July 23, 1946. R. M. STEPHENS 2,404,412

VACUUM CUP

Filed Oct. 7, 1943

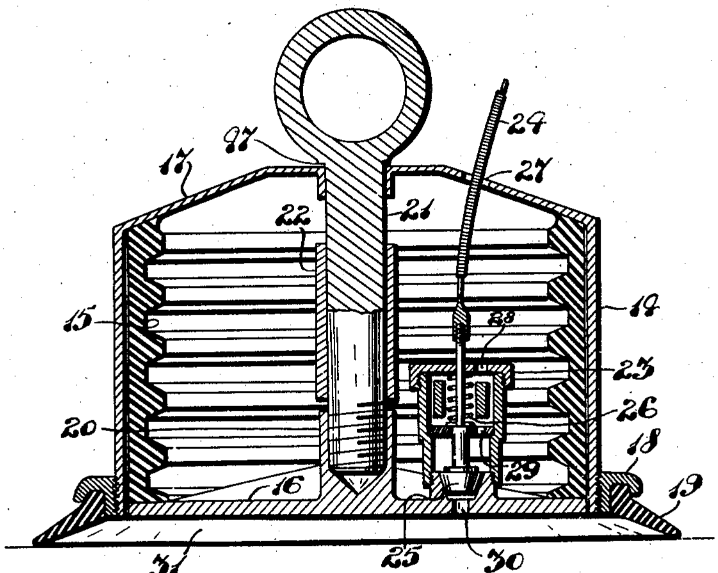

FIG. 2.

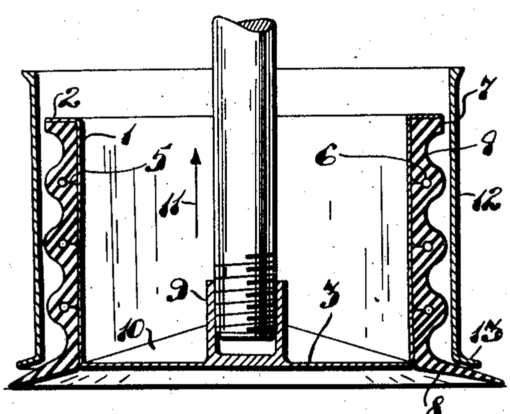

FIG. 1.

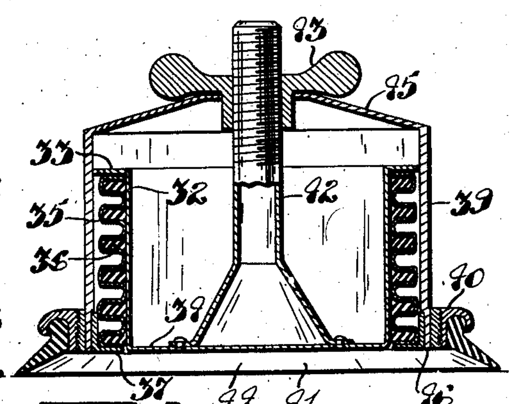

FIG. 3.

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2,404,412

VACUUM CUP

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5 Claims. (Cl. 248—206)

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My invention relates to improvements in vacuum cups, an object of the invention being to provide a device of the character herewithin described which derives its retentive power from the evacuating of fluid from beneath a volume displacement wall therein, by movement of said volume displacement wall in combination and simultaneously with the longitudinal movement of an expansible and contractile surrounding wall.

A further object of my invention is to provide a device of the character herewithin described in which material stresses such as are caused by the deformation of a hemi-spherical cup are eliminated in favour of a longitudinal movement of walls surrounding a volume displacement wall one of these walls being initially moved in a direction at right angles to the major plane thereof for the purpose of exhausting fluid from beneath the volume displacement wall, after which it is drawn in the opposite direction to create a high degree vacuum.

A further object of my invention is to provide a device of the character herewithin described which may be manufactured in any dimensions, being capable of providing a vacuum grip regardless of size, in contrast to conventional hemispherical rubber vacuum cups, which are limited by the material to small sizes.

A further object of my invention is to provide a device of the character herewithin described, in association with which a fluid valve is provided for the instantaneous admission of fluid when it is desired to terminate a vacuous condition in the cup.

