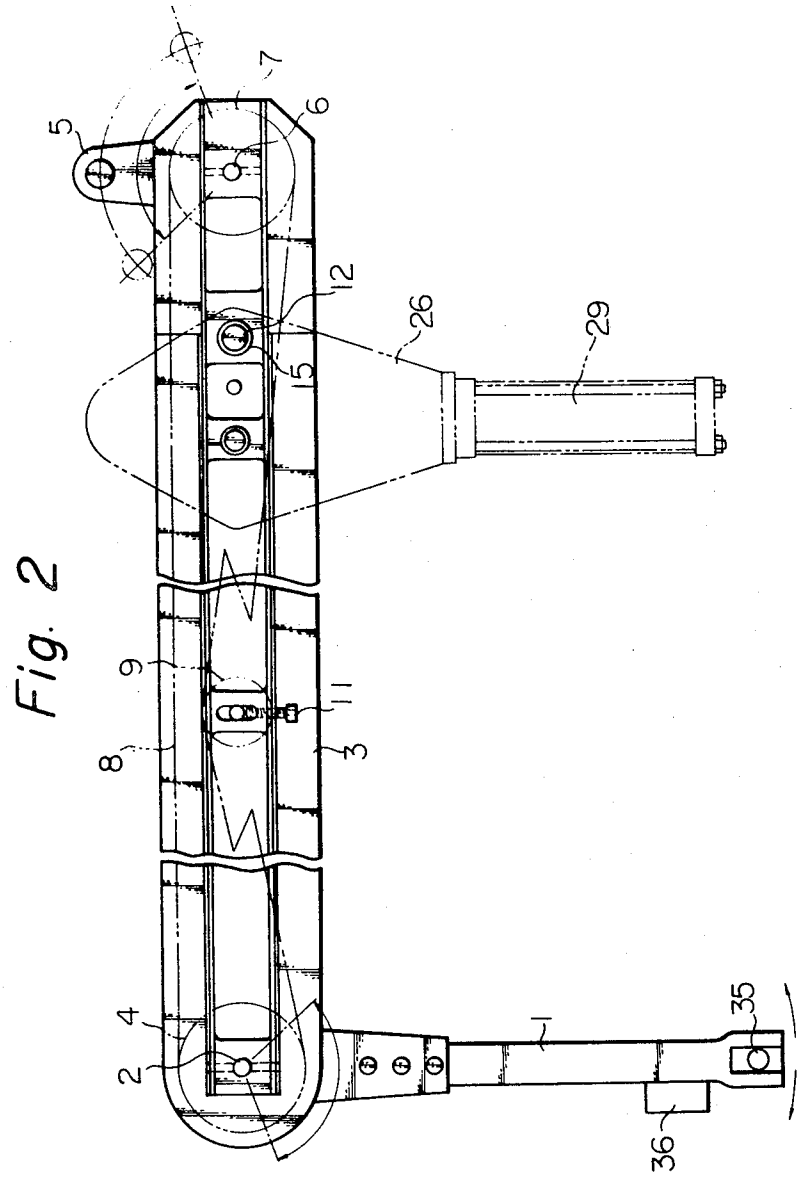


Fig. 2

Fig. 3

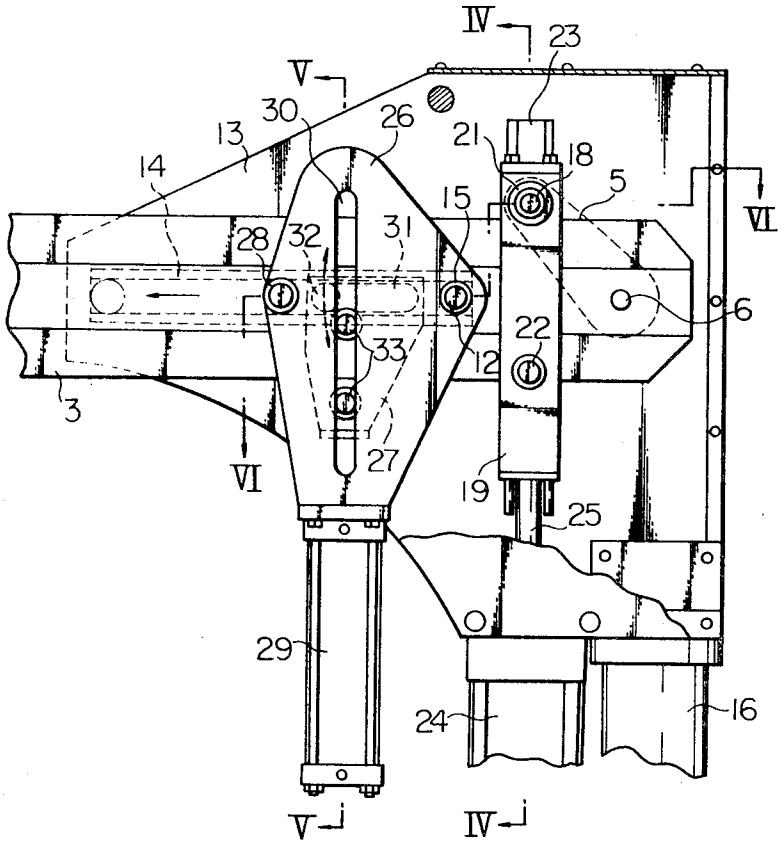

IV
23
V
30
26
13
21
18
14
