May 26, 1970 A. A. LITT ET AL 3,514,065

SUCTION CUP DEVICE

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FIG. 1.

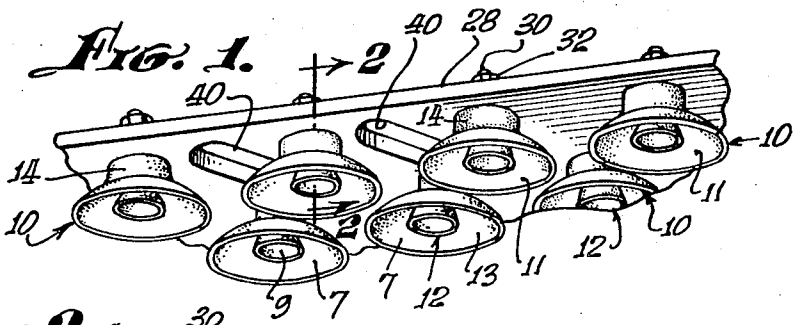


FIG. 2.

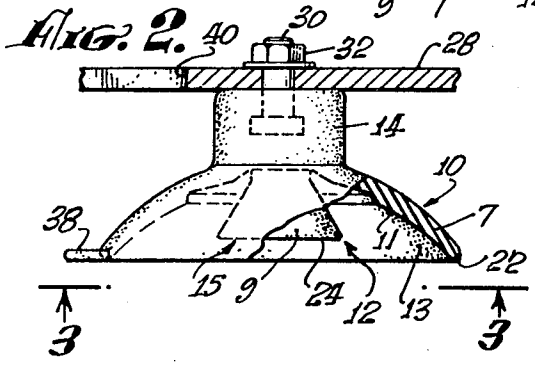


FIG. 3.

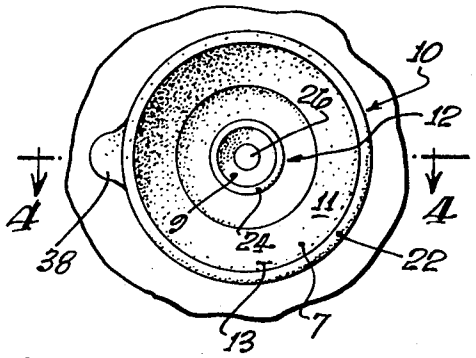
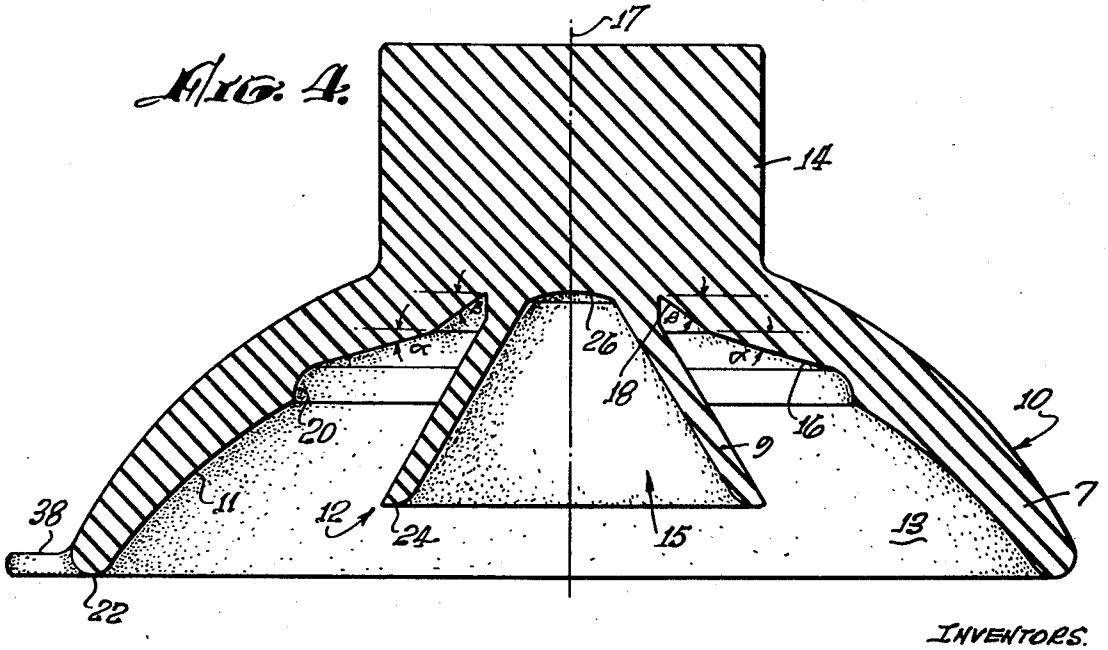


