

Jan. 4, 1966

D. A. HARRIS ETAL

3,227,482

VACUUM HEAD CONSTRUCTION AND METHOD

Filed March 27, 1963

3 Sheets-Sheet 1

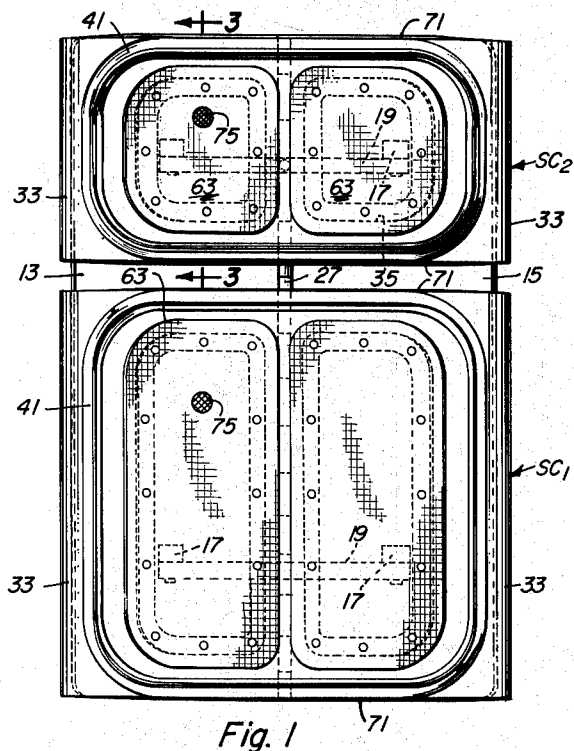


Fig. 1

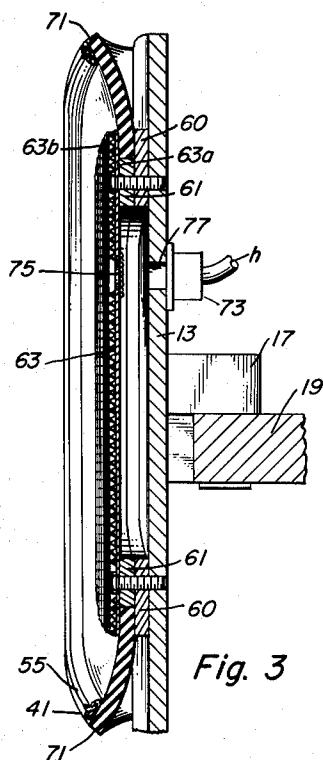


Fig. 3

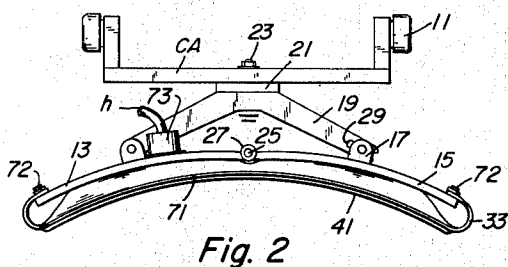


Fig. 2

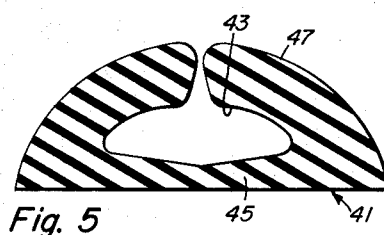


Fig. 5

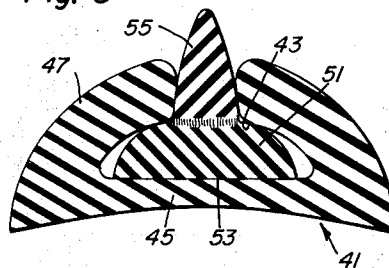


Fig. 6

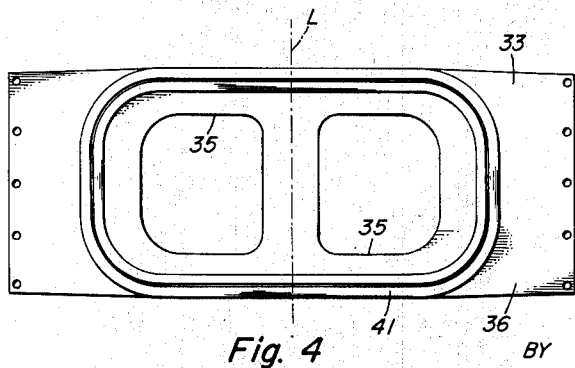


Fig. 4

DONALD A. HARRIS
JAMES R. AARON
JEROME F. MOSHOFSKY
INVENTORS.

