United States Patent [19]

Beck

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[54] **AIR CUSHION CONVEYOR LIFT CELLS**

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[52] **U.S. Cl.** **302/29**

[51] **Int. Cl.** **B65g 53/04**

[58] **Field of Search** 302/29, 31

[56] **References Cited**

UNITED STATES PATENTS

3,268,265 8/1966 Willott 302/29

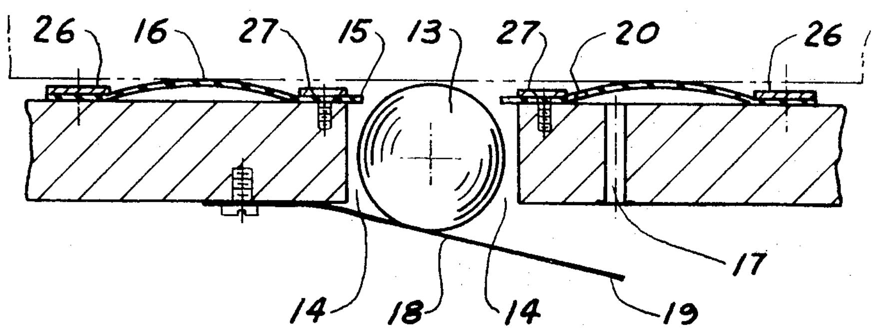
3,413,041 11/1968 Moorman 302/29

Primary Examiner—Evon C. Blunk
Assistant Examiner—H. S. Lane
Attorney—Jacobs & Jacobs

[57] **ABSTRACT**

A pneumatic lift cell for air cushion floors is described in which depression of a spherical valve member by a load is operative to expand an annular diaphram concentrically disposed about the spherical valve member. The resultant lift cell results in a more efficient use of air and permits conveyance of loads having uneven bottom surfaces.

8 Claims, 6 Drawing Figures



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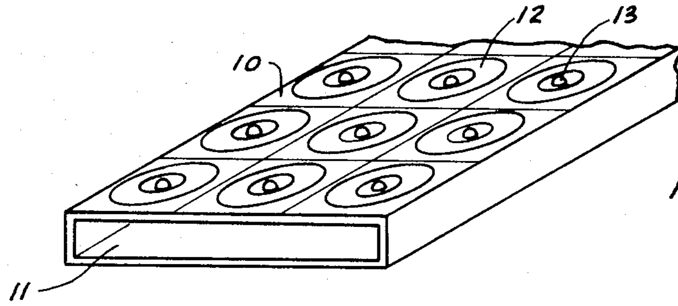