FIG. 4.



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FIG. 5.

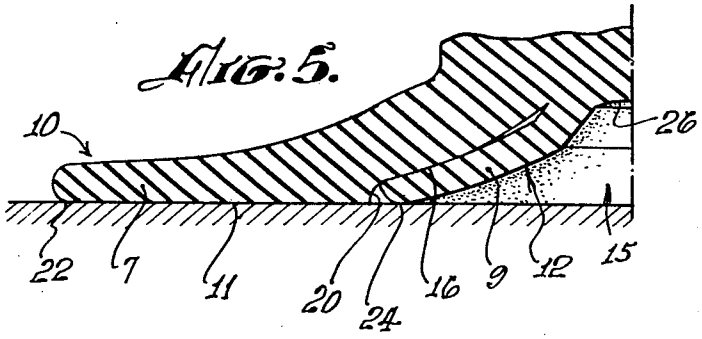


FIG. 9.

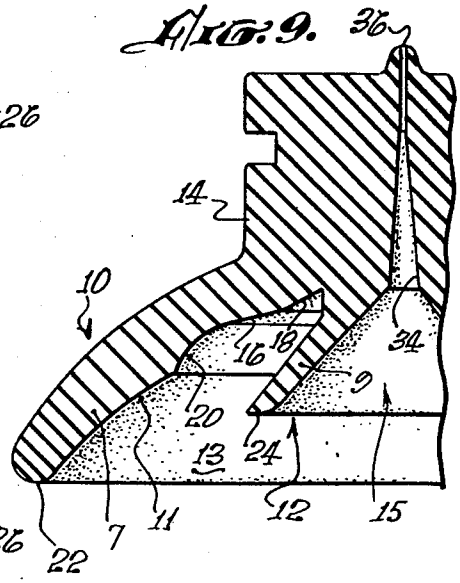


FIG. 6.

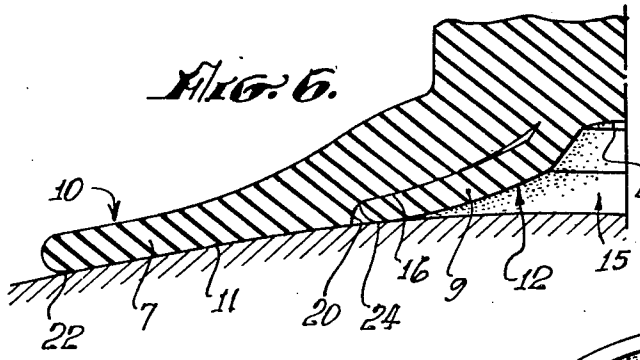


FIG. 7.