BY
BUCKHORN, BLORE, KLARQUIST & SPARKMAN
ATTORNEYS

Jan. 4, 1966

D. A. HARRIS ET AL

3,227,482

VACUUM HEAD CONSTRUCTION AND METHOD

Filed March 27, 1963

3 Sheets-Sheet 2

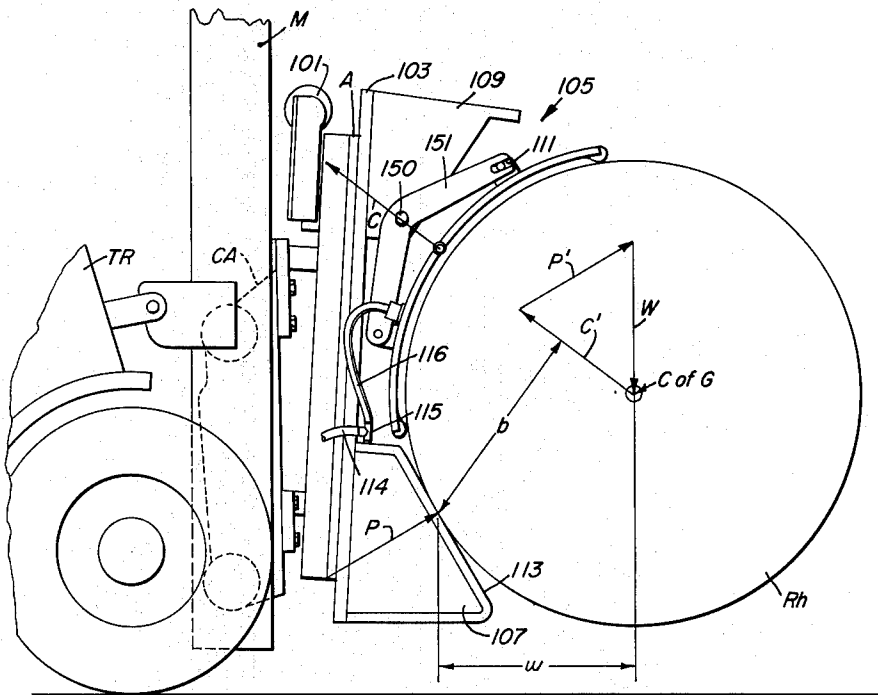


Fig. 10

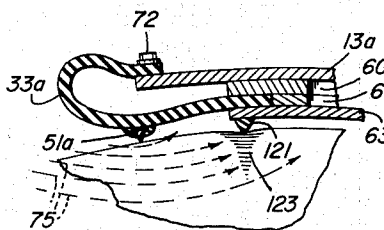


Fig. 11

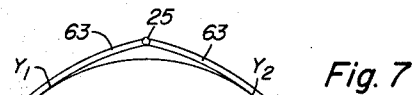


Fig. 7

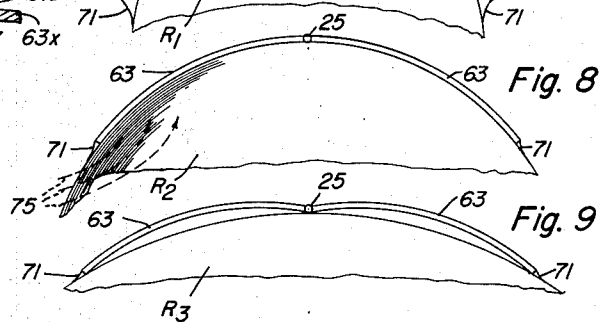


Fig. 8

Fig. 9

DONALD A. HARRIS
JAMES R. AARON
JEROME F. MOSHOFSKY
INVENTORS.

BY
BUCKHORN, BLORE, KLARQUIST & SPARKMAN
ATTORNEYS

Jan. 4, 1966

D. A. HARRIS ETAL

3,227,482

VACUUM HEAD CONSTRUCTION AND METHOD

Filed March 27, 1963

3 Sheets-Sheet 3

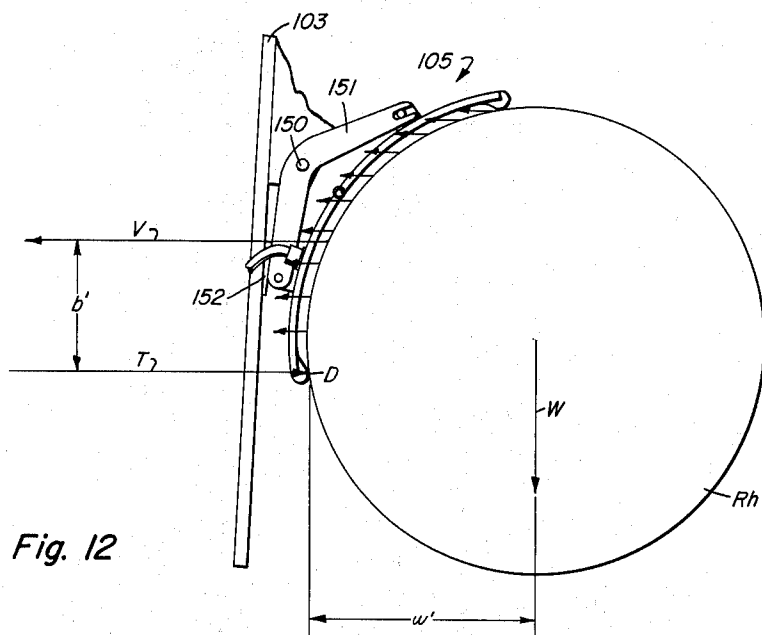


Fig. 12

DONALD A. HARRIS
JAMES R. AARON
JEROME F. MOSHOFSKY
INVENTORS.

BY
BUCKHORN, BLORE, KLARQUIST & SPARKMAN
ATTORNEYS

1

3,227,482

VACUUM HEAD CONSTRUCTION AND METHOD
Donald A. Harris, Vancouver, Wash., and James R. Aaron and Jerome F. Moshofsky, Portland, Oreg., assignors to Hyster Company, Portland, Oreg., a corporation of Nevada

Filed Mar. 27, 1963, Ser. No. 268,257
17 Claims. (Cl. 294-64)

This invention relates to improvements in suction cups for picking up loads and particularly heavy paper rolls, and also relates to improvements in suction cup apparatus. The invention further relates to a method of picking up a heavy roll of paper.

Vacuum cups are usually produced by a molding process. When a large vacuum cup is desired, or a range of sizes of large cups is desired, the expense of providing molds increases sharply, resulting in very costly cups.

It is a main object of the invention to provide a vacuum cup in which at least the major components can be fabricated from stock material to produce a fabricated cup at a fraction of the cost of producing a molded cup.

