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Ikeda et al.

[11] **3,898,046**

[45] **Aug. 5, 1975**

[54] **STOPPER FOR SEALING CONTAINERS**

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[73] Assignee:

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[30] **Foreign Application Priority Data**

Apr. 23, 1973 Japan 48-47564

[52] **U.S. Cl.** **23/259;** 23/292; 215/355; 215/DIG. 3

[51] **Int. Cl.**[2] **G01N 1/10;** B65D 39/00

[58] **Field of Search** ..... 23/292, 259, 253, 230 B; 215/355, 356, DIG. 3

[56] **References Cited**

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[57] **ABSTRACT**

A stopper for sealing a container having an annular lug inwardly projecting at the edge of the container opening portion, comprising a resilient, cylindrical stopper body provided spatially from the upper end thereof with an annular groove engageable with said lug.

6 Claims, 7 Drawing Figures

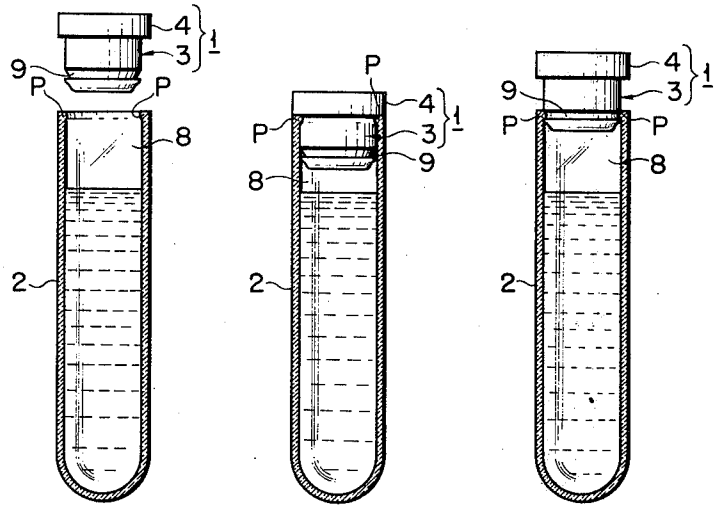


FIG. 1

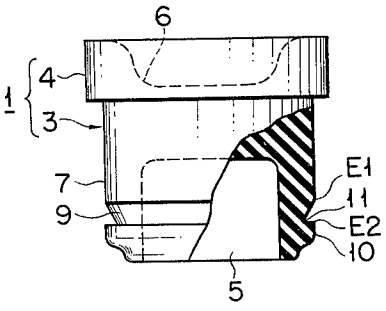


FIG. 2

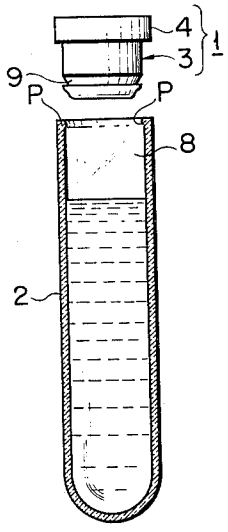


FIG. 3

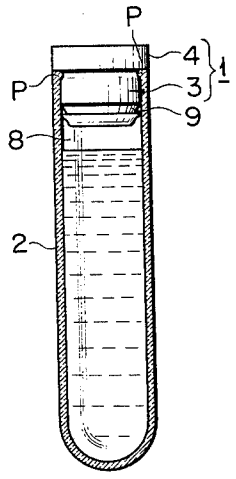


FIG. 4

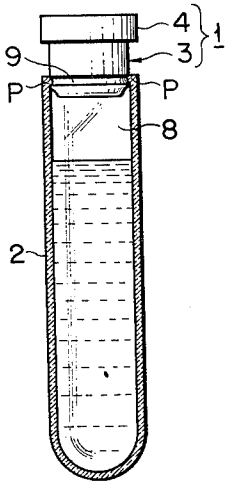


FIG. 5

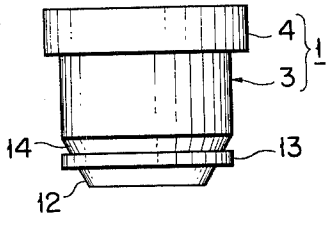


FIG. 6

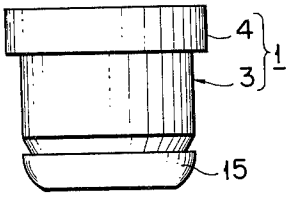
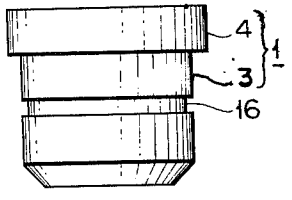


FIG. 7



STOPPER FOR SEALING CONTAINERS

This invention relates to a stopper for sealing a container such as an evacuated blood sampling tube or other test tubes, and more particularly to a stopper for sealing a container having a lug inwardly projecting at the edge of the container opening portion.

