

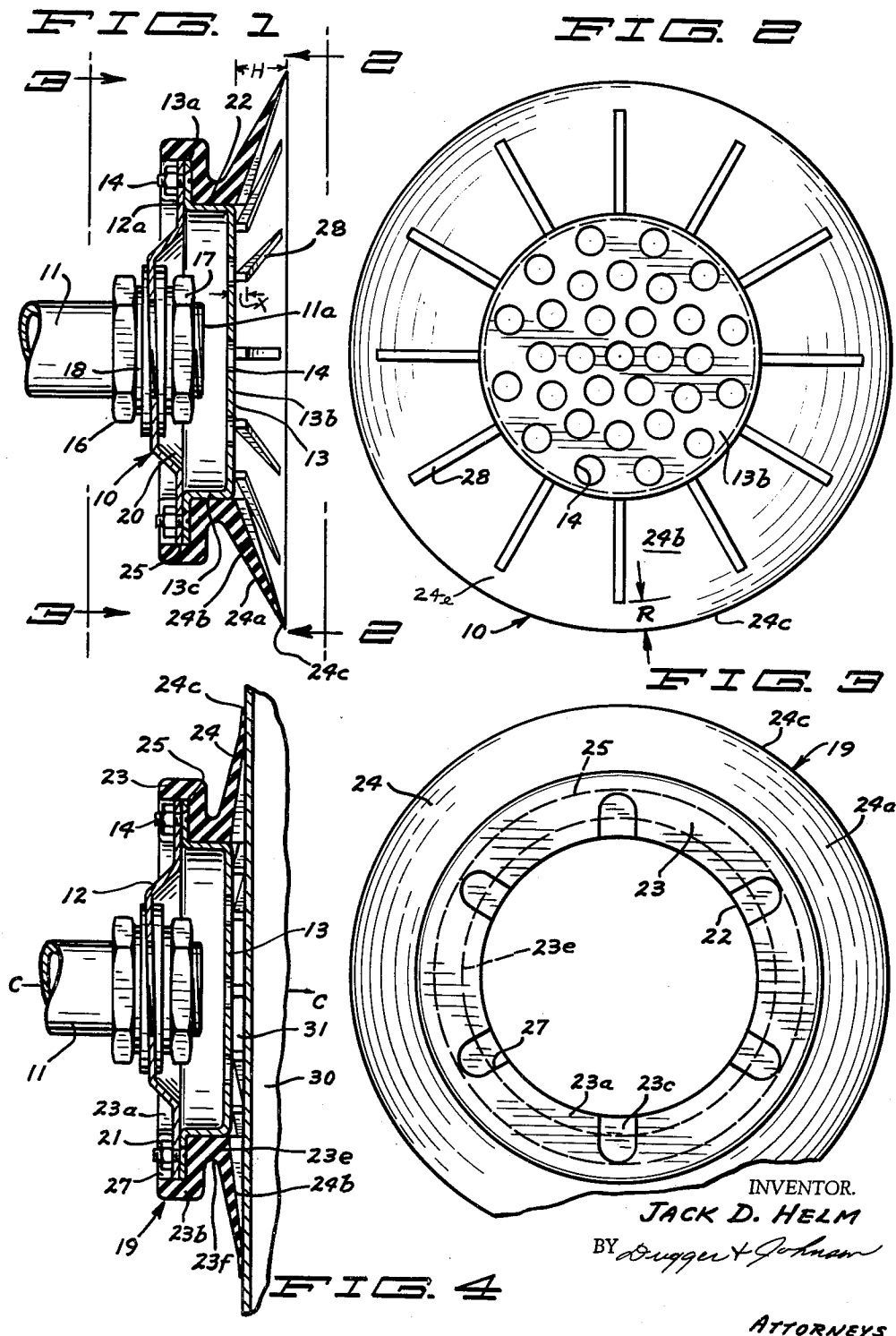
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VACUUM GRIPPING DEVICE

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VACUUM GRIPPING DEVICE

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This invention relates to a vacuum gripping device useable in apparatus for picking up and conveying objects from one location to another. More particularly, this invention relates to a new and novel vacuum cup seal member forming a part of a device especially useable in handling paper bags.

In vacuum gripping devices of the prior art, the utility thereof depends on the shape and rigidity of the device in addition to the rigidity of the object being picked up to provide air passage to insure its sealing around the outer peripheral edges to give maximum holding power. However, in handling of flexible objects, such as paper bags, the prior art devices do not work too well as the paper itself will flex to conform to the shape of the device, thus defeating the aforementioned purpose. This invention has been made to overcome problems of the aforementioned nature and in particular to provide a vacuum seal member that provides a gripping seal close to its outer peripheral edges at all times and at the same time one that has the necessary flexibility in order to conform to the irregularities in the material being handled.