5
15
VI
28
32
31
6
22
33
12
3
VI
27
19
25
29
24
16
V
IV

Fig. 4

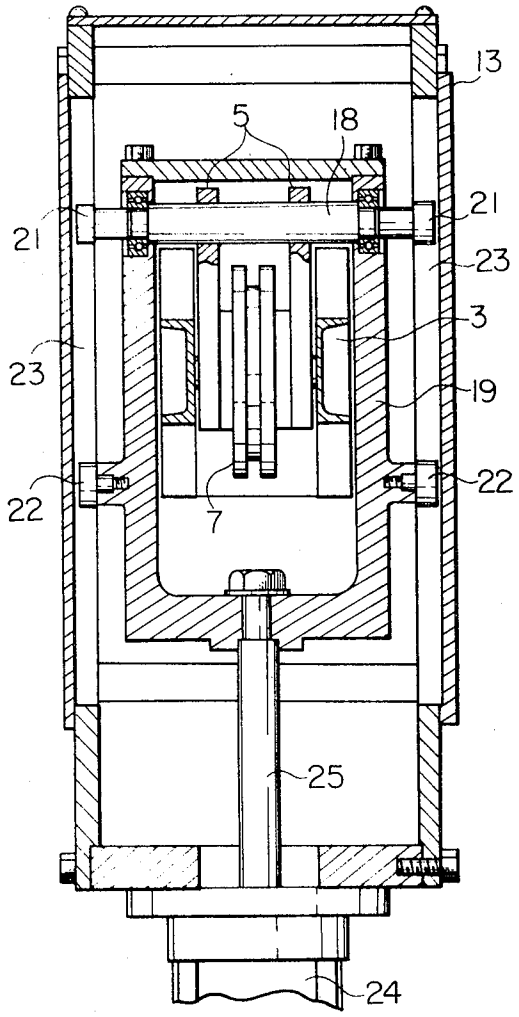


Fig. 5

