United States Patent

[11] 3,599,820

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Lexington, Ky.

[54] **HIGH VACUUM-SEALING CLOSURE**
3 Claims, 4 Drawing Figs.

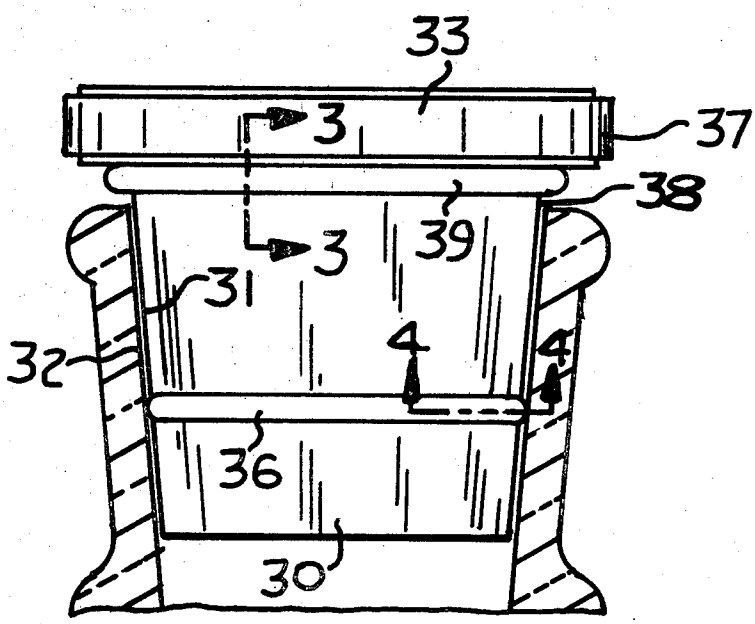
[52] **U.S. Cl.** **215/48,** 220/46, 285/332.3, 277/168
[51] **Int. Cl.** **B65d 39/00**
[50] **Field of Search** 215/47, 48; 220/46; 285/332.3; 277/168

[56] **References Cited**
UNITED STATES PATENTS

2,946,606	7/1960	Smith	215/48 X
3,017,047	1/1962	Payson et al.	215/48 X

Primary Examiner—George T. Hall
Attorney—William E. Sherwood

ABSTRACT: A means for sealing receptacles under a vacuum in the order of 10^{16} mmHg includes dual O-rings mounted on a closure in spaced relation to each other and arranged for easy application of the closure to and removal from the receptacle. A stopper providing a sealed ground glass fit illustrates a use of the invention.



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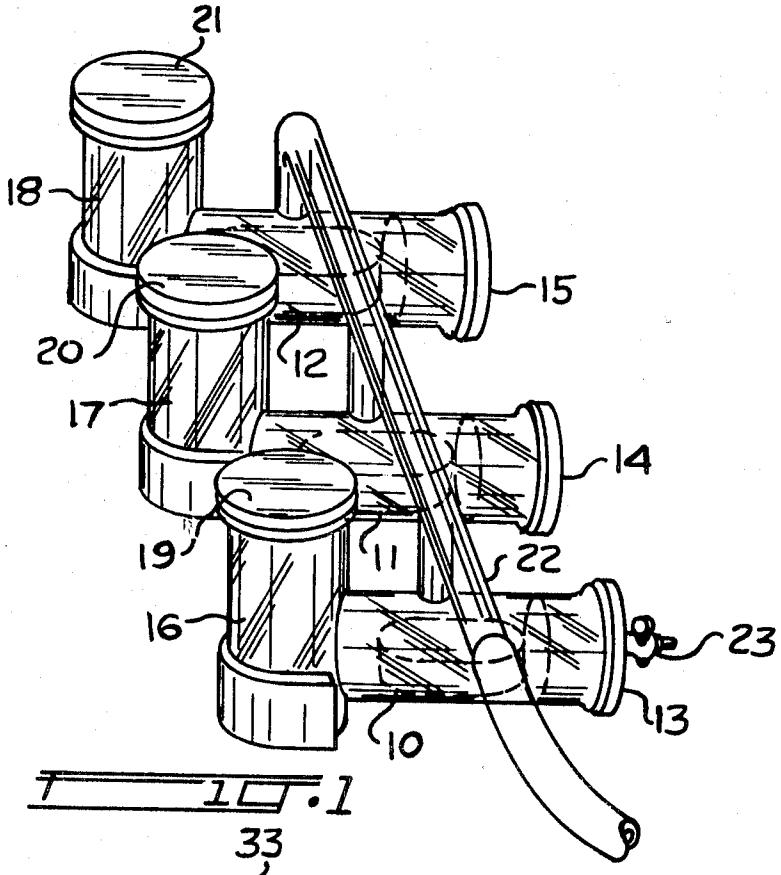