It is an object of this invention to provide a new and improved vacuum gripping device that is readily useable for handling generally planar rigid materials, and also readily useable in handling flexible objects. It is still a further object of this invention to provide a new and improved vacuum seal member that provides air passages adjacent the outer peripheral edges of said member to assure sealing around said outer edge and that does not depend upon the rigidity of said member to obtain the aforementioned results. It is still another object of this invention to provide a vacuum seal member that maximizes the holding power of a vacuum gripping device even though said vacuum device may be used for transferring flexible materials such as paper bags from one station to another.

Other and further objects are those inherent in the invention herein illustrated, described and claimed and will be apparent as the description proceeds.

To the accomplishment of the foregoing and related ends, this invention then comprises the features hereinafter fully described and particularly pointed out in the claims, the following description setting forth in detail certain illustrative embodiments of the invention, these being indicative, however, of but a few of the various ways in which the principles of the invention may be employed.

The invention is illustrated with reference to the drawings wherein:

FIGURE 1 is a cross-sectional view of the vacuum gripping device of this invention in vertical elevation;

FIGURE 2 is a front view of the vacuum gripping device of this invention, said view being generally taken along the line and in the direction of the arrows 2-2 of FIGURE 1;

FIGURE 3 is a back view of the vacuum seal member of this invention, the aforementioned view of the seal member being generally taken along the line and in the direction of the arrows 3-3 of FIGURE 1;

FIGURE 4 is a cross-sectional view of the vacuum gripping device illustrated in FIGURE 1 other than it has a vacuum applied thereto, there being illustrated a frag-

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mentary portion of a flexible object such as a paper bag held in gripping engagement by said device.

The vacuum gripping device of this invention, generally designated 10, includes a nipple or pipe 11, which at one end is threaded at 11a and at the opposite end is connected to a suitable source of vacuum (not shown). The aforementioned pipe may be mounted on a suitable arm for moving the vacuum gripping device between the various positions such as those illustrated in the co-pending application, U.S. patent application 806,955, filed April 16, 1959 or on other appropriate mechanism. Mounted on the threaded end of the pipe is a vacuum cup mounting member 12, said member being retained between seal nuts 16 and 17 that are threaded on the aforementioned pipe. On either side of the vacuum cup member and intermediate the respective seal nut is an adjustable annular shim 18, each shim being trapezoidal in shape in a plane parallel to the central axis of the shim. The aforementioned shims are provided in order to permit the vacuum cup member being properly aligned relative to the central axis C-C of the device, including pipe 11.

Bolted to the vacuum cup member is a vacuum cup cap 13, there being a plurality of cup screws 14 extended through appropriate apertures formed in the annular flange portions 12a and 13a of the vacuum cup member and vacuum cup cap 13 respectively. Nuts 21 are threaded on the cup screws 14. The aforementioned vacuum cup mounting member and vacuum cup cap are shaped to enclose a vacuum chamber 20 of a substantially larger diameter than the pipe 11 and into which said pipe opens, said mounting member and vacuum cup cap forming structure that is referred to as a vacuum cup. A gasket (not shown) may be provided between the aforementioned annular flanges of the vacuum cup member and the vacuum cup cap to prevent the loss of vacuum therebetween. The vacuum cup cap has a front circular central portion 13b that has a plurality of apertures 14 opening into the chamber 20. The aforementioned front portion 13b is axially spaced from the pipe 11 and annular flange 13a by the ring portion 13c, said ring portion being formed integral with the flange and front portion.

Positioned on the vacuum cup and resiliently retained thereon is an annular vacuum seal member, generally designated 19, of this invention. The vacuum seal member has a circular opening 22 formed therein that is generally of the axial length of the ring portion and of a diameter to resiliently engage the outer peripheral surface of said ring portion. The vacuum seal member 19 has a back annular mounting portion 23 and a forwardly extending annular gripping portion 24 formed integral with the portion 23. The mounting portion is provided with an inner annular recess 25 that has an outer diameter slightly less than the outer diameter of the vacuum cup and an axial dimension slightly less than the combined axial thicknesses of the vacuum cup member flange 12a, the vacuum cup cap flange 13a and of the gasket, if one is provided. Thus the annular mounting portion has a radially inwardly extending part 23a that abuts against the general planar surface of the vacuum cup mounting member flange 12a, an axially extending part 23b formed integral with part 23a and that abuts against the outer circumferential edges of the vacuum cup mounting member and the vacuum cup cap flanges, and a second radially extending part 23c that abuts against the general planar surface of the vacuum cup cap flange 13a. The first radial part 23a has a plurality of inner circumferentially spaced notches 27 through which the screws 14 extend, said notches being of a size and shape to permit loosening and tightening of the nuts without said nuts engaging the radial part 23a.