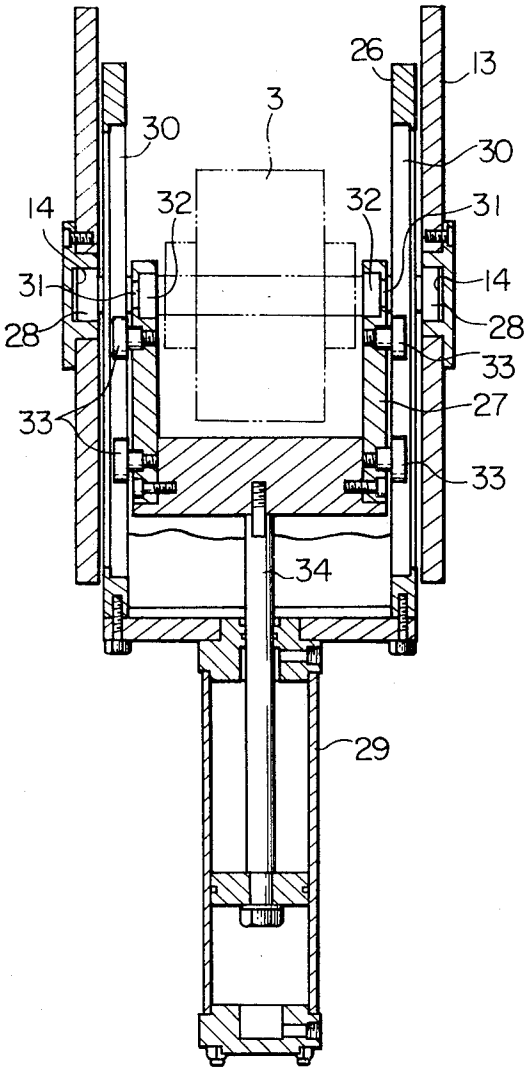


Fig. 6

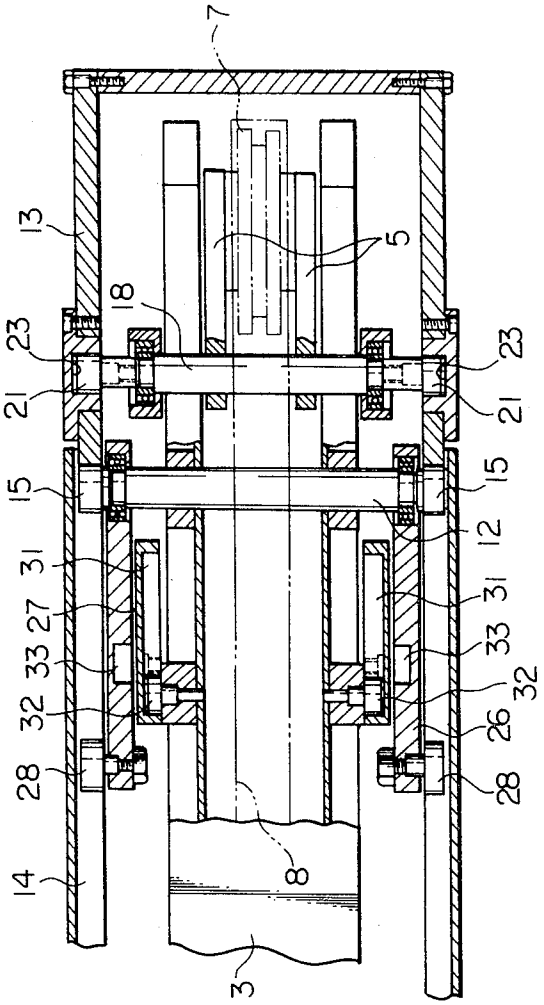
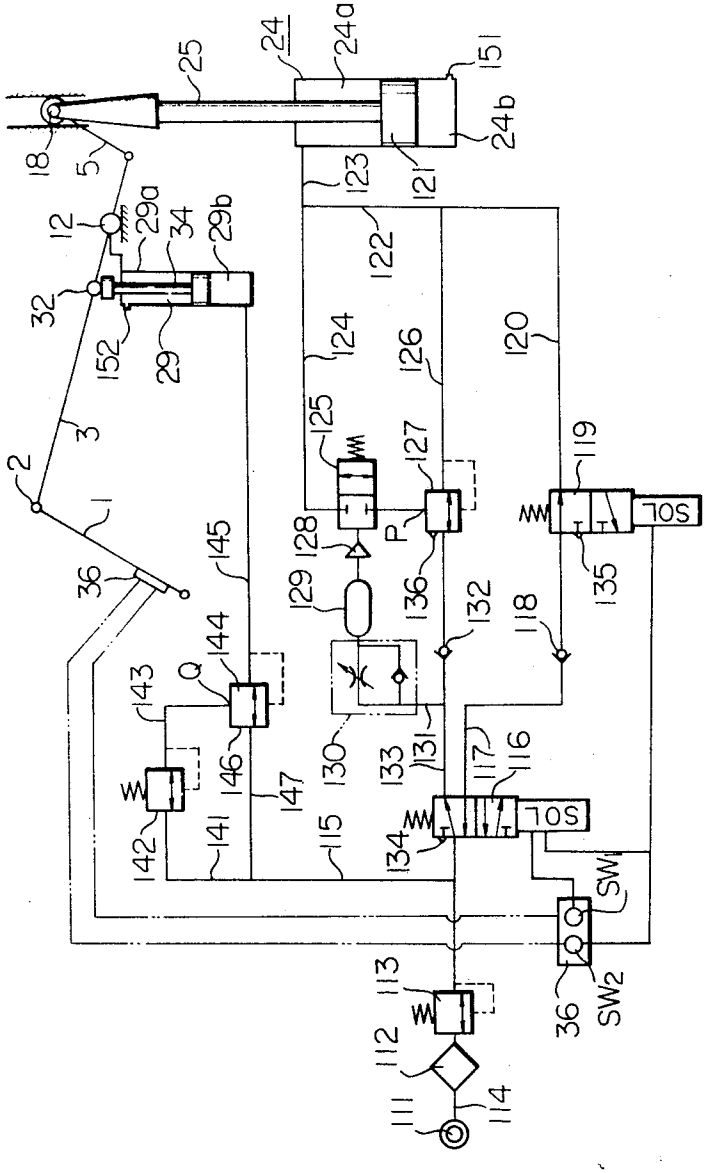