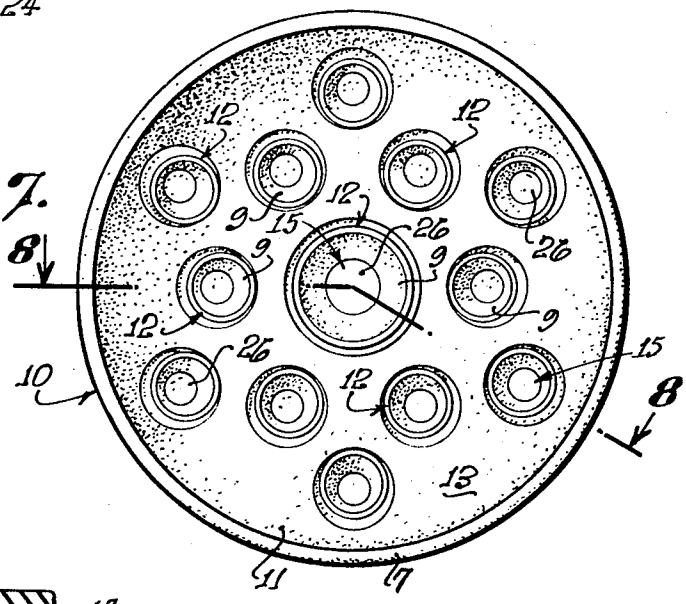
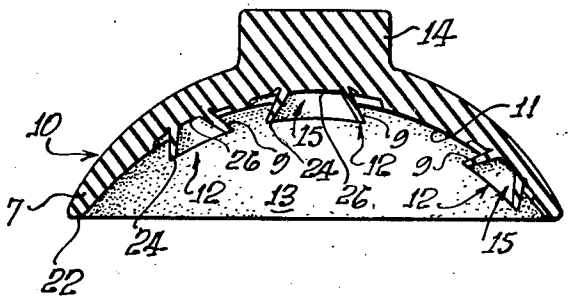


FIG. 8.



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SUCTION CUP DEVICE

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U.S. Cl. 248—363 11 Claims

ABSTRACT OF THE DISCLOSURE

A suction cup device comprising one or more flexible inner suction cups projecting from and wholly disposed within the interior cavity defined by a flexible outer suction cup wherein there is defined by the interior wall surface of the outer suction cup an annular clearance concentric about each of said inner suction cups, such annular clearance being of sufficient dimension whereby, upon compression of the device against an object, the walls of the inner suction cups become substantially coincident with the interior wall surface of said outer suction cup. The suction cup device disclosed may further include a self-sealing air exhaust valve facilitating the exhaustion of air from the aforesaid interior cavity.

BACKGROUND OF THE INVENTION

Field of the invention

The present invention relates to suction cup devices and more particularly to a plurality of integrally formed suction cup devices having greater holding power for use in moving heavy and hard to manage objects not having convenient support means.

Description of the prior art

For some time, it has been known in the art that the addition of a second or auxiliary suction cup to the interior of an outer, or master, suction cup will increase the holding power of the master cup over that obtainable with but a single, master cup. Such a dual configuration is shown in U.S. Letters Patent Nos. 1,298,139 and 1,758,962 issued to C. M. Wolcott and Carl Miller, respectively. A major disadvantage with similar structures now known in the art is that, due to the construction of such devices, upon compression against an object, the interior suction cup tends to crumple and double up against the interior wall surface of the outer suction cup thereby precluding the more complete exhaustion of trapped air achievable with the construction of the present invention. Furthermore, known devices of a related construction depend entirely upon exhaustion of trapped air from around the distal edges of the master or outer suction cup in order to create the desired negative pressure gradient. Such dependency is not desirable for the simple reason that air remaining trapped within the interior cavity of the device after the walls of the suction cup have become fully distended precludes the greater negative pressure gradient that could be created if the trapped air could be exhausted. Accordingly, an improved suction cup device has been invented which, in surmounting the shortcomings of the prior art, provides a device capable of greater holding power than that heretofore known.

SUMMARY OF THE INVENTION

The present invention is best summarized as a flexible outer suction cup which wholly encompasses within its interior cavity one or more inner suction cups projecting interiorly therefrom, and an annular clearance concentrically defined about each of said inner suction cups by the interior wall surface of said outer suction cup, wherein

said inner and outer suction cups may project from a common base member which may alternately include a self-sealing exhaust valve means to cooperate with the interior cavity of the inner suction cup to facilitate air exhaustion therefrom.

It is a primary object of the present invention to provide an improved suction cup device having an increased holding potential.

A further object of the present invention is to provide a suction cup device constructed to maximize the negative pressure gradient created within the cavity formed by such cups.