If loads having irregular or wrinkled surfaces are to be handled with a vacuum cup, it is desirable that the cup have a soft, resilient surface for contacting the load so as to form a good seal therewith. However, low durometer elastomer material which will provide a soft resilient surface is more easily damaged and wears faster than harder, less resilient elastomer material. The latter material however will not as readily form a good seal as the softer material. Damage to or wear of such soft resilient surfaces has heretofore meant replacement of the cup, with a consequent considerable expense, particularly if the cup is of a large size.

It is an object of the invention to provide a vacuum cup which has a soft resilient load contacting surface which can be readily replaced if worn or damaged, and more particularly to provide such a cup that is of simple design and in which the replaceable part is held in place by permanently mounted parts that can be manipulated to release the replaceable part.

Another object of the invention is to provide a vacuum type load handling apparatus especially adapted for handling a paper roll and particularly a range of sizes of rolls, and yet which apparatus comprises a minimum number of parts.

A further object is to provide a paper roll handling apparatus designed to lessen the leakage of air through the outer roll layers and hence prevent such leakage air from admittance into the suction passage of the cup.

Another object is to provide components and sub-combinations of the apparatus referred to in the previous objects.

Another object is to provide a novel method of handling a paper roll by means of vacuum.

Various other objects of the invention will be apparent from the following description taken in connection with the accompanying drawings wherein:

FIG. 1 is a front elevational view of a suction cup apparatus embodying the concepts of the present invention;

FIG. 2 is a plan view of the apparatus of FIG. 1;

FIG. 3 is an enlarged sectional view taken along line 3-3 of FIG. 1;

FIG. 4 is a front view of a blank used in fabricating a suction cup;

FIG. 5 is an enlarged view of the base strip in its undeformed condition;

2

FIG. 6 is a view of the base strip after insertion therein of the load contacting strip;

FIGS. 7, 8 and 9 are diagrammatic views showing the cup engaging rolls of different sizes;

FIG. 10 is a side elevational view of another modified form of the invention;

FIG. 11 is an enlarged fragmentary sectional view showing a modified form of the invention; and

FIG. 12 is a diagrammatic view in side elevation showing a suction cup picking up a roll, without provision of a lower support.

Referring to FIGS. 1 and 2, the suction cup apparatus disclosed provides two suction cups SC_1 and SC_2 which are mounted, in a manner to be described, on a load carriage CA. The carriage has rollers 11 for riding in the channels (not shown) of the mast of the lift truck.

The suction cups SC_1 and SC_2 are of sectionalized articulate construction and include a pair of arcuately curved rigid base plates 13 and 15 pivotally connected by ears 17 on a pair of vertically spaced mounting bars 19 (FIGS. 1 and 2). The mounting bars bear against elastomer pads 21 (FIG. 2) and are secured to the carriage CA by a pair of bolts 23.

The plates 13 and 15 are vertically elongate and have their opposed inner edges pivotally connected by a hinge pin 25 which passes through knuckles 27 on such inner edges. To enable the plates to pivot relative to one another, one set of ends of the bars 19 are slotted, as shown at 29 in FIG. 2 to accommodate movement of the associated pivot pins.

Each of the suction cups includes, as an important element, a sheet of elastomer material, such as neoprene, which is secured to the front faces of the base plates 13 and 15 in such a deformed manner as to cause the marginal portions of the sheet to project forwardly. The undeformed condition of the sheet 33 of cup SC_1 is shown in FIG. 4. It is apparent that the sheet has two openings 35 of identical shape formed therein and disposed in equally spaced relation on the opposite sides of a centerline L through the sheet.

A base strip 41 of elastomer material, which initially is straight, is arranged generally in the form of an oval on one face of the sheet 33 in surrounding spaced relation with respect to the openings 35 and in spaced relation to the ends of the sheet to leave tab portions 36. The strip is permanently secured to the face by an adhesive material. The ends of the strip are joined to one another before or after attachment to the sheet so that the strip may be considered as endless.

The base strip 41 is shown in cross section in FIG. 5 in its undeformed condition. In such condition it is shown as having a generally semicircular outline and is formed to provide an undercut groove 43 defined by a base portion 45 and two flange portions 47 providing opposed lips. The base surface of the base portion 45 is flat. The base portion has a minimum thickness at the center of the strip and increases in thickness in both directions away from the center.

The inner surfaces of the lips 47 are curved so that the lips are generally of uniform thickness. Also in the undeformed condition of the strip the opposed edges of the lips are closely adjacent or touch one another.

The base strip is designed to receive and retain an elastomer load contacting strip 51 (FIG. 6). This strip is generally of inverted T shape and includes a wide base portion 53 and a narrow upstanding load contacting portion 55. The portion 55 is considerably softer than the base portion 53 and in fact is soft to the touch so that it

readily forms a good seal with a load despite irregularities, such as wrinkles in the surface thereof which is engaged by the strip 51. The portions 55 and 53 are permanently joined or bonded together.

When the strip 51 is inserted into the base strip 41, the base strip is deformed so that it assumes the shape in FIG. 6. Thus it now has a concavely curved base surface and because the lips 47 are deformed outwardly they tightly grip the base portion 53 and also the load contacting portion 55 of the strip 51 and hence hold the strip in place. Preferably, the contact strip 51 is not inserted in the base strip 41 until after the sheet 33 is secured in place on the plates 13 and 15.

It should be mentioned that suction cup SC₁ includes a sheet like sheet 33, only of larger size in a vertical direction as the parts are shown in FIG. 1. Since the sheets for cups SC₁ and SC₂ are mounted on the plates 13 and 15 in a similar manner, only the manner of mounting sheet 33 will be described.