Fig. 7


25
24
24a
151
24b
18
5
123
121
12
29a
34
29b
122
32
152
29
124
126
120
3
125
127
119
2
1
128
P
SOL
145
129
136
132
118
36
135
144
Q
143
130
133
131
117
116
146
147
142
141
115
134
SOL
SW1
113
36
SW2
112
111
114

LOADING BALANCER

The present invention relates to an improved loading balancer, more particularly relates to an improved loading balancer which carries out an automatic load balancing action in accordance with the changes in the position of the hoisted load utilizing pressure forces provided by a controlled pressure system.

In the manual transportation of hoisted loads in every industrial field, there is a strong requirement to carry out such transportation under reduced load on the operators in charge. Such reduction in the load on the operators is nowadays increasingly appreciated from the view point of mitigation of operator fatigue, escalation of the efficiency of the transportation works, and reduction in the manual labour required for carrying out the transportation task. Particularly with recent shortages in the labour supply, the importance of the effect of the reduction in the manual labour requirement has been increasingly realized in various industries.

From this point of view, there have been proposed several transportation mechanisms wherein suitable pressure systems such as pneumatic pressure systems and oil pressure systems or balancing weight systems have been utilized so as to balance the load being handled. However, in the case of conventional mechanisms of this type, time-consuming operations are needed for optimum adjustment of the pressure system or for optimum selection of the balancing weight. It is empirically known that the extent of such time-consuming operations is quite significant in relation to the total length of time needed for the total transportation task.

It is the object of the present invention to provide a loading balancer capable of mitigating the load on the operator in charge of the task of transportation of the hoisted load while reducing the time needed for adjustment of the entire system to the maximum possible extent.

