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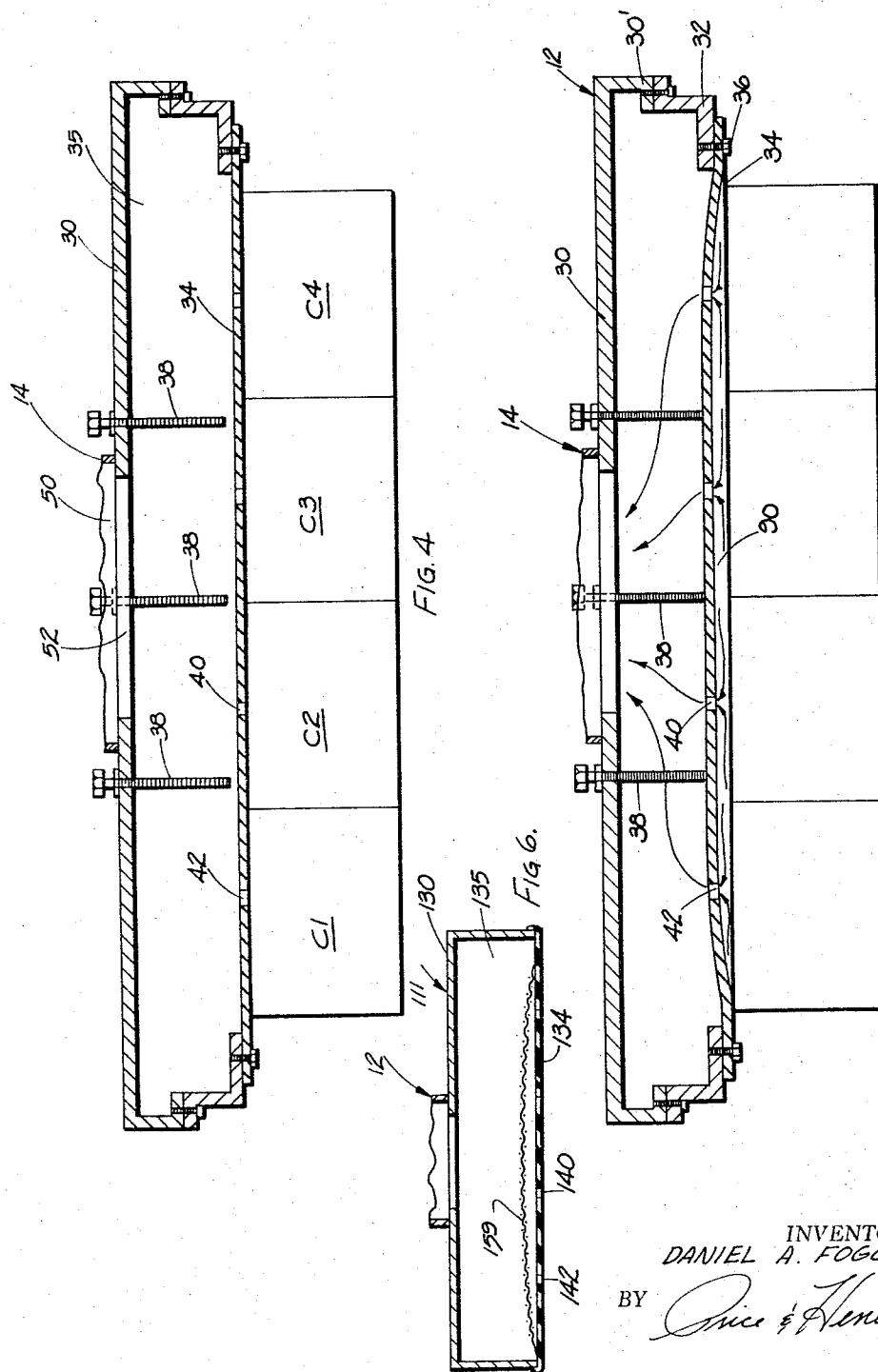
D. A. FOGG