The sheet 33 is mounted on the base plates 13 and 15 by means of a spacer 60, an expander member 61, and a load contact plate 63 for each base plate. Each spacer and expander member is shown in the form of a metal loop. Each load contact plate 63 is larger than its expander member 61 and is superposed thereon and both of these and the spacer 60 are secured to the associated base plate by means of bolts 65.

The expander members are of the same shape as the openings 35 of the sheet 33 but are larger, and the members have a thickness less than that of the sheet. The sheet is stretched to fit the edges of the openings 35 around the expanders 61, prior to tightening the bolts 65. After tightening, the bolts firmly hold the sheet in place.

The act of stretching the marginal portions around the opening 35 causes a displacement of the peripheral margins of the sheet from the plane of the sheet. Because of the presence of the base strip 41 on the front face of the sheet, the peripheral margins will be displaced forwardly as shown in FIG. 3 to provide flexible lips 71 which yield upon engagement of the load contact strip 51 with a load.

The tab portions 36 are reversely bent as shown in FIG. 2 and secured by bolts 72 to the rear surfaces of plates 13 and 15. One of the functions of the tab portions is to hold the side lip portions of the cup SC₂ from being folded inwardly when the cup rubs across a paper roll at a time when the cup is being brought into engagement with the roll.

Each of the cups SC₁ and SC₂ is connected to a source of vacuum on the lift truck (not shown) in a similar manner. Referring to FIG. 3, a hose "h" extends from the source on the body of the truck, over suitable slack take up means (not shown) and thence to a valve 73 mounted on the rear of the base plate 13. The valve is preferably like that shown in the copending application of John E. Olson, entitled "Suction Apparatus and Method for Picking Up Articles, Especially Paper Rolls," Serial No. 64,639, and filed October 24, 1960.

The valve 73 is placed in communication with a port 75 in the plate 63, by a port 77 in the plate 13 and by the space provided by the expander member 61.

The plate 63 is made up of a rigid metal base portion 63a to which is bonded layer 63b of yieldable, yet rather high durometer, elastomer material. The front surface of the layer 63b is defined by a plurality of isolated land portions which themselves define a plurality of crossing channels for the ready distribution of vacuum to all areas of the surface of the load contacted by the cup.

Operation

It will be assumed that the roll of paper to be picked up is in an upright position and is of a height to be engaged by the cup SC₁.

FIG. 8 shows diagrammatically the apparatus engaging a roll R₂ of a radius which is the same as that of the plates 63, while FIG. 7 shows a smaller roll R₁ and FIG. 9, a larger roll R₃. When the apparatus is brought up against the roll R₂, the lips 71 of the suction cup SC₁ are pressed rearwardly in rather uniform fashion, and the cup sections pivot about the pivot 25 so that the plates 63 assume a conforming concentric relation to the roll. The soft rubber portion 55 of the strip 51 forms a good seal with the roll and this enables subatmospheric pressure to be readily drawn within the confines of the cup to facilitate lifting the roll.

When the apparatus engages the roll R₁ (FIG. 7) the cup sections pivot so that the plates 63 are disposed in generally conforming relation with respect to the roll. In such positions, the roll R₁ contacts the plates at two places Y₁ and Y₂. Despite the non-concentric relation of the plates 63 and the roll R₁, the yielding lips 71 are able to conform readily to the shape of the roll, with the transverse portions of the lips being deflected to a greater extent than the vertical portions. It is pointed out that pressure against the middle portions of the transverse portions will tend to stretch the lips 71, which action pulls the vertical portions toward the roll to insure good contact. Continuous contact of the lips 71 is possible primarily because the lips 71 project substantially forwardly of the plates 63.

When the apparatus engages a larger roll R₃, the cup sections pivot so that each plate 63 engages the roll at the transverse end portions of the plate. Under these circumstances, the vertical portions of the lips 71 are deformed rearwardly to a greater extent than the transverse portions of the lips. Yet a continuous seal is effected because of the substantial forward projection of the lips and because their flexibility facilitates proper contact despite a substantial spacing between the roll R₃ and certain portions of the plates 63.

It is evident from the above description that the suction cup can pick up rolls, or other cylindrical objects, having a range of diameters despite the fact that the base members of the cup sections are essentially rigid.

If a taller roll is to be picked up, it can engage both cups SC₁ and SC₂. If a roll shorter than cup SC₁ is to be picked up, the cup SC₂ may be used. If the shorter roll is on the floor, the cups SC₁ and SC₂ could be mounted on a revolving apron to permit the cup SC₂ to be disposed lowermost.

While the invention in FIG. 1 has been described in connection with an articulated suction cup for picking up cylindrical objects, the concepts of the invention could be incorporated in a flat suction cup. It is also possible to form an expanded sheet type suction cup of the invention without the strips 41 and 51. Such a cup would be useful in picking up certain kinds of loads, but damage to the lips 71 would usually mean replacement of the sheet 33 rather than replacement of only a strip. In addition, in order to be reasonably form-sustaining, the sheet would have to be made of a higher durometer rubber than that of the strip portions 55, and thus not have as yielding and as full engagement with the load.

If the strip 51 becomes damaged, it may be readily replaced by deforming the base strip 41 so as to spread the lips 47. This enables the base portion 53 of the strip 51 to be pulled out between the lips. It is pointed out that deformation of the base strip 41 in the above fashion is possible because the base strip is mounted on a flexible member, the lips 71. It would be possible to construct the contact strip 51 and the base strip 41 so that the contact strip could be removed even though the base strip were secured to a rigid member. For instance, the provision of more flexible lips 47 and/or a less lip overlap and/or a softer base portion 53, would enable more ready removal of the strip 51. However, this would mean that the strip 51 could also be more readily inadvertently removed in use, which is undesirable.

