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(54) Title: CLOSURE SYSTEM FOR BOTTLES COMPRISING A STOPPER AND A SEALING ELEMENT

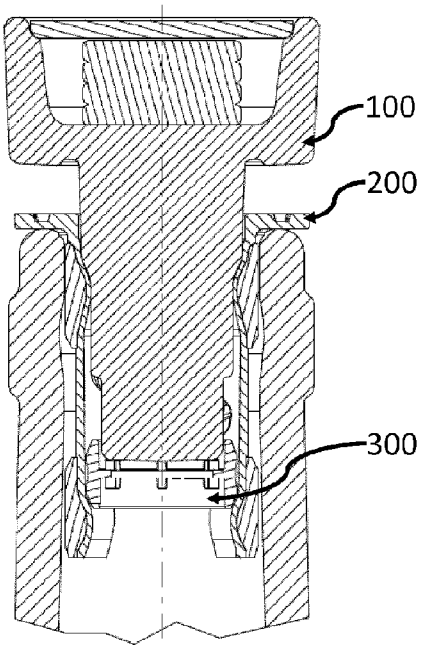

Fig. 7a

(57) Abstract: The present invention relates to a closure system for a bottle designed for commercial bottling of a beverage or liquid food, preferably a wine bottle. The closure system comprising a stopper (100) having a stopper part (102) for introduction into a mouth of the bottle and a head part (101) for remaining outside of the mouth, the head part having a diameter which is larger than that of the stopper part. The closure system also comprises a sealing element (200) which is separate from the bottle and from the stopper. The closure system is configured such that the sealing element is forced against the inner wall of a mouth of the bottle, upon introduction of the stopper into the mouth, bringing the closure system into a locked state, and the stopper part comprises interlocking means (121) to engage with counterpart interlocking means (221) on the sealing element. The said interlocking means (121) are configured to permit bringing the closure system into an unlocked state by an action which comprises rotating the stopper with respect to the bottle. The stopper part (102) of the stopper also comprises a holding means (122) configured to form an interlocking connection with counterpart holding means of the sealing element, to hold the stopper in a secured position with respect to the sealing element when the closure system is in a preassembled state. The present invention also describes a method of preassembling the closure system for a bottle and a method of closing a bottle using the preassembled closure system.

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Closure System for Bottles Comprising a Stopper and a Sealing Element

Field of the Invention

The invention relates to a closure system for a bottle, preferably a beverage bottle, like a wine bottle, and a stopper and sealing element for sealing the stopper for a bottle. The invention further relates to a method of sealing a bottle.

Background

A sealable bottle is known from European patents EP 1 451 081 B1 and EP 1 456 092 B1. A bottle disclosed in these patents comprises a stopper which is made of glass and can be inserted into the bottle opening. The bottle further comprises a fixing element that is attached to the bottle body in a detachable manner and retains the stopper inserted in the bottle opening in place. However, such a bottle presents several drawbacks. It is expensive since the fixing element needs to be attached to the bottle body. It is not reusable since once the detachable fixing element is removed it cannot generally be reattached. Therefore, proper sealing cannot be achieved any longer once the bottle has been opened. As a consequence, it cannot be stored any more, e.g., in horizontal position.

The closure systems disclosed in EP 1 451 081 B1 and EP 1456 092 B1 present another drawback, when used in the wine industry for closing a wine bottle. Indeed, since the closure systems cannot cope with the manufacturing tolerances of ordinary wine bottles, these closure systems require a specific wine bottle, the mouth of which is specifically adapted to the shape and dimensions of the stopper. Therefore, wine producers wishing to adopt such a closure system for sealing their wine bottles instead of corks made of natural or synthetic cork will be forced to change their bottling processes and adapt them to these specific bottles, which are more expensive than standard bottles and are also only available from a few glass bottle manufacturers.

A bottle stopper arrangement which does not need a fixing element attached to the bottle is disclosed in US 3,245,569. The bottle stopper arrangement described therein is specifically designed for a bottle in which a fluid is maintained under pressure, in particular a Champagne wine bottle. The bottle stopper arrangement comprises a tubular insert adapted to be secured in the mouth of the bottle, and a bottle stopper adapted to be inserted into the tubular insert. The tubular insert has an inner face defining a passage, the cross-sectional area of which decreases in the direction from its outer end in the mouth of the bottle and its inner end within the bottle. When the stopper is inserted into the tubular insert, the insert is spread in the lower part, due to the decreased width of the passage in the lower part of the insert. By doing so, the spread lower part of the insert comes into an interlocking connection with the inner wall of the bottle neck because going downwards, the bottle neck widens up in the area of the spread lower part of the insert. The inner face of the tubular insert has at its outer end a screw-threaded annular surface portion and the bottle stopper has at its outer end a screw-threaded annular surface portion for engaging with the screw-threaded annular surface portion of the inner face of the tubular insert. Due to the above-mentioned interlocking connection (which is supported by an additional interlocking connection outside at the rim of the mouth of the bottle), no fixing element is needed to hold the stopper securely on the bottle.

However, also the bottle stopper arrangement disclosed in US 3,245,569 has several drawbacks. For example, at least two steps have to be carried out during sealing the bottle in the bottling plant: in a first step, the insert needs to be put on the bottle, and only in a second step, the stopper can be placed on the bottle. The need for two steps makes bottling expensive. Further, the user needs to rotate the stopper over several turns before completely unscrewing the stopper, which makes the opening process cumbersome.

Another stopper configuration is disclosed in European patent application EP 2 692 657 A1 which provides a closure system for a bottle which allows sealing the stopper in the bottle sufficiently strong for transportation and/or storage of the bottle in horizontal position even in the absence of a fixing element attached to the bottle body. However, it has been found that the closure system of the above application could be improved in certain aspects. For example, although the stopper of EP 2 692 657 A1 is

primarily made of glass, a short plastic sealing element is always retained on the stopper. Therefore, the user sometimes mistakes the stopper to be made of more robust material than glass which leads to the breaking of the stopper due to misuse. Furthermore, the design of the stopper requires that its bottom part is relatively thin, which makes it breakable if the stopper is realized in glass. Moreover, the stopper of EP 2 692 657 A1 is held in the sealed position by way of a frictional connection between the sealing element and the inner wall of the mouth of the bottle. This connection is provided by pressing the sealing element by a portion of the stopper. However, the same portion is also provided with an interlocking means in form of screw threads to engage with the sealing element to bring it to the locked and unlocked states. This makes it difficult to provide a tight seal because liquid may go into the windings of the screw thread. It also causes the problem of providing a balance between a tighter sealing between the stopper and the sealing element and reduced friction between the interlocking means. That is, if a tighter seal is provided, it causes additional friction in the interlocking means making it difficult to rotate the stopper for unlocking.

Therefore, there is a need to provide an improved and robust closure system which allows for proper sealing and at the same time easy operation.

Summary of the Invention

It is an object of the invention to provide a closure system for a bottle that overcomes any one or all of the above-mentioned drawbacks of the above mentioned systems. Some or all of these objects are solved individually and/or in combination by the subject matter of the claims. Preferred embodiments are subject to the dependent claims.

A 1st embodiment of the present invention is a closure system for a bottle designed for commercial bottling of a beverage or liquid food, preferably a wine bottle, the closure system comprising a stopper comprising a stopper part for introduction into a mouth of the bottle; and a head part for remaining outside of the mouth, the head part having a diameter which is larger than that of the stopper part; and the closure system further comprising a sealing element which is separate from the bottle and from the stopper; the closure system is configured such that the sealing element is forced against the

inner wall of a mouth of the bottle, upon introduction of the stopper into the mouth, thereby bringing the closure system into a locked state; the stopper part comprises interlocking means configured to engage with counterpart interlocking means comprised by the sealing element; and the interlocking means are configured to permit bringing the closure system into an unlocked state by an action which comprises rotating the stopper with respect to the bottle.

A 2nd embodiment of the present invention is a stopper for a closure system for a bottle designed for commercial bottling of a beverage or liquid food, preferably a wine bottle, the stopper comprising a stopper part for introduction into a mouth of the bottle; and a head part for remaining outside of the mouth, the head part having a diameter which is larger than that of the stopper part; wherein the closure system is configured such that a sealing element which is separate from the bottle and from the stopper is forced against the inner wall of a mouth of the bottle, upon introduction of the stopper part into the mouth, thereby bringing the closure system into a locked state; wherein the stopper part comprises interlocking means configured to engage with counterpart interlocking means of the sealing element; and wherein the interlocking means are configured to permit bringing the closure system into an unlocked state by an action which comprises rotating the stopper with respect to the bottle.

A 3rd embodiment of the present invention is a sealing element for a closure system for a bottle designed for commercial bottling of a beverage or liquid food, preferably a wine bottle, the closure system comprising a stopper with a stopper part for introduction into a mouth of the bottle and a head part for remaining outside of the mouth, the head part having a diameter which is larger than that of the stopper part, wherein the sealing element is separate from the bottle and from the stopper; wherein the closure system is configured such that the sealing element is forced against the inner wall of a mouth of the bottle, upon introduction of the stopper into the mouth, thereby bringing the closure system into a locked state; and wherein the sealing element comprises counterpart interlocking means which are configured to engage with interlocking means comprised by the stopper part of the stopper, the interlocking means being configured to permit bringing the closure system into an unlocked state by an action which comprises rotating the stopper with respect to the bottle.

According to a 4th embodiment, in the 1st, 2nd, or 3rd embodiments, respectively, in the locked state, a force exceeding 50N, preferably 100N, more preferably 200N, most preferably 300N is required to pull the stopper or the closure system out of the mouth of the bottle.

According to a 5th embodiment, in any one of the preceding embodiments, in the locked state, the forcing the sealing element against the inner wall of the mouth of the bottle forms a seal between the stopper and the mouth of the bottle such that no liquid can exit through the mouth of the bottle.

Consequently, the bottle is tightly closed, and even turning the bottle upside down would not cause the liquid inside to exit the bottle.

According to a 6th embodiment, in any one of the preceding embodiments, in the locked state, the closure system is retained in the mouth of the bottle against a pressure of at least up to 1 bar inside the bottle, preferably at least up to 2 bar, more preferably at least up to 3 bar, most preferably at least up to 4 bar.

Such a high pressure resilience enables the closure system to remain inside bottles even if they are filled with highly pressurized liquids such as sparkling wines. Furthermore, a user unfamiliar with the closure system will immediately realize that simply pulling the stopper will not open the closure system.

According to a 7th embodiment, in any one of the 5th or 6th embodiments, the seal is sufficiently tight such that in the locked state, no signs of leakage such as bubble formation are observed at the stopper of a bottle filled with red wine after 1 minute at a pressure of at least up to 1 bar inside the bottle, preferably of at least up to 2 bar, more preferably of at least up to 3 bar and most preferably at a pressure of at least up to 4 bar.

By being able to withstand such high pressures, the closure system can be used with most liquids, including sparkling wines, and provides reliable sealing from outside influences such as dirt or moisture.

According to an 8th embodiment, in any one of the preceding embodiments, in the unlocked state, the stopper can be pulled out of the mouth of the bottle by a force of less than 20N, preferably less than 5N, more preferably less than 2N, most preferably by a force which substantially corresponds to the weight of the stopper.

A low force required to remove the stopper in the unlocked state indicates to the user that the closure system is in the unlocked state. It also makes it easier for the user to remove the stopper compared to conventional systems such as cork-based closure systems where a large force is required to pull the cork stopper out of the bottle.

According to a 9th embodiment, in any one of the preceding embodiments, in the unlocked state, no seal is formed between the stopper and the mouth of the bottle such that liquid can exit through the mouth of the bottle.

According to a 10th embodiment, in any one of the preceding embodiments, the mouth of the bottle is configured to comply with DIN EN 12726:2000.

According to an 11th embodiment, in any one of the preceding embodiments, the length of the stopper part of the stopper is at least 19 mm, preferably at least 24 mm, more preferably at least 29 mm, most preferably at least about 31 mm.

According to a 12th embodiment, in any one of the preceding embodiments, the length of the stopper part of the stopper is at most 43 mm, preferably at most 38 mm, more preferably at most 33 mm, most preferably at most about 31 mm.

This is a suitable length to co-operate with a sealing element having a length of 26 mm to 45 mm, preferably 32 mm. The advantages of a sealing element of that length are explained below.

According to a 13th embodiment, in any one of the preceding embodiments, the sealing element is configured to receive the stopper part of the stopper by way of introduction.

Such a shape facilitates providing a seal such that the stopper part of the stopper does not come in contact with the mouth of the bottle. For forming the seal, the sealing element can be expanded by the stopper part of the stopper.

According to a 14th embodiment, in the 13th embodiment, the sealing element has essentially the shape of a ring or tube.

Since such a shape corresponds to the shape of the mouth of the bottle, the sealing element can form a better contact with the bottle and can thus form a better seal between the sealing element and the mouth of the bottle.

According to a 15th embodiment, in any one of the 13th or 14th embodiments, the stopper part of the stopper is fully introduced into the sealing element when the stopper and the sealing element have the positional relationship to each other as intended for the locked state.

The head part of a stopper whose stopper part is "fully introduced" into the sealing element will in general be in contact with the upper end of the sealing element. However, there may also be a small gap between the head part of the stopper and the upper end of the sealing element, or even a larger gap, if this is intended by the design of the closure system. E.g., if the upper end of the sealing element is not intended to protrude from the tip of the mouth of the bottle when the sealing element is fully introduced into the bottle, there will be no contact between the head of the stopper and the sealing element.

According to a 16th embodiment, in any one of the preceding embodiments, the sealing element has a length of at least 18 mm, preferably at least 26 mm, more preferably at least 30 mm, most preferably at 32 mm.

According to a 17th embodiment, in any one of the preceding embodiments, the sealing element has a length of at most 45 mm, preferably of at most 38 mm, more preferably of at most 34 mm, most preferably of at most 32 mm.

Such a length not only provides a reliable and tight seal, it also allows the sealing element to be in contact with the section of increasing diameter from the top to the bottom in the neck of a standard wine bottle which may start about 25 mm below the tip of the mouth of the bottle, and to form an interlocking connection in this section.

According to a 18th embodiment, in any one of the preceding embodiments, the head part of the stopper has a diameter which deviates from the largest outer diameter of the top of the mouth of the bottle by not more than 4 mm, preferably not more than 3 mm, more preferably not more than 2 mm, and most preferably substantially corresponds the largest outer diameter of the top of the mouth of the bottle.

According to a 19th embodiment, in any one of the preceding embodiments, the head part of the stopper has a diameter of at least 22 mm, preferably at least 26 mm, more preferably at least 28 mm, most preferably at least about 30 mm.

According to a 20th embodiment, in any one of the preceding embodiments, the head part of the stopper has a diameter of at most 38 mm, preferably at most 34 mm, more preferably at most 32 mm, most preferably at most about 30 mm.

30 mm is the largest outer diameter of the top of the mouth of a standard wine bottle.

According to a 21st embodiment, in any one of the preceding embodiments, the head part of the stopper has a diameter of at least 150% of the largest diameter stopper part, preferably at least 170%, more preferably at least 190 %, most preferably at least about 210%.

According to a 22nd embodiment, in any one of the preceding embodiments, the head part of the stopper has a diameter of at most 260% of the largest diameter stopper part, preferably at most 240%, more preferably at most 230 %, most preferably at most about 210%.

According to a 23rd embodiment, in any one of the preceding embodiments, the sealing element comprises a covering section configured to remain outside the mouth of the bottle and configured to prevent the head part of the stopper from contacting the mouth of the bottle.

According to a 24th embodiment, in the 23rd embodiment, the covering section is a flange positioned at the upper end of the sealing element.

The covering section serves as a stop for the sealing element, thereby preventing the sealing element from being pushed too far into the bottle. Additionally, it prevents dirt and moisture from entering the bottle. Finally, it protects the tip of the mouth of the bottle because it prevents contact with the head part of the stopper, which is of particular importance in the bottling process.

According to a 25th embodiment, in any one of the 23rd or 24th embodiments, the width of the covering section is at least 0.5 mm, preferably at least 1 mm, more preferably at least 1.5 mm, most preferably at least about 2 mm.

According to a 26th embodiment, in any one of the 23rd to 25th embodiments, the width of the covering section is at most 6 mm, preferably at most 4 mm, more preferably at most 3 mm, most preferably of at most about 2 mm.

The covering section should be as narrow as possible. However, it must be sufficiently large to achieve the advantages described above. The inventors found that a width of about 2 mm is the preferred optimum width.

According to a 27th embodiment, in any one of the 23rd to 26th embodiments, the covering section has a height of at least 0.2 mm, preferably at least 0.5 mm, more preferably at least 0.7 mm, most preferably at least about 1 mm.

According to a 28th embodiment, in any one of the 23rd to 27th embodiments, the covering section has a height of at most 1.8 mm, preferably at most 1.5 mm, more preferably at most 1.2 mm, most preferably of at most about 1 mm.

A thickness of about 1 mm makes the covering section robust enough to not break during assembly and provides good enough protection to the head part of the stopper. It provides a good compromise between material usage and robustness.

According to a 29th embodiment, in any one of the 23rd to 28th embodiments, the covering section is configured to prevent or reduce dripping of liquid at the end of the process of pouring liquid out of the mouth of the bottle.

By configuring the covering section in such a way, e.g. by providing it with an edge which is sharper then the edge of the tip of the mouth of the bottle, the covering section can serve as a drop stop. The normal edge of the mouth of bottles is rounded and thus tends to cause dripping of the liquid after pouring.

According to a 30th embodiment, in the 5th embodiment, or the 5th embodiment and any one of the 6th to 29th embodiments, the distance between the highest point of the mouth of the bottle and the top end of the section where the seal is formed is at most 5 mm, preferably at most 3 mm, more preferably at most 2 mm, most preferably at most 1 mm.

Providing a seal which starts only at a very small distance from the tip of the mouth of the bottle prevents that dirt and moisture enter into a gap between the stopper and the sealing element or between the sealing element and the bottle at the top section of the sealing element.

According to a 31st embodiment, in the 5th embodiment or the 5th embodiment and any one of the 6th to 30th embodiments, the section where the seal is formed is located at least in part at a section of the mouth of the bottle with an increasing diameter from top to bottom.

This makes it possible that the connection between the sealing element and the inner wall of the mouth of the bottle in the section where the seal is formed is in part an interlocking connection, which increases the holding force on the closure system in the locked state.

According to a 32nd embodiment, in the 5th embodiment or the 5th embodiment and any one of the 6th to 31st embodiments, the length of the section where the seal is formed is at least 2 mm, preferably at least 4 mm, more preferably at least 6 mm, most preferably at least about 8 mm.

According to a 33rd embodiment, in the 5th embodiment or the 5th embodiment and any one of the 6th to 32nd embodiments, the length of the section where the seal is formed is at most at 14 mm, preferably at most 12 mm, more preferably at most 10 mm, most preferably at most about 8 mm.

Providing a sufficiently long seal enhances the capability of the closure system to withstand high pressures as well as the capability of preventing the liquid from exiting while the closure system is in the locked state. It further allows for compensating any manufacturing tolerances the mouth of the bottle and/or the closure system may have.

According to a 34th embodiment, in the 5th embodiment or the 5th embodiment and any one of the 6th to 33rd embodiments, the stopper part of the stopper comprises a first section configured to force the sealing element against the inner wall of the mouth in the locked state, to form the seal between the stopper part and the mouth of the bottle.

According to a 35th embodiment, in the 34th embodiment, the first section of the stopper part of the stopper has a substantially even surface.

An even surface allows to create a particularly tight seal between the stopper part of the stopper and the sealing element. It also makes it easier to introduce the first section into the sealing element.

According to a 36th embodiment, in any one of the 34th or 35th embodiments, the first section of the stopper part of the stopper has a substantially cylindrical shape.

A cylindrical shape of the first section the stopper part of the stopper allows this section to have as great a diameter as possible, and therefore to provide a particularly robust stopper, even if it is manufactured from breakable material such as glass. This is particularly important in the case where the stopper part comprises a hollow channel in its center for allowing controlled oxygen exchange. In particular in this configuration, every millimeter by which the diameter of the stopper part can be increased is extremely valuable.

According to a 37th embodiment, in the 36th embodiment, the first section of the stopper part of the stopper has a slightly conical shape, with decreasing diameter in the direction from the top to the bottom.

A slightly conical shape of the first section makes it easier to introduce the first section into the sealing element while keeping a substantially cylindrical shape.

According to a 38th embodiment, in the 37th embodiment, the diameter of the first section of the stopper part of the stopper decreases from top to bottom by at most 1 mm, preferably at most 0.5 mm, more preferably at most 0.3 mm, most preferably at most 0.2 mm.

According to a 39th embodiment, in any one of the 34th or 35th embodiments, the first section of the stopper part of the stopper has a substantially conical shape, with decreasing diameter in the direction from the top to the bottom.

A conical shape of the first section makes it easier to introduce the first section into the sealing element.

According to a 40th embodiment, in any one of the 34th to 39th embodiments, the first section of the stopper part of the stopper has a maximum diameter of at least 2 mm less than the minimum inner diameter of the top of the mouth of the bottle, preferably at least 3 mm, more preferably at least 3.5 mm, most preferably at least about 4 mm.

According to a 41st embodiment, in any one of the 34th to 40th embodiments, the first section of the stopper part of the stopper has a maximum diameter of at most 6 mm less than the minimum inner diameter of the top of the mouth of the bottle, preferably at most 5 mm, more preferably at most 4.5 mm, most preferably at most about 4 mm.

A diameter of the first section of the stopper part of this size allows the wall of the sealing element in the sealing section to be about 2 mm thick, which is appropriate for providing a tight seal and for balancing out manufacturing tolerances.

According to a 42nd embodiment, in any one of the 34th to 41st embodiments, the first section of the stopper part of the stopper has a maximum diameter of at least 12.5 mm, preferably at least 13.5 mm, more preferably at least 14.0 mm, most preferably at least about 14.4 mm.

According to a 43rd embodiment, in any one of the 34th to 42nd embodiments, the first section of the stopper part of the stopper has a maximum diameter of at most 16.0 mm, preferably at most 15.2 mm, more preferably at most 14.8 mm, most preferably at most about 14.4 mm.

14.4 mm is the preferred diameter in the case of a closure system for a standard wine bottle. In a standard wine bottle, the inner diameter at the top of the mouth of the bottle is 18.5 mm.

According to a 44th embodiment, in any one of the 34th to 43rd embodiments, the first section starts at most at 4 mm below the head part of the stopper, preferably at most at 2 mm, more preferably at most at 1 mm, most preferably at about 0 mm.

By arranging the first section at this position from the head part, the closure system can form a seal as close to the tip of the mouth as possible, which prevents that dirt particles and liquid can enter at the top. Furthermore, it improves the tightness of the closure system. For example, standard wine bottles have a particularly well-defined inner section within the first about 10 mm from the tip of the mouth of the bottle, which allows for a very good adaptation of the closure system to the mouth of the bottle in this section.

According to a 45th embodiment, in any one of the 34th to 44th embodiments, the length of the first section is at least 2 mm, preferably at least 6 mm, more preferably at least 9 mm, most preferably at least about 11 mm.

According to a 46th embodiment, in any one of the 34th to 45th embodiments, the length of the first section is at most 18 mm, preferably at most 15 mm, more preferably at most 13 mm, most preferably at most about 11 mm.

This length provides an optimal area in which the first section forces the sealing element against the inner wall of the mouth of the bottle, thus providing an optimally dimensioned seal. This is in particular true for standard wine bottles because they have a particularly well-defined inner section within the first about 10 mm from the tip of the mouth of the bottle, and many of them have a section with an increasing diameter from the top to the bottom after about 10 mm, which allows the formation of an interlocking connection between the sealing element and the mouth of the bottle in the area where the seal is formed.

According to a 47th embodiment, in the 5th embodiment or the 5th embodiment and any one of the 6th to 46th embodiments, the sealing element comprises a sealing section configured to be at least in part radially expanded by the stopper part of the stopper upon full introduction into the sealing element, the sealing section thereby at least in part being forced against the inner wall of the mouth of the bottle in the locked state, to form the seal between the stopper part and the mouth of the bottle.

This radial expansion enables the sealing section to form a tight connection with the inner wall of the mouth of the bottle, thus improving the tightness of the closure system. It is understood that no expansion of the outer surface may take place if the sealing element has already been full introduced into the mouth of the bottle because expansion may be blocked by the inner wall of the mouth of the bottle. However, even in this case, there will typically be a radial expansion at least of the inner surface of the sealing section.

According to a 48th embodiment, in the 47th embodiment, the sealing section of the sealing element substantially has the shape of a ring or tube.

Since this shape corresponds to the shape of the mouth of the bottle, the sealing element can make better contact with the bottle and can thus form a better seal between the sealing element and the mouth of the bottle.

According to a 49th embodiment, in any one of the 47th or 48th embodiments, the sealing section comprises a constricted section having a smaller inner diameter than other parts of the sealing section.

According to a 50th embodiment, in the 49th embodiment, the constricted section is configured to be forced radially outward upon full introduction of the stopper part of the stopper into the sealing element.

According to a 51st embodiment, in any one of the 49th or 50th embodiments, the constricted section is located within the section where the seal is formed.

The constricted section improves forcing the sealing section against the inner wall of the mouth of the bottle, thus improving the seal of the closure system. It also makes it possible that the length of the area where the seal is formed is greater than length of the upward movement of the stopper which is necessary to bring the closure system from the locked state to the unlocked state.

According to a 52nd embodiment, in any one of the 49th to 51st embodiments, the constricted section is positioned substantially at the center of the sealing section.

Such a positioning ensures that the strongest point of the seal is centrally located and the pressure in the locked state is evenly distributed across the sealing section.