The inner diameters of the annular mounting portion, i.e. the radial parts 23a, 23c, are substantially the same as the diameter of the opening 22. By making the recess of the aforementioned dimensions the annular mounting portion will resiliently bear against the respective portions of the vacuum cup mounting member and vacuum cup cap with sufficient force to be retained thereon even though the device is used for conveying a relatively heavy object. A connecting portion 23e having an outer rounded surface 23f is integrally joined to the part 23c and to the annular gripping portion 24.

The annular gripping portion 24 is frusto-conical in shape and has a back surface (back face) 24a that diverges away from the front surface (front face) 24b in a direction from the outer circumferential edge 24c inwardly toward the central axis of the device. That is, in cross-section, the front and back faces intersect at edge 24c while the angles formed by the intersection of the front and back faces with the central axis C—C are acute.

On the front face of the gripping portion, there are provided a plurality of elongated radially extending lands 28, said lands extending from the inside diameter of the mounting portion (opening 22) to a point adjacent the outside diameter (edge 24c). The axial height X of the lands is greatest at the inside diameter and gradually tapers to zero slightly before reaching the outside edge 24c. That is, the lands taper to zero at a point spaced a distance R from the circumferential edge 24c as illustrated in FIGURE 1. Each land in section perpendicular to the radial length thereof is preferably rectangular or trapezoidal with the minor base forming the front face of the land. For purposes of facilitating the description of this invention, the portion of the front face located between the outer radial edges of the lands and the circumferential edge 24c will be referred to as the rim 24e. That is, one of the important features of this invention is to taper the lands so that the rim is inclined slightly forwardly and outwardly of the lands but is of sufficient flexibility so that it will be flush against the surface of the object to be gripped even though, for example, the object is a paper bag having wrinkles therein.

It is preferred that the vacuum seal member be made of a material having the flexibility, "liveness" and ability to maintain its shape as the material meeting the specification of ASTM Designation R415 ABH Composition No. 1001. To further illustrate the invention, one embodiment thereof has a circumferential edge that is approximately $4\frac{3}{4}$ inches in diameter; an opening 22 of a diameter $2\frac{1}{16}$ inches; a back face forming with the plane of edge 24c, an angle of approximately 35° and a front face forming with plane of edge 24c, an angle of approximately 30° . The axial height H of the gripping portion is approximately $\frac{5}{8}$ inch, while the maximum axial thickness of a land is $\frac{1}{8}$ inch and the dimension R as measured along the front face is $\frac{1}{2}$ inch. It is preferred that between 10–16 lands be provided on a seal member of the above dimensions, it being understood that the above material and dimensions are given as illustrative of the invention rather than as a limitation thereon. The flexibility, "liveness" and ability of the material to maintain its shape is an important consideration. Another criteria of the invention is that it is preferable that the edge 24c be free of flashing.

In using the vacuum gripping devices of this invention, the pipe 11 is connected to a source of vacuum and the vacuum seal member is moved to a position closely adjacent or in contact with, for example, the side wall 30 of a paper bag to be picked up. The vacuum draws the side wall inwardly toward the vacuum cup cap and if the bag wall is of sufficient rigidity, it will cause the circumferential edge to be moved in an axial direction until the circumferential edge is located in the same plane as the faces of the lands 28. As may be readily noted in

FIGURE 4, due to the spacing of the lands, an air passage 31 bound by the adjacent set of lands, the face of the annular mounting portion, and the adjacent face of the bag side wall is provided to permit the vacuum being applied to adjacent rim portion of the vacuum seal member. Even if the bag is made of very flexible material, there will still be provided a space bound in part by one side wall of the land, the front face 24b and the bag wall, since in order to completely close such passages, it would be necessary that the material stretch a considerable amount. Thus the vacuum gripping device of this invention insures that there will be a vacuum seal adjacent the outer rim portion to obtain maximum holding power, even though the paper bag has a tendency to conform to the shape of the seal member. At the same time, the rim portion is of sufficient flexibility so that it may be conformed to the wrinkles in the material being handled in contrast to bridging over such wrinkles as occurs with vacuum devices of the prior art. The aforementioned conforming takes place in part due to the flexibility of the material from which the vacuum seal member is constructed and in part due to the tapering of the front and back faces toward one another so that they approach a line at the outer circumferential edge of the device. Further, due to the annular construction of the seal member and the relatively large circumferential diameter of the vacuum chamber, the generally frusto-conical space between the seal member and the bag wall when the rim first engages the bag wall may be rapidly evacuated. As may be noted in FIGURE 4, when the device is used to pick up a paper bag of relatively heavy gauge, the gripping portion has stretched in a radial direction and is moved axially so that the plane of the front faces of the lands is substantially coextensive with the plane of the edge 24c. Of course, if the object being picked up is highly flexible, the gripping portion will be deformed to assume a shape intermediate the shapes illustrated in FIGURES 1 and 4. When the object picked up is released by discontinuing the application of vacuum to the vacuum chamber, the gripping portion will resume its shape as illustrated in FIGURE 1.