So as to attain this object, in the loading balancer of the present invention, arms are pivoted to ends of an intermediate arm pivoted to a supporter shaft which is movable to and fro, pivotation of the two arms are mechanically related to each other, one of the two arms is linked to a main pressure cylinder and the magnitude of pivotation of the intermediate arm about the supporter shaft is transmitted to an auxiliary pressure cylinder.

Changes in the position of the load in vertical planes are sensed in the form of corresponding changes in the turning moment about the pivotal point of the intermediate arm and are balanced by the pressure forces provided by the pressure cylinders reacting in accordance with the sensed changes in the moment.

Further features of the present invention will be explained in more detail in the ensuing description in reference to the accompanying drawings, wherein;

FIG. 1 is a schematic side view of the loading balancer of the present invention,

FIG. 2 is an elevated schematic side view of a part of the balancer shown in FIG. 1,

FIG. 3 is an elevated schematic side view of the other part of the balancer shown in FIG. 1,

FIG. 4 is a partly sectional view taken along a line IV—IV in FIG. 3,

FIG. 5 is a partly sectional view taken along a line V—V in FIG. 3,

FIG. 6 is a partly sectional view taken along a line VI—VI in FIG. 3,

FIG. 7 is a diagram of the pressure system used in the balancer shown in FIG. 7.

In the arrangement shown in FIGS. 1 and 2, a hoist arm 1 for hoisting the given load is pivoted to the first lateral shaft 2 which is fixed to one end of an intermediate arm 3. A sprocket wheel 4 is rotatably mounted on the first shaft 2 also. The other end of the intermediate arm 3 is provided with the second lateral shaft 6 fixed thereto and a link arm 5 is pivoted to this second shaft 6. The second shaft 6 rotatably carries a sprocket wheel 7 also. A chain 8 runs endlessly in engagement with the two sprocket wheels 4 and 7 and a tension wheel 9 is pivoted to the intermediate arm 3 in engagement with the chain 8 so as to tension the latter. Location of the tension wheel 9 is adjustable via an adjustment screw 11. In the case of the embodiment shown, both sprocket wheels 4 and 7 are provided with similar diameters so that both arms 1 and 5 carry out a parallel movement. Between the two shafts 2 and 6, a supporter shaft 12 is fixed to the body of the intermediate arm 3. In FIG. 1, the ambit of movement of the free end of the hoist arm 1 is illustrated by chain-and-dot lines.

Both lateral ends of the supporter shaft 12 are provided with rolls 15 which are received in a lengthwisely elongated inner guide rail 14 of a supporter block 13. The supporter block 13 is mounted on the upright shaft 17 of an upright stand 16 in such a manner that the supporter block 13 can turn horizontally about the axis of the upright shaft 17.

It is seen from FIG. 3 that the link arm 5 is, at its other end, turnably mounted on the third lateral shaft 18 which is fixed to the upper end of a vertical connector 19. The arrangement inside the vertical connector 19 and its related parts is shown in detail in FIG. 4, wherein the intermediate arm 3 extends through the interior of the vertical connector 19. Both ends of the third shaft 18 are provided with guide pins 21 carrying rotatable rolls and the vertical connector 19 is also provided with sideway guide pins 22 carrying rotatable rolls. The four rolls of the guide pins 21 and 22 are rotatably received within guide rails 23 which are formed on the inside wall surfaces of the supporter block 13 extending lengthwisely along it.

The lower end of the vertical connector 19 is connected to a main pressure cylinder 24 via a piston rod 25. The main pressure cylinder 24 is connected to a given pressure source such as pneumatic, oil or other suitable liquid pressure source in a manner later described in detail. The load hoisted by the hoist arm 1 is sensed by the pressure cylinder 24 via the link arm 5, the vertical connector 19 and the piston rod 25. In response to this sensing, the pressure source imparts an input pressure to the pressure cylinder 24 so as to balance this sensed load. Therefore, no excessive load will be directly sensed by the operator in charge. By the operation of the pressure cylinder 24, the upper end of the link arm 5 moves vertically via the vertical connector 19 and this vertical movement of the upper end of the link arm 5 is accompanied by a corresponding lengthwise movement of the intermediate arm 3 while the rolls 15 of the supporter shaft 12 travel along the guide rails 14 of the supporter block 13. Concurrently with this lengthwise movement, the intermediate arm 3 also performs a swinging movement about the supporter shaft 12.