While the base strip **41** has been described as initially straight, the base strip could be molded into oval form, but this would be more expensive. Also, while the expander member is shown as being of loop form, it could be solid except for a port therethrough for passage of air between ports **75** and **77**.

While the strip **51** has been shown as constructed of two different durometer rubber pieces, it may, for the sake of economy, be constructed of a single durometer extrusion having a hardness between that of pieces **53** and **55**.

Modified form

FIG. 10 shows a lift truck **TR** having a load lifting attachment designed especially for picking up horizontal cylindrical objects, such as a paper roll R_h . The truck has the usual mast **M** along which is moved a carriage **CA**. The carriage **CA** supports a revolving apron **A** which is driven by a motor **101**. A base plate **103** is secured to the apron **A** and carries a suction cup unit generally entitled **105** and a fixed hollow airtight support member **107**.

The cup unit **105** is shown as including a bracket **109** and a cup assembly **111**, which is shown as being of the articulate sectionalized construction of FIG. 1, although it could be a plain cup or a cup of other construction.

The support member **107** has a load contact heeling plate **113** which is inclined upwardly and rearwardly relative to the axis of the roll R_h so as to be capable of engaging the roll on the undersurface thereof. Thus the place of contact is located forwardly of the rearmost surface of the roll.

When a horizontal roll is picked up, three principal forces are to be considered: The weight of the roll W , pressure P exerted by heeling plate **113** and force C exerted by vacuum plate **115**. The geometry is such that all these forces act at the geometric center of the roll regardless of the diameter of the roll. Forces C and P have been transferred to a stress diagram shown at the middle of the roll in accordance with the well established practice of graphic analysis. These forces appear in the stress triangle as W , C' and P' . If W is drawn to a scale representing the weight of the roll, and the other forces are drawn parallel to their lines of action in such position as to complete the stress triangle shown, the magnitude of the other forces is determined graphically. A glance at the stress triangle indicates that in this particular geometric arrangement, C the force exerted by the vacuum cup is less than W . This is so because heeling plate **113** is also exerting an effective supporting force on the roll.

In addition to this, it will be noted that the resultant force exerted by suction cup **105** is exactly centered and manifests itself as uniform tension throughout the area of the cup. This prevents the difficulty described as "peeling" which would be experienced if heeling plate **113** were not used in combination with the pivoted vacuum cup. In further explanation of "peeling" it should be pointed out that if heeling plate **113** were not present, the force exerted by the vacuum cup would be tensile at the top, zero at the center and compressive at the bottom. The result of this would be that the tensile force would not only be far greater than shown in the diagram but, it would have to be exerted over a much smaller area of the cup (practically all in the top third of the upper half of the cup). Obviously, this would give an exceedingly high unit stress at the top with the result that the cup would break away from the roll along the upper edge. This type of breakaway is referred to as peeling because it is similar to the removal of a piece of Scotch Tape from a piece of glass. It is easy to peel the tape off because the entire force is applied at one point, but it would take many times the force to lift the tape off by exerting an equal separating force simultaneously over all units of area of the tape.

FIG. 12 analyzes the conditions that would obtain if heeling plate **113** were missing. In this case, arms **151** have, for illustration, been blocked against pivoting movement by bearing plates **152**. The clockwise moment of the load about the lowermost point of support **D** would be greater than the moment in FIG. 10 because lever arm w' is greater than w . To make matters worse, the lever arm of the resisting moment provided by the suction cup is considerably reduced which increases the tensile force required of the suction cup. Thus, removal of heeling plate **113** compounds three disadvantages as will now be demonstrated.

(1) *Increased lever arm of the load.*—As demonstrated above.

(2) *Reduced lever arm of resisting force.*—By the nature of the vacuum cup, uniform force is applied throughout the entire area of the cup. The forces are actually radial in this case, but we will consider only the horizontal components of these forces for simplicity. (The vertical components must be relied upon to support the weight of the roll irrespective of the moment.) The horizontal components have been shown in FIG. 12 as a series of short arrows. These forces are all of equal intensity if taken in a radial direction so the horizontal component of the lowest force on the circle will amount to almost 100% of the radial force whereas the horizontal component of the uppermost force will be practically zero. To compensate for this, however, is the fact that the radial force draws the roll against the vacuum cup and produces friction between the two. This friction results in an additional horizontal force which must be overcome if the roll tries to break away from the vacuum cup. For the purposes of this illustration, it is assumed that all the horizontal forces between the cup and the roll are of equal intensity, even though we know that the upper forces (including frictional forces) are actually less than the lower forces. This is so because the friction forces result from radial forces but can never quite equal them because the coefficient of friction is less than unity. From the above, it follows that the resultant horizontal component of all the vacuum forces will act somewhere below the median force line shown at **V** which is drawn on the diagram halfway between the bottom and top of the vacuum cup. A glance at the diagrams shows without further proof that the lever arm b' between the heeling point **D** where thrust force T is exerted, and median vacuum force **V** is less than the lever arm b of FIG. 10.

(3) *Increased requirement for vacuum force.*—As the resisting moment in FIG. 12 is the product of V times b' , it is obvious that V would have to be greater than C if b' is less than b . This would be so even if the moment of the load about the lower support point were the same, but as demonstrated, the moment of the load in FIG. 12 is actually greater than the moment of the load of FIG. 10.

Thus, it is demonstrated that the use of heeling plate **113** in the general position shown reduces tremendously the depth of vacuum required for safe operation.

After the roll is picked up, it can be rotated to an upright position if desired.