FIG. 1

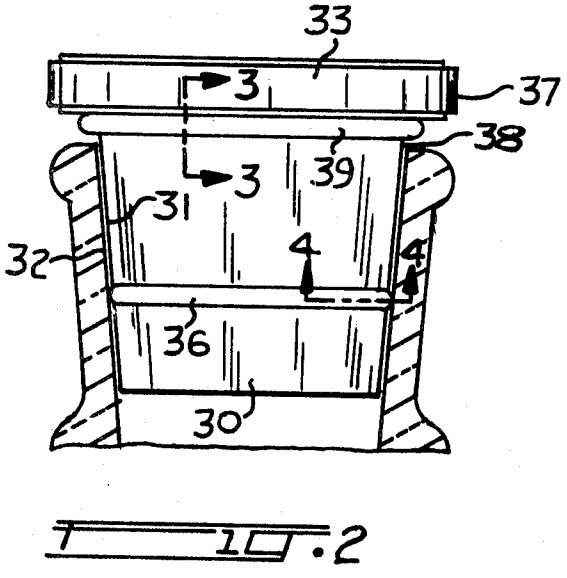


FIG. 2

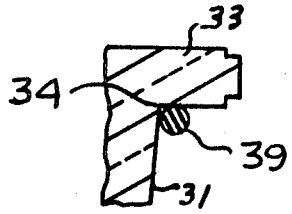


FIG. 3

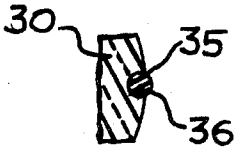


FIG. 4

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HIGH VACUUM-SEALING CLOSURE

BACKGROUND OF THE INVENTION

Various medical and chemical materials require treatment under high vacuum and with freedom from the likelihood of contamination. Certain simple forms of closures, such as solid stoppers fitting into the access opening of the receptacle in which the material is confined, have been proposed, but when the use of stopcock grease with such stoppers is impractical and a tight fit of the stopper and receptacle is demanded, recourse is usually made to a joint seal such as a ground glass fit. Under high vacuum over a period of time a freezing of the glass stopper in the receptacle mouth often occurs and upon later removal of the stopper, a breaking of the receptacle may result. Even under the best conditions with this type of joint seal, considerable physical effort may be required to remove the stopper.

Conventional stoppers employing a single O-ring as exemplified by Smith U.S. Pat. No. 2,946,606 have been employed for vacuums in the order of 10^{13} mmHg, but so far as I am aware are unsuitable for high vacuum ranges. A requirement therefore exists for a more reliable apparatus in which such higher vacuums may be used and without the damage of freezing of the closure to the receptacle when the vacuum is applied over an extended time period.

SUMMARY

The closure of the present invention includes a portion which extends a substantial distance into the mouth of the receptacle and carries a first elastomeric O-ring which normally has its major volume confined in a groove on the closure and with its minor volume in contact with the mouth of the receptacle. The head portion of the closure overlies the mouth of the receptacle and a second elastomeric O-ring is disposed at the juncture of the two portions of the closure. As higher and higher vacuum values are applied to the receptacle, the closure moves inwardly to compress both O-rings. Compression of the first O-ring builds up a restoring force therein which prevents freezing of the closure in the receptacle mouth and compression of the second O-ring effects a backup seal to the seal provided by the compressed first O-ring.

Among the objects of the invention are the provision of an improved simple stopperlike closure for use with receptacles subjected to high vacuum; an improved closure having a machined surface adapted to effect a close mating fit with the surface of the access opening of a receptacle and having dual seals provided by a pair of spaced O-rings; a closure which may be used repeatedly without replacement of its O-rings; and a closure which is resistant to freezing in place following an extended application of high vacuum.

These and other objects and advantages of the invention will become more apparent as the description proceeds and when considered in conjunction with the accompanying drawing in which:

FIG. 1 is a perspective view of one form of apparatus employing a battery of receptacles equipped with sealing closures embodying the present invention.

FIG. 2 is a view showing the closure in elevation and the receptacle mouth in section and with the closure in position prior to application of vacuum to the receptacle.

FIG. 3 is a section on line 3–3 of FIG. 2; and

FIG. 4 is s section on line 4–4 of FIG. 2.

Referring now to FIG. 1, a laboratory apparatus comprising three similar receptacles formed of glass includes horizontally extending sections **10**, **11**, **12**, having mouths in which separate stopper closures **13**, **14**, and **15** are adapted to be fitted. The horizontal sections, which may be adapted to receive boats containing the material to be heat-treated under high vacuum, are joined to upwardly extending sections **16**, **17**, **18** which at their upper ends have mouths in which separate stopper closures **19**, **20**, **21** are to be fitted. A vacuum manifold **22** connects with each of the receptacles and in one

of the stoppers, for example **13**, a valved outlet **23** may be conveniently provided for opening the receptacles to atmosphere when the vacuum in manifold **22** is interrupted. In the use of conventional apparatus of this type, considerable manual effort is required to remove the stoppers after the treatment of the material is completed, and if any one stopper should freeze in place and cause the breaking of the apparatus during the attempt to remove the frozen stopper the entire apparatus may then have to be discarded, or be taken down and rebuilt.