According to a 53rd embodiment, in any one of the 49th to 51st embodiments, the constricted section is positioned within or overlaps with the section where the seal is formed.

According to a 54th embodiment, in any one of the 49th to 53rd embodiments, the length of the constricted section is at least 2 mm, preferably at least 3 mm, more preferably at least 4 mm, most preferably at least about 5 mm.

According to a 55th embodiment, in any one of the 49th to 54th embodiments, the length of the constricted section is at most 10 mm, preferably at most 8 mm, more preferably at most 6 mm, most preferably at most about 5 mm.

According to a 56th embodiment, in any one of the 49th to 55th embodiments, the length of the constricted section is smaller than the length of the section where the seal is formed.

According to a 57th embodiment, in any one of the 49th to 56th embodiments, the length of the section where the seal is formed is at least 120% of the length of the constricted section, preferably at least 130%, more preferably at least 140% and most preferably at least about 160%.

According to a 58th embodiment, in any one of the 49th to 57th embodiments, the inner surface of the constricted section comprises a section which is substantially convex when the stopper part of the stopper is not introduced into the sealing element.

A convex section is relatively easy to manufacture, allows for an even distribution of the pressure in the locked state, and for easy introduction of the stopper part into the constricted section.

According to a 59th embodiment, in any one of the 49th to 58th embodiments, the inner surface of the constricted section comprises a section which has substantially the shape of one or more waves when the stopper part of the stopper is not introduced into the sealing element.

A constricted section in the shape of a wave further improves the above-mentioned properties of a constricted section having a convex section.

According to a 60th embodiment, in any one of the 47th to 58th embodiments, the outer shape of the sealing section of the sealing element is substantially cylindrical when the stopper part of the stopper is not introduced into the sealing element.

Since the mouth of a standard wine bottle has its smallest diameter at the top, a cylindrical outer shape of the sealing section allows the sealing section to come as close as possible to the inner wall of the mouth of the bottle in the preassembled or unlocked state, and at the same time not to touch the inner wall or to reduce the friction during introduction of the sealing element into the mouth of the bottle.

According to a 61st embodiment, in the 60th embodiment the outer shape of the sealing section of the sealing element is slightly convex when the stopper part of the stopper is not introduced into the sealing element.

This is due to manufacturing tolerances.

According to a 62nd embodiment, in any one of the 47th to 61st embodiments, the sealing section of the sealing element has a substantially even outer surface when the stopper part of the stopper is not introduced into the sealing element.

An even outer surface allows for a particularly tight seal because the inner wall of the mouth of most bottles is also even.

According to a 63rd embodiment, in any one of the 47th to 62nd embodiments, the outer surface of the sealing section of the sealing element comprises a section which is substantially convex when the stopper part of the stopper is fully introduced into the sealing element and the closure system is not introduced into the bottle.

This is a consequence of the constricted section of the sealing section of the sealing element.

According to a 64th embodiment, in any one of the 47th to 63rd embodiments, when the stopper part is not introduced into the sealing element, the sealing section has a maximum inner diameter of at least 8 mm, preferably at least 11 mm, more preferably at least 13 mm, most preferably at least 14 mm.

According to a 65th embodiment, in any one of the 47th to 64th embodiments, when the stopper part is not introduced into the sealing element, the sealing section has a maximum inner diameter of at most 21 mm, preferably at most 17 mm, more preferably at most 16 mm, most preferably at most 15 mm.

With such a diameter, which essentially deviates from the maximum diameter of the first section of the stopper part of the stopper by at most 2 mm, preferably at most 1

mm, more preferably at most 0.5 mm, most preferable at most 0.2 mm, the sealing section can be easily introduced into the mouth of the bottle while being sufficiently in contact with the inner wall of the mouth of the bottle to form a seal when the stopper is introduced.

According to a 66th embodiment, in any one of the 49th to 65th embodiments, when the stopper part is not introduced into the sealing element, the minimum inner diameter of the sealing section in the constricted section is at least 0.2 mm smaller than the inner diameter of the sealing section at the upper and/or lower end of the constricted section and/or than the inner diameter of the sealing section of the sealing element at its upper end and/or than the maximum inner diameter of the sealing section of the sealing element, preferably at least 0.6 mm, more preferably at least 0.8 mm, most preferably at least about 1 mm.

According to a 67th embodiment, in any one of the 49th to 66th embodiments, when the stopper part is not introduced into the sealing element, the minimum inner diameter of the sealing section in the constricted section is at most 1.8 mm smaller than the inner diameter of the sealing section at the upper and/or lower end of the constricted section and/or than the inner diameter of the sealing section of the sealing element at its upper end and/or than the maximum inner diameter of the sealing element, preferably at most 1.4 mm, more preferably at most 1.2 mm, most preferably at most about 1 mm.

By dimensioning the constricted section in this manner, the improvement of the seal provided by the constricted section is optimized.

According to a 68th embodiment, in any one of the 47th to 67th embodiments, when the stopper part is not introduced into the sealing element, the sealing section has a maximum outer diameter of at least 17.5 mm, preferably at least 18.0 mm, more preferably at least 18.1 mm, most preferably at least about 18.3 mm.

According to a 69th embodiment, in any one of the 47th to 68th embodiments, when the stopper part is not introduced into the sealing element, the sealing section has a maximum outer diameter of at most 19.0 mm, preferably at most 18.7 mm, more preferably at most 18.5 mm, most preferably at most about 18.3 mm.

18.3 mm is the preferred value in the case of closure systems for standard wine bottles. The inner diameter at the top of the mouth of such a bottle is specified to be 18.5 mm.

According to a 70th embodiment, in any one of the 47th to 70th embodiments, when the stopper part is not introduced into the sealing element, the sealing section has a maximum outer diameter of at most 1 mm less than the minimum inner diameter of the top of the mouth of the bottle, preferably at most 0.5 mm, more preferably at most 0.3 mm, most preferably at most about 0.2 mm.

According to a 71st embodiment, in any one of the 47th to 70th embodiments, when the stopper part is not introduced into the sealing element, the sealing section has a maximum outer diameter of at most 0.2 mm more than the minimum inner diameter of the top of the mouth of the bottle, preferably at most the minimum inner diameter of the top of the mouth of the bottle, more preferably at least 0.1 mm less than the minimum inner diameter of the top of the mouth of the bottle, more preferably at least about 0.2 mm less than the minimum inner diameter of the top of the mouth of the bottle.

This diameter renders it easy to introduce the sealing element into the mouth of the bottle during assembly and at the same time provides a minimum distance between the sealing section of the sealing element and the mouth of the bottle. A minimum distance is preferable because it reduces the amount by which the sealing section has to be expanded for bringing the system into the locked position.

According to a 72nd embodiment, in any one of the 47th to 71st embodiments, the closure system is configured such that the sealing section is radially expanded upon full introduction of the stopper part of the stopper into the sealing element, at the point of the largest expansion, by at least 0.4 mm in diameter, preferably by at least 0.6 mm, more preferably by at least 0.7 mm, most preferably by at least about 0.8 mm, when the closure system is not introduced into the bottle.

According to a 73rd embodiment, in any one of the 47th to 72nd embodiments, the closure system is configured such that the sealing section is radially expanded upon full

introduction of the stopper part of the stopper into the sealing element, at the point of the largest expansion, by at most 2.5 mm in diameter, preferably by at most 1.6 mm, more preferably by at most 1.2 mm, most preferably by at most about 0.8 mm, when the closure system is not introduced into the bottle.

A maximum expansion ("radial stroke") of about 0.8 mm allows the formation of a sufficiently tight seal, and it also allows to compensate manufacturing tolerances, while at the same time the pressure created by the expansion in the section where the seal is formed is small enough so that the torque required to bring the closure system into an unlocked position is not too high.

According to a 74th embodiment, in any one of the 47th to 73rd embodiments, the closure system is configured such that in the unlocked state, the sealing section of the sealing element is radially expanded, at the point of the largest expansion, by at most 1 mm in diameter, preferably at most 0.5 mm, more preferably at most 0.2 mm and most preferably not expanded at all, even if the closure system was not introduced into the bottle.

Having the expansion of the sealing section of the sealing element reduced to a minimum or even to zero in the unlocked state allows to minimize the friction which works against the removal of the stopper from the bottle in the unlocked state.

According to a 75th embodiment, in any one of the 47th to 73rd embodiments, the sealing section of the sealing element starts at least 5 mm below the upper end of the sealing element, preferably at least 4 mm, more preferably at least 2 mm, most preferably at least about 1 mm.

Arranging the sealing section at this location ensures that the seal is formed in the locked state as close as possible to the tip of the mouth of the bottle.

According to a 76th embodiment, in any one of the 47th to 75th embodiments, the sealing section of the sealing element has a length of at least 2 mm, preferably at least 5 mm, more preferably at least 8 mm, most preferably at least about 10 mm.

According to a 77th embodiment, in any one of the 47th to 76th embodiments, the sealing section of the sealing element has a length of at most 17 mm, preferably at most 14 mm, more preferably at most 12 mm, most preferably at most about 10 mm.

This length provides an optimally sized area for forming a seal of about 8 mm length.

According to a 78th embodiment, in the 36th embodiment and any one of the 47th to 77th embodiments, in the locked state, at least a part of the first section of the stopper part of the stopper is located within the sealing section of the sealing element.

Locating at least part of the first section of the stopper part within the sealing section in the locked state ensures that the first section, which has a relatively large diameter, can expand the sealing section of the sealing element to form the seal.

According to a 79th embodiment, in the 49th and 78th embodiments, in the locked state, at least a part of the first section of the stopper part of the stopper is located within the constricted section of the sealing section of the sealing element.

This ensures expansion of the sealing section in preferred embodiments in which the first section of the stopper part exerts radial pressure primarily in the constricted section.

According to an 80th embodiment, in the 36th and any one of the 47th to 79th embodiments, in the locked state, at least a part of sealing section has received at least a part of the first section of the stopper part of the stopper.

Receiving at least a part of the first section of the stopper part within the sealing section enables expansion of the sealing section by the first section of the stopper part in the locked state.

According to an 81st embodiment, in the 80th embodiment, in the locked state, at least the part of the sealing section which has the smallest inner diameter has received at least a part of the first section of the stopper part of the stopper.

Receiving at least a part of the first section of the stopper part within the part of the sealing section which has the smallest diameter ensures expansion of the sealing section by the first section of the stopper part in the locked state in preferred embodiments in which the first section of the stopper exerts radial pressure primarily in a constricted section.

According to an 82nd embodiment, in the 49th and any one of the 80th or 81st embodiments, in the locked state, at least a part of constricted section of the sealing section has received at least a part of the first section of the stopper part of the stopper.

Receiving at least a part of the first section of the stopper part within the constricted section enables expansion of the sealing section by the first section of the stopper part in the locked state in preferred embodiments in which the first section of the stopper exerts radial pressure primarily in the constricted section.

According to an 83rd embodiment, in the 36th embodiment, and the 49th embodiment or the 49th embodiment and any one of the 50th to 82nd embodiments, in the unlocked state, the first section of the stopper part of the stopper is not located within the constricted section of the sealing section of the sealing element.

Removing the first section of the stopper part from the constricted section of the sealing section of the sealing element may allow removing the pressure exerted on the sealing section by the stopper part.

According to an 84th embodiment, in the 34th embodiment or the 34th and any one of the 35th to 83rd embodiments, the stopper part of the stopper comprises a second section, which is arranged below the first section of the stopper part of the stopper.

According to an 85th embodiment, in the 84th embodiment, the second section of the stopper part of the stopper has a substantially cylindrical shape.

A cylindrical shape of the second section of the stopper part allows this section to have as great a diameter as possible, and therefore to provide a particularly robust stopper, even if it is manufactured from breakable material such as glass. This is particularly

important in the case where the stopper part comprises a hollow channel in its center for allowing controlled oxygen exchange. In particular in this configuration, ever millimeter by which the diameter of the stopper part can be increased is extremely valuable.

According to an 86th embodiment, in any one of the 84th or 85th embodiments, the smallest diameter of the second section of the stopper part of the stopper, without considering any recesses and/or protrusions, is at least 85% of the largest diameter of the first section of the stopper part of the stopper, preferably at least 90%, more preferably at least 92% and most preferably at least about 94%.

Dimensioning the second section of the stopper with a smaller diameter than the first section allows to bring the closure system into the unlocked state when the stopper is moved upward such that the second section of the stopper part enters into the sealing section of the sealing element.

According to an 87th embodiment, in any one of the 84th to 86th embodiments, the smallest diameter of the second section of the stopper part of the stopper, without considering any recesses and/or protrusions, is at most 97% of the largest diameter of the first section of the stopper part of the stopper, preferably at most 96%, more preferably at most 95% and most preferably at most about 94%.

Although the diameter of the second section of the stopper part should be smaller than the diameter of the first section of the stopper part, the difference in diameter should be as small as possible in order to provide a robust stopper, even if it is manufactured from breakable material such as glass.

According to an 88th embodiment, in any one of the 84th to 87th embodiments, the smallest diameter of the second section of the stopper part of the stopper, without considering any recesses and/or protrusions, is at least 10 mm, preferably at least 12 mm, more preferably at least 13 mm, most preferably at least about 13.5 mm.

According to an 89th embodiment, in any one of the 84th to 88th embodiments, the largest diameter of the second section of the stopper part of the stopper, without

considering any recesses and/or protrusions, is at most 16 mm, preferably at most 15 mm, more preferably at most 14 mm, most preferably at most about 13.5 mm.

13.5 mm is the preferred diameter of the second section of the stopper part where the diameter of the first section is 14.4 mm as mentioned above.

According to a 90th embodiment, in any one of the 84th to 89th embodiments, the length of the second section of the stopper part of the stopper is at least 6 mm, preferably at least 8 mm, more preferably at least 9 mm, most preferably at least about 10 mm.

According to a 91st embodiment, in any one of the 84th to 90th embodiments, the length of the second section of the stopper part of the stopper is at most 15 mm, preferably at most 12 mm, more preferably at most 11 mm, most preferably at most about 10 mm.

According to a 92nd embodiment, in any one of the 84th to 91st embodiments, the stopper part of the stopper comprises a transition section between the first section and the second section of the stopper part of the stopper.

According to a 93rd embodiment, in the 92nd embodiment, the length of the transition section is at least 0.4 mm, preferably at least 0.8 mm, more preferably at least 1.2 mm, most preferably at least about 1.5 mm.

According to a 94th embodiment, in any one of the 92nd or 93rd embodiments, the length of the transition section is at most 3.0 mm, preferably at most 2.5 mm, more preferably at most 2.0 mm, most preferably at most about 1.5 mm.

According to a 95th embodiment, in any one of the 92nd to 94th embodiments, the transition section has a substantially conical shape.

A substantially conical transition section between the first and the second section of the stopper part and of a length as specified above allows a smooth insertion of the stopper into the sealing element, for example to bring the closure system into the locked position.

According to a 96th embodiment, in the 47th embodiment and any one of the 84th to 95th embodiments, in the unlocked state, at least a part of the second section of the stopper part of the stopper is located within the sealing section of the sealing element.

Locating at least part of the second section of the stopper part within the sealing section of the sealing element in the unlocked state ensures that the second section, which has a relatively small diameter, can relax the sealing section.

According to a 97th embodiment, in the 49th and 96th embodiments, in the unlocked state, at least a part of the second section of the stopper part of the stopper is located within the constricted section of the sealing section of the sealing element.

This ensures relaxation of the sealing section in preferred embodiments in which the stopper part exerts radial pressure primarily in the constricted section.

According to a 98th embodiment, in the 47th embodiment and any one of the 84th to 97th embodiments, in the unlocked state, at least a part of sealing section has received at least a part of the second section of the stopper part of the stopper.

Receiving at least a part of the second section of the stopper part within the sealing section enables relaxation of the sealing section by the stopper part in the unlocked state.

According to a 99th embodiment, in the 98th embodiment, in the unlocked state, at least the part of the sealing section which has the smallest inner diameter has received at least a part of the second section of the stopper part of the stopper.

Receiving at least a part of the second section of the stopper part within the part of the sealing section which has the smallest diameter ensures relaxation of the sealing section by the second section of the stopper part in the unlocked state in preferred embodiments in which the stopper exerts radial pressure primarily in a constricted section of the sealing element.

According to a 100th embodiment, in the 49th and 99th embodiments, in the unlocked state, at least a part of the constricted section of the sealing section has received at least a part of the second section of the stopper part of the stopper.

Receiving at least a part of the second section of the stopper part within the constricted section enables relaxation of the sealing section by the second section of the stopper part in the unlocked state in preferred embodiments in which the stopper part exerts radial pressure primarily in the constricted section.

According to a 101st embodiment, in the 49th and any one of the 84th to 100th embodiments, in the locked state, the second section of the stopper part of the stopper is not located within the constricted section of the sealing section of the sealing element.

Removing the second section of the stopper part from the constricted section of the sealing section of the sealing element may allow exerting maximum pressure on the sealing section by the stopper part.

According to a 102nd embodiment, in the 47th embodiment or the 47th embodiment and any one of the 48th to 95th embodiments, the sealing element comprises a second section which is positioned below the sealing section.

According to a 103rd embodiment, in the 102nd embodiment, the second section is configured to be radially expanded by at most 1 mm in diameter, preferably at most 0.5 mm, more preferably at most 0.2 mm and most preferably not expanded at all, upon full introduction of the stopper part into the sealing element.

This facilitates introduction of the stopper into the sealing element and prevents that radial pressure is exerted on the interlocking means of the closure system if the interlocking means of the sealing element are located within the second section.

According to a 104th embodiment, in any one of the 102nd or 103rd embodiments, the second section of the sealing element, without considering any recesses and/or protrusions, has an outer diameter which is smaller than the smallest inner diameter of

the mouth of the bottle, preferably even when the stopper part of the stopper is fully introduced into the sealing element.

This allows introduction of the sealing element without the second section of the sealing element touching the inner wall of the mouth of the bottle, thereby reducing the friction during introduction.

According to a 105th embodiment, in any one of the 102nd to 104th embodiments, the second section of the sealing element, without considering any recesses and/or protrusions, has an outer diameter of at least 12 mm, preferably at least 14 mm, more preferably at least 15 mm, most preferably at least about 15.4 mm when the stopper part of the stopper is fully introduced into the sealing element and/or when the stopper part of the stopper is not fully introduced into the sealing element.

According to a 106th embodiment, in any one of the 102nd to 105th embodiments, the second section of the sealing element, without considering any recesses and/or protrusions, has an outer diameter of at most 18 mm, preferably at most 17 mm, more preferably at most 16 mm, most preferably at most about 15.4 mm when the stopper part of the stopper is fully introduced into the sealing element and/or when the stopper part of the stopper is not fully introduced into the sealing element.

The inner diameter of the mouth of a standard wine bottle is 18.5 mm. Therefore, dimensioning the second section of the sealing element in this manner prevents contact of the second section of the sealing element with the inner wall of the mouth of the bottle.

According to a 107th embodiment, in any one of the 102nd to 106th embodiments, the second section of the sealing element has a length of at least 6 mm, preferably at least 8 mm, more preferably at least 10 mm, most preferably at least about 11 mm.

According to a 108th embodiment, in any one of the 102nd to 107th embodiments, the second section of the sealing element has a length of at most 17 mm, preferably at most 14 mm, more preferably at most 12 mm, most preferably at most about 11 mm.

Interlocking means

According to a 109th embodiment, in any one of the preceding embodiments, the interlocking means are positioned in a section where the sealing element is not forced against the inner wall of the mouth of the bottle in the locked state.

A decoupling of the pressure zones from the zone where the interlocking means are located allows for a smooth and pressure-free interaction between the interlocking means on the stopper part of the stopper and the counterpart interlocking means on the sealing element, which in turn allows the user to easily bring the closure system from the locked position to the unlocked position or vice versa.

According to a 110th embodiment, in the 5th embodiment or the 5th embodiment and any one of the 6th to 109th embodiments, in the locked state, the section where the seal is formed is located above the interlocking means.

When the pressure zones are decoupled from the zone where the interlocking means are located, it is advantageous to arrange the pressure zone where the seal is formed above the zone where the interlocking means are located and not vice versa, in order to properly seal the sealing element at its top so that dirt particles or liquid cannot enter at the top or the seal.

According to a 111th embodiment, in any one of the preceding embodiments, the interlocking means are configured not to prevent a rotation of the stopper with respect to the sealing element at least in one direction.

This allows rotation of the stopper at least in one direction at any stage, thereby allowing to bring the closure system in the locked or unlocked state, respectively, by rotation. According to a 112th embodiment, in any one of the preceding embodiments, the interlocking means are configured to prevent an axial displacement of the stopper with respect to the sealing element in the upward direction in the locked state.

Holding the stopper in the sealing element, in the locked state, by the interlocking connection provided by the interlocking means allows the holding force provided by the frictional connection between the stopper part and the sealing section of the sealing element to be reduced. A lower friction in the area where the seal is formed allows the torque required to rotate the stopper for bringing the closure system into the unlocked position can also be reduced.

According to a 113th embodiment, in the 112th embodiment, the retention force provided by the interlocking means in the locked state corresponds to at least 60% of the force preventing axial displacement of the stopper with respect to the sealing element in the locked state, preferably at least 70%, more preferably at least 80%, most preferably at least 90%.

For the reason explained above, it is advantageous to shift as much of the holding force between the stopper and the sealing element in the locked position to the interlocking connection provided by the interlocking means.

According to a 114th embodiment, in any one of the preceding embodiments, the interlocking means of the stopper are configured not to prevent an axial displacement of the stopper with respect to the sealing element in the upward direction in the unlocked state.

This allows removal of the stopper from the sealing element in the unlocked state, which allows the sealing element to remain in the mouth of the bottle when the stopper is removed from the mouth of the bottle.

According to a 115th embodiment, in any one of the preceding embodiments, the interlocking means are configured to move the stopper, when in the locked state, upward until the unlocked state is reached, upon clockwise or counterclockwise rotation of the stopper with respect to the bottle.

This ensures that the second section of the stopper part, which has a smaller diameter than the first section of the stopper part, can be brought at least in part into at least a

part of the sealing section, whereby the sealing section is relaxed and the seal is released.

According to a 116th embodiment, in any one of the preceding embodiments, the interlocking means are configured to move the stopper, when in the unlocked state, downward until the locked state is reached, upon counterclockwise or clockwise rotation of the stopper with respect to the bottle.

This ensures that the first section of the stopper part, which has a larger diameter than the second section of the stopper part, can be brought at least in part into at least a part of the sealing section, whereby the sealing section is expanded and the seal is formed.

According to a 117th embodiment, in the 115th or 116th embodiments, respectively, the interlocking means are configured to move the stopper upward or downward, respectively, by at least 2 mm, preferably at least 3 mm, more preferably at least 4 mm, most preferably at least about 5 mm, upon rotation of the stopper with respect to the bottle.

It is necessary that there is a certain amount of distance the stopper travels upwards or downwards for transitioning between the locked and the unlocked state (the axial "stroke" provided by the interlocking means) because there has to be a certain length over which the first section of the stopper part is replaced by the second section for bringing the closure system into the unlocked state, and vice versa for bringing the system into the locked state. This length depends, *inter alia*, from the length of the section where the seal is formed.

According to a 118th embodiment, in any one of the 115th to 117th embodiments, the interlocking means are configured to move the stopper upward or downward, respectively, by at most 10 mm, preferably at most 7 mm, more preferably at most 6 mm, most preferably at most 5 about mm, upon rotation of the stopper with respect to the bottle.

It is preferable to keep the axial stroke provided by the interlocking means to a minimum because, for example, this allows the amount of rotation required to

transition from one state to the other to be kept to a minimum. Furthermore, it allows the distance to be travelled by the stopper to transition from the preassembled state to the locked state to be kept to a minimum because in the preferred embodiment and as explained below, this distance substantially corresponds to the axial stroke provided by the interlocking means.

According to a 119th embodiment, in the 34th and 49th embodiments and any one of the 115th to 118th embodiments, the interlocking means are configured to move the stopper upward or downward, respectively, by at least 70% of the distance between the lower end of the first section of the stopper part and the upper end of the constricted section, when the stopper is fully introduced into the sealing element, preferably at least 80%, more preferably at least 90%, most preferably at least about 100%.

According to a 120th embodiment, in the 34th and 49th embodiments and any one of the 115th to 119th embodiments, the interlocking means are configured to move the stopper upward or downward, respectively, by at most 150% of the distance between the lower end of the first section of the stopper part and the upper end of the constricted section, when the stopper is fully introduced into the sealing element, preferably at most 130%, more preferably at most 110%, most preferably at most about 100%.

In the preferred embodiment of the invention, the axial stroke required for a full transition between locked and unlocked state corresponds to about the distance between the lower end of the first section of the stopper part and the upper end of the constricted section, when the stopper is fully introduced into the sealing element.

According to a 121st embodiment, in the 5th embodiment and any one of the 115th to 118th embodiments, the interlocking means are configured to move the stopper upward or downward, respectively, by at least 20% of the length of the section where the seal is formed, preferably at least 40%, more preferably at least 50%, most preferably at least about 62%, upon rotation of the stopper with respect to the bottle.

According to a 122nd embodiment, in the 5th and any one of the 115th to 121st embodiments, the interlocking means are configured to move the stopper upward or downward, respectively, by at most 100% of the length of section where the seal is

formed, preferably at most 80%, more preferably at most 70%, most preferably at most about 62%, upon rotation of the stopper with respect to the bottle.

As mentioned above, the axial stroke provided by the interlocking means depends, *inter alia*, from the length of the section where the seal is formed. In the preferred embodiment of the invention, due to the use of a constricted section in the sealing section of the sealing element, the axial stroke only needs to be about 62% of the length of the section where the seal is formed. Without a constricted section, the axial stroke would essentially have to be at least 100% of the length of the section where the seal is formed.