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FLEX LIFT APPARATUS AND METHOD

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INVENTOR.
DANIEL A. FOGG

BY

Price & Heneveld

ATTORNEYS

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FLEX LIFT APPARATUS AND METHOD
Daniel A. Fogg, White Cloud, Mich., assignor to The
Rapids-Standard Company, Inc., Grand Rapids,
Mich., a corporation of Michigan
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ABSTRACT OF THE DISCLOSURE

Apparatus and method for hoisting patterns of articles such as filled cartons, having a lifting platen closing one face of a plenum chamber with which evacuation means is communicant, the platen having limited air flow orifices therethrough, being retained from stretching, but being slightly flexible to bend, in response to a pressure differential thereacross, to a compound curvature matching the periphery of the pattern of articles in a manner to seal the periphery while forming a communicant space within this periphery between articles and the platten.

This invention relates to article hoist equipment, and more particularly to pressure differential hoisting apparatus.

The hoisting apparatus illustrated and disclosed herein was developed primarily for hoisting groups of cartons arranged in patterns, e.g. square or rectangular, and transferring them from one location to another. For convenience, the apparatus will be described largely with respect to this type of article. It will be realized however, upon studying the disclosure, and understanding the concept taught, that many types of articles could conceivably be hoisted with the apparatus.

Various types of pressure differential hoisting apparatuses have been developed heretofore using a negative pressure plenum chamber, and an open mesh article engaging lifting platen to contact the upper surfaces of a group of cartons in a pattern. These have been used, for example, in the palletizing field, to transfer groups of cartons on to or off of pallets, loading platforms, etc. With the usual pressure differential hoisting units, it is important to have a good seal between the lifting unit and the outside of the outermost carton in a pattern to minimize air leakage and maintain a sufficient pressure differential for safe, reliable hoisting. Yet, since groups of cartons to be lifted contain a plurality of individual cartons, it is not always possible or likely to obtain a good seal with all of the cartons and without leakage between the cartons. Hence, peripheral depending curtains, peripheral resilient cushions, and gap filling cushions have been employed on the bottom of flat lifting platens to improve the likelihood of obtaining a good seal around and between the cartons. These supplemental devices, while improving sealing probabilities, immediately cause limitations in the size and configurations of the carton patterns to be hoisted with a particular hoist, since the suspending devices must match the carton pattern dimensions and configuration to extend closely around the periphery of the pattern. If these elements are not closely adjacent the outer faces or edges of the cartons, a complete seal is not obtained and the pressure differential is largely destroyed. This factor limits the utility of any particular hoist therefor. It also causes a slowdown in the rate of hoisting operations due to the necessity for exact alignment of the hoist with each pattern of cartons. If different carton patterns are to be hoisted, each hoist unit must be specifically modified to accommodate that particular pattern configuration and/or size.

Another critical operational factor involved with pres-

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sure differential or vacuum hoist units is the necessity of obtaining good air flow communication from the suction ports in the platen over the complete upper surface area of the group of cartons, including the outermost cartons, but without allowing communication from just beyond the outermost cartons to the suction apparatus, since the resultant leakage largely destroys the pressure differential needed to lift the cartons. Accordingly, it has been necessary to exactly control the area of the suction ports with respect to the dimensions of the group of cartons by the use of sliding doors, or the noted curtains and resilient cushions. It will be realized that the area of the suction ports must not only be the same size as the carton area, but must coincide exactly with it when aligned.

All of these considerations have caused known lifting units to be fairly complex in construction, relatively expensive, and specifically limited in application to particular carton pattern sizes and configurations, as well as having limited efficiency due to the time consumption necessary to manipulate, align, and exactly position the hoist with respect to each particular group of cartons.

It is an object of this invention to provide a novel hoist unit capable of employment on carton patterns of substantially differing dimensions and pattern configuration, yet without any supplemental curtains, cushions, slide doors and the like.