A further object of my invention is to provide a device of the character herewithin described, all embodiments of which are of extremely simplified construction, simple to operate, and designed to sell for a reasonable price.

With the above more important objects in view and such other minor objects as may appear as the specification proceeds, my invention consists essentially in the arrangement and construction of parts all as hereinafter more particularly described, reference being had to the accompanying drawing, in which:

Figure 1 is a sectional elevation illustrating the first embodiment of my vacuum cup.

Figure 2 is a sectional elevation illustrating an alternative embodiment of my vacuum cup.

Figure 3 is a sectional elevation illustrating a third embodiment of my vacuum cup including means for obtaining mechanical advantage in raising the piston.

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In the drawing like characters of reference indicate corresponding parts in the different figures.

In the first exemplification of my invention as illustrated in the accompanying Figure 1, it will be seen that I employ a rigid inner cylindrical wall 1, open at the upper edge thereof and outwardly flanged as at 2, while the lower edge is spanned with a circular volume displacement wall 3, which is secured all around the perimeter thereof to the lower edge of the wall 1 to make fluid sealing contact therewith.

Surrounding the rigid wall 1 is an expansible and contractile wall 4 of rubber or the like, the outer surface of which is corrugated, while the inner surface is provided with the annular fissures 5 terminating in the annular passages 6, whereby to produce a wall structure which is capable of considerable longitudinal movement.

The upper surrounding perimeter 7 of the wall 4 is secured in sealing contact to the underside of the flange 2, while the lower edge of this wall is annularly flared to provide the skirt or fluid sealing gasket 8.

Positioned concentrically upon the upper surface of my volume displacement wall 3 is an internally screw-threaded boss 9 suitably stiffened by the webs 10, and designed to receive means for effecting movement of the volume displacement wall in a direction at right angles to the major plane thereof, or in other words, in the direction of the arrow 11.

Surrounding the elements above described is a cylindrical enclosure 12 primarily for the purpose of facilitating the application of a uniform pressure via the outwardly flared flange 13 upon the sealing gasket 8 substantially simultaneously with the volume displacement wall 3 making contact with the surface to which the device is to adhere. The cylindrical enclosure 12 is primarily for the purpose of rubber conservation, since, by its use an expansible and contractile rubber wall of fairly frail construction may be used, the enclosure 12, in such case functioning as a species of straight jacket to resist the possible lateral distension of the rubber wall. Such distension might occur by reason of atmospheric pressure built up by air entrapped by the sealing gasket 8. From this it will be apparent that an expansible and contractile rubber wall of sufficiently robust construction would eliminate the need for the metallic enclosure 12.

However, in one particular use which has occurred to me, a separate cylindrical enclosure such as the enclosure 12 is essential, namely that

of a domestic plunger as used for household sinks and the like. In this instance, it will be realized that the presence of some air in the clogged drain will prevent the formation of a full vacuum being obtained, thus rendering impossible the self adhesion of the vacuum cup to the floor of the sink. It will be seen therefore that means will be required to keep the sealing gasket 8 in contact with the sink and this function is performed by a three point pressure on the upper edge of the rigid enclosure 12 ensuring a uniform pressure on the whole of the sealing gasket. The vacuum cup then functions as a suction pump and when the expansible wall is upwardly extended, a partial vacuum on the cup side of the locus of obstruction coupled with full atmospheric pressure on the other side tends to loosen the clogged matter. The efficiency of this arrangement can be increased by displacing the air in the drain with water.

In the second embodiment of my invention exemplified in the accompanying Figure 2, it will be seen that I provide a surrounding rigid wall 14 lined upon the inner side thereof with an adjacent and concentrically disposed expansible and contractile wall 15 of rubber or the like and of the configuration clearly illustrated. To the lower perimeter of the wall 15 is secured in fluid sealing contact a volume displacement wall 16, while the upper perimeter of the wall 15 is secured in similar fluid sealing contact either to the upper surrounding extremities of the rigid wall 14 or to a cover plate 17 integral therewith.