According to a 123rd embodiment, in the 34th embodiment or the 34th embodiment and any one of the 35th to 122th embodiments, the interlocking means of the stopper part of the stopper are not located within the first section of the stopper part of the stopper.

Since the first section of the stopper part is the section which exercises pressure on the sealing section of the sealing element in the locked state, the interlocking means of the stopper part of the stopper should not be located within the first section of the stopper part, for achieving the above-mentioned goal of decoupling the pressure zones from the zone where the interlocking means are located.

According to a 124th embodiment, in the 84th and 123rd embodiments, the interlocking means of the stopper part of the stopper are located within the second section of the stopper part of the stopper.

This achieves the above-mentioned end of decoupling the pressure zones from the zone where the interlocking means are located because the second section of the stopper part in the preferred embodiment of the invention is not a pressure zone.

According to a 125th embodiment, in any one of the 123rd or 124th embodiments, the interlocking means of the stopper part of the stopper comprise one or more grooves arranged on the circumference of the stopper part of the stopper.

According to a 126th embodiment, in the 125th embodiment, a groove spans at least 86° of the circumference of the stopper part, preferably at least 93°, more preferably at least 100°, most preferably at least about 110°.

The circumference of the groove determines the amount of rotation required to transition the closure system between the locked and the unlocked state. This amount should be large enough to prevent accidental or unintentional unlocking of the system.

According to a 127th embodiment, in any one of the 123rd or 126th embodiments, a groove spans at most 180° of the circumference of the stopper part, preferably at most 160°, more preferably at most 140°, most preferably at most about 110°.

On the other hand, the amount of rotation required to transition the closure system between the locked and the unlocked state should not be small enough so that the closure system can be locked or unlocked with a quick and comfortable movement. The inventors found that a rotation of about 110° strikes a good balance between the two requirements.

According to a 128th embodiment, in any one of the 123rd to 127th embodiments, the interlocking means of the stopper part comprise two or more grooves of substantially identical shape arranged on the circumference of the stopper part.

Providing two or more grooves results in interlocking means which hold the stopper more securely in the sealing element. Furthermore, it allows to reduce the amount of searching required for the user to find the entry point of the pins into the grooves for screwing the stopper back into the sealing element.

According to a 129th embodiment, in the 128th embodiment, the two or more grooves are distributed opposite and/or symmetrically to each other and/or equidistant from each other around the circumference of the stopper part.

With such an arrangement, any pin on the sealing element can enter into any groove on the stopper, which allows to reduce the amount of searching required for the user to

find the entry point of the pins into the grooves for screwing the stopper back into the sealing element.

According to a 130th embodiment, in any one of the 123rd to 129th embodiments, a groove comprises a main section, which extends diagonally downward from a higher position to a lower position on the stopper part.

This enables the stopper to move up- and downward, respectively, upon rotation.

According to a 131st embodiment, in the 130th embodiment, a groove further comprises a starting section which extends substantially horizontally or with a lower inclination than the main section, from the upper end of the main section.

The horizontal starting section reduces the amount of torque required to start the rotation of the stopper to unlock the system by not requiring the force to move the stopper up or down, respectively. Furthermore, the horizontal starting section provides a secure interlocking connection with the pins to hold the stopper in the sealing element in the locked position. In particular, there is no risk that a stopper under pressure rotates itself out of the sealing element.

According to a 132nd embodiment, in the 130th embodiment, in the locked state, respective counterpart interlocking means of the sealing element are located at the starting section of a groove at least with 60% of the width of the counterpart interlocking means of the sealing element, preferably at least 70%, more preferably at least 80%, most preferably at least 90%.

The starting section of the grooves on the stopper part should be sufficiently long to accommodate a large enough part of the pins to provide a secure interlocking connection with the pins to hold the stopper in the sealing element in the locked position and to avoid the risk that a stopper under pressure rotates itself out of the sealing element.

According to a 133rd embodiment, in any one of the 131st or 132nd embodiments, the starting section has a length of at least 60% of the width of the counterpart interlocking

means of the sealing element, preferably at least 70%, more preferably at least 80%, most preferably at least 90%.

The starting section of the grooves on the stopper part need not accommodate the pins on their entire width because a secure interlocking connection with the pins to hold the stopper in the sealing element in the locked position can be provided even if a part of the pins protrudes into the diagonal main section of the grooves.

According to a 134th embodiment, in any one of the 131st to 133rd embodiments, the starting section has a length of at least 2.5 mm, preferably at least 3 mm, more preferably at least 3.5 mm and most preferably at least about 4 mm.

According to a 135th embodiment, in any one of the 131st to 134th embodiments, the starting section has a length of at most 5.5 mm, preferably at most 5 mm, more preferably at most 4.5 mm and most preferably at most about 4 mm.

Such a length of the starting section of the grooves is preferred if the pins have a width of 4 to 5 mm.

According to a 136th embodiment, in any one of the 131st to 135th embodiments, the starting section has a surface which is configured to serve as a stop for the counterpart interlocking means of the sealing element.

This provides an indication to the user that the locked state has been reached when transitioning the closure system into the locked state, so that the user knows when he can stop rotating the stopper.

According to a 137th embodiment, in any one of the 130th to 136th embodiments, a groove further comprises an end section which extends substantially vertically or with a higher inclination than the main section, downward from the lower end of the main section.

A vertical end section provides a stop function for the pins, the purpose of which will be explained below.

According to a 138th embodiment, in the 130th embodiment, in the unlocked state, respective counterpart interlocking means of the sealing element are located at the end section of a groove at least with 60% of the width of the counterpart interlocking means of the sealing element, preferably at least 70%, more preferably at least 80%, most preferably at least 90%.

Such a width ensures that the pins on the sealing element sit securely in the grooves on the stopper when the pins are at the end section.

According to a 139th embodiment, in any one of the 137th or 138th embodiments, the end section is open toward a lower end thereof, thereby being configured to stop engaging the counterpart interlocking means of the sealing element.

This allows the pin to be removed from the groove when the stopper is to be removed from the bottle after the closure system has been brought to the unlocked state. On the other hand, it allows the pin to be inserted into the groove when the stopper is introduced into the sealing element in the unlocked state.

According to a 140th embodiment, in any one of the 137th or 139th embodiments, the opening of the end section has a tapered shape.

This further facilitates inserting the pin on the sealing element when introducing the stopper part into the sealing element in the unlocked state.

According to a 141st embodiment, in any one of the 137th to 140th embodiments, the end section has a surface which is configured to serve as a stop for the counterpart interlocking means of the sealing element.

This provides an indication to the user that the unlocked state has been reached when transitioning the closure system into the unlocked state, so that the user knows when he can stop rotating the stopper.

According to a 142nd embodiment, in any one of the 123rd to 141st embodiments, a groove has a depth of at least 0.3 mm, preferably at least 0.6 mm, more preferably at least 0.8 mm and most preferably at least about 1 mm.

According to a 143rd embodiment, in any one of the 123rd to 142nd embodiments, a groove has a depth of at most 2 mm, preferably at most 1.5 mm, more preferably at most 1.2 mm and most preferably at most about 1 mm.

According to a 144th embodiment, in any one of the 123rd to 143rd embodiments, a groove has a width of at least 1 mm, preferably at least 2 mm, more preferably at least 2.5 mm and most preferably at least about 3 mm.

According to a 145th embodiment, in any one of the 123rd to 144th embodiments, a groove has a width of at most 5 mm, preferably at most 4 mm, more preferably at most 3.5 mm and most preferably at most about 3 mm.

According to a 146th embodiment, in any one of the 123rd to 145th embodiments, a groove has one of a rectangular, u-shape, circular or oval cross-section.

According to a 147th embodiment, in the 47th embodiment or the 47th embodiment and any one of the 54th to 146th embodiments, the counterpart interlocking means of the sealing element are not located within the sealing section of the sealing element.

Since the sealing section of the sealing element is the section on which pressure is exercised in the locked state, the counterpart interlocking means of the sealing element should not be located within the sealing section, for achieving the above-mentioned goal of decoupling the pressure zones from the zone where the interlocking means are located.

According to a 148th embodiment, in the 102nd embodiment or the 102nd embodiment and any one of the 103rd to 147th embodiments, the counterpart interlocking means of the sealing element are located within the second section of the sealing element.

This achieves the above-mentioned end of decoupling the pressure zones from the zone where the interlocking means are located because the second section of the sealing element in the preferred embodiment of the invention is not a pressure zone.

According to a 149th embodiment, in any one of the preceding embodiments, the counterpart interlocking means of the sealing element are or comprise one or more protrusions on the inner wall of the sealing element.

According to a 150th embodiment, in the 123rd embodiment and the 149th embodiment, the protrusions are pins configured to run in the grooves of the stopper part of the stopper.

This provides a secure way of holding the stopper inside the sealing element. Screw threads need to be perfectly uniform and even throughout the entire thread. On the other hand, a pin can run in a groove even if the groove changes its angle along the way. Therefore, the pin can run in a groove having a starting section and an end section as described above. Advantageously the grooves are located on the stopper part and the pins on the sealing element, and not the other way round, because the stopper part will typically be manufactured from a harder material such as glass than the sealing element. A groove made from a relatively hard material ensures that the pin runs smoothly in the groove.

According to a 151st embodiment, in any one of the 149th or 150th embodiments, the protrusions are located on portions of the inner wall of the sealing element, which are partially or completely attached to the second section of the sealing element.

According to a 152nd embodiment, in the 151st embodiment, the portions of the inner wall of the sealing element are tabs.

According to a 153rd embodiment, in any one of the 151st or 152nd embodiments, the portions of the inner wall are mounted resiliently in the radial direction.

Having the protrusions sitting on pads which can slightly move in a radial direction allows for an easier transition of the pins from the holding means on the stopper part as

described below, to the grooves, when the closure system is brought from the pre-assembled to the locked state.

According to a 154th embodiment, in any one of the 149th or 153rd embodiments, the centroids of the protrusions are located at least 10 mm below the upper end of the sealing element, preferably at least 13 mm, more preferably at least 15 mm, most preferably at least about 16 mm.

According to a 155th embodiment, in any one of the 149th or 154th embodiments, the centroids of the protrusions are located at most 22 mm below the upper end of the sealing element, preferably at most 19 mm, more preferably at most 17 mm, most preferably at most about 16 mm.

According to a 156th embodiment, in any one of the 149th to 155th embodiments, the protrusions are at least 1 mm wide, preferably at least 1.3 mm, more preferably at least 1.7 mm, most preferably at least about 2 mm.

According to a 157th embodiment, in any one of the 149th to 156th embodiments, the protrusions are at most 5 mm wide, preferably at most 3 mm, more preferably at most 2.5 mm, most preferably at most about 2 mm.

According to a 158th embodiment, in any one of the 149th to 157th embodiments, the protrusions protrude at least 0.25 mm from the inner surface of the sealing element, preferably at least 0.5 mm, more preferably at least 0.75 mm, most preferably at least about 1 mm.

According to a 159th embodiment, in any one of the 149th to 158th embodiments, the protrusions protrude at most 1.75 mm from the surface of the sealing element, preferably at most 1.5 mm, more preferably at most 1.25 mm, most preferably at most about 1 mm.

According to a 160th embodiment, in any one of the 149th to 159th embodiments, the protrusions have a substantially rectangular, u-shape, circular or oval cross section.

The inventors found out that these dimensions and shapes ensure a secure fit with the interlocking means of the stopper.

According to a 161st embodiment, in any one of the 149th to 160th embodiments, the interlocking means of the sealing element comprise two or more protrusions distributed opposite to each other and/or equidistant from each other around the inner circumference of the sealing element.

This further improves holding the stopper part securely inside the sealing element. Furthermore, it allows to reduce the amount of searching required for the user to find the entry point of the pins into the grooves for screwing the stopper back into the sealing element.

According to a 162nd embodiment, in any one of the 149th to 161th embodiments, the one or more protrusions are configured to engage with the interlocking means of the stopper.

According to a 163rd embodiment, in the 131st embodiment and any one of the 149th or 162nd embodiments, a bottom surface of the protrusion is substantially parallel to the surface of the starting section of the groove with which is configured to make contact when the protrusion is located at the starting section.

This allows the bottom surface of the protrusions to provide an effective blocking (interlocking connection) in an upward axial direction.

According to a 164th embodiment, in the 130th embodiment and any one of the 149th or 163rd embodiments, a lower diagonal surface of the protrusion which is configured to make contact with the lower surface of the main section of the groove is substantially parallel to the lower surface of the main section; and/or an upper diagonal surface of the protrusion which is configured to make contact with the upper surface of the main section of the groove is substantially parallel to the upper surface of the main section.

The diagonal sides facilitate the movement of the protrusions in the diagonal main sections of the grooves by enlarging the contact surface.

According to a 165th embodiment, in the 136th embodiment and any one of the 149th or 164th embodiments, a side surface of the protrusion which is configured to make contact with the surface of the starting section which is configured to serve as a stop for the counterpart interlocking means is substantially parallel to the surface of the starting section which is configured to serve as a stop.

This allows the side surface of the protrusions to provide an effective blocking (interlocking connection) in one rotational direction.

According to a 166th embodiment, in the 141st embodiment and any one of the 149th or 165th embodiments, a side surface of the protrusion which is configured to make contact with the surface of the end section which is configured to serve as a stop for the counterpart interlocking means is substantially parallel to the surface of the end section that is configured to serve as a stop.

This allows the side surface of the protrusions to provide an effective blocking (interlocking connection) in the other rotational direction.

According to a 167th embodiment, in any one of the 163rd to 166th embodiments, the substantially parallel surfaces deviate in an angle at most be 20 degrees, preferably at most 10 degrees.

According to a 168th embodiment, in any one of the preceding embodiments, the stopper part of the stopper comprises holding means configured to form an interlocking connection with counterpart holding means of the sealing element, to hold the stopper in a secured position with respect to the sealing element when the closure system is in a preassembled state.

According to a 169th embodiment, in the 168th embodiment, in the preassembled state of the closure system, the stopper part of the stopper is partially introduced into the sealing element and the interlocking means of the stopper part are not engaged with the counterpart interlocking means of the sealing element.

According to a 170th embodiment, in any one of the 168th or 169th embodiments, holding the stopper in the secured position prevents at least a substantial rotational displacement of the stopper with respect to the sealing element.

According to a 171st embodiment, in any one of the 168th to 170th embodiments, holding the stopper in the secured position prevents at least a substantial axial displacement of the stopper with respect to the sealing element.

According to a 172nd embodiment, in any one of the 168th to 171st embodiments, holding the stopper in the secured position prevents that the stopper part of the stopper is fully introduced into the sealing element before the sealing element is fully introduced into the mouth of the bottle.

For example, if none of the sealing section or retaining section (described below) of the sealing element is expanded in the preassembled state, i.e. as long as the stopper is not fully introduced into the sealing element, preventing that the stopper part of the stopper is fully introduced into the sealing element before the sealing element is fully introduced into the bottle ensures that the friction between the sealing element and the mouth of the bottle remains small until the sealing element is fully introduced into the mouth of the bottle.

According to a 173rd embodiment, in the 23rd embodiment and any one of the 168th to 172nd embodiments, holding the stopper in the secured position prevents that the stopper part of the stopper is fully introduced into the sealing element before the covering section of the sealing element has made contact with the upper end of the mouth of the bottle.

This is because in the preferred embodiment, the sealing element is fully introduced into the mouth of the bottle as soon as the covering section of the sealing element has made contact with the upper end of the mouth of the bottle.

According to a 174th embodiment, in the 47th embodiment and any one of the 168th to 173rd embodiments, in the preassembled state, the radial expansion of the sealing

section of the sealing element is as defined as in the context of the 74th embodiment with regard to the unlocked state.

In the preferred embodiment described above, the sealing section of the sealing element is not expanded in the unlocked state. This is advantageous also for the preassembled state in order to avoid friction during introduction of the sealing element into the mouth of the bottle.

According to a 175th embodiment, in any one of the 168th to 174th embodiments, in the preassembled state, the positional relationship between the stopper part of the stopper and the sealing section of the sealing element is as defined in the context of the 83th embodiment or any one of the 96th to 100th embodiments with regard to the unlocked state.

The positional relationship between the stopper part of the stopper and the sealing section of the sealing element as defined for the unlocked state ensure that the sealing section of the sealing element is not expanded in the unlocked state. This is advantageous also for the preassembled state for the reason mentioned above.

According to a 176th embodiment, in any of the 168th to 175th embodiments, the holding means of the stopper part of the stopper comprise one or more depressions arranged on the stopper part of the stopper.

Depressions are advantageous because they can accommodate the above-described pins on the sealing element of the preferred embodiment of the invention as the counterpart holding means.

According to a 177th embodiment, in the 176th embodiment, the one or more depressions are open at the lower side of the depressions.

This allows for easy positioning of the holding means when the stopper is partially introduced into the sealing element to produce a preassembled closure system. However, the openings have the advantage that when the user re-introduces the stopper into the bottle to bring the closure system back to the locked state, he may

mistake the openings of the holdings means for the end sections of the interlocking means.

According to a 178th embodiment, in the 123rd embodiment and any one of the 176th or 177th embodiments, the one or more depressions are configured such that when the counterpart holding means of the sealing element are engaged with the depressions in the preassembled state, the counterpart holding means transition to respective grooves of the interlocking means, when the stopper part of the stopper is fully introduced into the sealing element by pushing.

This allows to concentrate the functions of the counterpart interlocking means and the counterpart holding means in the same elements, preferably pins.

According to a 179th embodiment, in the 153rd and 178th embodiments, the resilient mounting of the counterpart holding means facilitates the transition.

According to a 180th embodiment, in the 179th embodiment, the distance between the holding means and the interlocking means is at least 80% of the distance that the stopper is moved upward or downward in the groove, preferably at least 87%, more preferably at least 95%, most preferably at least about 100%.

According to a 181st embodiment, in the 178th or 180th embodiments, the distance between the holding means and the interlocking means is at most 130% of the distance that the stopper is moved upward or downward in the groove, preferably at least 120%, more preferably at least 110%, most preferably at least about 100%.

As already mentioned above, the distance to be travelled by the stopper to transition from the preassembled state to the locked state should substantially correspond to the axial stroke provided by the interlocking means. This is because as likewise mentioned above, the positional relationship between the stopper part of the stopper and the sealing section of the sealing element in the preassembled state should be the same as in the unlocked state, in order to ensure that the sealing section is not expanded in both of the states.

According to a 182nd embodiment, in any one of the 176th or 181st embodiments, the holding means of the stopper part of the stopper comprise two or more depressions arranged on the stopper part.

This is to accommodate the two or more counterpart interlocking means of the preferred embodiment mentioned above.

According to a 183rd embodiment, in the 182nd embodiment, the two or more depressions are distributed opposite and/or symmetrically to each other and/or equidistant from each other around the circumference of the stopper part of the stopper.

This is to accommodate the preferred arrangement of the two or more counterpart interlocking means of the preferred embodiment mentioned above.

According to a 184th embodiment, in the 123rd embodiment and any one of the 176th to 183rd embodiments, each depression is arranged below a groove on the circumference of the stopper part.

This is to facilitate that the counterpart holding means (preferred the pins) can transition from the depressions to the grooves on the stopper part as mentioned above.

According to a 185th embodiment, in the 131st embodiment and the 184th embodiment, each depression is arranged below the starting section of a groove on the circumference of the stopper part.

This is to ensure that when the counterpart holding means transition from the depressions to the grooves on the stopper part as mentioned above, they arrive at the starting section of the groove, which is the preferred section for the counterpart holding means (counterpart interlocking means) to be in the locked position.

According to a 186th embodiment, in the 185th embodiment, the distance between the holding means and the interlocking means is at least 2 mm, preferably at least 3 mm, more preferably at least 4 mm, most preferably at least about 4.5 mm.

According to a 187th embodiment, in the 185th or 186th embodiments, the distance between the holding means and the interlocking means is at most 7 mm, preferably at most 6 mm, more preferably at most 5 mm, most preferably at most about 4.5 mm.

This distance corresponds substantially to the axial stroke provided by the interlocking means in the preferred embodiment.

According to a 188th embodiment, in any one of the 176th to 187th embodiments, the depressions have a profile which forms a counterpart profile matching the profile of the counterpart holding means of the sealing element and/or the depth of the depressions and the height of the counterpart holding means of the sealing element are substantially equal.

This may help the depressions and the counterpart holding means to engage with less leeway.

According to a 189th embodiment, in the 84th embodiment and any one of the 168th to 188th embodiments, the holding means of the stopper part of the stopper are arranged on the second section of the stopper part.

This is because the interlocking are arranged on the second section of the stopper part as well.

According to a 190th embodiment, in any one of the 168th to 189th embodiments, the counterpart holding means of the sealing element are or comprise at least a portion of the counterpart interlocking means of the sealing element.

This concentration of the functions of the counterpart interlocking means and the counterpart holding means in the same elements, preferably pins, allows a reuse of the counterpart holding means and therefore save a requirement for an additional counterpart interlocking means. In addition, the counterpart holding means have to be "stored" in some depression in the locked/unlocked state, which depression is

conveniently provided by the grooves of the interlocking means if the counterpart holding means are the counterpart interlocking means as well.

According to a 191st embodiment, in any one of the preceding embodiments, the closure system is configured such that the sealing element remains in the mouth of the bottle after the closure system has been brought into the locked position, even when the stopper is subsequently removed from the mouth of the bottle.

This provides several advantages. First of all, since the look of the sealing element, which is typically made of plastic, is not particularly pleasing to the user, the sealing element should be as short as possible if the sealing element is to be removed from the bottle together with the stopper. However, a short sealing element is very limited in the quality of the sealing it can achieve. Therefore, leaving the sealing element in the mouth of the bottle allows to achieve a better sealing quality. Secondly, in a case where the stopper is made of glass, the stopper part of the stopper is fragile. However, if the plastic sealing element remains on the stopper part when the stopper is removed from the mouth of the bottle, the fragility of the stopper part is not recognizable any more by the user, which may lead to careless handling of the stopper and in the end to a breaking of the stopper part. This is avoided by leaving the sealing element in the bottle.

According to a 192nd embodiment, in the 191st embodiment, a force exceeding 10N, preferably exceeding 20N, more preferably exceeding 50N, most preferably more than 100N is required to pull the sealing element out of the mouth of the bottle after the closure system has been brought into the locked position, even when the stopper is subsequently removed from the mouth of the bottle.

This has the advantage that it will be very difficult for the user to remove the sealing element from the mouth of the bottle, even when the stopper has been removed. As a consequence, the sealing element, which will be needed later for re-closing the bottle, will not get lost, or improperly reintroduced into the mouth of the bottle. Furthermore, this ensures that the sealing element can perform a drip stop function as described above or an aerator function as will be described below.

According to a 193rd embodiment, in any one of the preceding embodiments, the sealing element comprises a retaining section configured to retain the sealing element in the mouth of the bottle by the retaining section being forced against the inner wall of the mouth of the bottle.

This provides an additional connection between the sealing element and the mouth of the bottle, so that the connection provided by the seal in the area where the seal is formed is not the only connection. As a consequence, the connection in the area where the seal is formed can be made weaker so that the torque required to rotate the stopper to bring it from the locked to the unlocked position can be reduced. In fact, in the preferred embodiment of the invention, the largest part of the force holding the sealing element in the mouth of the bottle is provided by the retaining section rather than the sealing section.

According to a 194th embodiment, in the 193rd embodiment, the connection between the outer surface of the retaining section and the inner wall of the mouth of the bottle created by the forcing of the retaining section against the inner wall of the mouth of the bottle is at least in part an interlocking connection.

Such an interlocking connection can typically provide a much greater holding force than a mere frictional connection.

According to a 195th embodiment, in any one of the 193rd to 194th embodiments, the retaining section is located at least in part at a section of the mouth of the bottle with an increasing diameter from top to bottom.

This location of the retaining section allows the retaining section to form an interlocking connection with the mouth (or neck) of the bottle.

According to a 196th embodiment, in any one of the 193rd to 195th embodiments, the retaining section starts at least at 18 mm below the upper end of the sealing element, preferably at least at 20 mm, more preferably at least at 22 mm, most preferably at least at about 24 mm.

According to a 197th embodiment, in any one of the 193rd to 196th embodiments, the retaining section starts at most at 40 mm below the upper end of the sealing element, preferably at most at 33 mm, more preferably at most at 27, most preferably at most at about 24 mm.

In a standard wine bottle, although considerable freedom is given to the manufacturers, it is very likely that a section of the mouth of the bottle with an increasing diameter from top to bottom is found at a section starting about 24 mm below the tip of the mouth of the bottle.

According to a 198th embodiment, in any one of the 193rd to 197th embodiments, the length of the retaining section is at least 4 mm, preferably at least 6 mm, more preferably at least 8 mm, most preferably at least about 10 mm.

According to a 199th embodiment, in any one of the 36th to 48th embodiments, the length of the first section is at most 23 mm, preferably at most 17 mm, more preferably at most 13 mm, most preferably at most about 10 mm.

According to a 200th embodiment, in any one of the 193rd to 195th embodiments, the retaining section is configured to be activated upon introduction of the stopper part of the stopper into the sealing element, whereby the retaining section is radially expanded.

Consequently, the interlocking connection in the preferred embodiment may be formed only when transitioning from the preassembled state to the locked state, and not before, which allows for easier introduction of the sealing element into the mouth of the bottle.

According to a 201st embodiment, in the 200th embodiment, an outer diameter of the retaining section is configured to be radially expanded upon activation by at least 1 mm, preferably by at least 1.6 mm, more preferably by at least 1.9 mm, most preferably by at least about 2.1 mm, when the closure system is not introduced into the bottle.