The support member **107** is preferably of hollow airtight construction to serve as a vacuum accumulator. A hose **114** extends from a source of vacuum (not shown) on the truck body to a branching fitting **115** which is secured to and communicates with the interior of the support **107**. A branch hose **116** extends from the fitting **115** to the cup unit **105**.

If a leak develops in the sealing rim of the cup unit, or elsewhere, some of the inrushing air will go into the accumulator so the pressure will not drop as fast as it would if there were no accumulator. Thus the load on the engine, and the speed with which the engine must react would be reduced.

While the FIGS. 1 and 10 forms have been described in connection with picking up a roll of paper, other cylindrical objects could be readily handled.

FIG. 11 Form

In FIG. 11, the construction of the cup shown is generally like that shown in FIGS. 1 and 2. Thus, the cup includes a sheet 33a which is secured by an expander member 61a and frontplate 63x to a rigid base plate 13a and also by bolts 72 to such plate.

The marginal portions of the plate 63x have a relatively hard endless bead 121 provided thereon for engaging the roll and indenting into the outer layers of the roll to compress such layers and provide a zone 123 of density.

Most paper, even of high quality, is pervious to a large extent and thus allows the passage of air through the paper when subjected to vacuum. This condition when the paper is in a roll or takes the form of a pile of laminates, is compounded because air can also pass between the laminates. We have found that if the roll of paper is subjected to a high unit pressure near the periphery of the vacuum cup, the infiltration of air can be reduced and a given vacuum pump therefore can maintain a higher vacuum. Dotted arrows 75 on FIGS. 8 and 11 illustrate how air enters the evacuated area from outside the sealing lip by filtering through the paper and passing between the laminates.

Without bead 121, the paper roll would be drawn by suction against a large area of frontplate 63 as shown in FIGS. 7 and 8. The total force drawing the roll against the vacuum cup is the same regardless of the area of contact between the roll and the cup, so therefore, the unit pressure available to compress the roll and reduce its perviousness is usually so low as to be ineffective. Further than that, the high pressure area under the condition illustrated in FIG. 7 is too far away from the lip of the cup to do much good. By installing a relatively hard bead like 121 near the periphery of the cup, we compress the paper under the bead as illustrated in FIG. 11 and form a barrier which reduces the quantity of air which can pass into the vacuum cup and thus increase the load on the pump.

Those parts of bead 121 which are parallel to the axis of the roll are effective regardless of the diameter of the roll but those parts of the bead which follow the periphery of the roll fit, and are effective, only when the diameter of the roll exactly conforms to the diameter of the bead. Thus, we sometimes prefer to leave off the peripheral beads. Nevertheless, the infiltration of air is materially reduced because of the axial beads. In any case, the bead is never 100% effective in its sealing contact with the roll so some of the air drawn by the pump comes from the border area between bead 121 and strip 51a. Thus, there is always sufficient vacuum in this border area to assure an effective seal between strip 51a and the outer laminate of paper. Due to the relatively small vacuum area effective to force strip 51a against the roll, and due to the softness of the strip, strip 51a performs the function of compressing the roll only to a negligible degree even though it forms nearly a perfect seal against the outer laminate. We find that it is not practical to eliminate strip 51a and rely entirely on bead 121 to seal against the passage of air because, as described above, bead 121 could only make an efficient seal when precisely placed on a perfectly smooth (unwrinkled) roll of exactly the required diameter. Thus, with the combination of the hard, rigid bead and the soft flexible strip, we have produced a paper roll cup of extraordinary efficiency.

Having described the invention in what is considered to be the preferred embodiment thereof, it is desired that it be understood that the invention is not to be limited other than by the provisions of the following claims.

We claim:

1. A vacuum cup comprising:

a base member including a flexible portion forming a cup for connection to a source of vacuum,
an endless elastomer sealing strip for engaging a load, means for creating a vacuum in said cup when said strip is engaging a load,
said strip being T shaped in cross section with the head of the T comprising a base portion and the leg of the T comprising a load engaging portion and being flexible at the tip end thereof,
means removably connecting said strip to a peripheral portion of said cup,
said means providing an undercut groove defined in part by a pair of lip portions extending toward one another in overlapping relation to the base portion of said strip,
said means mounting said lip portions for separating movement from one another to enable ready removal and insertion of said strip from said groove.

2. A vacuum cup comprising:

a basement member having a front face and a rear face, an elastomer sheet of material having an opening formed therein,
said front face having a forwardly extending load-engaging portion fitting in said opening that is larger than said opening so as to expand the marginal portions of said sheet surrounding said opening whereby the undeformed peripheral marginal portions of said sheet are constrained to assume positions offset from the plane of said opening so as to form a cup, including a peripheral lip for engaging a load,
means cupping said sheet in a direction forwardly of said front face such that said peripheral lip is maintained free of engagement with said base member and freely flexible relative thereto,
said lip being disposed forwardly of said load-engaging portion so that said lip can conform to the surface of a load to be lifted,
and means for creating a vacuum in said cup when said lip is engaging a load.

3. A vacuum cup comprising:

a base member having a front face and a rear face, a flat elastomer sheet of material having an opening formed therein,
said front face having a forwardly extending load-engaging portion fitting in said opening that is larger than said opening so as to expand the marginal portions of said sheet surrounding said opening whereby the undeformed peripheral marginal portions of said sheet are constrained to assume positions offset from the plane of said opening so as to form a cup including a peripheral lip,
at least certain of said peripheral marginal portions being reversely curved and secured to said base member so as to cup said sheet in a direction forwardly of said base member and maintain said peripheral lip free of engagement with said base member and freely flexible relative thereto,
said lip extending forwardly of the most forwardly disposed face of said load-engaging portion so that said lip can be conformed to the surface of a load to be lifted,
and means for creating a vacuum in said cup when engaging a load.