The present invention, together with the advantages thereof, will be better understood by reference to the following detailed description in the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings wherein like parts are accorded the same reference numerals wherever they are illustrated:

FIG. 1 is a lower perspective view of one configuration of a combination embodying the present invention;

FIG. 2 is a side elevation view and partial cross-section of an embodiment of the present invention taken along the lines 2—2 of FIG. 1;

FIG. 3 is a bottom plan view taken along the lines 3—3 of FIG. 2;

FIG. 4 is a cross-section view taken along the lines 4—4 of FIG. 3;

FIG. 5 is a cross-section view of a portion of an embodiment of the present invention in distended compression on a flat surface;

FIG. 6 is a cross-section view of a portion of an embodiment of the present invention in distended compression on a curved surface;

FIG. 7 is a bottom plan view of another embodiment of the present invention;

FIG. 8 is a section view taken along the line 8—8 of FIG. 7; and,

FIG. 9 is a cross-section view of another embodiment of the present invention.

DETAILED DESCRIPTION OF AN EMBODIMENT

Referring to the accompanying drawings and particularly to FIGS. 2, 3 and 4, there is illustratively depicted an embodiment of the present invention. The illustrative embodiment may be viewed as comprising an outer, or master, suction cup **10** and an inner suction cup **12** which project from the common base compression hub **14**. A preferred embodiment is constructed so that the wall **7** of the outer cup **10** forms a dome-like structure, the interior wall surface **11** of which defines the interior cavity **13** from which air is exhausted when the device is compressed to create a negative pressure gradient with respect to the exterior ambient pressure. It is found that the efficiency of the present invention is greatly increased over that achieved by known vacuum cup devices if the outer cup **10** is constructed to have a height to maximum diameter dimensional ratio of no less than 1:3. The wall **9** of the inner cup **12** preferably forms a substantially conical structure having a closed apex **26** which defines the interior cavity **15**.

It has been found to be most economical to integrally form the illustrative embodiment in a single unit of some suitably flexible material such as rubber. Flexibility ranges corresponding to readings of 45–65 on the rubber Durometer scale have been found to be preferable for efficient operation of the present invention.

In the illustrative embodiment, the outer cup **10** and the inner cup **12** integrally intersect one another and project from the common base compression hub **14**. In the formation of a single device, it has been found prefer-

able to concentrically dispose the inner and outer cup **10** and **12** and the compression hub **14** about a common axis **17**.

It has been found that the proximately adjacent annular undercut portions or clearances, **16** and **18** defined by the interior wall surface **11** of the outer cut, are important improvements in maximizing the negative pressure gradient generated by compression of the device against an object. It has been found advantageous to form the interior beveled surface of the clearance **16** at an acute angle α of approximately 16° with the projection of an imaginary plane passing perpendicularly through the axis **17**. Similarly, it has been found to be advantageous to form the annular clearance **18** at a larger acute angle β of approximately 35° with the projection of an imaginary plane perpendicular to the axis **17**. As illustrated in FIGS. 4, 5 and 6, the tapered wall **9** of the inner cup **12** is designed to have a lesser flexural strength than the wall **7** of the outer cup **10** so that upon compression against either a flat or a curved surface, the inner cup wall is distended into the clearances **16** and **18** to become substantially coincident with the interior wall surface **11** of the outer cup **10**. As depicted in the illustrative embodiment, the lesser flexural strength of the wall **9** may be achieved through thinner wall construction than that of the wall **7**. Thus, the two bearing surfaces, or walls of the inner and outer suction cups, cooperate under compression to form an effective single vacuum cup. The device thus collapsed combines the holding power of the multiple cup unit, yet achieves the maximized air exhaustion achievable with the single cup unit. While it is considered desirable that the base compression hub **14** have a relatively wide cross-sectional dimension to insure maximum "flattening" of the cups, it has been found preferable that such dimension be less than the diametrical dimension of the inner cup **12** when distended into the clearance **16** in order to avoid trapping unexhausted air within the area defined by the clearance **16**, **18** and the inner suction cup wall **9**.