According to a 202nd embodiment, in any one of the 200th or 201st embodiments, the outer diameter of the retaining section is configured to be radially expanded upon activation by at most 3.1 mm, preferably by at least 2.6 mm, more preferably by at least 2.3 mm, most preferably by at least about 2.1 mm, when the closure system is not introduced into the bottle.

As will be described below, the outer diameter of the retaining section should preferably be the same as the outer diameter of the sealing section of the sealing element, i.e. 18.3 mm in the preferred embodiment tailored for a standard wine bottle. In this case, the inventors found out that a radial stroke of 2.1 provided by the radial expansion of the retaining section is preferred to provide for a secure connection if the retaining section is located in the preferred area defined above.

According to a 203rd embodiment, in any one of the 200th to 202nd embodiments, the retaining section comprises one more cutouts which facilitate expansion of the retaining section.

According to a 204th embodiment, in the 203rd embodiment, the retaining section consists of or comprises one or more wings.

These wings are the "negatives" of the cutouts, i.e. they are what is left of the retaining section after the cutouts have been cut out.

According to a 205th embodiment, in any one of the 193rd to 204th embodiments, the retaining section of the sealing element has a substantially even outer surface when the retaining section is not activated.

Such an even outer surface allows to form a particularly strong connection with the likewise even inner surface of the mouth (or neck) of the bottle.

According to a 206th embodiment, in any one of the 203rd to 205th embodiments, the retaining section comprises two or more cutouts which are arranged opposite to each other and/or equidistant from each other.

According to a 207th embodiment, in any one of the 200th to 206th embodiments, the retaining section comprises a constricted section, having a smaller inner diameter than other parts of the retaining section.

This constricted section allows to provide for similar advantages as described above for the constricted section of the sealing section of the sealing element.

According to a 208th embodiment, in any one of the 200th to 207th embodiments, an inner surface of the constricted section of the retaining section comprises a section which is substantially convex at least when the retaining section is not activated.

This substantially convex section of the constricted section allows to provide for similar advantages as described above for the substantially convex section of the constricted section of the sealing section of the sealing element.

According to a 209th embodiment, in any one of the 200th to 208th embodiments, the outer shape of the retaining section is substantially cylindrical when the retaining section is not activated.

This substantially cylindrical outer shape of the retaining section allows to provide for similar advantages as described above for the substantially cylindrical outer shape of the sealing section of the sealing element.

According to a 210th embodiment, in any one of the 150th to 209th embodiments, the retaining section is not activated, it has a maximum outer diameter as defined in the context of any one of the 68th to 70th embodiments with regard to the sealing section of the sealing element.

This is because the retaining section has to enter the mouth of the bottle through the same top opening as the sealing section. In most bottles, including a standard wine bottle, the smallest diameter of the mouth is at the opening at the top of the mouth.

According to a 211th embodiment, in any one of the 200th to 210th embodiments, the outer shape of the retaining section comprises a section which is substantially tapered

with increasing diameter from top to bottom when the retaining section is activated and the closure system is not introduced into the bottle.

This outer shape allows to increase the interlocking connection with the counter-tapered inner shape of the mouth or neck of the bottle.

According to a 212th embodiment, in any one of the 200th to 211th embodiments, the sealing element is configured such that the retaining section remains activated when the stopper part of the stopper is removed from the sealing element.

This allows to achieve the force described above in the context of the 192nd embodiment, required to pull the sealing element out of the mouth of the bottle when the stopper is removed from the mouth of the bottle.

According to a 213th embodiment, in any one of the 200th to 212th embodiments, the sealing element comprises a retainer element as a separate object and is configured such that the retaining section of the sealing element is activated by the stopper part of the stopper pushing the retainer element down along the longitudinal axis of the sealing element when the stopper part is fully introduced into the sealing element.

This allows to achieve that the retaining section is activated when the closure system is transitioning from the preassembled state to the locked state, and that the retaining section remains activated when the stopper part of the stopper is removed from the sealing element.

According to a 214th embodiment, in the 213th embodiment, the retaining section is activated by the retainer element being pushed down by the bottom end of the stopper, the stopper part enters the retainer element at least partially.

This allows for a particularly secure interface between the stopper part of the stopper and the retainer element, to ensure that the retainer element is reliably pushed down when the stopper is fully introduced into the sealing element.

According to a 215th embodiment, in any one of the 213th or 214th embodiments, the retainer element has the shape of a ring.

According to a 216th embodiment, in any one of the 213th to 215th embodiments, the retainer element has a minimum inner diameter of at least 6 mm, preferably at least 9 mm, more preferably at least 10.5 mm, most preferably at least about 11.5 mm.

According to a 217th embodiment, in any one of the 213th to 216th embodiments, the retainer element has a minimum inner diameter of at most 17 mm, preferably at most 14 mm, more preferably at most 12.5 mm, most preferably at most about 11.5 mm.

According to a 218th embodiment, in any one of the 213th to 217th embodiments, the retainer element has a maximum outer diameter of at least 8 mm, preferably at least 11 mm, more preferably at least 13 mm, most preferably at least about 14 mm.

According to a 219th embodiment, in any one of the 213th to 218th embodiments, the retainer element has a maximum outer diameter of at most 20 mm, preferably at most 17 mm, more preferably at most 15 mm, most preferably at most about 14 mm.

According to a 220th embodiment, in any one of the 213th to 219th embodiments, the sealing element is configured such that the retaining section is activated by the retainer element expanding the retaining section.

According to a 221st embodiment, in any one of the 213th to 220th embodiments, the retaining section is configured to hold the retainer element after being activated.

This ensures that the retaining section remains activated when the stopper part of the stopper is removed from the sealing element.

According to a 222nd embodiment, in the 221st embodiment, the retaining section is configured to hold the retainer element by an interlocking connection between an outer surface of the retainer element and an inner surface of the retaining section.

An interlocking connection is preferred because it is typically stronger than a frictional connection.

According to a 223rd embodiment, in the 222nd embodiment, a section of the inner surface of the retaining section configured to be engaged to form the interlocking connection is substantially convex, and a section of the outer surface of the retainer element configured to be engaged to form the interlocking connection is substantially concave.

Surfaces in with such a shape are easy to manufacture, and the interlocking connection is easy to engage when the retainer element is pushed down. Furthermore, in the preferred embodiment, an inner surface of the retaining section is already convex, and having a concave counter-shape at the outer surface of the retainer element allows reuse of that convex shape for the interlocking connection.

According to a 224th embodiment, in the 208th and 223rd embodiments, the substantially convex section of the inner surface of the retaining section configured to be engaged to form the interlocking connection is the inner surface of the constricted section of the retaining section which is substantially convex at least when the retaining section is not activated.

According to a 225th embodiment, in any one of the preceding embodiments, the stopper part of the stopper comprises a third section configured to form an interface with a retainer element which is separate from the stopper and the sealing element, in such a way that the retainer element can be pushed down by the third section and/or the bottom of the section above the third section when the stopper part of the stopper is fully introduced into the sealing element.

According to a 226th embodiment, in the 213th and 225th embodiments, the third section of the stopper part of the stopper is configured to at least partially enter into the retainer element of the sealing element.

This is in order to provide a particularly secure interface with the retainer element as described above.

According to a 227th embodiment, in the 84th and any one of the 225th or 226th embodiments, the third section of the stopper part of the stopper is located below the second section of the stopper part of the stopper

According to a 228th embodiment, in any one of the 225th to 227th embodiments, the third section of the stopper part of the stopper has a diameter which is smaller than the diameter of the section above the third section.

According to a 229th embodiment, in the 228th embodiment, the third section of the stopper part of the stopper has a minimum diameter of at least 63% of the diameter of the section above the third section, preferably at least 70%, more preferably at least 78%, most preferably at least about 85%.

According to a 230th embodiment, in any one of the 228th or 229th embodiments, the third section of the stopper part of the stopper has a minimum diameter of at most 95% of the diameter of the section above the third section, preferably at most 90%, more preferably at most about 85%.

According to a 231st embodiment, in any one of the 225th to 230th embodiments, the third section of the stopper part of the stopper has a minimum diameter of at least 7 mm, preferably at least 9 mm, more preferably at least 10.5 mm, most preferably at least about 11.5 mm.

According to a 232nd embodiment, in any one of the 225th to 231st embodiments, the third section of the stopper part of the stopper has a maximum diameter of at most 16 mm, preferably at most 14 mm, more preferably at most 12.5 mm, most preferably at most about 11.5 mm.

According to a 233rd embodiment, in any one of the 225th to 232nd embodiments, the third section of the stopper part of the stopper ends at a distance of least 1 mm below the section above the third section, preferably at least 3 mm, more preferably at least 4 mm, most preferably at least about 5 mm.

According to a 234th embodiment, in any one of the 225th to 233rd embodiments, the third section of the stopper part of the stopper ends at a distance of at most 9 mm below the section above the third section, preferably at most 7 mm, more preferably at most 6 mm, most preferably at most about 5 mm.

According to a 235th embodiment, in any one of the proceedings embodiments, the sealing element further comprises one or more protrusions provided on the outer surface of the sealing element and configured to contact the inner wall of the mouth of the bottle during and/or introduction of the sealing element and/or closure system into the mouth of the bottle.

According to a 236th embodiment, in the 235th embodiment, the protrusions are configured to center the sealing element and/or closure system within the mouth of the bottle during and/or after introduction into the mouth of the bottle.

The protrusions ensure that the sealing element and/or closure system is centered within the mouth of the bottle to avoid the sealing element to be in an inclined position which causes higher friction when it is in uneven contact with the mouth of the bottle. Such a higher friction may even have the consequence that the softer components of the sealing element (described below) roll off from the sealing element.

According to a 237th embodiment, in any of the 235th or 236th embodiments, the protrusions are configured to wipe at least parts of the inner wall of the mouth of the bottle during introduction of the sealing element and/or closure system into the mouth of the bottle.

The protrusions may also wipe the mouth of the bottle to be free from liquid or dirt prior to sealing. This enables a better seal between the sealing element and the inner surface of the mouth of the bottle.

According to a 238th embodiment, in the 5th embodiment and any one of the 235th to 237th embodiments, the protrusions are located at least in part on the outer surface of the sealing element below the section where the seal is formed.

This allows for a centering and a wiping in the area of the sealing section and therefore at the same time protects and improves the efficiency of the sealing section.

According to a 239th embodiment, in the 238th embodiment, the upper end of at least a part of the protrusions is located at most 15 mm below the lower end of section where the seal is formed, preferably at most 10 mm, more preferably at most 5 mm, most preferably at most 3 mm.

According to a 240th embodiment, in the 102nd embodiment and any one of the 235th to 239th embodiments, the protrusions are positioned at least in part at the upper half, preferably the upper third, more preferably at the upper quarter of the second section of the sealing element.

According to a 241st embodiment, in the 147th embodiment and any one of the 235th to 240th embodiments, the protrusions are located at least in part on the outer surface of the sealing element below the retaining section of the sealing element.

This allows for a centering and a wiping in the area of the retaining section. Since the retaining section in the preferred embodiment is located at the lower end of the sealing element, having the protrusions below the retaining section in addition ensures that the closure system is centered during introduction into the mouth of the bottle from the moment on the system enters the mouth.

According to a 242nd embodiment, in the 241st embodiment, the upper end of at least a part of the protrusions is located at most 10 mm below the lower end of section to retain the sealing element in the mouth of the bottle, preferably at most 5 mm, more preferably at most 3 mm, most preferably at most 2 mm.

The protrusions are provided close to the retaining section, in order to keep the overall length of the sealing element to a minimum.

According to a 243rd embodiment, in any one of the 235th to 242nd embodiments, the protrusions have a substantially longish shape and are substantially horizontally oriented.

According to a 244th embodiment, in any one of the 235th to 242nd embodiments, the protrusions have a substantially longish shape and are substantially vertically oriented.

The orientation is selected according to the desired configuration of the protrusions and to balance between different effects to be achieved. Horizontal orientation is preferred for better wiping but has higher friction and the vertical orientation is preferred for better centering having a lower friction.

According to a 245th embodiment, in any one of the 235th to 244th embodiments, at least a part of the protrusions are arranged on the circumference of the outer surface of the sealing element, forming an overall outer diameter on the sealing element greater than or equal to the minimum inner diameter of the mouth of the bottle.

This ensure that the protrusions contact the mouth of the bottle and at the same time do not cause higher friction or make a hindrance in entry of the closure system.

According to a 246th embodiment, in any of the 235th to 245th embodiments, the sealing element comprises a plurality of protrusions at least in part distributed opposite and/or symmetrically to each other and/or equidistant from each other around the circumference of the sealing element.

This feature ensures that the closure system is suitably balanced such that it is not in an inclined position and causes higher friction.

According to a 247th embodiment, in any one of the preceding embodiments, the sealing element is or comprises an aerator configured to mix a liquid in the bottle with air when pouring the liquid out of the bottle, thereby increasing the oxygen content of the liquid.

The aerator provides an additional benefit to the sealing element and the overall closure system by allowing to aerate for example wine during the pouring into a glass. It is known that aerating and in particular providing oxygen to wine is important for the wine to develop its full flavor and taste.

According to a 248th embodiment, in the 247th embodiment, the aerator is configured to yield an average dissolved oxygen saturation in a wine, preferably red wine, of at least 45%, preferably at least 50%, more preferably at least 55%, more preferably at least 60% and most preferably at least 65% by directly pouring the wine containing almost no dissolved oxygen out of the bottle.

The preferred embodiments of the aerator allow for high aerating function, which is in particular advantageous to the taste of e.g. wine, such as red wine.

According to a 249th embodiment, in any one of the 247th or 248th embodiments, the aerator is configured such that the pouring time for pouring 750 ml of wine contained in the bottle can be effected in less than 10 seconds, preferably less than 8 seconds more preferably less than 6 seconds and most preferably less than 5 seconds.

Increased aerating function usually comes at the expense of prolonged pouring times. In preferred embodiments of the aerator, the pouring times are hardly increased as compared to a standard bottle not equipped with a sealing element with an aerator.

According to a 250th embodiment, in any one of the 247th to 249th embodiments, the aerator is configured such that it allows for a smooth pouring of the wine.

The wine should not spatter into the glass for optical reasons or even spatter such that wine drops next to a wine glass during pouring. In preferred embodiments the aerator allows for a smooth pouring of the wine such avoiding these scenarios.

According to a 251st embodiment, in any of the 247th to 250th embodiments, the aerating function is substantially provided by a ring or tube shaped element.

According to a 252nd embodiment, in the 180th embodiment, the aerating function is achieved or enhanced by the ring or tube shaped element forming or having a constricted section with an inner diameter which is smaller than the inner diameter of other parts of the tube shaped element or other parts of the sealing element.

The constricted section provides for good ventilation. It is believed that the aerating function and the resulting dissolved oxygen in the poured wine is achieved or increased by a constriction of the inner diameter of the ring or tube shaped element, such as via the described venturi effect.

According to a 253rd embodiment, in any one of the 251st to 252nd embodiments, the minimum inner diameter of the ring or tube shaped element in the constricted section is between 7.5 and 11.5 mm, preferably between 8 and 11 mm, more preferably between 8.5 and 10.5 mm and most preferably between 9 and 10 mm.

These preferred diameters allow for both, good aerating function and good pouring speed.

According to a 254th embodiment, in any one of the 251st to 253rd embodiments, the minimum inner diameter of the ring or tube shaped element in the constricted section is constricted over a length of less than 20 mm, preferably less than 15 mm, preferably less than 10 mm, preferably less than 5 mm, preferably less than 2.5 mm and most preferably less than 1.25 mm.

Aerating is optimized when the constricted section is minimized.

According to a 255th embodiment, in any one of the 251st to 254th embodiments, the ring or tube shaped element is located at least within the lower two thirds, preferably the lower half, more preferably the lower third, most preferably the lower quarter of the length of the sealing element.

According to a 256th embodiment, in any one of the 251st to 255th embodiments, the ring or tube shaped element is located within the lower 21 mm, preferably the lower 16 mm, more preferably the lower 11 mm, most preferably the lower 8 mm of the length of the sealing element.

The inventors found out that the lower the aerator is located in the mouth of the bottle, the better is the aerating function.

According to a 257th embodiment, in any one of the 251st to 256th embodiments, the constricted section in the ring or tube shaped element is constricted over the inner diameter of the other parts of the ring or tube shaped element or the other parts of the sealing element by a ring-shaped protrusion from the ring or tube shaped element towards the central axis of the closure system, stopper, or sealing element, the ring-shaped protrusion may be a continuous or discontinuous structure.

According to a 258th embodiment, in any one of the 251st to 257th embodiments, the ring or tube shaped element comprises turbines, blades or wings positioned at least partially inside the constricted section of the ring or tube shaped element, the turbines, blades or wings are preferably configured to increase the oxygen content of a liquid in the bottle when pouring the liquid out of the bottle.

These features of the preferred embodiments allow for a further increase in aerating effectiveness.

According to a 259th embodiment, in any one of the 251st to 258th embodiments, the ring or tube shaped element is releasably attached to the bottom of the sealing element.

In this way, the same sealing element may or may not be combined with the ring or tube shaped element acting as an aerator, depending on the configuration preferred by the customer.

According to a 260th embodiment, in the 213th embodiment and any one of the 251st to 259th embodiments, the ring or tube shaped element is the retainer element.

According to a 261st embodiment, in any one of the preceding embodiments, the closure system comprises a tamper proof element which allows the user to find out whether the stopper, after the system had been fully assembled, has been moved with respect to the sealing element in radial and/or axial direction.

Since the closure system is configured such that the stopper must be displaced with respect to the sealing element in order to open the bottle, the tamper proof element provides a secure indication of whether or not the bottle has been opened after bottling.

According to a 262nd embodiment, in the 184th embodiment, the tamper proof element is connected to the stopper and to the sealing element such that when the stopper is moved with respect to the sealing element in radial and/or axial direction, the tamper proof element is at least partially broken.

The tamper proof element allows the user to find out if the bottle has already been opened or moved in either the radial or the axial direction. Any axial or radial movement which occurs in a bottled state breaks the tamper proof element which signifies that the bottle has been opened or tampered with.

According to a 263rd embodiment, in the 262nd embodiment, the connection between the tamper proof element and the stopper is an interlocking connection, an adhesive connection, or a frictional connection in radial and/or axial direction.

At least in the axial direction, a connection which is at least in part interlocking is preferable.

According to a 264th embodiment, in any one of the 261st to 263rd embodiments, the tamper proof element comprises or consists of a material chosen out of the group consisting of aluminium, laminated aluminium, or preferably plastic, preferably a foil.

The material is selected for the tamper proof element such that it is soft enough to be broken easily when opening, but hard enough to withstand normal wear and tear during transportation.

According to a 265th embodiment, in any one of the 261st to 264th embodiments, the tamper proof element is a shaped in the form of a tube.

The tube shaped tamper proof element allows establishing a reliable connection between the tamper proof element and the stopper and/or the sealing element easily by way of wrapping and thereby allows for an easier preassembly process.

According to a 266th embodiment, in any one of the 261st to 265th embodiments, when the system is fully assembled, the tamper proof element is at least partially wrapped around the lateral portions and at least parts of the upper surface of the head part of the stopper.

This allows establishing the connection between the tamper proof element and the stopper.

According to a 267th embodiment, in any one of the 261st to 266th embodiments, when the system is fully assembled, the tamper proof element is at least partially wrapped around the sealing element.

This allows establishing the connection between the tamper proof element and the sealing element. The strength of the interlocking connection and/or a frictional connection will depend on the portion of the sealing element and stopper which is wrapped.

According to a 268th embodiment, in the 23rd and 267th embodiments, the tamper proof element is at least partially wrapped around the lateral portions and at least parts of the lower surface of the covering section of the sealing element.

The covering section, in particular a covering section in the form of a flange, provides the possibility to create an interlocking connection in the axial direction. Also, since the covering section will remain outside of the mouth of the bottle, it allows the tamper proof element to fully remain outside of the bottle.

According to a 269th embodiment, in any one of the 266th to 268th embodiments, the tamper proof element is wrapped around by means of a shrink wrap mechanism. Shrink wrap is a particularly easy and cost-efficient way of wrapping a tamper proof element around the closure system such that a reliable connection is created between the tamper proof element and the stopper/the sealing element.

According to a 270th embodiment, in the 268th embodiment or the 268th and the 269th embodiments, the lower part of the tamper proof element is connected to the covering

section by means of an interlocking and/or frictional connection in radial and/or axial direction.

The connection between the tamper proof element and the sealing element should be made so strong that the tamper proof element does not move along with the stopper on rotating.

According to a 271st embodiment, in the 270th embodiment, the covering section is provided with means for increasing the connection between the tamper proof element and the covering section in radial and/or axial direction.

The means for increasing the connection ensure that the tamper proof element does not move along with the stopper on rotating without damaging the tamper proof element.

According to a 272nd embodiment, in the 271st embodiment the means of increasing the connection are one of more teeth provided on at least part of the lateral portion and/or lower surface of the covering section, and preferably not on the upper surface of the covering section.

Teeth provided on at least part of the lateral portion and/or lower surface of the covering section are suitable for increasing the frictional radial connection between the tamper proof element and the covering section, and may even be suitable for creating in part an interlocking connection in the radial direction. The position is at the lower and lateral surface of the covering section as this portion encounters the maximum restraint when rotation takes place. It is preferable that the teeth are not provided on the upper surface of the covering portion. This is to ensure that when the bottle is opened, the upper surface is smooth to avoid injury to the user when handing the bottle.

According to a 273rd embodiment, in any one of the 271st or 272nd embodiments, the one or more teeth are provided along the circumference on at least a part of the covering section.

According to a 274th embodiment, in any of the 261st to 273rd embodiments, the tamper proof element is provided with a predetermined breaking point or line, preferably a perforation.

The perforations on the tamper proof element are provided to enable easier breaking at the appropriate point without the need to provide excessive rotational force.

According to a 275th embodiment, in the 274th embodiment, the predetermined breaking point or line is located at a position corresponding to the position of the lower half of the head of the stopper, preferably the lower third, more preferably under the head part of the stopper.

The position is selected to ensure that the breaking is not affected by holding of the stopper by the user, thereby providing easier breaking.

According to a 276th embodiment, in any one of the 261st to 275th embodiments, the tamper proof element is configured to be placed on to the closure system in a preassembled state, in which there is a predetermined gap between the head part of the stopper and the covering section of the sealing element.

Wrapping the closure system with the tamper proof element already in the preassembly stage has the advantage that in the bottling line, the closure system only needs to be placed into the mouth of the bottle, and no additional step of adding a tamper proof element is required in the bottling stage. Furthermore, wrapping the closure system before placing it into the mouth of the bottle allows the tamper proof element to be wrapped around at least parts of a flange positioned at the upper end of the sealing element. As explained above, in the preferred embodiment, the stopper part is not fully introduced into the sealing element during preassembly. Therefore, there is a gap between the head part of the stopper and the covering section of the sealing element.

According to a 277th embodiment, in the 276th embodiment, a section of the tamper proof element between the head part of the stopper and the covering section of the sealing element is configured to fold inwardly towards the center of the closure system when the stopper part is fully introduced into the sealing element.

This ensures that the lateral surface of the closure system in the area of lower surface of the head part of the stopper and the covering section is clean in the fully assembled state.

According to a 278th embodiment, in the 277th embodiment, the section of the tamper proof element between the head part of the stopper and the covering section of the sealing element is configured to fold between the head part of the stopper and the covering section of the sealing element.

This is one way to ensure that the lateral surface of the closure system in the area of lower surface of the head part of the stopper and the covering section is clean in the fully assembled state. The excess material of the tamper proof element in the fully assembled state, i.e. after removal of the gap between the head part of the stopper and the covering section of the sealing element, which in the preassembled state bridges the gap is stored away by folding (into the now very small gap) between the head part of the stopper and the covering section of the sealing element.

According to a 279th embodiment, in the 269th and any one of the 276th to 278th embodiments, the tamper proof element has a thickness such that it is retained in a stretched position between the head part of the stopper and the covering section of the sealing element as a result of shrink wrapping.

It is advantageous to keep the section of the tamper proof element which bridges this gap in a stretched position, thereby keeping this section as short as possible. This allows storing the excess material of the tamper proof element away more easily when during the full introduction of the stopper part into the sealing element the gap will be (largely) closed.

According to a 280th embodiment, in any one of the 261st to 279th embodiments, the thickness of the tamper proof element is more than 35µm, preferably more than 40µm, more preferably more than 45 µm, most preferably more than about 50µm.

According to a 281st embodiment, in any one of the 261st to 280th embodiments, the thickness of the tamper proof element is at most 100µm, preferably at most 70µm, more preferably at most 60 µm, most preferably at most about 50µm.

This thickness is selected for the tamper proof element such that it is soft enough to be broken easily when opening, but hard enough to be retained in a stretched position when shrink wrapped in the preassembled state.

According to a 282nd embodiment, in any one of the preceding embodiments, the stopper is made of one or more materials chosen out of the group comprising glass, ceramic, plastic, metal and wood.

According to a 283rd embodiment, in any one of the preceding embodiments, the sealing element has a main body configured to form the entire or at least a portion of the part of the sealing element which is in contact with the side surface of the stopper part of the stopper when the stopper part is introduced in the sealing element.

The main body provides the contour and shape of the sealing element. In a preferred embodiment, the main body is tubular.

According to a 284th embodiment, in the 235th and 283rd embodiments, the one or more protrusions are part of the main body of the sealing element.

This is because in the preferred embodiment described below, the main body is made of a relatively hard material. The protrusions should be made of a relatively hard material so that they can perform the function of centering the closure system during introduction into the mouth of the bottle.