Another object of this invention is to provide a novel pressure differential hoist unit achieving excellent communication between the upper surfaces of all of the cartons in a group to the passages for the evacuation means, yet always with excellent sealing action between the outer peripheral edges on the outermost cartons and the lifting platen, even with carton pattern variations, to prevent significant leakage that could destroy the operative pressure differential.

Another object of this invention is to provide a pressure differential hoisting apparatus that is actually relatively simple in construction, with no suspended supplemental peripheral members, yet capable of repeatedly automatically obtaining excellent sealing action on the surfaces to be hoisted, and of maintaining sufficient pressure differential over the entire surface area, even though the size and configuration of the surface area varies from one hoisting action to the next.

Another object of this invention is to provide a pressure differential hoist apparatus having a unique platen flexing action that automatically accommodates the hoist to the particular dimensions and configurations of the surface area, e.g. of cartons to be hoisted, to cause optimum peripheral edge sealing of the surface area, and complete communication to the entire surface area inside the peripheral edge, thereby obtaining a maximum pressure differential hoisting force.

These and several other related objects of this invention will become apparent upon studying the following specification in conjunction with the drawings in which:

FIG. 1 is a perspective view of the top portion of the hoist unit;

FIG. 2 is a perspective view of the underside of the novel hoist unit, showing the orificed lifting platen;

FIG. 3 is a fragmentary perspective view of the valve operating mechanism for the evacuation discharge, taken in the direction indicated by the arrow III in FIG. 1;

FIG. 4 is a side elevational sectional view of the plenum chamber and lifting platen portion of the apparatus showing its relationship to a group of cartons prior to evacuation;

FIG. 5 is a sectional view of the apparatus in FIG. 4, showing the relationship during evacuation and hoisting; and

FIG. 6 is a sectional view similar to the views in FIGS.

4 and 5 but showing a modified construction of the assembly.

Referring now specifically to the drawings, the complete assembly 10 there shown includes the housing 12 forming an internal plenum chamber, blower type evacuation means 14 mounted on an operative housing 12, electric motor 16 drivably connected to evacuation means 14, and control means 18 operatively associated with electrical switching and connection system 20 to motor 16 and solenoid assembly 22 that controls exhaust valve 24 of the blower.

Housing subassembly 12 includes an upper horizontal support platform 30 having a depending peripheral connection flange 30'. Mounted to flange 30' is a peripheral bracket flange 32 forming an opening over which a special underside panel 34 is secured as by bolts 36. The nature of panel 34 is important to this invention. It is preferably a metal sheet having slight flexibility to bend from a generally flat configuration (as shown in FIG. 4), to a slightly inwardly curved, concave, compound curvature configuration with a large radius of curvature (as shown in FIG. 5). Preferably, the member is non-stretchable so as not to draw uncontrollably into the housing under a pressure differential across it. It is generally semi-rigid with only slight flexibility. The specific curvature illustrated in FIG. 5 is actually exaggerated for purposes of illustration. The actual height difference between the center and edges of a panel on a hoist several feet wide and several feet long is only a small fraction of an inch.

The curvature is initially created by a pressure differential across the panel in a manner to be described, and is maintained by a pressure differential across the combined cartons and panel as described hereinafter. The curvature is controlled as by limiting it, for example, by a plurality of stop members such as adjustable studs 38 threaded down through platform 30 and extending down within a fraction of an inch of member 34. These may be spaced at intervals and in the number needed to suit the size and configuration of the particular panel.

The pressure differential across membrane 34 is created by a greater substantial negative pressure in plenum chamber 35, i.e. on the inner face of panel 34, and a lesser negative pressure on the lower article contacting surface of panel 34. This can be achieved by providing somewhat restricted gas flow passages e.g. 40 and 42 in patterns of selected configuration and location in the member. When a negative pressure is initially applied to chamber 35, a negative pressure is also created beneath panel 34 because of flow through orifices, but since the upper surface area of the panel is entirely instantly exposed to a greater negative pressure, a pressure differential is formed.