4. A vacuum cup comprising:

a base member having front and rear faces, an elastomer sheet of material having an opening formed therein,
said front face having a load-engaging portion fitting in said opening that is larger than said opening so as to expand the marginal portions of said sheet surrounding said opening whereby the undeformed peripheral marginal portions of said sheet are con-

strained to assume positions offset from the plane of said opening so as to form a cup,
 means cupping said sheet in a direction forwardly of said front face,
 and a load contacting strip on the forwardly directed surface of said sheet adjacent said peripheral marginal portions for engaging a load,
 said strip being removable whereby it can be replaced when worn out without replacing the entire said sheet,
 and means for creating a vacuum in said cup when said strip is engaging a load.

5. A vacuum cup according to claim 4 wherein:
 said load contacting strip has a base portion and a load contacting portion projecting from said base portion intermediate the edges of said base portion to leave flanges flanking said load contacting portion,
 means removably mounting said strip on said sheet,
 said mounting means including a pair of opposed lips overlapping said flanges,
 said lips being permanently secured to said sheet,
 said sheet being flexible in the portions thereof between said lips to enable said lips to be separated from said flanges by flexing said sheet.

6. A vacuum cup comprising:
 a cup-shaped member.
 means for creating a vacuum within said cup-shaped member,
 an endless elastomer load contacting strip,
 said strip being of inverted T shape in cross section and including a base portion which constitutes the head of the T and a load contacting portion which constitutes the shank of the T,
 support means for supporting said strip,
 said means including a member providing a surface against which said base portion of the strip contacts,
 said member providing a pair of opposed elastomer lips overlapping the opposite marginal portions of the base portion to retain said strip against said surface,
 said lips being resilient to enable them to be pulled back to release said strip,
 at least the shank of said strip having a lower durometer hardness index than said lips,
 said shank in cross section being of a width substantially less than that of the head and tapering inwardly from said base portion in a direction toward the free, load-contacting end of said shaft so as to define a blunt point at said end.

7. A vacuum cup comprising:
 a rigid base plate having a front face and a rear face,
 a sheet of elastomer material having an opening formed therein,
 said base plate having a portion on its front face disposed in said opening,
 said portion being larger than said opening to expand the marginal portions of the sheet which surround the opening and thus cause a relative displacement of such marginal portions and the remainder of said sheet in a direction perpendicular to the plane of the sheet,
 at least certain of the peripheral portions of said sheet being reversely bent in a rearward direction and secured to said base plate to constrain said sheet to flare or cup in a forward direction,
 said base plate having a suction passage adapted for connection to a source of vacuum and opening through the front face within the area defined by said marginal portions of said sheet,
 an endless elastomer base strip permanently secured to the front face of said sheet intermediate the inner and outer margins thereof in surrounding relation to said opening in said sheet,

said base strip being formed with a forwardly facing longitudinally extending undercut groove defined in part by a pair of flexible opposed flanges,
 and an endless load contacting strip having a base portion disposed in said groove and a portion projecting forwardly from said groove for engaging a load, the base portion of said strip projecting laterally to underlie said base strip flanges so that said strip is retained by said base member but said strip is removable by separation of said flanges.

8. A suction apparatus for picking up a cylindrical object having its axis horizontal,
 said apparatus comprising,
 a fixed support for partially supporting the cylindrical surface of said object at a place below the axis thereof,
 and suction cup means for engaging the cylindrical surface of the object at a place above said object axis,
 said suction cup means including a sheet of elastomer material and a base structure having a portion fitting in an undersize opening in said sheet to cause the sheet to assume a cup form and hold said object partially on said support,
 and means for connecting said base structure to a source of vacuum.

9. A suction apparatus as set forth in claim 8 in which said suction cup means is pivoted at its longitudinal center so it can automatically adjust its position so all portions of the evacuated area pull only radially on the cylindrical object and with equal intensity.

10. A suction cup comprising:
 a pair of cylindrically curved base sections including support portions hingedly connected together at certain longitudinal edges thereof for pivotal movement about an axis parallel to the axes of curvature of said base sections and an elastomer sheet covering and supported by the support portions,
 elastomer lip means around the outer edges of the connected sections for engaging a load,
 means mounting each section for pivotal movement about an axis parallel to the above mentioned axes so that said sections can assume a generally conforming relation to a cylindrical object,
 fixed means inwardly of said lips for engaging said object and limiting approaching movement of said cup and said object,
 and means for creating a vacuum in said cup,
 said lip means projecting substantially forwardly of said fixed means so that said lip means can conform to objects of different diameters to permit them to be picked up,
 the said sheet passing over the hingedly connected longitudinal edges of said support portions so as to provide an airtight connection along said edges.

11. A suction apparatus for picking up a cylindrical object having its axis horizontal,
 said apparatus comprising,
 a fixed support for engaging the cylindrical surface of said object at a place below the axis thereof,
 suction cup means for engaging the cylindrical surface of the object at a place above said object axis,
 said suction cup means including a sheet of elastomer material and a base structure having a portion fitting in an undersize opening in said sheet to cause the sheet to assume a cup form,
 and means for connecting said base structure to a source of vacuum,
 said support having a load engaging face which is inclined to the vertical and faces generally upwardly for disposition at least partially under the cylindrical surface of said object for partially supporting the same,

said load engaging face constituting a friction surface against which said roll bears to retard downward movement of said roll.