According to a 285th embodiment, in the 283rd or 284th embodiments, the main body is made of or comprises polypropylene and/or polyethylene.

The inventors found out that these materials provide for a good stiffness of the sealing element while being food safe. Stiffness is *inter alia* required for pushing the sealing

element into the mouth of the bottle and for transmitting pressure uniformly and extensively.

According to a 286th embodiment, in any one of the 283rd or 285th embodiments, the material of the main body has a shore D hardness between 40 and 130 Rockwell (R-scale), preferably between 50 and 120, more preferably between 60 and 110, most preferably between 70 and 100.

The inventors found out that this hardness confers a stiffness that is suitable for the main body to fulfill its above-mentioned functions.

According to a 287th embodiment, in any one of the 283rd to 286th embodiments, at least a part of the material configured to be in contact with the inner wall of the mouth of the bottle is a material which is different from the material of the main body.

This allows giving specifically tailored properties like hardness or friction coefficient to the material configured to be in contact with the stopper part and to the material configured to be in contact with the mouth of the bottle.

According to a 288th embodiment, in any one of the preceding embodiments, the different material is softer than the material of the main body.

The softer material allows for a smooth adaptation of the sealing element to the inner wall of the mouth of the bottle. Due to the softness of the material, the different material can also correct for small deviations in the shape of the inner wall of the mouth of the body, this way allowing for a better grip to the mouth of the bottle and thus for a better leak tightness. At the same time, the softness of the material also provides for an increased radial stroke while maintaining more or less a similar radial pressure built-up, such as while bringing the closure system into the locked state.

According to a 289th embodiment, in any one of the 287th or 288th embodiments, the different material is or comprises a thermoplastic elastomer and/or a thermoset elastomer.

The inventors found out that these materials provide for an appropriate softness of the different material while being food safe.

According to a 290th embodiment, in the 289th embodiment, the thermoplastic elastomer and/or the thermoset elastomer has a Shore A hardness between 25 and 90.

The inventors found out that this hardness is suitable for the different material of the sealing element to fulfill its above-mentioned functions.

According to a 291st embodiment, in the 188th embodiment, the different material has a higher friction coefficient with respect to glass than the material of the main body configured to be in contact with the side surface of the stopper part of the stopper.

The higher friction of the different material *inter alia* ensures that the sealing element does not spin when the stopper is brought from the locked state in the unlocked-state.

According to a 292nd embodiment, in the 47th embodiment and/or the 190th embodiment and any one of the 287th to 291st embodiments, the different material is arranged on an outer surface of the sealing section and/or the retaining section.

These two sections are the ones which are configured to be brought in contact with the inner wall of the mouth of the bottle in the preferred embodiment.

According to a 293rd embodiment, in any one of the 287th to 292nd embodiments, the different material is not arranged on an outer surface of a section of the sealing element which is not configured to be forced against the inner wall of the mouth of the bottle in the locked state of the closure system.

The discontinuous distribution of the different material on the one hand aims to ensure that the friction of the sealing element at the inner wall of the mouth of the bottle is not too strong during introduction of the sealing element into the mouth of the bottle. On the other hand, for a preferred embodiment in which sections of the sealing element which are not configured to be forced against the inner wall of the mouth of the bottle in the locked state of the closure system are configured to not be brought in contact

with the inner wall of the mouth of the bottle at all, applying the different material in such a section is unnecessary and will typically increase manufacturing costs.

According to a 294th embodiment, in the 102nd embodiment and any one of the 287th to 293rd embodiments, the different material is not arranged on an outer surface of the second section of the sealing element.

This is because the second section of the sealing element in the preferred embodiment is not configured to be forced against the inner wall of the mouth of the bottle in the locked state of the closure system.

According to a 295th embodiment, in the 213th embodiment or the 213th embodiment and any one of the 214th to 294th embodiments, the retainer element is made of homo-polypropylene.

The inventors found out that this material provides for an appropriate hardness of the retainer element while being food safe.

According to a 296th embodiment, in any one of the preceding embodiments, the sealing element is manufactured by a two-component injection molding method.

This manufacturing method is a particularly reliable and economical one for manufacturing a sealing element having a main body configured to form the part of the sealing element which is in contact with the stopper part of the stopper and a different material configured to be in contact with the inner wall of the mouth of the bottle.

According to a 297th embodiment, in the 283rd embodiment and any one of the 287th to 296th embodiments, the main body and the different material are unreleasably connected with one another during manufacturing of the sealing element.

This increases the stability of the sealing element and ensures that the different material is held on the main body of the sealing element, in particular during the introduction of the sealing element into the mouth of the bottle.

According to a 298th embodiment, in the 297th embodiment, the unreleasable connection is obtained by melting at least one contacting surface of the different material and the main body.

This is a particularly reliable and economical method for manufacturing a sealing element having two different unreleasably connected materials.

A 299th embodiment of the present invention is a method of preassembling a closure system for a bottle designed for commercial bottling of a beverage or liquid food, preferably a wine bottle, the closure system comprising a stopper with a head part and a stopper part, and a sealing element into which the stopper can be introduced, wherein the stopper part comprises interlocking means and the sealing element comprises counterpart interlocking means, the method comprising the step of partially introducing the stopper part of the stopper into the sealing element such that preferably the interlocking means of the stopper part are not engaged with the counterpart interlocking means of the sealing element.

The preassembling of the closure system may allow closing the bottle with the same bottling plant that is used for conventional corks. Introducing the stopper only partially into the sealing element, and not fully, has the advantage that there is less force needed to introduce the closure system in the preassembled state, as the sealing element is not expanded or at least not to the extent the sealing element is expanded when the stopper is full introduced into the sealing element, so that the closure system can easily be introduced into the mouth of the bottle.

According to a 300th embodiment, in the 299th embodiment, the stopper part of the stopper comprises holding means configured to form an interlocking connection with counterpart holding means comprised by the sealing element; and during the step of partially introducing the stopper part into the sealing element, the holding means of the stopper part engage with the counterpart holding means of the sealing element.

The holding means may hold the stopper in a secured position with respect to the sealing element, thereby preventing at least a substantial rotational and/or axial displacement of the stopper with respect to the sealing element. Prevention of a

rotational displacement ensures that the counterpart interlocking means on the sealing element arrive at the correct starting position on the stopper part when the stopper part is fully introduced into the sealing element. Prevention of an axial displacement ensures that that the stopper part is fully introduced into the sealing element only once the sealing element has been fully introduced into the bottle. Therefore, there is no expansion of the sealing element until the sealing element has been fully introduced into the bottle.

According to a 301st embodiment, in any one of the 299th or 300th embodiments, the sealing element comprises a sealing section configured to be at least partially radially expanded by the stopper part when the stopper part is fully introduced into the sealing element; and during the step of partially introducing the stopper part into the sealing element, the sealing section is radially expanded at most 1 mm in diameter by the stopper part of the stopper, preferably at most 0.5 mm, more preferably at most 0.2 mm and most preferably not expanded at all.

This allows an easy introduction of the sealing element into the mouth of the bottle in the preassembled state, with low force and without damaging the sealing section of the sealing element. At the same time, it allows a configuration of the closure system such that the sealing section of the sealing element is forced against the mouth of the bottle with a relatively high force.

According to a 302nd embodiment, in any one of the 299th to 301st embodiments, the sealing element comprises a retaining section configured to be radially expanded in order to be forced against the inner wall of the mouth of the bottle upon introduction of the closure system into the mouth of the bottle, and during the step of partially introducing the stopper part into the sealing element, the retaining section is radially expanded at most 1 mm in diameter, preferably at most 0.5 mm, more preferably at most 0.2 mm and most preferably not expanded at all.

This allows an easy introduction of the sealing element into the mouth of the bottle in the preassembled state, with low force and without damaging the retaining section of the sealing element. At the same time, it allows a configuration of the closure system

such that the retaining section of the sealing element is forced against the mouth of the bottle with a relatively high retaining force after the activation of the retaining element.

According to a 303rd embodiment, in any one of the 299th to 302nd embodiments, the method further comprises the step of wrapping the closure system with a tamper proof element, after the step of partially introducing the stopper part of the stopper into the sealing element.

Wrapping the closure system with the tamper proof element already in the preassembly stage has the advantage that in the bottling line, the closure system only needs to be placed into the mouth of the bottle, and no additional step of adding a tamper proof element is required in the bottling stage. Furthermore, wrapping the closure system before placing it into the mouth of the bottle allows the tamper proof element to be wrapped around at least parts of a flange positioned at the upper end of the sealing element.

According to a 304th embodiment, in any one of the 299th to 303rd embodiments, the tamper proof element is at least partially wrapped around the lateral portions, at least parts of the upper surface of the head part of the stopper, and at least parts of the lower surface of a flange positioned at the upper end of the sealing element.

This allows to establish a secure connection between the head part of the stopper and the sealing element which will necessarily have to be broken if the stopper is displace axially and/or radially with respect to the sealing element. Since the closure system is configured such that the stopper must be displaced with respect to the sealing element in order to open the bottle, the tamper proof element provides a secure indication of whether or not the bottle has been opened after bottling.

According to a 305th embodiment, in any one of the 303rd or 304th embodiments, wrapping the closure system is performed by way of a shrink wrap mechanism.

Shrink wrap is a particularly easy and cost-efficient way of wrapping a tamper proof element on the closure system such that a reliable connection is created between the

tamper proof element and the head part of the stopper/the flange of the sealing element.

According to a 306th embodiment, in the 304th embodiment, or the 304th and 305th embodiments, the tamper proof element is retained in a stretched position between the head part of the stopper and the covering section of the sealing element as a result of wrapping.

Since in the preassembled closure system, the stopper part is only partially introduced into the sealing element, there will be a gap between the head part of the stopper and the flange of the sealing element. It is advantageous to keep the section of the tamper proof element which bridges this gap in a stretched position, thereby keeping this section as short as possible. When during the closing of the bottle the gap will be closed, the excess material of the tamper proof element can then be stored away more easily.

A 307th embodiment of the present invention is a method of closing a bottle designed for commercial bottling of a beverage or liquid food, preferably a wine bottle, by means a closure system comprising a stopper with a head part and a stopper part, and a sealing element into which the stopper can be introduced, wherein the stopper part of the stopper comprises interlocking means and the sealing element comprises counterpart interlocking means, the method comprising the steps of inserting the closure system in a preassembled state into a mouth of the bottle, wherein in the preassembled state, the stopper part of the stopper is partially introduced into the sealing element, and the interlocking means of the stopper part of the stopper are preferably not engaged with the counterpart interlocking means of the sealing element; and pushing the closure system further into the mouth of the bottle, whereby the stopper part of the stopper is fully introduced into the sealing element and the interlocking means of the stopper part of the stopper preferably engage with the counterpart interlocking means of the sealing element.

Closing the bottle may be performed using the same bottling plant that is used for conventional corks. It is advantageous that the closure system is preassembled such that the stopper part of the stopper is partially introduced into the sealing element. This

allows insertion of the sealing element and the stopper at the same time, wherein the sealing element is not expanded or at least not to the extent the sealing element is expanded when the stopper is full introduced into the sealing element, so that the closure system can easily be introduced into the mouth of the bottle. When the stopper is only partially introduced into the sealing element, the interlocking means will typically not yet be engaged. Therefore, they engage during the step of pushing the closure system further into the mouth of the bottle whereby the stopper part of the stopper is fully introduced into the sealing element.

According to a 308th embodiment, in the 307th embodiment, the interlocking means of the stopper part of the stopper comprise a starting section, and during the step of pushing the closure system further into the mouth of the bottle, the interlocking means of the sealing element engage with the interlocking means of the stopper part of the stopper at the starting section.

Where the interlocking means on the stopper part of the stopper have a well-defined starting section, the interlocking means of the sealing element should engage with the interlocking means of the stopper part of the stopper at the starting section so that the starting section can perform its intended function.

According to a 309th embodiment, in any one of the 307th or 308th embodiments, the sealing element comprises a covering section positioned at the upper end of the sealing element and configured to remain outside the mouth of the bottle and to prevent the head part of the stopper from contacting the mouth of the bottle.

The covering section protects the head part of the stopper as well as the mouth of the bottle from damages during the closing of the bottle. In particular, the covering section may serve as a softer layer between the head part and the mouth of the bottle.

According to a 310th embodiment, in the 309th embodiment, during the step of pushing the closure system further into the mouth of the bottle, the stopper part of the stopper is further introduced into the sealing element only after the covering section of the sealing element has made contact with the upper end of the mouth of the bottle.

This assures that the sealing element is fully expanded only after full introduction of the sealing element into the mouth of the bottle, which facilitates the introduction of the sealing element.

According to a 311th embodiment, in any one of the 307th to 310th embodiments, during the step of pushing the closure system further into the mouth of the bottle, a seal is formed between the inner wall of the mouth of the bottle and the stopper part of the stopper.

According to a 312th embodiment, in the 309th and 311th embodiments, the seal is only formed after the covering section of the sealing element has made contact with the upper end of the mouth of the bottle.

This assures that the sealing section of the sealing element is fully expanded only after full introduction of the sealing element into the mouth of the bottle, which facilitates the introduction of the sealing element.

According to a 313th embodiment, in any one of the 307th to 312th embodiments, during the step of pushing the closure system further into the mouth of the bottle, the stopper part of the stopper activates a retaining section of the sealing element by radially expanding the retaining section and thereby forcing the retaining section against the inner wall of the mouth of the bottle.

The advantages of such a retaining section are explained above in the context of the 193rd embodiment of the invention.

According to a 314th embodiment, in the 313th embodiment, the sealing element comprises a retainer element as a separate object, and the stopper part of the stopper activates the retaining section of the sealing element by pushing the retainer element down along the longitudinal axis of the sealing element.

The advantages of such a retainer element are explained above in the context of the 213th embodiment of the invention.

According to a 315th embodiment, in the 309th embodiment and any one of the 313th or 314th embodiments, the retaining section is activated only after the covering section of the sealing element has made contact with the upper end of the mouth of the bottle.

This assures that the retaining section of the sealing element is fully expanded only after full introduction of the sealing element into the mouth of the bottle, which facilitates the introduction of the sealing element.

According to a 316th embodiment, in any one of the 307th to 310th embodiments, the stopper part of the stopper comprises holding means configured to form an interlocking connection with counterpart holding means comprised by the sealing element; and in the preassembled state, the holding means of the stopper part of the stopper are engaged with the counterpart holding means of the sealing element.

The purpose of such holding means is explained above in the context of the 168th to 171st embodiments.

According to a 317th embodiment, in the 316th embodiment, during the step of pushing the closure system further into the mouth of the bottle, the counterpart holding means of the sealing element disengage from the holding means of the stopper part of the stopper.

The holding means are provided to hold the stopper with respect to the sealing element only in the preassembled state. Therefore, when the closure system transitions to the locked state during full assembly, the holding means disengage.

According to a 318th embodiment, in the 309th embodiment and any one of the 316th or 317th embodiments, the counterpart holding means of the sealing element disengage from the holding means of the stopper part of the stopper only after the covering section of the sealing element has made contact with the upper end of the mouth of the bottle.

It is the task of the holding means to ensure that the stopper part is introduced further into the sealing element only after the covering section of the sealing element has made

contact with the upper end of the mouth of the bottle. Therefore the holding means should disengage only in or after that moment.

According to a 319th embodiment, in any one of the 316th to 318th embodiments, the counterpart holding means of the sealing element are the counterpart interlocking means of the sealing element; and during the step of pushing the closure system further into the mouth of the bottle, counterpart holding means engage with the interlocking means of the stopper part of the stopper after disengaging from the holding means of the stopper part of the stopper.

The advantage of the counterpart interlocking means on the sealing element being the counterpart holding means on the sealing element are explained above in the context of the 190th embodiment. In this case, during the step of pushing the closure system further into the mouth of the bottle, the counterpart holding means need to engage with the interlocking means of the stopper part of the stopper after disengaging from the holding means of the stopper part of the stopper.

According to a 320th embodiment, in the 309th embodiment or the 309th embodiment and any one of the 310th to 319th embodiments, the closure system has a tamper proof element wrapped on in the preassembled state, and during the step of pushing the closure system further into the mouth of the bottle, a section of the tamper proof element between the head part of the stopper and the covering section of the sealing element folds inwardly towards the center of the closure system.

The advantages of the closure system having a tamper proof element wrapped on in the preassembled state are explained above in the context of the 303rd embodiment. The advantages of the section of the tamper proof element folding inwardly towards the center of the closure system are explained above in the context of the 277th embodiment.

According to a 321st embodiment, in any one of the 319th or 320th embodiments, the section of the tamper proof element between the head part of the stopper and the covering section of the sealing element is configured to fold between the head part of the stopper and the covering section of the sealing element.

The advantages of this are explained above in the context of the 278th embodiment.

According to a 322nd embodiment, in any one of the 307th to 319th embodiments, the steps of inserting the closure system into the mouth of the bottle and pushing the closure system further into the mouth of the bottle are performed in one single step.

According to a 323rd embodiment, in any one of the 307th to 322nd embodiments, prior to the step of inserting the closure system into the mouth of the bottle, the closure system is preassembled by the method according to any one of the 299th to 302nd embodiments.

According to a 324th embodiment, in any one of the 299th to 323rd embodiments, the closure system is the closure system according to any one of the 1st or 4th to 296th embodiments.

According to a 325th embodiment, in any one of the 299th to 324th embodiments, the stopper is the stopper according to any one of the 2nd or 4th to 296th embodiments.

According to a 326th embodiment, in any one of the 299th to 325th embodiments, the sealing element is the sealing element according to any one of the 3rd to 296th embodiments.

According to a 327th embodiment, in the 35th embodiment or the 35th embodiment and any one of the 36th to 326th embodiments, the 62nd embodiment or the 62nd embodiment and any one of the 63rd to 326th embodiments, or the 205th embodiment or the 205th embodiment and any one of the 206th to 326th embodiments, any irregularities or deviations in the substantially even surface like protrusions or recesses have an amplitude which is smaller than 0.5 mm, preferably smaller than 0.4 mm, more preferably smaller than 0.3 mm, most preferably smaller than 0.1 mm.

According to a 328th embodiment, in the 60th embodiment or the 60th embodiment and any one of the 61st to 327th embodiments, or the 36th embodiment or the 36th embodiment and any one of the 37th to 327th embodiment, or the 85th embodiment or

the 85th embodiment and any one of the 86th to 327th embodiment, or the 209th embodiment or the 209th embodiment and any one of the 210th to 327th embodiment, wherein, without considering any recesses and/or protrusions, the difference between the minimum and the maximum outer diameter of the substantially even surface is at most 1 mm, preferably at most 0.5 mm, more preferably at most 0.3 mm, most preferably at most 0.2 mm.

Brief Description of the Drawings

The present invention will be best understood with reference to the following detailed description and the drawings, in which like reference signs throughout the drawings indicate like elements.

Fig. 1 shows a perspective view of a stopper of the closure system according to one embodiment of the present invention;

Fig. 2a shows a side view of one side of the stopper of the closure system according to one embodiment of the present invention;

Fig. 2b shows a side view of another side of the stopper of the closure system according to one embodiment of the present invention;

Fig. 3 shows a perspective view of a sealing element of the closure system according to one embodiment of the present invention;

Fig. 4a shows a side view of one side of the sealing system of the closure system according to one embodiment of the present invention;

Fig. 4b shows a side view of another side of the sealing element of the closure system according to one embodiment of the present invention;

Fig. 5a shows a top view of a sealing element of the closure system according to one embodiment of the present invention;

Fig. 5b shows a section view of a sealing element of the closure system according to one embodiment of the present invention;

Fig. 6a shows a perspective view of a retainer elements of the closure system according to one embodiment of the present invention;

Fig. 6b shows a top view of a retainer element of the closure system according to one embodiment of the present invention;

Fig. 6c shows a side view of a retainer element of the closure system according to one embodiment of the present invention;

Fig. 7a to c show a section view of the closure system in the preassembled, locked and unlocked states, respectively, according to one embodiment of the present invention;

Fig. 8 shows an x-ray of the closure system in the locked state according to one embodiment of the present invention;

Fig. 9 shows a perspective view of a sealing element of the closure system according to one embodiment of the present invention;

Fig. 10a shows a perspective view of a retainer element within an aerator of the closure system according to one embodiment of the present invention;

Fig. 10b shows a top view of a retainer element with an aerator of the closure system according to one embodiment of the present invention;

Fig. 11 shows a perspective view of the sealing element according to another embodiment of the present invention;

Fig. 12a shows a side view of the sealing element according to another embodiment of the present invention;

Fig. 12b shows a side view of the sealing element according to another embodiment of the present invention;

Fig. 13a shows a perspective view of an aerator of the closure system according to another embodiment of the present invention;

Fig. 13b shows a side view of an aerator of the closure system according to another embodiment of the present invention;

Fig. 14 shows the sealing element of Figs. 11 to 12b combined with the aerator of Figs. 13a and 13b according to another embodiment of the present invention;

Fig. 15a to d show four different aerators fixedly attached to a sealing element according to different embodiments of the present invention;

Fig. 16 shows the aerating results obtained by example embodiments of the present invention;

Fig.17a shows a side view of the closure system in the preassembled state with a tamper proof element according to one embodiment of the present invention;

Fig.17b shows a side view of the closure system in the locked state with a tamper proof element according to one embodiment of the present invention;

Detailed Description

The following detailed description relates to a closure system for a bottle designed for commercial bottling of a beverage or liquid food, preferably a wine bottle. The closure system comprises a stopper and a sealing element, which is separate from the bottle and from the stopper. The stopper will be described with reference to Figs. 1 to 2b, the sealing element will be described with reference to Figs. 3 to 7b and the functioning of the closure system will be described with reference to Fig. 8. Further embodiments will be described with regard to Figs. 9 to 13.

The stopper of the closure system comprises a stopper part for introduction into a mouth of the bottle and a head part for remaining outside of the mouth, wherein the head part has a diameter which is larger than that of the stopper part. The closure system is configured such that the sealing element may be forced against the inner wall of a mouth of the bottle, upon introduction of the stopper into the mouth, thereby bringing the closure system into a locked state. The stopper part comprises interlocking means configured to engage with counterpart interlocking means comprised by the sealing element, wherein the interlocking means are configured to permit bringing the closure system into an unlocked state by an action which comprises rotating the stopper with respect to the bottle.

In the context of the present invention, "bottle" may refer to, but is not limited to, a bottle having a mouth whose dimensions comply with the DIN EN 12726:2000 standard.

This standard defines the measurements of the mouth of wine bottles using closure systems such as natural corks or capsules. According to this standard, the mouth of the bottle is defined as going from the tip of the bottle 45 mm downwards. The diameter of the mouth of the bottle has to be 18.5 mm, with a tolerance of ±0.5 mm. Additionally, the mean inner diameter in the section 10 mm below the tip of the mouth of the bottle must not be more than 1 mm larger than the diameter at the entry of the bottle, wherein the entry is defined as the section located 3 mm below the tip of the bottle. The inner diameter increases from the top to the bottom of the mouth of the bottle and has to be 20 mm with a tolerance of ±1 mm at 45 mm downwards from the tip of the mouth of the bottle. The outer diameter at the very tip of the bottle has to be 27 mm with a tolerance of ±0.5 mm. The largest outer diameter of the mouth of the bottle has to be 29.5 mm with a tolerance of ±0.5 mm.

Throughout this specification, terms which express relative locations or directions, like "above", "under", "up", "down", "upper", "lower", "top", "bottom", etc., refer to the natural position of the bottle, the stopper, and the sealing element, when the bottle is standing.

Fig. 1 shows a stopper 100 for a closure system for a bottle defined for commercial bottling of a beverage or liquid food, preferably a wine bottle. The stopper 100 comprises a stopper part 102 which may be introduced into the mouth of a bottle. In one embodiment, the stopper part has a length of 31 mm. The length of the stopper part 102 is defined as the part of the stopper 100 which can be entirely introduced into the sealing element, as shown in Fig. 7b.

Furthermore, the stopper 100 comprises a head part 101 for remaining outside of the mouth, which may be arranged directly above the stopper part 102. In one embodiment, the head part 101 may have an even lower surface, which is directly connected to the stopper part 102 of the stopper 100. However, the lower surface of the head part 101 may also be curved or exhibit any other design that directly transitions into the stopper part 102 of the stopper 100.

The head part 101 has a diameter which is larger than that of the stopper part 102. In one embodiment, the diameter of the head part corresponds to the outer diameter of the mouth of the bottle, i.e. the inner diameter of the mouth of the bottle plus twice the thickness of the glass of the bottle. In one embodiment, the diameter of the head part is about 30 mm.

The stopper part 102 of the stopper 100 may comprise a first section 110. In one embodiment, the first section starts exactly below the head part 101 of the stopper 100 and has a diameter of 14.4 mm, as well as the length of 11 mm. As shown in Fig. 1, the first section 110 may have a substantially even surface and a substantially cylindrical shape, wherein the first section 110 may also have a slightly conical shape with a decreasing diameter in the direction from top to bottom, wherein the diameter decreases from top to bottom by 0.2 mm.

The stopper part 102 may further comprise a second section 120, which is arranged below the first section 110 of the stopper part 102 of the stopper 100. In one embodiment, the second section 120 has a diameter of about 13.5 mm. Furthermore, the second section 120 may have a length of 10 mm. The shape of the second section may be a substantially cylindrical one. In one embodiment, a minimum diameter of the second will section 120 is 0.2 mm smaller than a maximum diameter of the second

section 120. Interlocking means 121 and holding means 122 may be arranged on the surface of the second section. The interlocking means 121 and the holding means 122 will be described in greater detail with reference to Figs. 2a and 2b.