The swinging movement of the hoist arm **1** about the intermediate arm **3** and that of the intermediate arm **3** about the supporter shaft **12** causes a corresponding change in the magnitude of the total moment about the supporter shaft **12.** This change in the magnitude of the total moment is compensated by the action of the main pressure cylinder **24** as later described in more detail. In order to make this compensation more perfect, an auxiliary balancing mechanism is incorporated in the above-described arrangement which functions as described below.

As is shown in detail in FIGS. **3, 5** and **6,** this auxiliary balancing mechanism includes a carriage **26** and a displacer **27** in combination with each other. As is clearly seen in FIG. **5,** the carriage **26** spacedly sandwiches the intermediate arm **3** and the displacer **27** spacedly sandwiches the carriage **26** also. The lower end of the displacer **27** is connected to the piston rod **34** of an auxiliary pressure cylinder **29** which is fixed to the lower end of the carriage **26.** As is shown in FIGS. **3** and **5,** the carriage **26** is provided, on its outer sides, with a pair of pins **28** having guide rolls, which are rotatably received in the inside guide rails **14** of the supporter block **13.** Owing to this rolls-rails combination, the carriage is movable along the intermediate arm **3.**

The displacer **27** is provided with horizontal slots **31** formed laterally therethrough, wherein rolls of the lateral guide pins **32** of the intermediate arm **3** rotatably rest. The outer walls of the displacer **27** are provided with laterally extending guide pins **33** carrying rolls, which are rotatably received in vertical slots **30** made through the walls of the carriage **26.** Owing to the above described structure, when the intermediate arm **3** swings about the supporter shaft **12,** the guide pin **32** fixed to the arm **3** moves around the shaft **12** as shown by an arrow in FIG. **3** and, upon this movement of the guide pin **32,** the displacer **27** moves in a direction perpendicular to the lengthwise direction of the intermediate arm **3.** This movement of the displacer **27** is transmitted to the auxiliary pressure cylinder **29** via the piston rod **34.**

The auxiliary balancing mechanism of the above-explained structure functions as follows. Upon occasional movements of the parts such as the hoist arm **1,** corresponding changes are caused in the magnitude of the total moment about the supporter shaft **12** and the main pressure cylinder **24** functions so as to compensate such changes in the total moment. This compensation is made more perfect by the balancing function of the auxiliary balancing mechanism, the swinging movement of the intermediate arm **3** being responded to by the auxiliary pressure cylinder **29** via the corresponding up-and-down displacement of the displacer **27.** The auxiliary balancing mechanism responds to the changes in the total moment.

In addition, as is shown in FIG. **1,** the hoist arm **1** is provided, at its free end, with a cut-off **35** for hanging the load and a switch box **36** for piloting the operations of the pressure cylinders **24** and **29.**

Referring to FIG. **7,** one example of the pressure system for operating the pressure cylinders **24** and **29** is shown. In this case, a pneumatic pressure system is employed as a typical example.