These orifices can be plural in number as shown, or singular. The orifice means may be only at the center of the platen if desired, as will be understood, or can extend somewhat from the center as shown. It is necessary to limit the outward extent of the orifices to an area smaller than that of the smallest surface area or pattern area to be hoisted.

The negative pressure in plenum chamber 35 is created by evacuation means 14 which may comprise a conventional centrifugal blower. It may be mounted directly on platform 30 for example. Its central axial inlet 50 (FIG. 4) communicates with plenum chamber 35 as by a central opening 52 in platform 30. It is rotationally driven at high speeds by electrical motor 16 which may also be mounted above the blower and supported for example by suitable bracing means 60.

The tangential exhaust outlet 64 of the blower is controlled by a pivotal butterfly valve 24 on pivot shaft 66. This valve may be shifted between its closed and open positions manually or by power means. If the latter, a sprocket 70 can be attached to shaft 66. The sprocket is rotated at alternative directions with a length of roller

chain 72 with one end attached to a core 74 of a solenoid 22, and the other end attached to a tension coil return spring 78 attached to bracing member 80 or the like.

A plurality of upstanding rigid columns 84 are mounted to the platform, and have suitable hoist connection means such as eyelets 86 for attachment of tension members such as the plurality of chains 88 for hoisting the assembly on a suitable crane or the like (not shown).

Method

The operation of the mechanism may be controlled remotely, by the operator holding a hand held switching control unit 18 connected electrically by extensible electrical cord 19 to electrical control system 20 associated in conventional fashion with motor 16, and with solenoid 22.

To lift a pattern of cartons, e.g. cartons C1, C2, C3 and C4 arranged, for example, in a square or rectangular pattern, the hoist unit is lowered by chains 88 until the under surface of generally flat membrane 34 contacts the upper surface area of the cartons between the peripheral edges of the group carton pattern so that the few orifices 40 and 42 are covered. This is normally done with motor 16 operating the centrifugal blower assembly, but with exhaust valve 24 closed so as to not create a significant negative pressure in plenum chamber 35. After the carton pattern is positioned within the general confines of membrane 34, valve 24 is opened by shifting solenoid core 74 with electrical actuation through the control assembly 18. This instantly creates a substantial negative pressure in plenum chamber 35 by exhaustion of the air therein through port 52 and inlet 50 to the centrifugal blower. As this negative pressure forms, air is also drawn up through passages 40 and 42, but since the flow through these ports is somewhat restricted, the negative pressure above the panel is initially substantially greater than below the panel, causing a pressure differential across member 34. This pressure differential causes the panel to flex or bow inwardly against the stops, so as to have a concave undersurface. Although the flexing action is initially caused by a pressure differential across the panel, this differential subsequently is largely reduced to an insignificant amount because the air in the space above the cartons is substantially evacuated, particularly since a substantially complete seal is formed between the outer carton pattern periphery and the panel. The flexed curvature is maintained by the upward thrust of the carton due to atmospheric pressure pressing on the bottom of the cartons and imposing a load up on member 34 which conforms with pattern size.

This flexing action is very significant. Extensive experimentation shows that the flexing action occurs in a manner to cause the compound curvature of the panel to match the actual pattern configuration, so that the peripheral edge of the carton pattern remains in close engagement with the member. This causes a nearly complete sealing contact between the upper outer edge of the outermost cartons as shown in FIG. 5, while the entire membrane area inside the periphery flexes away from the cartons to form a space. By sealing is meant that any air flow occurring between the cartons and the panel is such a small fraction of the blower drawing capacity that it is insignificant. (In actual use, it has been found that the undersurface of the flexible panel may even have small spaced embossments protruding a $\frac{1}{16}$ " or so without significantly hindering the action.)

This pattern conforming flexing action occurs automatically, and repeatedly, even though the pattern varies considerably in size and configuration. For example, the same unit works just as effectively, without modification, on a 30" x 30" pattern, or a 48" x 53" pattern.