Between the first section 110 and the second section 120, the stopper part 102 may comprise a transition section 115. The transition section 115 may be 1.5 mm long. Furthermore, the transition section 115 may have a substantially conical shape.

The stopper part 102 may further comprise a third section 130, which is in one embodiment positioned below the second section 120. In an embodiment without the second section 120, however, the third section 130 may be positioned directly below the first section 110. The diameter of the third section 130 may be smaller than the diameter of the second section 120. In one embodiment, the diameter of the third section 130 is 11.5 mm. Additionally, in an embodiment, the third section 130 is 5 mm long.

Figs. 2a and **2b** show two different side views of the stopper 100, which illustrate the interlocking means 121 and the holding means 122.

The interlocking means 121, as shown in figs. 2a and 2b, are located within the second section 120 of the stopper part 102 of the stopper 100. However, the interlocking means 121 may be located in different sections of the stopper part 102, in particular as long as they do not interfere with a seal formed between the closure system and the mouth of the bottle, which will be explained later with reference to Fig. 8.

In one embodiment, the interlocking means 121 ore one or more grooves arranged on the circumference of the stopper part 102 of the stopper 100. This can be seen in Figs. 2a and 2b, where two grooves 121 run along the circumference of the second section 120, starting approximately in the center of the second section 120 in Fig. 2a and ending at the lower end of the second section 120 in Fig. 2b. The one or more grooves 121 may span 110° of the circumference of the stopper part 102. In some embodiments, the grooves 121 have an identical shape. Furthermore, the grooves 121 may be distributed opposites and/or symmetrically to each other and/or equidistant from each other. The grooves 121 may have a depth of about 1 mm, and they may be 3 mm wide.

In some embodiments, the grooves 121 may have a rectangular, u-shape, circular or oval cross-section.

The grooves 121 may comprise a main section, which extends diagonally downward, as can be seen in Figs. 2a and 2b. In some embodiments, the grooves 121 also comprise a starting section, which extends substantially horizontally. This starting section may start from the upper end of the main section, as can be seen in Fig. 2a. In some embodiments, the starting section has a length of 4 mm.

The grooves 121 may also comprise an end section, which extends vertically downwards from the lower end of the main section. The end section is illustrated in Fig. 2b at the lower end of the second section 120. The end section may be open toward a lower end thereof. In some embodiments, in which the end section is open toward the lower end, this opening has a tapered shape.

The stopper part 102 may further comprise holding means 122. In some embodiments these holding means 122 comprise one or more depressions. In some embodiments (not shown), these depressions are open to a lower side thereof. Furthermore, the depressions 122 may be arranged on the second section 120 of the stopper part 102. This can be seen in Fig. 2a, which shows an exemplary depression 122 at the lower end of second section 120.

The depressions 122 may be distributed opposite and/or symmetrically to each other and/or equidistant from each other around the circumference of the stopper part 102 of the stopper 100. Furthermore, the depressions 122 may be arranged below grooves 120, as seen in Figs. 2a and 2b. In particular, the depressions 122 may be arranged below the starting sections of the grooves 120, as can be seen in Fig. 2a. In some embodiments, the depressions or holding means 122, respectively, are arranged 4.5 mm below the interlocking means.

Figs. 3 to 5b show a sealing element 200 for a closure system for the bottle which has been previously defined with regard to **Fig. 1**.

The sealing element 200 is configured to be introduced into the mouth of the bottle. The sealing element may receive the stopper part of the stopper by way of introduction. In some embodiments, the stopper part of the stopper may be regarded as fully introduced into the sealing element when the stopper and the sealing element have the positional relationship to each other as intended for the locked state. In some embodiments, the sealing element 200 has the shape of a ring or tube. In one embodiment, the sealing element 200 has a length of 32 mm.

Fig 3 shows a perspective view of the sealing element 200 of the closure system, and **Fig. 4a** and **Fig. 4b** show side views of the sealing element 200 of the closure system according to one embodiment of the present invention. The side view of Fig. 4b shows a view which is rotated by 90 degrees compared to the side view of Fig. 4a.

Fig. 4a shows the sealing element 200, comprising a covering section 201 that remains outside of the mouth of the bottle. The covering section 201 is positioned at the upper end of the sealing element 200. In one embodiment, the covering section 201 is a flange which protrudes from the upper surface of the mouth of the bottle.

The covering section 201 may prevent or reduce dripping of liquid at the end of the process of pouring liquid out of the mouth of the bottle. For example, the dripping of liquid is reduced when the edge of the flange is sharper than the edge tip of the mouth of the bottle. The flange may also have a rounded inner edge to assure that drips flow back into the bottle.

The sealing element 200 may further comprise a sealing section 210. The sealing section 210 of the sealing element 200 may have a shape of a ring or tube. The sealing element may have a shape which is adapted to the shape of the mouth of the bottle, i.e. the shape may be or comprise the counterpart profile of the mouth of the bottle. In some embodiments, when the stopper part of the stopper is not introduced into the sealing element 200, the sealing section 210 is substantially cylindrical. The outer surface of the sealing section 210 may be substantially even when the stopper is not introduced into the sealing element 200. In one embodiment, the sealing section 210 of the sealing element 200 is slightly convex. In the illustrated embodiment, the

difference between the minimum and the maximum outer diameter of the sealing section 210 is about 0.2 mm.

In one embodiment, the sealing section 210 of the sealing element 200 starts at about 1 mm below the upper end of the sealing element 200 and the sealing section 210 has a length of about 10 mm.

The sealing element 200 may further comprise a second section 220 which is positioned below the sealing section 210. In some embodiments, the length of the second section 220 of the sealing element 200 is about 11 mm. The second section 220 may be not expanded at all upon full introduction of the sealing part into the sealing element 200.

The second section 220 may comprise interlocking means 221, which are the counterpart interlocking means of the interlocking means 121 on the stopper part. In the preferred embodiment, the interlocking means 221 are also the counterpart holding means of the holding means 122 on the stopper part.

In some embodiments, the interlocking means 221 are not located within the sealing section 210 of the sealing element 200. Instead, the interlocking means may be positioned in a section where the sealing element 200 is not forced against the wall of the mouth of the bottle in the locked state.

In some embodiments, the interlocking means 221 of the sealing element 200 are protrusions, for example in the form of pins 221, as shown in more detail in **Fig. 5b**. These pins 221 may be positioned on portions of the inner wall of the sealing element 200 which are partially or completely attached to the second section 220 of the sealing element, the portions of the inner wall being tabs 222, for example. In particular, the protrusions may be formed on u-shaped portions of the wall, which are attached to the wall of the second section of the sealing element by their upper part, as shown in Fig. 4a. The tabs 222 may protrude towards the inside of the sealing element and/or may be resiliently mounted and/or have an elastic effect in the radial direction.

The sealing element 200 may further comprise a retaining section 230. The retaining section 230 may retain the sealing element 200 in the mouth of the bottle by being forced against the inner wall of the mouth of the bottle. The connection between the outer surface of the retaining section 230 and the inner wall of the mouth of the bottle created by the forcing of the retaining section 230 against the inner wall of the mouth of the bottle may be at least in part be an interlocking connection. An interlocking connection is possible, for example, if the retaining section 230, after full introduction into the mouth of the bottle, is located at least in part at a section where the mouth of the bottle increases in diameter from top to bottom. In some embodiments, the retaining section 230 starts at about 24 mm below the upper end of the sealing element.

In some embodiments, the retaining section 230 may be activated upon introduction of the stopper part of the stopper into the sealing element 200, whereby the retaining section 230 may be radially expanded. An outer diameter of the retaining section 230 may be radially expanded upon activation by about 2.1 mm, when the closure system is not introduced into the bottle. The retaining section 230 may comprise one more cutouts which facilitate expansion of the retaining section 230 by the retainer element. For example, the retaining section 230 may consist of or comprise one or more wings. Some embodiments may comprise two or more cutouts and/or wings which are arranged opposite to each other and/or equidistant from each other.

The outer shape of the retaining section 230 may be substantially cylindrical and may have a substantially even outer surface when the retaining section 230 is not activated. In some embodiments, the retaining section 230 comprises a section whose outer shape is substantially tapered with increasing diameter from top to bottom when the retaining section 230 is activated and the closure system is not introduced into the bottle. The retaining section 230 may comprise one or more constricted sections 232, which will be described in more detail with regard to **Fig. 5b**.

Fig. 5a shows a top view of a sealing element 200 of the closure system according to one embodiment of the present invention.

In particular, **Fig. 5a** shows a top view of the covering section 201. The covering section 201 should be as narrow as possible, while still providing protection to the tip of the mouth of the bottle against contact with the head part of the stopper. In the illustrated embodiment, the width of the covering section 201 is about 2 mm and to height of the covering section 201 is about 1 mm.

Furthermore, **Fig. 5a** shows two pins 221 protruding from the inner surface of the sealing element 200. The two pins 221 are arranged opposite to each other. In other embodiments, there may be only one pin or more than two pins 221. If there are several pins 221, they are preferably distributed opposite to each other and/or equidistant from each other around the inner circumference of the sealing element 200.

The cross section of the pins 221 may be rectangular, circular, u-shaped or oval shape or may have any other suitable cross section for an interlocking mechanism.
Fig. 5b shows a cross section view of a sealing element 200 of the closure system of **Fig. 4a** according to one embodiment of the present invention. In the illustrated embodiment, the sealing element 200 comprises a main body 204 and a different namely softer material 203 arranged on the main body 204. The softer material will be described later. As shown in **Fig. 5b,** the softer material may be located in the sealing section and/or in the retaining section of the sealing element.

As also shown in **Fig. 5b**, the sealing section 210 may comprise a constricted section 211. The constricted section 211 has a smaller diameter than other parts of the sealing section 210. In some embodiments, the constricted section 211 is positioned substantially at the center of the sealing section 210. The length of the constricted section 211 may be about 5mm. In some embodiments, the sealing section 210 comprises more than one constricted section 211. Although the constricted section 211 of **Fig. 5b** is illustrated having the shape of a wave with a substantially convex section when the stopper is not introduced in the sealing element 200, other shapes of the constricted section 211 are possible, such as a triangular shape or a shape of several waves, possibly with different amplitudes.

When the stopper part of the stopper is introduced into the sealing element 200, the outer shape of the sealing section 210 may be substantially convex, when the sealing

element 200 is not introduced into the bottle. This results from pushing the constricted section in a radial direction. The softer material is thereby expanded and forms a convex shape on the outer surface of the sealing section.

In some embodiments, when the stopper is not introduced into the sealing element 200, the sealing section 210 has a maximum inner diameter of about 14 mm. In the illustrated embodiment, when the stopper is not introduced into the sealing element 200, the minimum inner diameter of the sealing section 210 at the top of the wave formed by the constricted section 211 is about 1 mm smaller than the inner diameter of the sealing section 210 at the upper and lower end of the constricted section 211, which corresponds to the inner diameter of the sealing section 210 at its upper end and is the maximum inner diameter of the sealing section 210 of the sealing element 200.

In some embodiments, when the stopper is not introduced into the sealing element 200, the sealing section 210 has an outer diameter of about 18.3 mm. In some embodiments, when the stopper part is not introduced into the sealing element, the sealing section has a maximum outer diameter of about 0.2 mm less than the minimum inner diameter of the mouth of the bottle in the section where the seal is formed.

In some embodiments, the sealing section 210 is radially expanded upon full introduction of the stopper part of the stopper into the sealing element 200, at the point of the largest expansion by about 0.8 mm, when the closure system is not introduced into the bottle.

In some embodiments, the closure system is configured such that in the unlocked state, the sealing section 210 of the sealing element 200 is not be expanded at all in the radial direction, even if the closure system is not introduced into the bottle.

As shown in **Fig. 5b**, the second section 220 of the sealing element may have an outer diameter which is smaller than the smallest inner diameter of the mouth of the bottle, even when the stopper part of the stopper is fully introduced into the sealing element. In some embodiments, the outer diameter may be about 15.4 mm when the stopper part of the stopper is fully introduced into the sealing element and/or when the stopper part of the stopper is not fully introduced into the sealing element.

Furthermore, **Fig. 5b** shows the shape and location of some embodiments of one of the pins 221 in detail. The centroids of the pins 221 may be located about 16 mm below the upper end of the sealing element 200. The pins 221 may be 1 mm wide, and they may protrude 1 mm from the inner surface of the sealing element 200. The pins 221 may have a rectangular, circular, u-shaped or oval shape or any other shape suitable for a pin of an interlocking mechanism where the pin runs in a groove. As shown in **Fig. 5b** the pins 221 may also have pairs of horizontal, vertical and diagonal sides.

As shown in **Fib. 5b**, the retaining section 230 may comprise a constricted section 232, having a smaller inner diameter than other parts of the retaining section 230. In some embodiments, the constricted section 232 has a convex shape when the retaining section 230 is not activated. The properties of the constricted section 211 of the sealing element discussed above may also apply for the constricted section 232 of the retaining section.

In some embodiments, the retaining section 230 may have a maximum outer diameter as defined with regard to the sealing section 210.

Figs. 6a to 6c show a retainer element of the sealing element as a separate object. The retainer element may also be attached to the sealing element and therefore not a separate object. The retainer element may have the shape of a ring, with a minimum inner diameter of about 11.5 mm and a maximum outer diameter of about 14 mm. The retainer element 300 may comprise an outer surface 301, which may be substantially concave. The retainer element may have protrusions on the inner wall of the retainer element. These protrusions may form a web 302 as shown in **Figs. 6a** and **6b**.

Figs. 7a to 7c show the interaction between the different elements of the closure system. Fig 7a shows the closure system in a preassembled state, Fig. 7b shows the closure system in a locked state and Fig. 7c shows the closure system in an unlocked state. The different states, as well as the transitions from one state to another, will now be described in detail.

Preassembled state

Fig. 7a illustrates the closure system in the pre-assembled state before the closing of the bottle. In this state, the respective elements of the closure system may be arranged such that the bottle may be closed in a similar way as a bottle with a conventional wine bottle cork.

The sealing element 200 may be fully introduced into the mouth of the bottle and the stopper 100 is only partially introduced into the sealing element and the mouth of the bottle. Therefore, the head part of the stopper 100 is not in contact with the covering section in this state.

In some embodiments, the second section 120 of the stopper 100 element, which has narrower diameter than the first section, is partially located within the sealing section 210 of the sealing element 200, such that the sealing section 210 is not radially expanded, and no seal is formed between the stopper 100 and the mouth of the bottle. In fact, the radial expansion of the sealing section 210 of the sealing element 200 in the preassembled state is as defined below with regard to the unlocked state and with regard to the description of the sealing element 200 of Fig. 5b. Furthermore, the positional relationship between the stopper part 102 of the stopper 100 and the sealing section 210 of the sealing element 200 is as defined with regard to the unlocked state and will be described below.

In some embodiments, the holding means of the stopper part 102 of the stopper 100, i.e. the depressions, may be in an interlocking connection with the counterpart holding means of the sealing element 200, i.e. pins 221, to hold the stopper 100 in a secured position with respect to the sealing element 200. The interlocking means of the stopper part 102 may not be engaged with the counterpart interlocking means of the sealing element 200.

Holding the stopper 100 in the secured position may prevent at least a substantial rotational displacement of the stopper 100 with respect to the sealing element 200. Due to tolerances of the interlocking connection of the holding means, smaller displacements (by about 1 or 2 mm) of the stopper 100 may still be possible. In some embodiments, holding the stopper 100 in the secured position may furthermore

prevent at least a substantial axial displacement of the stopper 100 with respect to the sealing element 200.

When the sealing element of the preassembled closure system is not yet fully introduced into the mouth of the bottle (not displayed), the holding of the stopper 100 in the secured position may prevent the stopper part 102 of the stopper 100 from being fully introduced into the sealing element 200 before the sealing element 200 is fully introduced into the bottle. In particular, holding the stopper 100 in the secured position may prevent that the stopper part 102 of the stopper 100 is fully introduced into the sealing element 200 before the covering section of the sealing element 200 has made contact with the upper end of the mouth of the bottle.

The holding means on the stopper part of the stopper may be depressions with a profile which forms a counterpart profile matching the profile of the pins 221 of the sealing element 200. The depth of the depressions of the stopper part 102 and the height of the pins 221 of the sealing element 200 may be substantially equal. This may help the depressions and the pins 221 to engage with less leeway.

In some embodiments, in the preassembled state, the retainer element is located above the constricted section 232 of the retaining section 230. In that case, the constricted section 232 of the retaining section 230 may not be expanded in the radial direction. Thus, the retaining section 230 may not retain the sealing element 200 in this state.

Transition to the Locked State

The transition from the preassembled state to the locked state may be achieved by pushing the stopper 100 in the downward direction. This transition is made during the closing of the bottle. The closure system may be completely assembled after the transition. In some embodiments, the closure system transitions from the preassembled state to the locked state only once in the lifetime of the system.

The changes in the configuration of the closing system during the transition from the preassembled state to the locked state will now be explained in detail.

The counterpart holding means (the pins) 221 of the sealing element 200, which are engaged with the holding means of the stopper part (the depressions) 102 of the stopper in the preassembled state, transition to the respective grooves 121 of the interlocking means, when the stopper part 102 of the stopper 100 is fully introduced into the sealing element 200 by pushing. To facilitate the transition, the depressions may have an upper surface that is flatter than the other surfaces of the depression. In this way, disengaging from the depressions may be easier for the pins 221 of the sealing element 200. Also the elastic effect of the tabs 222 may facilitate the disengaging of the pins 221 from the depressions and the engaging with the respective grooves 121 of the interlocking means. The elastic tabs 222 may spring outwardly to enable and/or facilitate the radial displacement of the pins 221.

The distance of the axial displacement of the stopper with respect to the sealing element during the transition from the preassembled state to the locked state, which will correspond to the distance between the holding means and the interlocking means, may be about the same as the axial stroke of the stopper 100 when it is moved upward or downward in the grooves 121, as will be described below.

During the transition, the first section of the stopper 100, which as a larger diameter than the second section, is moved (further) into the sealing section 210 of the sealing element 200, thereby causing a radial expansion of the sealing section 210 of the sealing element 200.

The pins 221, as described in **Fig. 5b**, may be or comprise at least a portion of the counterpart interlocking means of the sealing element 200. In this case, after the transition, the pins 221 are located in the interlocking means, i.e. in the grooves 121, in particular in the starting sections of the grooves 121.

The retaining section 230 of the sealing element 200 may be activated by the stopper part 102 of the stopper 100 pushing the retainer element 300, as described with regard to **Figs. 6a to 6c**, down along the longitudinal axis of the sealing element 200 when the stopper part 102 is fully introduced into the sealing element 200. The third section 130 of the stopper part 102 of the stopper 100 may form an interface with the retainer element 300 in such a way that the retainer element 300 can be pushed down by the

third section 130 and/or the bottom of the section above the third section 130 when the stopper part 102 of the stopper 100 is fully introduced into the sealing element 200. Thereby, the third section 130 of the stopper part 102 of the stopper 100 may at least partially enter into the retainer element 300 of the sealing element 200. By entering the retainer element 300, the stopper part 102 may make contact with the web 302 of the retainer element 300. The web 302 may be adapted to prevent that the stopper passes through the retainer element 300. Therefore, the retainer element may be pushed together with the stopper in a downward direction, when the stopper makes contact with the web 302.

The retainer element 300 may expand the retaining section 230 during its activation. Hence, the outer wall of the retaining section 230 may make contact with and be forced against the inner wall of the bottle. The diameter at the bottom of the retainer element may increase more than the diameter at the top of the retainer element during activation. In this way, the retaining section 230 may be additionally adapted to the shape of the bottle, which may also have an increasing diameter from top to bottom in the section where the retainer element is located.

Locked state

Fig. 7b illustrates the locked state of the closure system, after the closing of the bottle. In this state, the seal is formed between the mouth of the bottle and the stopper. Hence, no liquid can leave the mouth of the bottle in this state.

In the locked state, the head part of the stopper 100 may be in contact with the covering section. The stopper 100 and the sealing element 200 may have a positional relationship as described below.

At least a part of the first section 110 of the stopper part 102 of the stopper 100 may be located within the sealing section 210 of the sealing element 200. In particular, at least a part of the first section 110 may be located within the constricted section 211 of the sealing section 210. In that case, at least a part of sealing section 210 has received at least a part of the first section 110 of the stopper part 102. In particular, at least a part of constricted section 211 of the sealing section 210 has received at least a part of the

first section 110 of the stopper part 102 of the stopper 100. In some embodiments, at least the part of the sealing section 210 which has the smallest inner diameter has received at least a part of the first section 110 of the stopper part 102. In some embodiments, the second section 120 of the stopper part 102 is not located within the constricted section 211 of the sealing section 210 of the sealing element 200.

The described positional relationship may result in the formation of a seal between the stopper part and the mouth of the bottle as described below.

The first section 110 of the stopper part 102 of the stopper 100 may force the sealing element 200 against the inner wall of the mouth of the bottle to form the seal between the stopper part 102 and the mouth of the bottle. The sealing section 210 of the sealing element 200 may be at least in part radially expanded by the stopper part 102 upon full introduction into the sealing element 200, whereby the sealing section 210 may at least in part be forced against the inner wall of the mouth of the bottle to form the seal between the stopper part 102 and the mouth of the bottle. There will be one side of the seal between the stopper part 102 and the sealing element 200 forming an inner seal, and another side of the seal between the sealing element 200 and the inner wall of the mouth of a bottle forming an outer seal. The inner seal and the outer seal may be located in the same section (axial position). In the preferred embodiment, the inner seal and the outer seal partially overlap.

To form the seal, the constricted section 211 of the sealing element 200 may be forced radially outward upon full introduction of the stopper part 102 into the sealing element 200. The constricted section 211 may be positioned within or overlaps with the section where the seal is formed. The length of the constricted section 211 may be smaller than the length of the section where the seal is formed. Throughout this description, the “section where the seal is formed” refers to the section where the outer seal is formed. In this way, the length of the section where the seal is formed may be greater than the axial stroke of the stopper 100 for bringing the closure system from the locked state to the unlocked state, therewith providing a more effective seal. Preferably, the length of the section where the seal is formed is about 160% of the length of the constricted section 211. The softer material 203 on the sealing element 200 located in the constricted section 211 may partially expand in an axial direction, i.e. in an upward

and/or downward direction. The expansion of the softer material 203 leads to a larger and/or longer sealing section 210 and thereby to a more effective seal. In some embodiments, the length of the section where the seal is formed is about 8 mm.

Fig. 7b shows also the contours of the cross section of the sealing element 200 of Fig. 7a in a relaxed state to clearly illustrate the positional relationship between the sealing element 200 and the stopper part 202 in the locked state. However, it is understood that in actuality, the sealing section of the sealing element 200 will be compressed and/or expanded, as will now be described with reference to Fig. 8.

Fig. 8 shows a representation of an x-ray image taken of the closure system in the locked state according to one embodiment of the present invention. It can be observed where the seal is formed in the mouth of the bottle. The first section of the stopper part of the stopper 100 may expand the constricted section 211 of the sealing element 200 in a radial direction so that the constricted section 211 becomes almost flat, i.e. vertical. In addition, the length of the seal can be observed, which is formed between the sealing element 200 and the mouth of the bottle. It is larger than the length of the constricted section 211 of the sealing section 210 of the sealing element 200.

In Fig. 8, the top end of the section where the seal is formed is about 1 mm under the highest point of the mouth of the bottle. The section where the seal is formed is located in part (with its lower end) in a section of the mouth of the bottle with an increasing diameter from top to bottom. As previously stated, the DIN EN 12726:2000 standard allows that inner diameter of the bottle in the section 10 mm below the top to be up to 1 mm larger than in the section 3 mm below the top, which may lead to the mentioned section with an increased diameter. When the softer material 203 is pushed outward in the radial direction, it adapts to the profile of the inner surface of the mouth of the bottle and may hence provide a stronger seal.

Although this disclosure describes merely the formation of one seal, multiple seals at different locations are possible and incorporated in the scope of this invention. There may be, for example, multiple smaller seals in the sealing section 210 and/or there may be one or more seals formed by the retaining section 230.

In the locked state, the one or more pins 221 of the sealing element 200 are engaged with the grooves of the stopper 100.

In some embodiments, the interlocking means (pins and grooves) are arranged on sections of the stopper part 102 and the sealing element 200 where the sealing element is not forced against the inner wall of the mouth of the bottle in the locked state. The side of the seal between the stopper part and the sealing element can therefore be formed by an even surface of the (first section of the) stopper part pushing against an even counter-surface of the (sealing section of the) sealing element, thereby providing a more effective seal. Additionally, this has the advantage that the interlocking means are disburdened from radial pressure so that the pins can run smoothly within the grooves. Advantageously, the section where the seal is formed is located above the interlocking means so that a seal can be formed at the very top of the mouth of the bottle, avoiding that dirt particles or liquid can enter a gap between the sealing element and the mouth of the bottle, or between the sealing element and the stopper part of the stopper.

In the locked state, the interlocking means do not prevent a rotation of the stopper 100 with respect to the sealing element 200 at least in one direction but may prevent a rotation of the stopper 100 with respect to the sealing element 200 in the other direction. The rotation of the stopper 100 may be used to unlock the closure system as will be described further below. The interlocking means may prevent an axial displacement of the stopper 100 with respect to the sealing element 200 in the upward direction in the locked state. Hence, the stopper 100 has to be rotated to bring the closure system into the unlocked state.

The retention force provided by the interlocking means in the locked state corresponds to about 90% of the force preventing axial displacement of the stopper 100 with respect to the sealing element 200 in the locked state. The counterpart interlocking means, i.e. the pins 221 of the sealing element 200 are located in the starting sections of the grooves 121 by about 90% of their width.