Rimmed within an annular flange 18 threadably secured to the lower edge of the wall 14 is an annular fluid sealing gasket 19, and centrally upon the upper surface of the volume displacement wall 16 is an internally screw-threaded boss 20 to which an eye-bolt 21 is secured, and upon which a sleeve 22 may be shrunk for the purpose of limiting the upward longitudinal movement thereof in the manner clearly illustrated. A variety of means for limiting the upward movement of the volume displacement walls 3 or 16 may be resorted to obviously without inventive ingenuity.

In association with the embodiment of Figure 2 I have illustrated a conventional fluid escape valve assembly 23 positioned on the volume displacement wall 16, and operated by a Bowden cable 24 whereby the valve element 25 is lifted from its seating against the resistance of the spring means 26 to permit air to enter through the apertures 27, 28, 29 and 30 and to the area 31 beneath the volume displacement wall 16.

In the accompanying Figure 3 I have illustrated a third exemplification of my vacuum cup wherein I provide a rigid inner cylindrical wall 32 substantially similar to the rigid inner wall associated with my first embodiment, an outwardly projecting annular flange 33 being positioned around the upper rim of the wall 32, while the lower edge thereof is spanned by the volume displacement wall 34. Surrounding the wall 32 is an intermediate expansible and contractile metallic wall 35, the interior corrugations whereof are filled with resilient packing material 36.

The upper end of the wall 35 is secured in fluid sealing contact to the underside of the flange 33 while the lower annular edge is secured in similar fluid sealing contact to the annular angle member 37, which, it will be noted is united to the lower edge of a surrounding structural enclosure 39 to the lower edge of which is secured the annular rim 40 to which is in turn attached a fluid sealing gasket 41 similar to the gasket 19 of Figure 2.

Concentrically secured to the upper side of the volume displacement wall 34 is a screw-threaded bolt 42, on which is threaded the screw 43, and by means of the foregoing assembly it will be apparent that when the vacuum cup is in situ, and after air in the space 44 has been forced out by the depression of the surrounding edge of the structural enclosure 39 and the volume displacement wall 34, these parts are released, the volume displacement wall rising and leaving the space 44 in a vacuous condition. If it is desired to elevate the plane of the volume displacement wall so that it is no longer coextensive with the edge of the enclosure 39, this can easily be accomplished by rotating the screw 43.

Although I have illustrated the structural enclosure 39 in the form of a cylinder and provided with a cover plate 45 against which the screw 43 bears when the volume displacement wall is held in an elevated position, I desire to explain in this context that the said structural enclosure need not necessarily take the form of a cylindrical housing or boxing, but may take the form of a cage or framework as long as the surrounding edge 46 thereof is uninterrupted by any aperture which would permit the introduction of air into the area 44.

From all the foregoing, it will be recognized that I have provided a variety of exemplifications of a vacuum cup novel in principle, and wherein a very high degree of vacuum may be attained when the device is placed against a flat surface, following which it is depressed to flatten out the surrounding gasket and drive out air by bringing the volume displacement wall and the lower edge of the housing into contact with the surface. Thereafter, a tensile force applied on the bosses of the volume displacement wall and tending to move the same within the enclosure bounded by the outer surrounding wall, will create a very high degree of vacuum having the effect of causing the device to adhere with a great tenacity to the surface against which it has been applied, and which tendency to adhere can be utilized in a great variety of industrial ways.

I also desire to draw attention to the fact that the plane of the volume displacement wall must never be lower than that of the surrounding edge 46, or project below the level to which the surrounding gasket may be depressed or flattened out when the device is pressed against a flat surface. In the embodiment of Figure 3, this can be effected by means of the screw 43, and in the embodiment of Figure 2 is effected by the shoulder 47, while it will be obvious that similar means may be resorted to in respect of the embodiment of Figure 1 without the exercise of further invention. On the other hand, it will be obvious that the volume displacement wall must make contact with the flat surface against which the device is being pressed when bringing about a vacuous condition, as otherwise air will not be sufficiently exhausted from below the volume displacement wall.