With the formation of the concave under surface of member 34, the continuous space 90 formed over the entire surface area to be hoisted (except at the outermost peripheral edge of the outermost cartons) creates excel-

lent evacuation communication of the entire surface area to exhausting ports 40 and 42, causing a pressure differential over the height of the cartons. When the hoist mechanism is elevated to lift the cartons off their support surface, the cartons retain their horizontally aligned relation as shown in FIG. 5, held tightly as a group, so that the inner cartons do not even contact the flexed member. The cartons can be dislodged only with considerable force, as has been proven. Of course, the particular amount of lifting force employed will depend upon the weight, size and nature of the articles. This can be varied in conventional fashion by varying the size of the hoist membrane, the capacity of the evacuating means, and the like. It has been found that cartons weighing several hundred pounds can be readily hoisted with safety and reliability using an evacuation means capacity typical of present blowers.

As noted previously, the flexing action which occurs with evacuation is highly desirable, as well as the resulting compound curvature of the concave flexed membrane, to obtain automatic adaptation to differing dimensions and configurations. In some instances, however, it is possible to employ a permanently flexed membrane. Lifting action with such a permanently curved membrane can be achieved on pre-selected configurations, for example, of square patterns utilizing a square lifting membrane, or round patterns using a square lifting membrane. However, the permanently flexed membrane will not automatically accommodate different configurations, e.g. a square membrane on an elongated, rectangular pattern. Although sealing will readily occur along the two short edges of such a carton pattern, the elongated edges will allow leakage unless the lifting platen is correspondingly shaped. This permanently curved unit can therefore be considered as part of the broadest aspects of the novel concept, but does not constitute the preferred form of the invention.

It is also conceivable that the structure can employ a flexible membrane other than a semi-rigid, non-stretchable metallic panel like that shown in FIGS. 4 and 5, but any stretchable membrane must be controlled over its extent to prevent significant stretching, and is not as universal in the pattern configuration to be accommodated since its final curvature tends to be determined by the means used to limit its flexing and stretching. Specifically, referring to the modified form of the apparatus in FIG. 6, the assembly 110 includes a blower subassembly 14 and motor (not shown) cooperative with platform 130 as in FIG. 1. The platform may have a depending peripheral portion defining a plenum chamber 135 having its bottom surface closed by a flexible membrane 134. In this instance, the membrane comprises an element such as rubber. It includes orifices 140 and 142 through it. If the member is stretchable, i.e. rubber without integral reinforcing to prevent its stretching action, a negative pressure in plenum chamber 135 could cause uncontrolled deformation of the membrane into the housing. Therefore, a permanently configured open mesh control member such as a bowed, inwardly concavely curved rigid screen or expanded metal layer 159 or the like is extended across the opening on the bottom of the inside plenum chamber 135, adjacent member 134. This control element determines the flexing extent, to effectively prevent significant stretching of the orificed membrane 134. If the membrane 134 is formed of a reinforced rubber or plastic, e.g. having a non-stretchable sheet or sheets as of metal screen, woven fabrics or the like bonded or otherwise secured to it, so as to no longer have significant stretch characteristics, then the membrane 134 can be nicely employed in the manner of the first form of the invention.

The operation of this modified form is basically like that described with respect to FIGS. 4 and 5. Specifically, the hoist is lowered until the carton pattern contacts the generally flat membrane 134, at which time the exhaust

valve of the blower is opened to cause evacuation of plenum chamber 135 to form a negative pressure in it. This creates a pressure differential across membrane 134 due to the restricted air flow up through the membrane, flexing the membrane up against the form or stop means 159 in a predetermined concavely curved configuration. The periphery of the carton pattern remains in sealing engagement with member 134 so that a shallow space is created over the entire carton pattern area except at the peripheral edge. A pressure differential is thereby created over the cartons since the spacing above the cartons is subjected to a negative pressure by flow of the air through this shallow space and ports 140 and 142.