In the medical, biological or laboratory fields, various stoppers are widely accepted which are used to seal containers such as an evacuated blood sampling tube or other test tubes. Such a stopper should be prevented from unexpectedly disengaging from the container due to the action of a pressure produced when the stopper is fitted or inserted into the container or due to the increase in inner pressure resulting from the elevated temperature, and should be designed tightly to seal said container. To this end, the stopper has heretofore been subjected to various contrivances.

In U.S. Pat. No. **3,057,502**, disclosure is made of the provision of a plurality of annular ribs in the outer periphery of the cylindrical hollow body of a stopper made of resilient plastic material. The outer periphery of said annular rib constitutes the contacting surface with the inner wall of a glass tube. The above-mentioned publication further discloses that the annular rib surface is rough-finished in order to increase the coefficient of friction between the inner wall of the glass tube and the stopper body.

The U.S. Pat. No. **3,136,440** relates to an elastomeric material-made self sealing pierceable stopper for sealed container. Said stopper comprises a cylindrical plug and an enlarged flange like head integrally formed at the upper end thereof. In said plug and head is respectively formed a recess, and these two recesses are separated from each other by a diaphragm having a concave section at its upper portion and a convex section at its lower portion. The outer diameter of said plug is slightly larger than the inner diameter of the container, thereby enabling said plug to tightly engage the container. Further, around the plug portion immediately adjacent the head there is formed a circumferential groove, which serves to minimize or relieve the stresses adjacent this portion of the plug resulting from the resistance of the head of the stopper to compression of the plug when it is inserted in one opening in the container.

The prior art stoppers including those disclosed in said two United States Patents are so designed as to tightly engage the container at a position in which the stopper is forced into the container.

It would not fully attain the purpose even if the stopper is once forced into the container. The stopper is usually repeatedly dismounted from the container in order to make tests on its contents. Under the condition in which the stopper is maintained forced into the container, the air inside of the container is kept compressed. When, therefore, the stopper is pulled out from the container, it pops out therefrom with force, and where the contents are liquid, they are likely to pop out simultaneously with the disengagement of the stopper from the container. Further, after the stopper is dismounted, the liquid contents frequently adhere onto the inner wall surface of the container opening portion so as to decrease the force of friction between the stopper and the container inner wall, which causes the stopper to gradually rise for ready disengagement with the aid of the compressed air attained by the reinsertion of

the stopper. As the result, a blood sampling tube used to make a blood test, for example, had the drawback that blood was spilt or scattered to infect the tester. Particularly, a usual rubber stopper for use with an evacuated blood sampling tube is so formed as to enlarge as much as possible the contacting portion of the stopper body surface with the container inner wall mainly for the purpose of maintaining the evacuated state. For this reason, in such rubber stopper, the stopper body except for its top end portion is so formed as to have a greater outer diameter than the inner diameter of the container and, in order to make a blood sampling needle readily pierceable into the stopper body, said stopper is formed at its both end portions with recesses. Accordingly, where said stopper is reinserted into the container after once dismounted therefrom it is more decreased in fitted strength and is more likely to raise the above-mentioned problems as compared with a stopper for use with an ordinary wholly-tapered test tube.

Accordingly, an object of the invention is to provide an elastomeric material-made stopper for sealing a container which is prevented from being unexpectedly dismounted from the container once it is inserted thereinto.

Another object of the invention is to provide a stopper which is so designed as to seal the container without being dismounted therefrom even when raised due to the action of the compressed air within the container produced when it is inserted thereinto.

According to the invention, there is provided an elastomeric stopper for sealing a container having an annular lug inwardly projecting at the edge of the container opening portion, comprising a cylindrical stopper body and an anuular groove formed in said body spatially from the upper end thereof, said annular groove being engageable with said lug.

This invention can be more fully understood from the following detailed description when taken in conjunction with the accompanying drawing, in which:

FIG. **1** is a front view, partly exploded, of a stopper according to the invention;

FIGS. **2** to **4** respectively are views illustrating the function of the stopper shown in FIG. **1**; and

FIGS. **5** to **7** respectively are front views of other embodiments of the stopper according to the invention.