As seen in Fig. **2** each of the stoppers has a first portion **30** with an outer wall configuration **31** here shown as truncated conical form adapted to mate with the inner wall configuration **32** of the receptacle opening. A second or head portion **33** of the stopper is joined to the first portion and is adapted to overlie the mouth of the receptacle opening and to provide a shoulder **34** at the juncture of the two portions. Adjacent the distal end of the first portion, a deep continuous groove **35** is formed in the periphery of the first portion and has a volumetric capacity for about 90percent of the volume of a first O-ring **36**. This ring is formed of an elastomeric material, such as Neoprene, or when toxic materials are being handled, it may be formed of Teflon When such toxic materials are used, both the stopper and receptacle mouth are formed of glass with a ground fit, but when practicable, the stopper is formed of Plexiglas, or other plastic less expensive than ground glass, and which is machined to size. Such machining may include knurling **37** at the periphery of the stopper head for ease in handling.

At the shoulder **34** formed by the juncture of the stopper portions, an elastomeric O-ring **39** in stretched condition is placed, and which is retained in position by reason of its inherent tension, but which is capable of deforming when compressed. In contrast to the groove-confined first O-ring **36** whose compression into the groove builds up a restoring force, the compression of the second O-ring **39** serves to push the material thereof in a radial direction under the head **33** of the stopper and to result in an enlarged sealing surface which provides an excellent backup seal for the seal being simultaneously provided by the first O-ring.

When the described apparatus is first assembled as seen in FIG. **2** by manual insertion of the stopper to a point at which a space **38** of about one-eighth to one-sixteenth inch remains between the upper edge of the receptacle mouth and lower edge of O-ring **39**, a vacuum is then applied to the receptacle. The length of the first portion **30** is, of course, sufficiently long to insure that no canting of the stopper in the opening will result. When the vacuum reaches a value in the order of 10^{13} to 10^{14} mmHg the stopper is bodily pushed the remaining distance into the receptacle mouth by the pressure of ambient air at which time the O-ring **39** is caused to deform into its described backup sealing position. Significantly, the compression of the material of O-ring **36** occuring at this time stores a force which becomes effective to resist freezing of the stopper wall to the access opening wall as well as holding the material of O-ring **36** in tight sealing relation to the wall of that access opening.

Extended testing of an apparatus as thus described has shown long seal life, ease in assembly and disassembly after repeated usages of the same O-rings and freedom from freezing and resultant breakage of parts. After the vacuum is interrupted, the stopper may be manually lifted with little effort since the compressed and substantially unconfined O-ring **39** does not resist a lifting movement and since the compressed and substantially wholly confined O-ring **36** permits the easy lifting movement of the stopper. Despite the simplicity of the described apparatus the efficacy of the arrangement is superior to any conventional high-vacuum-sealing device with which I am familiar. As used herein, the term "high vacuum" signifies a vacuum of at least 5×10^{14} mmHg. For certain usages of the apparatus much higher vacuums may be employed and indeed in one test lasting for several days, a vacuum of 5×10^{16} mmHg was maintained, and after the apparatus was then

quickly disassembled without breakage, no noticeable wear on the O-rings was detected.

Having thus described a preferred form of closure by means of which the invention may be practiced, it will be understood that the invention may be embodied in forms other than such preferred form.

What I claim is:

1. For use with a receptacle adapted for subjection to a high vacuum and having an access opening, a readily detachable closure having a first portion tapered insertable in the opening and with an outer wall configuration mating with the inner wall configuration of the opening, a second portion attached to said first portion and forming a head adapted to overlie the mouth of the opening and providing a main seal seat at the shoulder joining said first and second portions, a continuous peripheral groove extending about said first portion adjacent the distal end of the same and providing an initial seal seat, a first elastomeric O-ring having the major portion of its volume normally confined in said groove, and a second elastomeric O-ring in normally stretched condition disposed in contact with said shoulder, said second O-ring being adapted to be compressed upon its seat for backup sealing by ambient air pressure during the application of high vacuum to said receptacle.

2. Apparatus as defined in claim 1 wherein at last about 90percent of the volume of said first O-ring is normally confined in said groove prior to application of vacuum to said receptacle.

3. Apparatus as defined in claim 1 wherein said second O-ring is free to expand laterally beneath said closure head as said closure is pushed into the access opening of said receptacle.

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,599,820 Dated August 17,1971

Inventor(s) Kenneth P. Lee

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

In the abstract, line 2, change ' 10^{16} ' to -- 10^{-6} --

In the specification; column 1, line 21, change ' 10^{13} ' to -- 10^{-3}--; column 2, line 23, change insert a period after 'Teflon'; column 2, line 49 change ' 10^{13}' to --10^{-3}--; column 2, line 50 change '10^{14}' to --10^{-4}--; column 2,line 72 change '10^{14}' to-- 10^{-4}--; column 2,line 74, change '10^{18}' to -- 10^{-6} --.

Signed and sealed this 16th day of May 1972.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents

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