FIG. 1

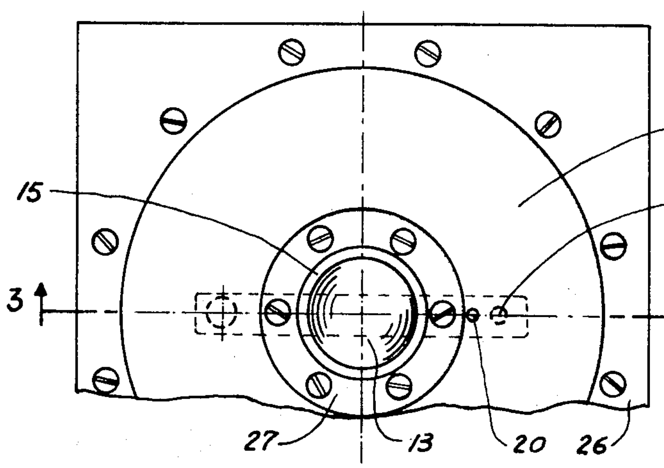

FIG. 2

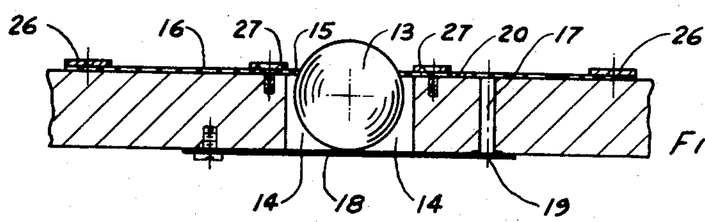

FIG. 3A

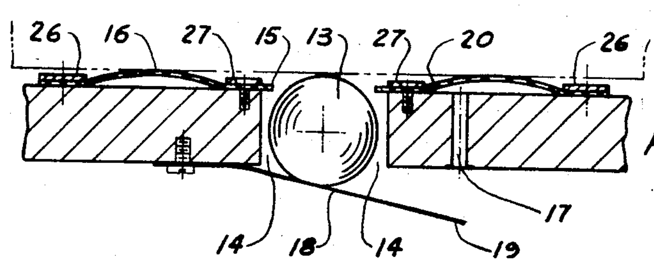

FIG. 3B

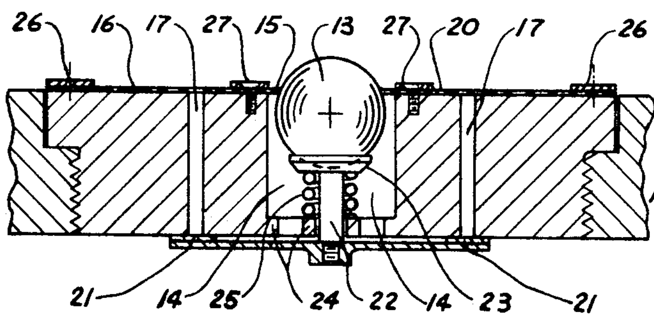
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FIG. 4

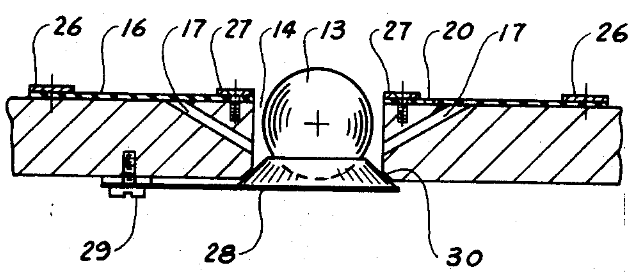
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FIG. 5

AIR CUSHION CONVEYOR LIFT CELLS

DETAILED DESCRIPTION

The present invention is directed at improved lift cells for air cushion conveying surfaces. Such systems, in which packages, bales, sheet material and the like are moved or conveyed over smooth, flat surfaces on a cushion of air, are well-known in the art. In these systems, such as those disclosed for example in U.S. Pat. Nos. 2,315,627, 2,785,928 and 3,268,265, an air pressure differential between the upper and lower surfaces of the floor or conveying surface forces air from the space beneath the floor to the load carrying surface through a plurality of spaced valved orifices. The resultant flow of air under the load acts as a lubricant, reducing the amount of force necessary to move the article. Since air is desired only under the load, the orifices are equipped with automatic valves.

A variety of valves for controlling the passage of air through these orifices has been described. These valves, ranging from relatively complex devices such as that described in U.S. Pat. No. 3,417,878 to considerably simpler embodiments such as the snap-in ball check valve described in U.S. Pat. No. 3,235,098, selectively open so as to permit the flow of air when the load is above the valve and terminate the flow of air when no load is above the valve. These valves however permit little or no control of the amount of air escaping when the valve is open since the prior art valves are generally either simply in an open or closed position. Increased sensitivity in such valves is apparently provided by the device of U.S. Pat. No. 3,417,878 but the complexity of this valve, and indeed of any variable type device presents a disadvantage for large scale installation and operation. Moreover, previous air cushion conveyor systems require that the load material have a substantially flat bottom. Warped, uneven or imperfectly finished surfaces are not easily conveyed due to the uneven escape of the air.

The present invention provides a novel lift cell, including valve means, for use in such air cushion conveyor systems which maintain sensitivity to a proximity of a load object but which also limits the amount of air escaping through the valve. This valve is of a simple design and can be readily installed, repaired if necessary and replaced with a minimum of effort. In additinn the lift cell of the present invention operates efficiently even with loads having uneven surfaces.

The characteristics of the present invention and its objects will be apparent from the following detailed description and the accompanying drawings in which:

FIG. **1** is a schematic isometric view of the air cushion floor or surface;

FIG. **2** is a top plan view of a portion of one embodiment of the present lift cell;

FIGS. **3A** and **3B** are sectional views of the embodiment shown in FIG. **2** taken along the lines **3'–3'**, FIG. **3A** depicting the lift cell in a closed, "no-load" position and FIG. **3B** depicting a lift cell in an open "loaded-bearing" position;

FIG. **4** is a sectional elevation of a further embodiment of the lift cell of the present invention; and

FIG. **5** is a sectional elevation of a further embodiment of the lift cell of the present invention.