Even though the above identified invention has been described as being mounted on a pipe 11, it is to be understood that it may be mounted on a flexible hose or other appropriate type structure. Additionally, it is to be understood that the shape of the vacuum cup mounting member and vacuum cup cap also may be varied, although the present shape described is preferred since it provides means for easily mounting the vacuum seal member.

As many widely apparent embodiments of this invention may be made without departing from the spirit and scope thereof, it is to be understood that I do not limit myself to the specific embodiments herein.

What I claim is:

1. A vacuum gripping device for picking up an object comprising a vacuum cup including enclosing a vacuum chamber, means for placing said chamber in fluid communication with a vacuum source, said vacuum cup having a front perforated circular portion, and a vacuum seal member mounted on said cup to form a sealing engagement with the object to be picked up when the vacuum is applied to said chamber, said vacuum seal member having an annular gripping portion that has a front object engaging face extending radially outwardly from the circular portion and axially forwardly thereof and a plurality of spaced lands elongated in a radial direction formed on the front face of the gripping portion to engage the object to be picked up.

2. The structure of claim 1 further characterized in that each of said lands is tapered to be of decreasing axial height from adjacent the inner diameter of the gripping portion to a zero axial height at a point slightly inwardly of the portion adjacent the outer circumferential edge of said gripping portion.

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3. The structure of claim 1 further characterized in that the vacuum cup includes a vacuum cup cap having a generally radially extending annular flange, a vacuum cup mounting member having a generally radially extending annular flange, and means for securing said flanges together, and that said vacuum seal member is made of resilient material and has an annular mounting portion with a recess formed therein to form a resilient fit with the aforementioned annular flanges.

4. Apparatus for grippingly engaging an object to be transferred from one station to another comprising a generally circular vacuum cup enclosing a chamber, means connected to the vacuum cup and opening into the chamber for placing said chamber in fluid communication with a vacuum source, said vacuum cup having a front plate portion with at least one aperture formed therein, and means mounted on said vacuum cup for grippingly engaging an object to be picked up when a vacuum is applied to said vacuum chamber, said last mentioned means comprising an annular gripping portion that extends axially forwardly of the vacuum cup, said gripping portion having a front face with a plurality of object engaging lands formed thereon, each of said lands being elongated in a radial direction and of sufficient length to extend adjacent the outer circumferential edge thereof.

5. The structure of claim 4 further characterized in that said annular gripping portion is made of a resilient material and has a back face, said faces diverging inwardly and away from one another in a direction from the outer circumferential edge thereof towards the central axis of said portion.

6. For mounting on a suction applying member having at least one aperture formed therein and to form a vacuum seal between said suction applying member and an object to be picked up, a vacuum seal member having an annular mounting portion around the suction applying member, an annular gripping portion extending axially forwardly and radially outwardly from said mounting portion, said gripping portion having an outer frusto-conical surface and an inner frusto-conical surface, said surfaces forming acute angles with the central axis of said seal member and converging toward one another to intersect on an outer circumferential edge and a plurality of spaced radially extending lands formed on the

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inner face, said lands gradually tapering from a maximum axial height adjacent the inner diameter of said gripping member to a zero axial height at points spaced radially inwardly from the outer circumferential edge, and adjacent the circumferential edge said lands having forward object engaging faces that are throughout their radial length located axially inwardly of the outer circumferential edge of said gripping member.

7. A vacuum seal member for a suction device to grippingly engage an object to be picked up when a vacuum is applied to the suction device, said member being made of a flexible material of sufficient rigidity to resiliently retain its shape and having an opening through which the vacuum is applied, a front object engaging face with the opening formed therein and an outer parametric rim portion for initially engaging said object, said front face being shaped to converge inwardly from the rim toward said opening, and a plurality of spaced radially extending lands formed on said front face extending from said opening to said rim portion, said lands being tapered from a maximum height adjacent the opening to a minimum height adjacent the rim portion.

8. A vacuum seal member for a suction device to grippingly engage an object to be picked up when a vacuum is applied to the suction device, said member being made of a flexible material of sufficient rigidity to resiliently retain its shape and having an opening through which the vacuum is applied, said member including an annular gripping portion having an outer frusto-conical surface and an inner frusto-conical surface forming an object engaging face, said surfaces converging toward one another to intersect at an outer circumferential edge and a plurality of spaced radial extending lands formed on the inner frusto-conical surface extending to adjacent the circumferential edge, each of said lands being gradually tapered in a radial direction from a maximum axial height to a zero axial height adjacent the circumferential edge.

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