A pneumatic pressure source **111** of given pressure, e.g. a pressure of 6 kg/cm², is connected to a four-port electric magnet valve **116** via a pneumatic supply conduit **114** through a pneumatic filter **112** and a pneumatic reducing valve **113.** When the switch SW_1 of the switch box **36** is manually pressed, the valve **116** functions so as to supply the primary pressured air to a three-port electro-magnetic valve **119** via a conduit **117** through a check valve **118.** In this situation, the valve **119** is maintained open and the primary pressured air is introduced into an upper chamber **24***a* of the main pressure cylinder **24** via conduits **120, 122** and **123.** By this introduction of the pressured air into the upper chamber **24***a*, the piston **121** of the cylinder **24** is lowered, causing a corresponding lowering of the third lateral shaft **18** via the piston rod **25.** Upon this lowering of the shaft **18,** the intermediate arm **3** turns clockwise in the drawing about the supporter shaft **12,** causing a corresponding lifting of the hoist arm **1** so as to lift the load hanging on the hoist arm **1.**

After completion of this lifting, the switch SW_1 is released and the primary pressured air fills the upper chamber **24***a*. Under this situation, the pneumatic pressure inside the upper chamber **24***a* balances with the moment of the load about the supporter shaft **12.** Under this situation, the two-port pressure valve **125** is kept open so that the pressured air, which is at the same pressure as the air in the upper chamber **24***a* of the cylinder **24,** is introduced to the signal inlet terminal P of a buster relay **127** via conduits **123** and **124** through the valve **125.**

Upon release of the switch SW_1 of the switch box **36,** the primary pressured air is branches into two streams, one being a flow running to the buster relay **127** from the valve **116** via conduit **133** and check valve **132** and the other being a flow running to an air port **128** via conduit **131,** speed control valve **130** and an air reservoir **129.**

After a certain length of time, the two-port pressure valve **125** closes and the pneumatic pressure in the signal inlet terminal P of the buster relay **127,** which is at the same pressure as the primary pressured air in the chamber **24***a* of the main pressure cylinder **24,** is kept independent of to the change in the pressure condition within the chamber **24***a*. This is because of the time delay effect of the elements **128, 129** and **130** in the conduit **131** connecting the primary conduit **133** to the two-port pressure valve **125.**

The buster relay **127** is connected to the primary conduit **133** of the four-port pressure valve **116** via the check valve **132** so that it always supplies the secondary pressured air to the chamber **24***a*, whose pneumatic pressure is the same as the pneumatic pressure at the signal inlet terminal P. When the hoist arm **1** operates to lift the load, the third shaft **18** moves downward causing the simultaneous downward movement of the piston **121** and the internal space of the chamber **24***a* is enlarged. This enlargement of the chamber space naturally causes lowering of the pneumatic pressure in the chamber **24***a*. At this moment, the buster relay **127** functions so as to supply pressured air into the chamber **24***a* via the conduits **126, 122** and **123,** whose pressure is equal to the difference between the lowered pressure in the chamber and the pressure at the terminal P. Conversely, when the hoist arm **1** operates to lower the load, the third shaft **18** moves upward causing the simultaneous upward movement of the piston **121** and the internal space of the chamber **24***a* is reduced. This reduction of the chamber space naturally causes an increase in the pneumatic pressure in the chamber **24***a*. In other words, the internal pressure is made higher

than the pressure at the terminal P. At this moment, excess pressured air is discharged outside the system through a relief outlet **136** of the buster relay **127** so as to balance the chamber pressure with the pressure at terminal P. The chamber **24***b* of the main pressure cylinder **24** communicates with the surrounding atmosphere so that it absorbes or discharges air in accordance with the up-and-down movement of the piston **121.**

The pressure system relating to the operation of the auxiliary pressure cylinder **29** will now be explained in detail with reference to FIG. **7** also.

The lower chamber **29***b* of the cylinder **29** is connected to a conduit **115,** which branches from the supply conduit **114** at a position just upstream of the four-port valve **116,** via conduits **145, 147** and a buster relay **144.** In this pressure system, the buster relay **144** carries out a balancing action in response to the pressure change in the chamber **29***b* as in the case of the buster relay **127** in the pressure system of the main cylinder **24.** At a position upstream of the buster relay **144,** a conduit **141** branches from the conduit **115** and connects to a reducing valve **142** which is connected to the signal inlet terminal Q of the buster relay **144** via conduit **143.** The buster relay **144** operates in a manner such that the internal pressure of the chamber **29***b* of the auxiliary cylinder **29** is kept similar to the pressure at the terminal Q of the buster relay **144.**

The upper chamber **29***a* of the auxiliary cylinder **29** communicates to the surrounding atmosphere and absorbes or discharges air via a relief outlet **152** in response to the up-and-down movement of the piston.