Referring now in greater detail to FIG. **1**, there is provided a conventional floor or conveyor surface **10** which defines an upper surface of hollow duct **11** in which air is supplied under pressure. Disposed on the conveyor surface are a plurality of lift cells **12** which communicate between the upper load bearing surface of the floor and duct **11** below the floor through orifices (not shown in FIG. 1). Each of the lift cells contains a spherical valve member **13** which, upon assumption of a load, is depressed downwards so as to permit the passage of air from the duct to the load-bearing surface.

Referring now to FIGS. **2**, **3A** and **3B**, spherical valve member **13** is disposed within orifice **14**. At the upper end of each orifice is an annular valve seat **15**. Spherical valve member **13** fluidtightly engages valve seat **15** in its closed, "no-load" position, shown in FIG. **3A**, a portion of the valve member extending above the floor. Disposed on the upper side of the floor concentrically about valve seat **15** is elastic annular diaphram **16**. This diaphram,constructed of rubber, flexible plastic or the like, communicates with the hollow duct beneath the floor through a second orifice or channel **17**. Disposed beneath spherical valve member **13** and urging it in fluidtight engagement with valve seat **15** is spring means **18**. In the embodiment shown in FIGS. **2**, **3A** and **3B**, spring means **18** also serves as a secondary valve means at one end **19** which seals the opening second orifice **17** when the spherical valve member **13** is in its closed "no-load" position.

Upon the passage of a load over a spherical valve member, it is depressed downwards in turn depressing leaf spring **18**. This not only permits the passage of air past valve seat **15** and under the load but also opens the second orifice **17** so that the air flows into, and causes expansion of, diaphram **16**. As a result, the diaphram is inflated against the load and forms a circular seal, thereby preventing the main flow of air through orifice **14** from rapidly escaping.

Upon removal or lateral movement of the load, spring **18** urges spherical valve member **13** back into fluidtight engagement of annular valve seat **15** and simultaneously seals secondary orifice **17**. A small bleed hole **20** in the diaphram results in its contraction to its original shape.

FIG. **4** depicts an alternative embodiment of the present invention in which the spring means and secondary valve means are distinct units. Thus the secondary valve means **21** carries an extension composed of a lower throat portion **22** and an upper shoulder **23** in which rides spherical valve member **13**. This vertical extension is disposed within the first orifice which in turn has a lower shoulder portion **24** in opposition to the upper shoulder portion **23** of the extension. Disposed within these two shoulder portions is helical compression coil spring **25**. Spherical valve member **13** rides in annular valve seat **15** in the same manner as described for the embodiment of FIGS. **2**, **3A** and **3B**. Depression of spherical valve member **13** and the extension in which it rides opens orifice **17** with resultant expansion of diaphram **16**.

In the embodiment shown in FIG. **5**, the secondary orifice **17** is disposed transversally so as to communicate with primary orifice **14** and diaphram **16**. In place of an annular valve seat at the top of orifice **14**, the valve means for both the first and second orifices are provided by spring means **28** which is attached to the floor with a suitable fastener **29** at one end and carries spherical member **13** at the other end in dish **30**. Dish **30** is in the shape of a conical section and fluidtightly closes orifice **14**. Upon assumption of a load, spherical member **13** depresses spring **28** and its dish **30** away from orifice **14**, thereby opening the same. As a result, the air pressure differential is conveyed not only through primary orifice **14** and then under the load, but also through secondary orifice **17** so as to inflate diaphram **16**.

The lift cell of the present invention may be assembled on a rigid floor of plywood, sheet metal or the like utilizing the individual components, as for example is the case in the embodiment of FIGS. **2**, **3A** and **3B**. Alternatively, the entire lift cell may be a single unit which is installed into the floor or conveyor surface, as for example in the case of the embodiment depicted in FIG. **4**.

Diaphram **16** is secured to the surface by two diaphram retainer rings **26** and **27**. These rings are of a thickness greater than the thickness of the diaphram, so that when the lift cell is in a "no-load" configuration, the diaphram rests below the top of the retainer rings. At the same time, the thickness of the retainer rings should be less than the height of the expanded diaphram so that the diaphram can form a seal with the bottom surface of the load without interference from the retainer rings.