This invention will now be described by reference to the accompanying drawing. Referring to FIG. **1**, a stopper according to the invention is denoted by a reference numeral **1**, and is made of resilient material such as, for example, vulcanized rubber mainly consisting of butyl rubber, and presents a hardness of approximately **50°** when its head portion is pressed from the lateral side thereof by a hardness tester according to the Japanese Industrial Standard. The stopper **1** is fitted or inserted into the opening portion of a container, for example, an evacuated blood sampling tube **2**, having an annular lug inwardly projecting at the edge of the container opening portion, so as to seal said tube **2**. Where the tube is made of glass, said lug may be the one which is necessarily formed during heating of the container opening portion. In the case of a tube having a capacity of **7** ml, the container is approximately **10.50** mm in inner diameter. The stopper **1** consists of a cylindrical stopper body **3** tapered from its lower end portion **10** to its lowest end and having a maximum diameter of approximately **11.8** mm, and of an enlarged head **4**

formed integrally at the upper end of the body. In the lower end surface of the stopper body **3** and the upper end surface of the stopper head **4** are formed recesses **5** and **6** so as to make a blood sampling needle readily pierceable into the central portion of the stopper **1**. When, in this case, a blood sampling needle having a diameter of **0.08** mm is pierced at a speed of **20** mm/min., the piercing resistance accounts for approximately **3.0** pounds as measured by Chatillon gauge. As above described, the stopper body is designed to have a relatively elastic construction. The stopper body **3** is provided with an annular groove **9**, spatially from the lower end of the stopper head **4** and at that portion of the outer circumference **7** of the body which is in the proximity of the lower end portion **10** of the stopper body **3**. The annular groove **9** has a longitudinal section in which a line connecting a groove upper end E1 on the side of the head **4** and the groove bottom **11** inclines toward said bottom **11**, and a line connecting together the other groove upper end E2 and said groove bottom **11** is perpendicular to the central axis of the stopper body. The longitudinal section of the groove may be of any shape if said groove has only to engage the container lug.

As hereinafter explained, when the stopper body **3** is gradually raised from the position in which it is inserted into the blood sampling tube **2** up to the upper end of the body, due to, for example, the inner pressure of the blood sampling tube, the annular groove **9** is engaged with the tube lug **2** to suppress the raising of the stopper body. The groove is formed in the stopper body spatially from the upper end of the stopper body, or preferably in the vicinity of the lower end of the body. The groove position is determined with the stopper hardness, container lug height, or groove depth synthetically taken into consideration. However, the container lug height should of course be limited to the range within which the stopper is insertible into the container.

Referring to FIG. **2** to **4**, the function of the stopper according to the invention will now be described. The evacuated blood sampling tube **2** prior to blood sampling is hermetically sealed by the stopper **1**, and the inside of the tube is in an evacuated state. The stopper body **3** is inserted into the opening portion of the blood sampling tube **2** up to the lower end of the enlarged head **4**. When the needle of a blood sampling instrument is pierced into the stopper **1** thereby to perform blood sampling, the reduction degree of pressure within the tube is decreased so that the stopper is brought to a manually dismountable state.

Where the general test on blood (the erythrocyte number, leukocyte number or hematocrit value) is carried out, a lot of blood is sampled in the evacuated blood sampling tube **2** previously charged with a blood anticoagulant. The stopper **1** is then dismounted (see FIG. **2**) from the tube and said blood is discharged therefrom exactly to an extent necessary for the test on one item, and the stopper **1** is again inserted (see FIG. **3**). The stopper-inserted tube is set on a blood mixing instrument until the next test is carried out, or is manually shaked at the time of performing the next test, thereby mixing the blood with the anticoagulant. The foregoing operations are repeatedly carried out up to the brief completion of tests. During said operations the sampled blood frequently adheres to the stopper **1** to decrease the coefficient of friction between the stopper body **3** and the inner wall of the blood sampling tube **2**, so that the stopper becomes liable to disengage from the tube. For this reason, even when the stopper **1** is again forced into the tube **2** and the stopper body **3** is sufficiently inserted into the tube up to the lower end of the stopper head **4**, said sufficient insertion so acts as to increase the pressure of the interior **8** of the tube, and said increased pressure so acts as to raise the stopper by degrees. At this time, as shown in FIG. **4**, the annular groove **9** formed in the stopper body **3** is tightly engaged with the annular lug P of the blood sampling tube **2** fully to stop the upward movement of the stopper **1**, thereby preventing the disengagement of the stopper from the tube. Further, also when the blood sampling tube is laid or upset for mixing its charged mass, it is maintained sealed without causing the mass to be spilt therefrom. When this is viewed from the inner pressure condition of the tube, the rise of the stopper body **3** decreases the tube inner pressure previously kept relatively increased by the insertion of the stopper body **3** into the tube. Upon disengagement of the stopper, therefore, the mass is prevented from forcibly popping out from the tube.