When the load hanging on the hoist arm **1** is to be lowered, the switch SW_2 of the switch box **36** is manually pressed. Upon making the switch SW_2, the four-port electro-magnet valve **116** and the three-port electro-magnet valve **119** function so as to discharge the pressured air from the chamber **24***a* outside the system through the relief outlet **135** of the valve **119.** Concurrently with this, the pressured air in the speed control valve **130,** the air port **128** and the air reservoir **129** is also discharged outside the system through a relief outlet **134** of the valve **116.** By the above-described, pressured air discharges, the upper chamber **24***a* of the main cylinder **24** is made pressureless so that the piston **121** moves upward for lowering of the load hanging on the hoist arm **1.**

What is claimed is:

1. An improved loading balancer comprising, in combination, a stationary upright stand, a supporter block pivotally mounted on said upright stand for rotation about a vertical axis whereby said supporter block is horizontally rotatable about said axis, a supporter shaft horizontally mounted on said supporter block for movement to-and-fro with respect to said supporter block, an elongated intermediate arm pivoted on said supporter shaft, a hoist arm pivoted to one end of said intermediate arm and for hoisting the load at its free end, a link arm pivoted to the other end of said intermediate arm, means for co-relating pivotal movement of said hoist arm with that of said link arm, a main pressure cylinder disposed on said supporter block and linked to one end of said link arm, an auxiliary pressure cylinder, means for coupling said auxiliary pressure cylinder to said intermediate arm at a point spaced from said supporter shaft to compensate for the self weight of the intermediate arm and hoist arm whereby the load is solely supported by said main pressure cylinder, a pressure source, a pressure system connecting said two pressure cylinders to said pressure source and an electric system including switches for controlling the operation of said pressure system.

2. An improved loading balancer of claim **1,** wherein said co-relating means comprises a sprocket wheel disposed on said intermediate arm rotatable about the pivotal point of said hoist arm in synchronism with the pivotal movement of said hoist arm, another sprocket wheel disposed on said intermediate arm rotatable about the pivotal point of said link arm in synchronism with the pivotal movement of said link arm and an endless chain running in engagement with said two sprockets.

3. An improved loading balancer of claim **1,** wherein said transmitting means comprises a carriage mounted on said supporter block in a to-and-fro slidable arrangement and a displacer disposed on said carriage in an up-and-down slidable arrangement and connected to said auxiliary pressure cylinder to said given pressure source.

4. An improved loading balancer of claim **1,** wherein said pressure system comprises a main pressure system for connecting said main pressure cylinder to said given pressure source and an auxiliary pressure system branched from said main pressure system and for connecting said auxiliary pressure cylinder to said given pressure source.

5. An improved loading balancer of claim **4,** wherein said main pressure system comprises a **4** port valve connected at its inlet to said given pressure source and electro-magnetically piloted by said electric system; a **3** port valve connected at its inlet to said **4** port valve, connected at its outlet to said main pressure cylinder and electromagnetically controlled by said electric system; a buster relay connected at its inlet to said **4** port valve and at its outlet to said main pressure cylinder; and a **2** port pressure valve connected to said **4** port valve, buster relay and main pressure cylinder.

6. An improved loading balancer of claim **4,** wherein said auxiliary pressure system comprises a buster relay connected at its inlet to said given pressure source and at its outlet to said auxiliary pressure cylinder; and a reducing valve bypassed from the conduit between said given pressure source and said buster relay, and connected to said buster relay.

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