In conclusion I would state that the method of obtaining sealing contact between the flange of the rigid and contractile walls is as follows. In the case of the metallic bellows, by soldering, or brazing, or else by the method of sealing her-

metically as used in the sealing of coffee cans. In this case the interfaces of the flange and wall to be united are coated with a rubber latex solution and then folded over upon themselves. This is well illustrated on page 124, of "Rationed Rubber" a book by Haynes and Hauser published by Alfred A. Knopf of New York. Should the problem be one of bonding the synthetic rubber noprene to a brass flange, sulphur is added to the neoprene before same is cured (vulcanising process). Other methods in addition are cited by Naunton in his book "Synthetic Rubber"—page 108—McMillan, London, 1937.

Since many modifications can be made in the invention herein described and since the accompanying drawing has been prepared only to illustrate the relative arrangement and interaction of parts and not with regard to accuracy of dimensions for manufacturing purposes which in view of this disclosure I consider to entail merely mechanical skill together with the skill of the mechanical draftsman, and since many apparently widely different embodiments of this invention may be made within the scope of the accompanying claims without departing from the spirit and scope of the same it is intended that all matter contained in the accompanying specification shall be interpreted as illustrative only and not in a limiting sense and I desire only such limitations placed thereon as justice dictates.

What I claim as my invention is:

1. A vacuum cup for attachment to surfaces, comprising in combination a longitudinally expansible and contractile tubular wall, a rigid tubular wall concentric with and adjacent to said first mentioned wall, a volume displacement wall lying at right angles to the tubular axis of said walls, said volume displacement wall being sealed to that perimeter of said inner wall which is adjacent said surface, for movement with said inner wall, said walls being also sealedly secured to each other at the mutually adjacent ends which are opposite to the surface-adjacent ends thereof, a gasket around the surface-adjacent end of one of said walls, and means for effecting simultaneous movement of said volume displacement wall and said inner wall connected thereto, to increase the tubular volume adjacent said surface.

2. The device as defined in claim 1 which includes a valve assembly for permitting the admission of fluid when it is desired to terminate a vacuous condition on the surface side of said volume displacement wall.

3. A vacuum cup for attachment to surfaces, comprising in combination a longitudinally expansible and contractile tubular inner wall, a rigid wall surrounding said inner wall, a volume displacement wall lying at right angles to the tubular axis of said walls, said volume displacement wall being sealed to that perimeter of said inner wall which is adjacent said surface, for movement with said inner wall, said walls being also sealedly secured to each other at the mutually adjacent ends thereof which are opposite the surface-adjacent ends, a fluid sealing gasket secured around one end of said rigid surrounding wall, and means for effecting simultaneous movement of said volume displacement wall and said inner wall connected thereto, to increase the tubular volume adjacent said surface.

4. A vacuum cup for attachment to surfaces, comprising in combination a rigid tubular inner wall, a longitudinally expansible and contractile wall surrounding said rigid wall, a volume displacement wall lying at right angles to the tubular axis of said walls, said volume displacement wall being sealed to that perimeter of said inner wall which is adjacent said surface, for movement with said inner wall, said walls being also sealedly secured to each other at the mutually adjacent ends thereof which are opposite to the surface-adjacent ends, a fluid sealing gasket around one end of said expansible and contractile wall, and means for effecting simultaneous movement of said volume displacement wall and said inner wall connected thereto, to increase the tubular volume adjacent said surface.

5. A vacuum cup for attachment to surfaces comprising in combination a rigid tubular inner wall, a longitudinally expansible and contractile tubular wall surrounding said rigid wall, a volume displacement wall lying at right angles to the tubular axis of said walls, said volume displacement wall being sealed to that perimeter of said inner wall which is adjacent said surface, for movement with said inner wall, said inner and surrounding walls being also sealedly secured to each other at the mutually adjacent ends thereof which are opposite the surface-adjacent ends, a structural enclosure surrounding said tubular walls, a fluid sealing gasket around the surface-adjacent edge of said structural enclosure, means for effecting simultaneous movement of said volume displacement wall and said inner wall connected thereto, to increase the tubular volume adjacent said surface and means co-acting with said structural enclosure for maintaining said volume displacement wall in various transverse planes medially of the length of said surrounding wall, against atmospheric pressure when the cup is in situ and enclosing a vacuum.

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