12. A suction cup comprising:

means for creating a vacuum in said cup, 5
a pair of cylindrically curved base sections hingedly connected together edge to edge at certain edges thereof for pivotal movement about an axis parallel to the axes of curvature of said base sections, 10
and an elastomer sheet secured to both base sections but permitting pivotal movement between said sections, 15
said sheet providing a lip at the periphery thereof and spaced forwardly of said base sections for engaging a load, 20
said sheet passing over the hingedly connected edges of said base sections so as to provide an airtight connection along said edges.

13. A vacuum cup for picking up a cylindrical paper roll, said cup comprising:

means for creating a vacuum in said cup, 20
a sheet of elastomer material and a rigid base structure having a portion fitting in an undersized opening in said sheet to cause said sheet to assume a cup form having an offset peripheral lip portion, 25
means deflecting said sheet forwardly of said base structure and maintaining said peripheral lip portion free to flex toward and away from said base structure, 30
an endless elastomer load-contacting strip having a base portion and a resilient load-contacting portion projecting from said base portion, 35
means mounting said strip on the flexible peripheral lip portion of said sheet, 40
and a bead of greater hardness than the load-contacting portion of said strip, said bead being mounted on said base structure and positioned interiorly of the periphery of said sheet and spaced inwardly of said load-contacting strip for engaging said paper roll and providing a zone of density in said roll to retard infiltration of ambient air through said roll into said cup.

14. A vacuum cup for picking up a cylindrical object comprising:

a pair of cylindrically curved rigid base sections hingedly connected together at certain edges thereof for pivotal movement about an axis parallel to the axes of curvature of said base sections, 45
each of said base sections having a concavely curved front face, 50
a sheet of elastomer material having a pair of openings therein, 55
each of said base sections having a load-engaging portion on its front face disposed in a different one of said openings and at least one of said base sections also including vacuum forming means, 60
said load-engaging portions being larger than their respective openings to expand the marginal portions of said sheet which surround said openings and thus cause a relative displacement of the peripheral edge portions of said sheet in a direction normal to said front faces, 65
said cup including means for constraining said sheet to cup in a forward direction such that peripheral portions of said sheet are disposed forwardly of said load-engaging portions and are free to flex toward and away from said front faces for readily conforming to the surfaces of cylindrical objects of different diameters, 70
the hinged connection between said base sections being substantially impervious to ambient air, 75
and means mounting each of said base sections for pivotal movement about an axis parallel to the

above-mentioned axes so that said sections can assume a generally conforming relation to a cylindrical object.

15. A vacuum cup comprising:

a rigid base plate having a front face and a rear face, 5
a sheet of elastomer material having an opening formed therein, 10
said base plate having a portion on its front face disposed in said opening, 15
vacuum forming means coupled to said opening, 20
said portion being larger than said opening to expand the marginal portions of the sheet which surround the opening and thus cause a relative displacement of the remainder of said sheet in a direction perpendicular to the plane of the sheet, 25
at least certain of the peripheral portions of said sheet being reversely bent in a rearward direction and secured to said base plate to constrain said sheet to flare or cup in a forward direction, 30
said base plate having a suction passage adapted for connection to a source of vacuum and opening through the front face within the area defined by said marginal portions of said sheet, 35
and an endless load-contacting strip on the forwardly flaring portion of said sheet intermediate the inner and outer margins thereof in surrounding relation to said opening.

16. A vacuum cup comprising:

a rigid base plate having a front face and a rear face, 40
a sheet of elastomer material of generally rectangular shape having an opening formed therein, 45
said base plate having a portion on its front face disposed in said opening, 50
said portion being larger than said opening to expand the marginal portions of the sheet which surround the opening and thus cause a relative displacement of the remainder of said sheet in a direction perpendicular to the plane of the sheet, 55
said sheet having extensions on one pair of opposite edge portions thereof, 60
said extensions being reversely bent in a rearward direction and secured to said base plate to constrain all four peripheral edge portions of said sheet to flare or cup in a forward direction, 65
the other pair of opposite peripheral edge portions of said sheet being free of said base plate and spaced forwardly of said front face so as to conform readily to irregular and curved surfaces of different sizes and shapes, 70
said base plate having a suction passage adapted for connection to a source of vacuum and opening through the front face within the area defined by said marginal portions of said sheet.

17. In a pickup device for a horizontal cylindrical object,

a lift carriage, 75
a stationary support mounted on the carriage tangent to said object at a point below the center of said object and above the lowermost point of said object, 80
a plurality of rigid panel members hingedly connected to each other on an axis parallel to the longitudinal axis of said object, 85
a flexible sheet of elastomer material secured to and covering said panel members and forming a load-engaging cup, 90
connecting means hingedly connected to said panel members and to said carrier member to enable said flexible sheet to conform to the cylindrical face of said object, 95
and means extending through said sheet and at least one of said panel members for creating a vacuum in said cup.

13

References Cited by the Examiner

UNITED STATES PATENTS

438,584	10/1890	Jarboe	294—65	
762,499	6/1904	Sprague	294—64	
1,964,623	6/1934	Durand	222—386	X 5
2,667,283	1/1954	MacDonald.		
2,683,546	7/1954	Sherriff	294—88	
2,754,016	7/1956	Anderson	214—147	
2,819,111	1/1958	Cozzens	294—106	
2,893,581	7/1959	Cushman	294—64	10

14

2,903,803	9/1959	Austin	214—147
2,942,745	6/1960	Horton	214—650
3,089,723	5/1963	Fortson	294—65

FOREIGN PATENTS

508,556	12/1954	Canada.
---------	---------	---------

M. HENSON WOOD, JR., *Primary Examiner.*

ANDRES H. NIELSEN, WILLIAM B. LABORDE,

ROBERT B. REEVES, *Examiners.*