The retainer element presses the constricted section 232 of the retaining section 230 outward in the radial direction, which exerts a force to the inner wall of the mouth of the bottle, and thereby fixes the sealing element 200 in the bottle. The constricted

section 232 may have a substantially convex shape and may be expanded in the same way as already described with regard to the constricted section 211 of the sealing element.

The retaining section 230 holds the retainer element 300 once it has been activated. In some embodiments, the retaining section 230 holds the retainer element 300 at least in part by an interlocking connection between the outer surface of the retainer element 300 and the inner surface of the retaining section 230. A section of the inner surface of the retaining section 230 which is engaged to form the interlocking connection may be substantially convex, i.e. it may be formed by the constricted section 232, and a section of the outer surface 301 of the retainer element 300 which is engaged to form the interlocking connection may be substantially concave. In this way, the retainer element can be held in the retaining section. The shape of the constricted section 232 and the outer surface of the retainer element may have other shapes, wherein the constricted section 232 may have a counterpart profile of the shape of the outer surface of the retainer element.

Transition to the Unlocked State

The transition between the locked state to the unlocked state is achieved by rotating the stopper 100 in one direction. The changes in the configuration of the closing system during the transition between the locked state to the unlocked state will now be described in detail.

The interlocking means may move the stopper 100, when in the locked state, upward until the unlocked state is reached, upon clockwise or counterclockwise rotation of the stopper 100 with respect to the bottle. On the other hand, when in the unlocked state, the interlocking means may move the stopper 100 downward until the locked state is reached, upon rotation of the stopper 100 in the opposite direction with respect to the bottle.

The axial stroke of the stopper when fully being moved upward or downward by the interlocking means may be about 5 mm. The axial stroke may correspond to about the distance between the lower end of the first section 110 of the stopper part 102 and the

upper end of the constricted section 211 of the sealing section 210 of the sealing element 200, when the stopper is fully introduced into the sealing element 200. The axial stroke may correspond to about 50% of the length of the section where the seal is formed, upon rotation of the stopper 100 with respect to the bottle.

As previously described, the constricted section 211 and the softer material 203, which may be partially expanded in axial directions, may lead to a larger sealing section 210 and thereby to a more effective seal. Put differently, it allows to reduce the stroke, while maintaining the length of the sealing section 210.

The movement of the second section of the stopper part of the stopper 100 into the sealing section 210 of the sealing element 200, during the rotation of the stopper 100, may cause a lessening of the expansion of the sealing section 210 of the sealing element 200.

The starting sections of the interlocking means (grooves) of the stopper part 102 may have a surface which serves as a stop for the counterpart interlocking means of the sealing element 200. Additionally, the end sections of the interlocking means (grooves) of the stopper part 102 may have a surface which serves as a stop for the counterpart interlocking means of the sealing element 200 in the other direction.

The pins 221 may run in the grooves 121 of the stopper part 102, during the rotation of the stopper 100. The pins 221 run from the starting sections through the main sections to the end sections of the grooves 121.

As illustrated by **Fig. 5b**, the pins 221 may have a pair of horizontal sides. One of the horizontal sides may be the bottom surface of the pins 221, and it may be substantially parallel to the surface of the starting sections of the grooves 121 with which it makes contact when the pins 221 are located in the starting section. Thus, the bottom surface of the pins 221 may provide an effective blocking (interlocking connection) in an upward axial direction.

The pins 221 may also have diagonal sides. One side of the diagonal sides may be the lower diagonal surface of the pins 221 which makes contact with the lower surface of

the main section of the groove, and it may be substantially parallel to the lower surface of the main section of the groove. Another side of the diagonal sides may be an upper diagonal surface of the pins 221 which makes contact with the upper surface of the main section of the groove, and it may be substantially parallel to the upper surface of the main section of the groove. The diagonal sides facilitate the movement of the pins 221 in the main section of the groove by enlarging the contact surface.

The pins 221 may also have vertical sides. One of the vertical sides may be the side surfaces of the pins 221 which is in contact with the surface of the starting section which serves as a stop for the counterpart interlocking means, and it may be substantially parallel to the surface of the starting sections which may be configured to serve as a stop. Another one of the vertical sides may be the side surface of the pins 221 which is in contact with the surface of the end section which serves as a stop for the counterpart interlocking means, and it may be substantially parallel to the surface of the end section which serves as a stop.

The expansion of the (constricted section 232 of the) retainer element remains unchanged during the transition to the unlocked state.

Unlocked State

In the unlocked state, the stopper 100 may be removed from the bottle and the liquid may leave the bottle.

The sealing element 200 of the closure system remains in the mouth of the bottle after the closure system has once been brought into the locked position, even when the stopper 100 is subsequently removed from the mouth of the bottle. Even in this case, the force required to pull the sealing element 200 out of the mouth may exceed 100N.

In the unlocked state, the head part of the stopper 100 is not in contact with the covering section of the sealing element 200 anymore. The stopper 100 and the sealing element 200 may have a positional relationship as described below.

In the unlocked state, at least a part of the second section 120 of the stopper part 102 may be located within the sealing section 210 of the sealing element 200. In particular, at least a part of the second section 120 of the stopper part 102 may be located within the constricted section 211 of the sealing section 210 of the sealing element 200. In that case, at least a part of the sealing section 210 may have received at least a part of the second section 120 of the stopper part 102 of the stopper 100. In particular, at least the part of the sealing section 210 with the smallest inner diameter may have received at least a part of the second section 120 of the stopper part 102. In that case, at least a part of the constricted section 211 of the sealing section 210 has received at least a part of the second section 120 of the stopper part 102 of the stopper 100. In some embodiments, the first section 110 of the stopper part 102 is not located within the constricted section 211 of the sealing section 210 of the sealing element 200.

This positional relationship may lead to a lessening of the pressure on the sealing section 210 of the sealing element 200 and thereby to a reduction and/or removal of the seal between the stopper 100 and the sealing element 200. However, there may still remain the side of the seal between the mouth of the bottle and the sealing element 200. This side of the seal may be needed to prevent that liquid passes between the sealing element 200 and the mouth of the bottle.

In the unlocked state, the pins 221 of the sealing element 200 may still be engaged with the (end sections of the) grooves 121 of the stopper 100 element. However, the end sections of the grooves 121 of the stopper 100 do not prevent an axial displacement of the stopper 100 with respect to the sealing element 200 in the upward direction. Thus, the stopper 100 can be removed from the closure system, wherein the pins 221 of the sealing element 200 leave the grooves through the bottom of the end sections. The tapered shape of the end sections as described with regard to **Figs. 2a** and **2b** may facilitate the alignment with the pins 221 of the sealing element 200 and therefore reintroducing the stopper 100 into the sealing element 200, once taken off.

The retaining section 230 may remain activated even when the stopper 100 is removed from the sealing element 200. In this case, the retaining section may be hold the sealing element in the same position as in the locked state.

Materials

Stopper

The stopper can be made, e.g., of one or more materials chosen out of the group comprising glass, ceramic, plastic, metal and wood. In a preferred embodiment, the material of the stopper is glass.

Sealing element

The sealing element of the closure system comprises two parts in the preferred embodiment.

One part is a main body of the sealing element 204, cf. **Fig. 5b**. The main body is configured to form the entire or at least a portion of the part of the sealing element which is in contact with the side surface of the stopper part of the stopper when the stopper part is introduced in the sealing element. It provides the skeleton for the sealing element. The covering section 201, the pins 221, the pads 222 and the protrusions 224 form part of the main body, cf. **Fig. 3**, **Fig. 4** and **Fig. 5**. In a preferred embodiment, the main body basically defines the shape of the sealing element and is therefore for example substantially tubular. In a preferred embodiment, the main body is made of or comprises polypropylene and/or polyethylene. The material of the main body should be a relatively hard material, e.g. having a shore D hardness between 50 and 120 Rockwell (R-scale), preferably between 70 and 100.

Another part of the sealing element is the part that is at least in part configured to be in contact with the inner wall of the mouth of the bottle. It is the part which is of a material which is different from the material of the main body, as mentioned above. This other part is at least partially arranged on the outer side of the main body of the sealing element, i.e. the side which is opposed to the side of the main body that contacts the side surface of the stopper part of the stopper when the stopper part is introduced in the sealing element.

In a preferred embodiment, the different material 203 is softer than the material of the main body 204. In this embodiment, the main body provides stability to the sealing

element in the axial direction, which is particularly important to prevent an upsetting during the introduction of the sealing element into the mouth of the bottle. It also assures that the softer material is not or only to some minor extent displaced under persistent high pressure, such as in the locked state of the closure system in the mouth of the bottle. Also, the hardness of the main body is required to transmit pressure more uniformly across a larger area. The softer material allows for a smooth adaptation of the sealing element to the inner wall of the mouth of the bottle. Due to the softness of the material, the different material can also correct for small deviations in the shape of the inner wall of the mouth of the body, this way allowing for a better grip to the mouth of the bottle and thus for a better leak tightness. At the same time the softness of the material also provides for an increased radial stroke while maintaining more or less a similar radial pressure built-up, such as while bringing the closure system into the locked state. In a preferred embodiment, the different material is or comprises a thermoplastic elastomer and/or a thermoset elastomer. Preferably, the thermoplastic elastomer and/or thermoset elastomer has a Shore A hardness between 25 and 90. However, the different material should not be too soft as the different material would otherwise be squeezed out of the pressure zones, such as at the sealing section 210.

It also preferred that different material has a higher friction coefficient with respect to glass than the material of the main body that is configured to be in contact with the side surface of the stopper part of the stopper. The higher friction of the different material ensures *inter alia* that the sealing element does not spin when the stopper is brought from the locked state in the unlocked-state.

Preferably, the different material 203 is arranged on the outer surface of the sealing section 210 and/or the retaining section 230 because these section are configured to be in contact with the inner wall of the mouth of the bottle, cf. **Fig. 5b**. It is further preferred that the different material is not arranged on the outer surface of a section of the sealing element which is not configured to be forced against the inner wall of the mouth of the bottle in the locked state of the closure system. For example, in a preferred embodiment, the different material is not arranged on the outer surface of the second section 220 of the sealing element. This ensures that the friction of the sealing element at the inner wall of the mouth of the bottle is as small as possible.

The sealing element is preferably manufactured by a two-component injection molding method. In a preferred embodiment, the main body and the different material are unreleasably connected with one another during manufacturing of the sealing element. The unreleasable connection is obtained for example by melting at least one contacting surface of the different material and the main body. While other manufacturing processes that do not result in an unreleasable but in a releasable connection between the main body and the different material can also be considered and may even be advantageous due to the resulting lower production costs, injection molding is the preferred manufacturing method, because it ensures that the other part, made from the different material, is held on the main body of the sealing element, in particular during the introduction of the sealing element into the mouth of the bottle.

Retainer element

In a preferred embodiment, the retainer element is made of homo-polypropylene.

Pressure Resilience and Leak Tightness

In a preferred embodiment, in the locked state, a force exceeding 50N, preferably 100N, more preferably 200N, most preferably 300N is required to pull the stopper or the closure system out of the mouth of the bottle. Preferably, in the locked state, the forcing the sealing element against the inner wall of the mouth of the bottle forms a seal between the stopper and the mouth of the bottle such that no liquid can exit through the mouth of the bottle.

In another preferred embodiment, the closure system is retained in the mouth of the bottle against a pressure of at least up to 1 bar inside the bottle, preferably at least up to 2 bar, more preferably at least up to 3 bar, most preferably at least up to 4 bar. Preferably, the seal is sufficiently tight such that in the locked state, no signs of leakage such as bubble formation are observed at the stopper of a bottle filled with red wine after 1 minute at a pressure of at least up to 1 bar inside the bottle, preferably of at least up to 2 bar, more preferably of at least up to 3 bar and most preferably at a pressure of at least up to 4 bar.

In another preferred embodiment, in the unlocked state, the stopper can be pulled out of the mouth of the bottle by a force of less than 20N, preferably less than 5N, more preferably less than 2N, most preferably by a force which substantially corresponds to the weight of the stopper. Preferably, in the unlocked state, no seal is formed between the stopper and the mouth of the bottle such that liquid can exit through the mouth of the bottle.

The following experiments have been conducted to test the functionality of certain embodiments the closure system according to the invention.

To assess the leak tightness of the closure system according to the invention a stainless steel closure system according to the invention was equipped with two different embodiments of the and was tested according to the following protocol:

Commercially available Saverglass wine bottles of 750 ml volume complying with the DIN EN 12726:2000 standard were equipped with a pressure port. Stainless steel stoppers were equipped with two variants of the sealing element according to the invention.

Initial testing was conducted at ambient temperature and 1 hour after the closure system was installed in the bottle. A second test series with new closure systems was conducted 24 hours after the closure system was installed. In this second test, the bottles were placed into the pressure test apparatus, and equilibrated to 35 °C for 10 minutes.

Gas pressure was applied to the interior of the bottles as follows:

0 – 1 min (during the 1st minute): 1 bar
1 – 2 min (during the 2nd minute): 2 bar
2 – 3 min (during the 3rd minute): 3 bar
3 – 4 min (during the 4th minute): 4 bar

The individual testing of a bottle – closure system set-up was deemed completed when leakage or closure ejection occurred. For each set-up, three independent repetitions were conducted. The following table summarizes the obtained results:

Sealing element	Repetition	Time sealed	Temperature	Time till completion of test
model I	1	1 hour	ambient	3 min 45 sec
model I	2	1 hour	ambient	3 min 35 sec
model I	3	1 hour	ambient	3 min 7 sec
model II	1	1 hour	ambient	2 min 28 sec
model II	2	1 hour	ambient	2 min 30 sec
model II	3	1 hour	ambient	2 min 22 sec
model I	1	24 hours	35 °C	3 min 9 sec
model I	2	24 hours	35 °C	3 min 20 sec
model I	3	24 hours	35 °C	3 min 10 sec
model II	1	24 hours	35 °C	2 min 10 sec
model II	2	24 hours	35 °C	2 min 15 sec
model II	3	24 hours	35 °C	2 min 12 sec

In summary, the tests demonstrate that the closure systems equipped with both sealing elements, model I and model II, withstand a pressure within the bottle as compared to the surrounding, atmospheric pressure of at least 2 bar without showing any leakage.

Aerator

In a preferred embodiment, the sealing element is or comprises an aerator configured to mix a liquid in the bottle with air when pouring the liquid out of the bottle, thereby increasing the oxygen content of the liquid. Preferably, the aerator is configured to yield an average dissolved oxygen saturation in a wine, preferably red wine, of at least 45%, preferably at least 65%, by directly pouring the wine containing almost no dissolved oxygen out of the bottle.

In one embodiment of the aerator, the aerator is configured such that the pouring time for pouring 750 ml of wine contained in the bottle can be effected in less than 10 seconds, preferably less than 6 seconds and, in a further preferred embodiment, the aerator is configured such that it allows for a smooth pouring of the wine. Increased

aerating function usually comes at the expense of prolonged pouring times. In preferred embodiments of the aerator, the pouring times are hardly increased as compared to a standard bottle not equipped with a sealing element with an aerator.

In one embodiment, the aerating function is substantially provided by a ring or tube shaped element. Preferably, the minimum inner diameter of the ring or tube shaped element in the constricted section 232 is between 7.5 and 11.5 mm, preferably between 8 and 11 mm, more preferably between 8.5 and 10.5 mm and most preferably between 9 and 10 mm.

In a preferred embodiment, the minimum inner diameter of the ring or tube shaped element in the constricted section 232 is constricted over a length of less than 20 mm, preferably less than 15 mm, preferably less than 10 mm, preferably less than 5 mm, preferably less than 2.5 mm and most preferably less than 1.25 mm.

Preferably, the ring or tube shaped element is located at least in the lower 2/3, preferably the lower half, more preferably the lower 1/3 and most preferably the lower 1/4 of the length of the sealing element. In this or another preferred embodiment, the ring or tube shaped element is located at least in the lower 21 mm, preferably the lower 16 mm, more preferably the lower 11 mm and most preferably the lower 8 mm of the length of the sealing element.

It is believed that the aerating function and the resulting dissolved oxygen in the poured wine is achieved or increased by a constriction of the inner diameter of the ring or tube shaped element, an effect which is also described as the “venturi" effect. Furthermore, it is believed that the quality of the aerating is improved if the ring or tube shaped element is positioned as deeply as possible in the mouth or neck of the bottle. A combination of both, i.e. a large constriction of the inner diameter of the ring or tube shaped element and the ring or tube shaped element being positioned deeply in the mouth or neck of the bottle, yield the best aerating function. Nevertheless, an overly large constriction if the inner diameter of the ring is in conflict with the requirement of fast flow of the liquid, respectively short pouring times.

In a preferred embodiment, the constricted section 232 in the ring or tube shaped element is constricted in comparison with the inner diameter of the other parts of the ring or tube shaped element or the other parts of the sealing element by a ring-shaped protrusion from the inner side wall of the ring or tube shaped element towards the central axis, wherein the ring-shaped protrusion may be a continuous or discontinuous structure.

Also, in a preferred embodiment, the ring or tube shaped element comprises turbines, blades or wings positioned at least partially inside the constricted section 232 of the ring or tube shaped element, wherein the turbines, blades or wings are preferably configured to increase the oxygen content of a liquid in the bottle when pouring the liquid out of the bottle.

In a preferred embodiment, the ring or tube shaped element is the retainer element. **Fig. 10a** and **10b** show an embodiment of a retainer ring 300 which functions at the same time as an aerator. The retainer ring 300 depicted in **Fig. 10a** and **10b** also exhibits blades 303.

In other embodiments, the ring or tube shaped element is releasably attached to the bottom of the sealing element. Preferably, and as shown in **Fig. 11, Fig. 12a** and **12b**, the sealing element 200 in these embodiments has a recess 223. As shown in **Fig. 13a**, the aerator 350 has a nib 304 which can clip into the recess 223 of the sealing element 200, thereby attaching the aerator 350 in a releasable manner to the sealing element 200. **Fig. 14** shows an aerator 350 releasably attached to the sealing element 200.

To assess the functionality of the aerator that may optionally be employed in the closure system, four different embodiments of an aerator according to the invention were tested for their ability to increase the amount of oxygen which is dissolved in red wine. The pouring time was equally measured for each set-up.

The following protocol was adhered to:

A sealing element according to the invention was used as a basis and 4 different embodiments of aerator termed "Oenologic decanting 1" to "Oenologic decanting 4" designed as depicted respectively in **Fig. 15a to 15d**. The four tested aerators are specific embodiments of the retainer ring. Accordingly, the aerators are located at the very bottom of the sealing element, in the retaining section 200.

Commercially available Saverglass wine bottles of 750 ml volume were filled with a red wine (13.0% alcohol) which had been in bottle for >6 months, which leads to nearly 0 mg/l dissolved oxygen, DO). The four different closure systems were compared to the aerating performance of the bottle alone, of a typical wine decanter and of a venturi type wine aerator. The temperature of the wine bottle was adjusted to 17 °C, i.e. a representative cellaring temperature. The cork was removed and 150 ml of the wine were poured with the respective treatment (e.g. with the installed sealing element in the bottle neck) in an ISO standard wine glass fitted with a Pst3 oxygen sensor. The pouring of 150 ml of the wine into the wine glass was then repeated three times (in total four glasses of wine). The comparative wine decanter was filled only just before pouring the wine again in the four glasses. The theoretical maximum dissolved oxygen level in the wine at the indicated conditions is 7.9 mg/l.

The results, which are shown in **Fig. 16**, demonstrate that the sealing element equipped with the different aerators all exhibit superior oxygen saturation properties as compared to the wine bottle alone or a conventional wine decanter. Also, while there is a correlation between good aeration and increased pouring time, the pouring time is not unduly increased by the four different aerator embodiments according to the invention. Also, it was noted that embodiment "Oenologic decanting 4" depicted in **Fig. 15d** exhibits the smoothest pouring characteristic.

Guiders/Wipers

Fig.9 shows the sealing element according to another embodiment of the invention. In this embodiment, one or more protrusions 224 are provided on the outer surface of the sealing element 200. The protrusions 224 are provided such that they make contact with the inner wall of the mouth of the bottle. This contact is made when the sealing element (with the closure system) is introduced into the mouth of the bottle.

It is advantageous that the sealing element and/or closure system is centered within the mouth of the bottle during and/or after introduction into the mouth of the bottle. This avoids the sealing element to be in an inclined position, and also avoids higher friction caused by the soft components on the sealing element having an uneven contact with the mouth of the bottle. Such a higher friction may have the consequence that the softer components roll off from the sealing element and cause difficulties during the bottling process. To overcome this problem, the one or more protrusions 224 provided enable the centering of the sealing element and/or the closure system within the mouth of the bottle during and/or after introduction into the mouth of the bottle. The shape and placement of the protrusions 224 on the sealing element are selected to appropriately balance between the proper centering and avoiding too high a friction caused by the protrusions during the introduction of the sealing element into the mouth of the bottle. Furthermore, it is recommended to avoid the protrusions from impairing the seal formed by the sealing section of the sealing element or the holding properties of the retaining section of the sealing element.

The centering can be achieved by providing the protrusions 224 at appropriate sides of the sealing element, of appropriate shape, and of appropriate rigidity. The protrusions have a substantially longish shape, i.e. the length is significantly longer than the width/height of the protrusions, and the protrusions are substantially horizontally and/or vertically (not shown in Fig. 11) oriented. In order to ensure that the protrusions 224 make contact with the mouth of the bottle, the size of the protrusions 224 is such that the overall outer diameter of the sealing element at least at one point of the protrusion is greater than or equal to the (minimum) inner diameter of the mouth of the bottle. The protrusions 224 of the preferred embodiment are part of the main body of the sealing element. Thereby, the materials used for the main body of the sealing element is also used for the protrusions. That is, the protrusions are made of harder materials than the softer parts of the sealing element which are configured to contact the inner wall of the mouth of the bottle, like the sealing section and/or the retaining section of the sealing element.

Additionally, it is preferred that at least part of the plurality of protrusions are distributed opposite to and/or symmetrically to each other, and they may also be equidistant from each other around the circumference of the sealing element. Such a symmetrical configuration along the circumference is provided in order to maintain the overall symmetry of the sealing element and the closure system and to improve the effect of centering. As a skilled person may understand, a single protrusion may also be provided along the entire circumference of the sealing element in order to form a closed ring. However, it is preferred that protrusions are divided at least at one point. This is to enable easier manufacturing process and designing a mold with parting line provided at appropriate position. Additionally, the sealing element may also contain a channel which forms a connection of the softer material between the sealing section and the retaining section in order to assist in manufacturing of the sealing element 200.

The protrusions 224 may also be tapered appropriately to form one or more chords along the circumference. That is, the protrusions may not be perfectly circular but may have flat sides with tapered corners or edges. This may be provided to aid in guiding the closure system to be centered during its introduction into the mouth of the bottle.

An additional advantage of the protrusions will be described herein. As it can be understood, it is advantageous that the mouth of the bottle is free from liquid or dirt prior to sealing. This is to enable a better sealing between the sealing element and the surface of the bottle. The protrusions 224 make contact with the inner wall of the mouth and wipe at least a part of the inner surface of the mouth of the bottle when the sealing element is introduced into the mouth of the bottle. As it can be understood, the area of inner wall of the mouth which is wiped depends on the length of the protrusion and the placement of the protrusion on the sealing element.

Taking the above into consideration, the protrusions 224 are preferably placed below the sealing section of the sealing element or the section where the seal is formed. That is, the protrusions 224 are formed on the second section 220 of the sealing element such that the upper end of the protrusion is below the sealing section of the sealing element or the section where the seal is formed. The upper end of the protrusions 224 is located anywhere between 1mm and 15mm below the lower end of the section where

the seal is formed. It is preferable to have the protrusion close to the sealing section or the section where the seal is formed to avoid unnecessary wiping in an area other than the area where the seal is formed. They are therefore preferably provided at most 10 mm, more preferably at most 5 mm and most preferably at most 3 mm below the lower end of the sealing section of the sealing element or the section where the seal is formed. However, in order to not impair the seal, they should not be placed too close to the sealing section or the section where the seal is formed. If they are too close to the seal they could impair the seal because in the preferred embodiment, the protrusions form an overall outer diameter on the sealing element which is greater than the inner diameter of the mouth of the bottle.

Elements on the second section 220 are also considered when placing the protrusion. For example, the protrusions are provided above the tap 221 for ease of the manufacturing process.

Other or additional placements of the protrusions 224 are also possible. For example, in an embodiment not shown in the Figures, the protrusions 224 are provided below the retaining section 230 of the sealing element to ensure that the sealing element is centered already at the moment when the retaining section enters the mouth of the bottle during insertion of the sealing element. The advantage of having the protrusions below the retaining section is that it ensures that the closure system is centered during introduction into the mouth of the bottle from the moment on the system enters the mouth. They are provided preferably close to the retaining section of the sealing element, e.g. between about 2mm to 10mm below the lower end of the retaining section, for the reasons described above, and also in order to keep the overall length of the sealing element to a minimum.

Tamper proof element

In another embodiment of the invention, a tamper proof element 400 for the closure system of the present invention is provided. As it will be described in further detail below, the fully assembled state is a state which is reached when the preassembled closure system is brought to a closed state during bottling. Since the closure system is configured such that the stopper must be displaced with respect to the sealing element

in order to open the bottle, the tamper proof element provides a secure indication of whether or not the bottle has been opened after bottling. When the closure system is in a fully assembled state, this tamper proof element 400 allows the user to find out whether the stopper has been moved in an axial direction and/or in a radial direction with respect to the sealing element. That is, the tamper proof element 400 allows the user to find out whether the stopper has been rotated with respect to the sealing element. As discussed above, the stopper moves upwards with respect to the sealing element on rotation, therefore has an axial and radial movement at the same time. Furthermore, even if the stopper has been pulled by force in the axial direction, the tamper proof element 400 allows the user to find if the stopper was moved.