This form of the invention is not preferred, since membrane 134 will tend to repeatedly deform to the specific configuration of member 159, rather than flexing in a pattern to match the peripheral edge of the cartons or other like articles to be hoisted. Therefore, it would work effectively for predetermined patterns, e.g., if the hoist membrane is square, it will hoist a square or a round pattern. However, an oblong pattern would tend to create leakage along the elongated edges of the pattern, with this leakage being detrimental in some instances, depending upon the weight of the cartons or like articles to be hoisted. Therefore, the preferred form of the invention illustrated in FIGS. 4 and 5 have advantages over this construction. It is entirely conceivable, however, that this modified construction could be employed in some instances.

Certain additional details of construction of the apparatus could conceivably be changed within the concept presented herein. Hence, it is intended that the invention is to be limited only by the scope of the appended claims and the reasonable equivalent methods and structures to those defined therein.

I claim:

1. A pressure differential hoist comprising: support means including means for attachment of elevating means; a lifting platen on one side of said support means and secured on its periphery to said support means; said platen having first and second opposite faces; means forming a plenum chamber adjacent to and communicant with the first face of said platen, between it and said support means; said second face comprising an article contacting surface for engaging the surface area of articles to be hoisted; evacuation means operatively associated with said plenum chamber to form a negative pressure therein and on said platen first face; restricted port means from said plenum chamber to said second surface to allow formation of an article hoisting negative pressure adjacent said second surface slightly less than said plenum chamber negative pressure to cause a pressure differential across said platen; and said platen being non-stretchable, semi-rigid, and slightly flexible within its periphery to bodily flex a slight amount into a compound curvature toward said support under the pressure differential applied thereto, causing said first face to be convex and said second face to be concave, to create an air evacuation space adjacent said second face and the surface area of articles to be hoisted, and to form a peripheral edge seal between said second face and the periphery of said surface area.

2. A pressure differential hoist for hoisting articles having a surface area, comprising: hoisting housing means forming an internal plenum chamber and having bottom panel means having an article contacting outer surface; said panel means being generally non-stretchable, and slightly flexible to bend into a compound curvature of large radius with said outer surface concave, under the influence of a negative pressure in said plenum chamber, to create a shallow space at said second surface and cause a peripheral edge seal to the article surface area; evacuating means operatively associated with said plenum chamber to create a negative pressure therein, and pas-

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sage means from said plenum chamber to said outer surface to create a negative pressure at said outer surface, said shallow space, and the article surface area, to create a pressure differential across the articles.

3. A pressure differential hoist comprising: hoistable housing means forming an internal plenum chamber having a bottom, article-contacting, orificed surface means, said surface means having a slight compound concave curvature, at least when said plenum chamber is at a negative pressure; and evacuation means operatively associated with said plenum chamber to create a negative pressure therein and create a negative pressure at said surface means for lifting articles contacting it.

4. The hoist in claim 2 wherein said panel means is a thin membrane having orifice means in the central portions thereof.

5. The hoist in claim 2 wherein said panel means is a relatively thin metal plate having a plurality of restricted orifices in a pattern.

6. The hoist in claim 2 including stop means in said housing limiting the flexing of said panel means.

7. The hoist in claim 3 wherein said surface means includes a porous curved form and a flexible, stretchable membrane shiftable from a relaxed condition away from said form, to a flexed condition against said form under a pressure differential applied thereto.

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8. A method of providing a slightly flexible lifting panel having limited air flow orifices therethrough hoisting one or more articles having a generally flat surface area comprising the steps of: placing one face of said orificed lifting panel against said surface area, creating a negative pressure at the second face of said panel, and through the orifices in said panel creating a smaller negative pressure at said surface area, thereby also simultaneously creating a pressure differential across said panel to flex said panel in a concavity away from said surface area to cause a slight compound curvature of said panel at said second surface, to create a space between said panel and substantially all of said surface area, while retaining a peripheral seal between said second surface of said flexed panel and said surface area; and lifting said panel and articles.

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HUGO O. SCHULZ, *Primary Examiner.*