Although the annular valve seat and the diaphram may be made as separate units, it is convenient to extend the diaphram within the inner retainer ring so that this extension serves as the annular valve seat. As a result of the incorporation of the diaphram into the present lift cell and the coaction between the spherical valve member, spring means, secondary valve member and diaphram, substantially improved performance of the entire conveyor system is realized. Not only is there a reduction in the total air flow when the present lift cells are employed but also an excellent air cushion under the load is obtained even when its bottom surface is imperfect. Thus the diaphram, being flexible, will form itself parallel to the bottom surface of the load being transported even if this bottom surface is not parallel to the floor itself. Finally, the fact that the load is carried above the expanded diaphram, which is a measurable distance above the floor surface itself, reduces the necessity to maintain a floor completely free of all foreign objects. Hence in previous conveyor systems, the load is transported just above the floor surface and foreign objects such as dust, dirt and small particles of material can have an adverse effect on the efficiency and operation of the entire system. In the present system, the presence of such foreign objects does not affect the performance of the conveyor.

The foregoing description typifies presently preferred embodiments of the present invention. It is apparent that the various specific embodiments described herein may be varied or modified without departing from the spirit of the present invention since such embodiments have been presented solely for the purpose of exemplification and not for limitation of the invention, the invention being defined solely by the appended claims.

What is claimed is:

1. A pneumatic lift cell for air cushion floors having a plurality of orifices operative to communicate an air pressure differential from the lower side of the floor to the upper, load-bearing side of the floor, said cell comprising an elastic annular diaphragm disposed on the upper side of the floor concentrically about said orifice; a spherical member moveably disposed in said orifices for movement from a "no-load" position in which a portion of said spherical member extends above said floor to a second "load" position; spring means urging said spherical member into said "no-load" position; a second orifice operative to communicate said air pressure differential from the lower side of the floor to said elastic annular diaphragm; valve means operative to open both of said first and second orifices upon movement of said spherical member from its "no-load" to its "load" positions and to seal both of said orifices upon return of said spherical member from its "load" to its "no-load" positions.

2. A pneumatic lift cell according to claim **1** wherein said valve means includes an annular valve seat disposed at the upper end of each said orifice; said spherical member in its closed, "no-load" position fluidtightly engaging said valve seat and said spherical member being urged into engagement with said valve seat by said spring means; and secondary valve means sealing said second orifice when said spherical member is in its closed position but opening to convey said pressure differential through said second orifice for expansion of said diaphram when said spherical member is depressed by a load away from its closed position.

3. A pneumatic lift cell according to claim **2** wherein said diaphram is secured to said floor by inner and outer concentric retainer rings, relative to said second orifice, said rings being of thicknesses greater than the thickness of the diaphram but less than the height of the diaphram upon expansion thereof by an air pressure differential.

4. A pneumatic lift cell according to claim **3** wherein said diaphram extends within said inner ring to its concentric inner circumference so as to define a concentric circular opening, said inner extension of said diaphram serving as said valve seat.

5. A pneumatic lift cell according to claim **2** wherein said secondary valve means includes a vertical extension disposed within said first orifice, said extension having a lower throat portion and an upper shoulder carrying said spherical valve member portion; said first orifice has a lower shoulder portion in opposition to the upper shoulder portion of said extension; and a helical compression coil spring is disposed between said upper shoulder of said extension and lower shoulder of said orifice.

6. A pneumatic lift cell according to claim **2** wherein said spring means is a leaf spring, one end of which is secured to the lower side of the floor and the other end of which serves as said secondary valve means sealing said second orifice when said spherical valve member is in its closed "no-load" position.

7. A pneumatic lift cell according to claim **1** wherein said valve means are disposed on said spring means for fluidtight engagement of said first orifice, and said second orifice communicates with said diaphram and said first orifice.

8. A pneumatic lift cell for air cushion floors having a plurality of orifices operative to communicate an air pressure differential between the lower side of the floor and the upper, load-bearing side of the floor, said cell comprising each said orifice; an elastic annular diaphram disposed on the upper side of the floor concentrically about each of said orifices, said diaphram being secured to said floor by inner and outer concentric retainer rings of thicknesses greater than the thickness of the diaphram but less than the height of the diaphram upon of the diaphram but less than the height of the diaphram upon expansion thereof, and extending within said inner ring to its concentric inner circumference so as to define an annular valve seat; a spherical valve member which in its closed, "no-load" position fluidtightly engages said valve seat with a portion of said valve member extending above said floor; a leaf spring urging said spherical valve member into engagement with said valve seat; and a second orifice communicating between said diaphram and said lower side of the floor; said leaf spring being secured at one end and sealing said second orifice with its other end when said spherical valve member is in its closed position but opening said second orifice to convey said pressure differential to said diaphram when said spherical valve member is depressed by a load away from its closed position.

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