Referring now with particularity to FIG. 4, the present invention embodies several novel concepts for insuring virtually complete exhaustion under compression and for preserving the integrity of the negative pressure gradient thereby created. For example, it has been found preferable to curvilinearly shape the apex **26** of the inner cup **12** to extend above the clearance **18**. In like manner, the distal edge **20** of the clearance **16** is curvilinearly formed to facilitate air exhaustion from the respective cavities **13** and **15**. It has also been found preferable to form the distal edges **22** and **24** of the outer and inner cups **10** and **12**, respectively, in a curvilinear configuration to preserve the integrity of the negative pressure gradient created across the outer suction cup **10**; in the illustrative embodiment such curvilinear configurations are portions of substantially circular arcs.

Because of the high degree of efficiency of the holding force created by the previously described device, it has been found desirable to include the tab **38** at the distal edge **22** of the outer cup **10** for the purpose of breaking the vacuum seal when release is desired.

Having thus described the basic unit of the present invention, with reference now to FIGS. 7 and 8, there is depicted an additional embodiment of the present invention wherein a single master or outer cup **10** encompasses a plurality of the previously described inner cups **12** to maximize the novel features of the present invention. While the number of inner cups **12** may be left to choice, in each case they are concentrically disposed within the previously described clearances **16** and **18** annularly defined by the interior wall surface **11** of the outer cup **10**.

With reference to FIG. 9, substantially complete air exhaustion from the cavities **13**, **15** of the illustrative embodiment of the present invention may be achieved through the self-sealing exhaust valve comprised of the substantially conical exhaust chamber **34** and the substantially cylindrical exhaust chamber **36** axially defined through the base compression hub **14**. The exhaust valve may be constructed of a flexibly soft material having rubber-like characteristics so that upon compression of the device, air trapped within the cavities **13**, **15** may be exhausted not only around the distal edges **22**, **24** but also through the chambers **34**, **36** to the atmosphere. It has then been found that upon release of the compressive force, the negative pressure gradient thereby created across the outer suction cup **10** acts on the device to seal off the chambers **34**, **36** against the further introduction of air at the exterior ambient pressure.

As illustratively depicted in FIGS. 1 and 2, the present invention embodying the features hereinbefore described may be individually attached to handles or attached in groups to holding platforms **28** for convenient use in handling or moving large or bulky objects. One form of attachment is depicted in FIG. 2 wherein a threaded bolt **30** is embedded in the compression hub **14** to project therefrom through the platform **28** to be secured by means of the nut **32**. It will be apparent that the same result may be achieved by embedding any of various types of nuts, such as a Tinnerman nut for example, within the hub **14** through which may be threaded an affixing bolt or screw. The platform **28** may be provided with suitably spaced optinings **40** to permit access to the release tabs **38** forming a part of suction cups interiorly affixed to the platform.

There has thus been described a novel, improved suction cup device constructed to maximize the advantages inherent in multiple suction cup configurations and to overcome the disadvantages of such configurations presently known in the art. While the foregoing detailed description has been made with reference to selected embodiments of the present invention, it will be understood that the true scope or the present invention is as defined in the following claims.

What is claimed is:

1. A suction cup device comprising:
(a) a flexible outer suction cup having an interior wall surface;
(b) a flexible inner suction cup projecting from and wholly encompassed within the cavital area defined by said interior wall surface; and,
(c) an annular clearance defined in said interior wall surface about the exterior periphery of said inner suction cup on an axis common to said inner suction cup and said annular clearance.

2. A suction cup device comprising:
(a) a flexible outer suction cup having an interior wall surface, said outer suction cup being constructed to form a substantially dome-like structure having a minimum interior height dimension of not less ⅓ of the distance between diametrically disposed points on the distal edge thereof;
(b) a flexible inner suction cup projecting from and wholly encompassed within the cavital area defined by said interior wall surfaces; and,
(c) an annular clearance defined in said interior wall surface about the exterior periphery of said inner suction cup on an axis common to said inner suction cup and said annular clearance.

3. A suction cup device comprising:
(a) a flexible outer suction cup having an interior wall surface;
(b) an annular clearance defined in said interior wall surface;
(c) a flexible inner suction cup wholly disposed within the interior cavity defined by said outer suction cup; and,
(d) a common base compression member from which said suction cups concentrically project in a spaced apart relationship about a common axis, said base compression member having a maximum cross sectional dimension less than the distance between dia-

metrically opposed points on the distal edge of said outer suction cup.