The provision of the annular groove in close proximity to the lower end portion **10** of the stopper body **3**, when the stopper **1** is inserted, causes said ring-shaped lower end portion **10** to be bent in the opposite direction to the direction of the stopper insertion, thus to facilitate the stopper insertion.

FIGS. **5** to **7** respectively illustrate other embodiments of the stopper according to the invention. FIG. **5** shows a stopper wherein the lower end portion of the stopper body **3** is largely tapered; and a ring-shaped protrusion **13** having its outer circumference made substantially flush with the outer circumference of the stopper body **3** is formed on the intermediate portion of the outer circumference of said tapered section, whereby an annular groove is defined by said ring **13** with the tapered plane above it. FIG. **6** shows another stopper having a similar construction to that shown in FIG. **1**, in which the lower end portion **15** of the stopper body **3** presents a tapered curved surface. FIG. **7** shows another stopper having an annular groove **16** formed in the central portion of the outer circumference of the stopper body.

The preceding embodiments referred to the case where the stopper of the invention is applied to the evacuated blood sampling tube, but the above-mentioned problems are not raised only about said tube and therefore the stopper of the invention is also applicable to containers such as ordinary test tubes.

The use of the stopper according to the invention enables the reliable prevention of infection due to the stopper popping out or due to the charged mass being scattered upon disengagement of the stopper. The intrahospital infection such as the infection of serum cholangeitis or syphilis with a blood tester via a patient's blood scattered, for example, in a clinical examination room or laboratory room has recently become an important problem. The use of the stopper according to the invention enables the complete prevention of such intrahospital infection. Accordingly, the stopper of the invention prevents a prominent effect when put to practical use.

What is claimed is:

1. An elastomeric stopper for sealing a container having an annular lug inwardly projecting at the edge of

the container opening portion, comprising a cylindrical stopper body and an annular groove formed in said body spatially from the upper end of the stopper body, whereby said stopper inserted with its groove below the lug of the container may be pushed up with the pressure built up in the container during the insertion of the stopper until the groove engages the lug and becomes fixed tight in the container.

2. A stopper according to claim **1**, wherein the stopper body is tapered at its lower end portion, and said annular groove is defined by a ring-shaped protrusion formed on the intermediate portion of the outer circumference of said tapered section and having its outer circumference made substantially flush with the outer circumference of the stopper body and the tapered plane positioned above said ring-shaped protrusion.

3. A stopper according to claim **1**, wherein said annular groove is formed adjacent to the lower end of said stopper body.

4. An elastomeric stopper for sealing a container having an annular lug inwardly projecting at the edge of the container opening portion, comprising a cylindrical hollow stopper body whose lower end portion is tapered, an enlarged head formed integrally at the upper end of said body and having a recess at its upper end, and a ring-shaped protrusion which is formed on the intermediate portion of the outer circumference of said tapered end portion of said body, has its outer circumference made substantially flush with the outer circumference of the stopper body and constitutes an annular groove with the tapered plane of said stopper body positioned above it, whereby said stopper inserted with its groove below the lug of the container may be pushed up with the pressure built up in the container during the insertion of the stopper until the groove engages the lug and becomes fixed tight in the container.

5. An elastomeric stopper for sealing a container having an annular lug inwardly projecting at the edge of the container opening portion comprising a cylindrical stopper body having a tapered lower end, an enlarged head formed integrally on the upper end of said body, central recesses in said body and head whereby the stopper presents a closure barrier in its central portion of substantially less longitudinal dimensions than the overall length of the stopper, and a single annular groove on said stopper body adjacent the lower end thereof, said groove being defined by a first plane which extends radially into the stopper body and a second plane which extends into the stopper body above said first plane at an acute angle to said first plane and intersects said first plane within the stopper body.

6. A blood sampling container comprising a sampling tube having a closed end and an open end, an annular lug inwardly projecting at the edge of said open end and an elastomeric stopper comprising a cylindrical stopper body having a tapered lower end, an enlarged head formed integrally on the upper end of said body, the lower end of said head presenting a flat ledge extending radially beyond said stopper body, central recesses in said body and head whereby the stopper presents a closure barrier in its central portion of substantially less longitudinal dimension than the overall length of said stopper and a single annular groove on said stopper body adjacent the lower end thereof, said groove having a depth substantially corresponding to the radial dimension of said annular lug, said stopper extending into the open end of said tube with said flat ledge of the stopper in contact with said edge of the open end sealing the container by engagement of said lug with a portion of said stopper body above said annular groove.

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