4. A suction cup device comprising:

(a) a flexible outer suction cup having an interior wall surface;

(b) a flexible inner suction cup having its distal edge interiorly disposed within the cavity defined by said interior wall surface, said inner suction cup having a wall of lesser flexural strength than the wall of said outer suction cup;

(c) a base compression member from which suction cups concentrically project in spaced apart relationship about a common axis, said base compression member having a maximum cross sectional dimension less than the distance between diametrically opposed points on the distal edge of said outer suction cup;

(d) said outer suction cup defining about its interior wall surface an annular clearance of sufficient dimension whereby upon sufficient compression against an object, said wall of said inner suction cup becomes substantially coincilent with the interior wall surface of said outer suction cup.

5. A suction cup device comprising:

(a) a flexible outer suction cup having an interior wall surface;

(b) a base compression member from which said outer suction cup coaxially projects;

(c) a plurality of inner suction cups interiorly projecting from said interior wall surface having their distal edges wholly disposed within the cavity defined by said interior wall surface; each of said inner suction cups having a wall of lesser flexural strength than the wall of said outer suction cup; said inner suction cups being so disposed within said cavity that not more than one of said inner suction cups is concentrically aligned with respect to said outer suction cup; and,

(d) an annular clearance defined by said interior wall surface about each of said interior suction cups, said clearance having a sufficient dimension whereby upon sufficient compression against an object, said walls of each of said inner cups become substantially coincident with said interior wall surface of said outer suction cup.

6. The device defined in claims 1, 2, 3, 4 or 5 and further including a second annular clearance defined by said interior wall surface concentrically about the intersection of said inner and outer suction cups.

7. In the device in claims 1, 2, 3, 4 or 5 wherein the distal edges of said outer and inner suction cups define portions of substantially circular arcs of predetermined radii.

8. In the device defined in claims 1, 2, 3 or 4 wherein said annular clearance forms an acute angle with a plane passing perpendicularly through said axis, and said clearance curvilinearly intersects said interior wall surface at a predetermined radial distance from said axis.

9. The device defined in claim 3 or 4 and further including a self-sealing exhaust means axially disposed through said base compression member whereby air is exhausted from the interior cavities defined by said suction cups upon application of compressive force.

10. An integrally formed suction cup device comprising:

(a) a flexible outer suction cup having a dome-like configuration, the wall of which defines a first interior cavity, said wall having a curvilinear distal edge of predetermined radius;

(b) a flexible inner suction cup having a substantially conical configuration with a concave apex of predetermined radius, the wall of which defines a second interior cavity, said inner suction cup being concentrically disposed wholly within said first interior cavity, said inner suction cup wall having a decreasing thickness from said apex to the distal edge thereof;

(c) a base compression member from which said outer and inner suction cups project on an axis common to said suction cups and said base compression member; said compression member having a maximum cross-sectional dimension less than the maximum distended diametrical dimension of said inner suction cup when under compression;

(d) a first annular clearance defined by the interior wall surface of said outer suction cup concentrically about the exterior periphery of said inner suction cup proximate and below the apex thereof, said first annular clearance being constructed to form a first acute angle with a plane passing perpendicularly through said common axis; and,

(e) a second annular clearance defined by the interior wall surface of said outer suction cup immediately adjacent said first annular clearance to be concentric about said inner suction cup, said second annular clearance being of sufficient dimension whereby upon sufficient compression against an object, said wall of said inner suction cup becomes substantially coincident with the interior wall surface of said outer suction cup.

11. The device defined in claims 1, 2, 3, 4 or 5 and further including a tab-like protrusion integrally formed with said outer suction cup to project outwardly from a position proximate the distal edge of said outer suction cup.

References Cited

UNITED STATES PATENTS

1,577,608	3/1926	Brewer	248—206 X
2,910,264	10/1959	Lindenberger	248—362

FOREIGN PATENTS

544,154	3/1942	Great Britain.

CHANCELLOR E. HARRIS, Primary Examiner

U.S. Cl. X.R.

248—206