The tamper proof element 400 is connected to the stopper on the one hand and is connected to the sealing element on the other hand, in such a way that, in case the stopper is moved either in the radial and/or axial direction with respect to the sealing element in its fully assembled state, the tamper proof element 400 is at least partially broken. This connection between the tamper proof element 400 and the stopper can be made by either one of or combination of an interlocking connection or a frictional connection or an adhesive connection in the radial and/or axial direction. Similarly, the connection between the tamper proof element 400 and the sealing element can be made by either one of or a combination of an interlocking connection or a frictional connection or an adhesive connection in the radial and/or axial direction.

The tamper proof element 400 is shaped in the form of a tube for easy wrapping for providing a reliable connection by way of wrapping and allows for an easier preassembly process. However, other shapes of the element can be envisaged by the skilled person depending on the shape of the closure system and method of wrapping. The tamper proof element 400 is preferably made from thin materials such as aluminium sheet or laminated aluminium or plastic materials such that it is soft enough to be broken easily when opening, but hard enough to withstand normal wear and tear during transportation. The element preferably is in the form of a film to allow easy molding and wrapping as will be explained below.

Fig.17a shows the closure system is in a preassembled state having a tamper proof element 400 according to a preferred embodiment. The upper part of the tamper proof

element 400 is at least partially wrapped around the stopper to form an interlocking connection and/or a frictional connection. The portion of the lateral surface and the upper surface of the head part 101 of the stopper that is wrapped by the tamper proof element 400 depends on the strength of the interlocking connection and/or the frictional connection which is required.

Similarly, the lower part of the tamper proof element 400 is connected to the sealing element. In the preferred embodiment, the lower part of the tamper proof element 400 is wrapped around the covering portion of the sealing element and thereby connected by means of an interlocking and/or frictional connection. The tamper proof element 400 is at least partially wrapped around the lateral portions and at least parts of the lower surface of the covering section 201 of the sealing element. As it can be seen, the lower surface of the covering section of the sealing element is the surface in contact with the mouth of the bottle. The covering section provides the possibility to create an interlocking connection in the axial direction.

In a preferred embodiment, the covering section 201 is also provided with a means for increasing the connection between the tamper proof element 400 and the covering section 201 in radial and/or axial direction as seen in **Fig.9**. This means for increasing the connection is preferably in form of one or more teeth 202 which are provided on at least a part of the lateral portion. The teeth ensure that the tamper proof element does not move along with the stopper on rotating without damaging the tamper proof element. In addition to or alternatively, the teeth 202 may also be provided on the lower surface of the covering section 201. However, it is preferable that the teeth are not provided on the upper surface of the covering portion. This is to ensure that when the bottle is opened, the upper surface is smooth to avoid injury to the user when handing the bottle. The teeth 202 are provided along the circumference on at least a part of the covering section 201 or the entire circumference of the covering section 201. The preferable design of the teeth is such that they are at the same time both on the lower surface and on the lateral surface and have a circumference smaller than the circumference of the upper surface of the covering section 201.

When the tamper proof element 400 is wrapped around the covering section 201, the teeth 202 on the covering section 201 provides a surface which provides higher

frictional and interlocking force on the tamper proof element 400. This ensures that the lower part of the tamper proof element 400 is securely connected to the sealing element and thereby does not slip or rotate along with the rotation of the stopper. The teeth 202 also ensure that the tamper proof element 400 breaks at least at the part where it is in contact with the teeth to enable the user to find out that the stopper has been moved in the radial and/or axial direction.

In order to further assist in determining if the stopper was moved, the tamper proof element 400 may be also provided with a breaking point or line at a predetermined position on the tamper proof element 400. This breaking point or line is preferably a perforation. The perforation is provided on at least part of the circumference of the tamper proof element 400 when wrapped around the closure system, such that the tamper proof element 400 breaks along the perforation when the stopper is moved in the radial and/or axial direction.

To enable easier breaking, the predetermined breaking point or line is located at a position corresponding to the position of the lower half of the head of the stopper when the tamper proof element 400 is wrapped around the closure system. This is to ensure that in the fully assembled state, the breaking point or line is preferably below or relatively at the same line as the thumb of the user when holding and rotating the stopper. It is also preferable to provide the predetermined breaking point or line at the lower third or even completely under the under the head part 101 of the stopper to ensure that the breaking is not affected by holding of the stopper by the user. For example, the breaking point or line is provided along the same position where the teeth on the closure is provided. Additionally, since the closure system requires axial and radial movement at the same time, it is preferable that the perforations are provided such that it is easily broken by rotational as well as upward movement. Therefore, the perforations are preferably provided in a diagonal manner across the circumference in the direction of rotation of the head part.

As will be explained in detail later with regard to the preassembly and closing process, the tamper proof element 400 is placed on the closure system in a preassembled state before the closing of the bottle is performed. In order to ensure that the tamper proof element 400 can be wrapped around the preassembled closure system, the tamper

proof element 400 is provided with a predetermined length. As shown in in Fig.7a, a space which is formed between the head part of the stopper 200 and the covering section of the sealing element 201 forms a gap in the preassembled state. Therefore, the length of the tamper proof element 400 includes a part to accommodate the gap which is formed between the head part 101 of the stopper and the covering section 201 of the sealing element. That is, the tamper proof element 400 contains a part between the upper part that is wrapped on the head part 101 of the stopper and the lower part which is wrapped on the covering section 201 of the sealing element.

During closure of the bottle, when the stopper part is fully introduced into the sealing element, at least a section of the part of the tamper proof element which is between the upper and lower part of the tamper proof element is folded inwardly towards the center of the closure system. **Fig.17b** shows the tamper proof element is folded into the gap in between the head part 101 and the sealing element. That is, in the fully assembled state of the closure system, the part of the tamper proof element 400 which accommodates the gap is now in between the head part of the stopper and the sealing element when the closure is fully introduced into the sealing element. In an alternative embodiment, the predetermined breaking point or line on the tamper proof element 400 may be located such that it is on the part which is between the upper and lower part and is folded into the gap between the head part 101 and the sealing element. Wrapping the closure system with the tamper proof element already in the preassembly stage has the advantage that in the bottling line, the closure system only needs to be placed into the mouth of the bottle, and no additional step of adding a tamper proof element is required in the bottling stage.

The skilled person will understand that the tamper proof element 400 may be wrapped around the stopper and sealing element by means of any possible mechanism, including heat wrapping or gluing. In the preferred embodiment, the tamper proof element 400 is wrapped using a shrink wrap mechanism. This mechanism provides for easy and cost-efficient way of wrapping a tamper proof element and faster bottling mechanism. It also may allow folding of the tamper proof element 400 towards the closure system. The thickness of the tamper proof element is provided such that it is retained in a stretched position between the head part of the stopper and the covering

section of the sealing element as a result of shrink wrapping. The thickness is preferably selected to be between 35µm and 100µm, more preferably 50µm.

Method of bottling - Preassembling

The method of bottling using the closure system according to the present invention will now be described. The method includes preassembling a closure system and then closing the bottle with the closure system. As a skilled person may understand, both these actions may be performed within a short period of time one after another or separately at a different periods of time.

For preassembling the closure system, the stopper part of the stopper is partially introduced into the sealing element. As described above, in the preassembled state, the holding means of the stopper part are preferably engaged with the counterpart holding means of the sealing element. By partially introducing the stopper part of the stopper into the sealing element, the interlocking means of the stopper part are not engaged with the counterpart interlocking means of the sealing element but only the holding means of the stopper part engage with the counterpart holding means of the sealing element. This partial introduction is ensured, e.g., by providing only an adequate amount of force when introducing the stopper into the sealing element. The amount of force is determined in advance and depends on the strength of the interconnection formed between the holding means of the stopper and the sealing element.

Going back to **Fig. 7a**, this figure shows the closure system with the sealing element and the stopper in the preassembled state. As already discussed, the stopper part of the stopper comprises holding means which engage when the stopper is partially introduced, to form an interlocking connection with counterpart holding means of the sealing element.

As described above, the sealing element is designed to be at least partially radially expanded by the stopper part when the stopper part is fully introduced into the sealing element. However, the configuration of the sealing element and the stopper is preferably such that when the stopper is partially introduced, the sealing section is not radially expanded, or by a maximum of 0.5 mm.

Similarly, the sealing element is also provided with a retaining section 230 which is radially expanded in order to be forced against the inner wall of the mouth of the bottle upon introduction of the closure system into the mouth of the bottle. However, the configuration of the sealing element and the stopper is preferably such that when the stopper is partially introduced, the retaining section 230 is not radially expanded at all. At most, the retaining section 230 is radially expanded by a maximum of 0.5 mm. The radial expansion of the sealing element is reduced to the minimum in order to ensure that the sealing element can be introduced into the mouth of the bottle with incurring additional friction during the bottling step.

At this stage, it is preferable to also perform the step of wrapping the tamper proof element 400 after the step of partially introducing the stopper part of the stopper into the sealing element. However, this is dependent on the supply chain management of the bottling process. For example, the wrapping may either be performed on the preassembled closure system during preassembling. On the other hand, wrapping may also be performed on the preassembled closure system prior to closing the bottle.

The tamper proof element 400 is wrapped around the stopper, preferably on the lateral portions and the upper surface of the head part 101 of the stopper. Similarly, the tamper proof element 400 is wrapped around the sealing element, preferably around a flange positioned at the upper end of the sealing element to provide an interlocking and/or frictional connection. The wrapping is performed such that the lower part of the tamper proof element 400 is held by the flange by means of an interlocking and/or frictional connection. However, as discussed above, the portion of the surface of stopper and sealing element that is wrapped by the tamper proof element 400 depends on the strength of interlocking connection and/or a frictional connection which is required.

In the preferred embodiment, the wrapping of the closure system is performed by way of a shrink wrap mechanism. However, as described above and as a skilled person will understand, the tamper proof element 400 may be wrapped around the stopper and sealing element by means of any possible mechanism.

Method of bottling – closing the bottle

The method of closing the bottle using the preassembled closure system will now be explained.

The closing of the bottle includes inserting the closure system in a preassembled state into a mouth of the bottle. Going back to **Fig.7a**, this figure shows the closure system in the preassembled state inserted in the mouth of the bottle. As described above, in the preassembled state, the stopper part of the stopper is partially introduced into the sealing element such that the holding means of the stopper part engage with the counterpart holding means of the sealing element. That is, the interlocking means of the stopper part of the stopper are not engaged with the counterpart interlocking means of the sealing element.

To ensure that the closure system is inserted properly into the mouth of the bottle, one or more protrusions 224 are preferably provided on the sealing element as described above. These protrusions 224 allow the closure system to be axially centered with respect to the mouth of the bottle in order to ensure that the sealing element is not skewed to one side. Centering of the sealing element avoids friction and enables the easy insertion of the closure system into the mouth of the bottle.

Going back to **Fig.7b**, this figure shows a cross section in the next stage where the closure system in the bottle is in the locked state. After inserting the closure system into the mouth of the bottle, the closure system is pushed further into the mouth of the bottle to bring the bottle into the locked state. On pushing, the covering section 201 of the sealing element makes contact with the upper end of the mouth of the bottle and remains there. This is because the diameter of the covering section 201 is larger than the mouth of the bottle. Thereafter, on further pushing, the sealing element abuts to the bottle and only the stopper part of the stopper moves further until it is fully introduced into the sealing element in a way that the counterpart holding means (the pins) of the sealing element disengage from the holding means of the stopper part of the stopper and engage with the interlocking means (the groove) of the stopper part of the stopper, preferably at their starting section. The covering section which is provided between the lower side of the head part of the stopper and the tip of the mouth of the bottle to avoid

the contact of the stopper with the tip of the mouth of the bottle. Since the stopper and bottle may be made of materials such as glass, the covering section of the sealing element ensures that the stopper and/or bottle is not damaged when the stopper is further pushed into the mouth of the bottle, by forming an elastic layer between them.

The pushing of the stopper also enables forming of a seal between the inner wall of the mouth of the bottle and the stopper part of the stopper. Preferably, as described above, the pushing the stopper part of the stopper also activates the retaining section 230 of the sealing element by radially expanding the retaining section 230 and thereby forcing the retaining section 230 against the inner wall of the mouth of the bottle. The radial expansion of the retaining section 230 retains the sealing element inside the bottle. As a skilled person will understand, inserting the closure system into the mouth of the bottle and pushing the closure system further into the mouth of the bottle may be performed in one single step instead of different steps by the bottling plant.

In the preferred embodiment, a tamper proof element 400 is provided to the closure system. When pushing the closure system further into the mouth of the bottle, the section of the tamper proof element 400 which stretches between the head part 101 of the stopper and the flange 201 of the sealing element folds inwardly towards the closure system, preferably between the head part 101 of the stopper and the flange 201 of the sealing element as seen in **Fig.17b**. However, a skilled person would understand that the tamper proof element may also be designed such that this section is folded into the cavity formed between the tip of the mouth of the bottle and the head part of the stopper depending on their dimensions.

CLAIMS

1. A closure system for a bottle designed for commercial bottling of a beverage or liquid food, preferably a wine bottle, the closure system comprising:

a stopper comprising

a stopper part for introduction into a mouth of the bottle; and

a head part for remaining outside of the mouth, the head part having a diameter which is larger than that of the stopper part; and

a sealing element which is separate from the bottle and from the stopper;

wherein the closure system is configured such that the sealing element is forced against the inner wall of a mouth of the bottle, upon introduction of the stopper into the mouth, thereby bringing the closure system into a locked state;

wherein the stopper part comprises interlocking means configured to engage with counterpart interlocking means comprised by the sealing element;

wherein the interlocking means are configured to permit bringing the closure system into an unlocked state by an action which comprises rotating the stopper with respect to the bottle; and

wherein the stopper part of the stopper comprises holding means configured to form an interlocking connection with counterpart holding means of the sealing element, to hold the stopper in a secured position with respect to the sealing element when the closure system is in a preassembled state.

2. The closure system according to any one of the preceding claims, wherein the sealing element comprises a flange positioned at the upper end of the sealing element.

3. The closure system, according to any one of claims 1 or 2, wherein in the preassembled state of the closure system, the stopper part of the stopper is partially introduced into the sealing element and the interlocking means of the stopper part are not engaged with the counterpart interlocking means of the sealing element; and

wherein holding the stopper in the secured position prevents at least a substantial rotational displacement of the stopper with respect to the sealing element and/or axial displacement of the stopper with respect to the sealing element.

4. The closure system according to any one of claims 1 to 3, wherein the sealing element comprises a sealing section configured to be at least in part radially expanded upon full introduction into the sealing element; and

wherein in the preassembled state, the outer diameter of the sealing section is radially expanded, at the point of the largest expansion, by at most 1 mm in diameter, preferably at most 0.5 mm, more preferably at most 0.2 mm and most preferably not expanded at all, when the closure system is not introduced into the mouth of the bottle.

5. The closure system, according to any one of claims 1 to 4, wherein holding the stopper in the secured position prevents that the stopper part of the stopper is fully introduced into the sealing element before the sealing element is fully introduced into the mouth of the bottle.

6. The closure system, according to claim 2 or claim 2 and any one of claims 3 to 5, wherein holding the stopper in the secured position prevents that the stopper part of the stopper is fully introduced into the sealing element before the flange of the sealing element has made contact with the upper end of the mouth of the bottle.

7. The closure system, according to any of claims 1 to 6, wherein the interlocking means of the stopper part of the stopper comprise one or more grooves arranged on the circumference of the stopper part of the stopper;

wherein each groove comprises a starting section;

wherein the holding means of the stopper part of the stopper comprise one or more depressions arranged below a starting section of a groove on the stopper part of the stopper;

wherein the counterpart holding means of the sealing element are or comprise at least a portion of the counterpart interlocking means of the sealing element; and

wherein the one or more depressions are configured such that when the counterpart holding means of the sealing element are engaged with the depressions in the preassembled state, the counterpart holding means transition to the starting sections of the respective grooves of the interlocking means when the stopper part of the stopper is fully introduced into the sealing element by pushing.

8. The closure system according to claim 2 or claim 2 and any one of claims 3 to 7, comprising a tamper proof element which allows the user to find out whether the stopper, after the system had been fully assembled, has been moved with respect to the sealing element in radial and/or axial direction;

wherein the tamper proof element is configured to be placed on to the closure system in a preassembled state, in which there is a predetermined gap between the head part of the stopper and the flange of the sealing element; and

wherein a section of the tamper proof element between the head part of the stopper and flange is configured to fold inwardly towards the center of the closure system when the stopper part is fully introduced into the sealing element.

9. A stopper or a sealing element configured for use in a closure system according to any one of claims 1 to 8.

10. A method of preassembling a closure system for a bottle designed for commercial bottling of a beverage or liquid food, preferably a wine bottle, the closure system comprising a stopper with a head part and a stopper part, and a sealing element into which the stopper can be introduced, wherein the stopper part comprises interlocking means and the sealing element comprises counterpart interlocking means, the method comprising the step of:

partially introducing the stopper part of the stopper into the sealing element such that preferably the interlocking means of the stopper part are not engaged with the counterpart interlocking means of the sealing element.

11. The method according to claim 10, wherein the stopper part of the stopper comprises holding means configured to form an interlocking connection with counterpart holding means comprised by the sealing element; and

wherein during the step of partially introducing the stopper part into the sealing element, the holding means of the stopper part engage with the counterpart holding means of the sealing element.

12. The method according to any one of claims 10 or 11, wherein the sealing element comprises a sealing section configured to be at least partially radially expanded when the stopper part is fully introduced into the sealing element; and

wherein during the step of partially introducing the stopper part into the sealing element, the sealing section is radially expanded at most 1 mm in diameter, preferably at most 0.5 mm, more preferably at most 0.2 mm, and most preferably not expanded at all.

13. The method according to any one of claims 10 to 12, the method further comprising a step of wrapping the closure system with a tamper proof element, after the step of partially introducing the stopper part of the stopper into the sealing element;

wherein the tamper proof element is at least partially wrapped around the lateral portions, at least parts of the upper surface of the head part of the stopper, and at least part of the lower surface of a flange positioned at the upper end of the sealing element; and

wherein the tamper proof element is retained in a substantially stretched position between the head part of the stopper and the flange of the sealing element as a result of wrapping.

14. A method of closing a bottle designed for commercial bottling of a beverage or liquid food, preferably a wine bottle, by means a closure system comprising a stopper with a head part and a stopper part, and a sealing element into which the stopper can be introduced, wherein the stopper part of the stopper comprises interlocking means and the sealing element comprises counterpart interlocking means, the method comprising the steps of:

inserting the closure system in a preassembled state into a mouth of the bottle, wherein in the preassembled state, the stopper part of the stopper is partially introduced into the sealing element, and the interlocking means of the stopper part of the stopper are preferably not engaged with the counterpart interlocking means of the sealing element; and

pushing the closure system further into the mouth of the bottle, whereby the stopper part of the stopper is fully introduced into the sealing element and the interlocking means of the stopper part of the stopper preferably engage with the counterpart interlocking means of the sealing element.

15. The method according to claim 14, wherein the stopper part of the stopper comprises holding means configured to form an interlocking connection with the counterpart interlocking means of the sealing element;

wherein in the preassembled state, the holding means of the stopper part of the stopper are engaged with the counterpart interlocking means of the sealing element;

wherein during the step of pushing the closure system further into the mouth of the bottle, the counterpart interlocking means of the sealing element disengage from the holding means and then engage with the interlocking means of the stopper part of the stopper.

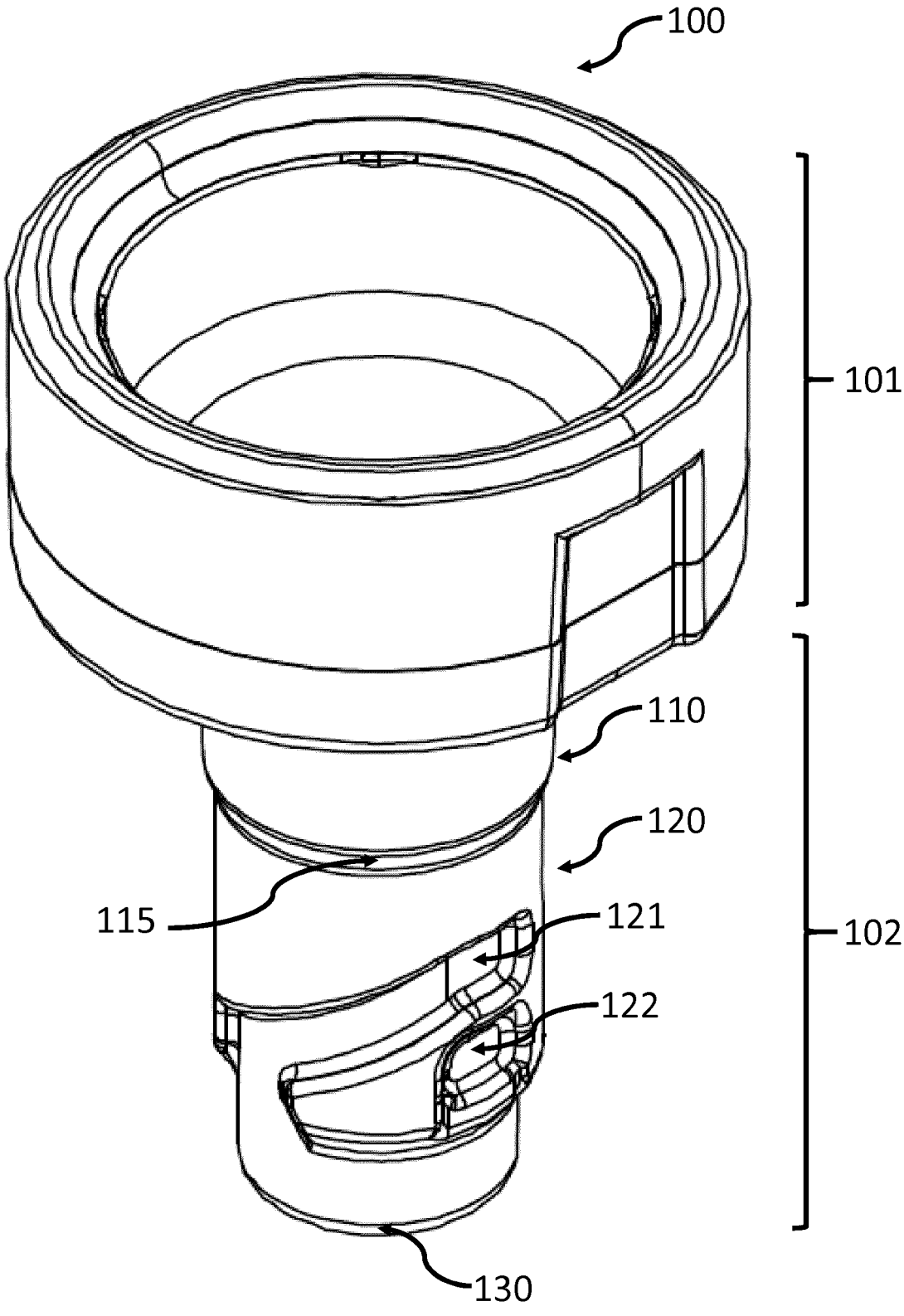
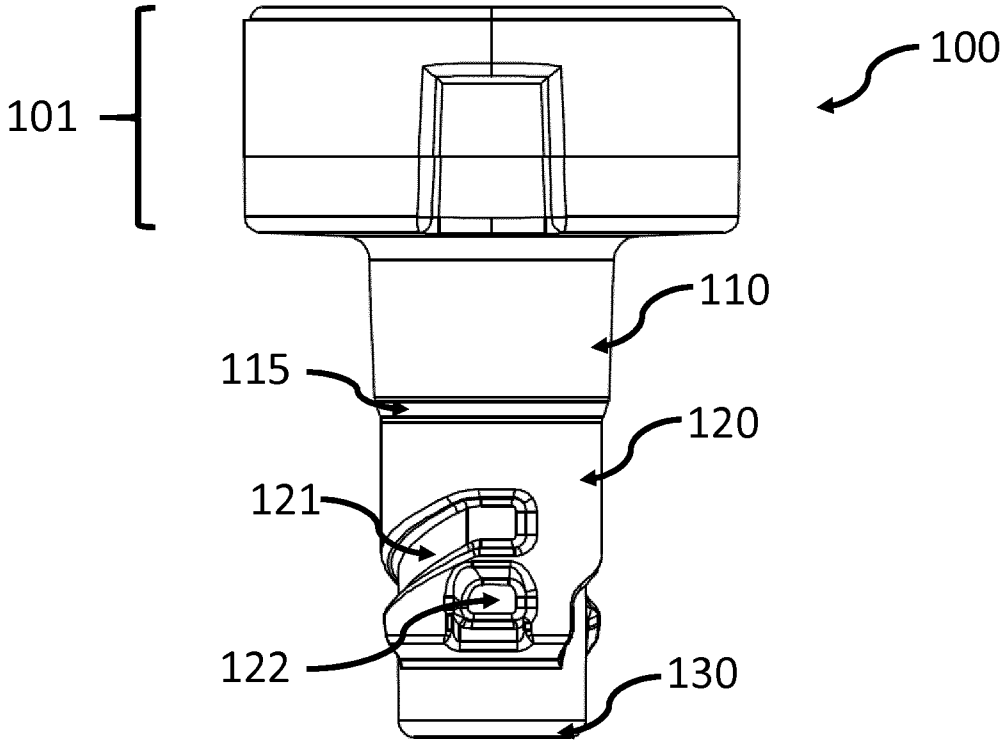


Fig. 1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122
130

Fig. 2a

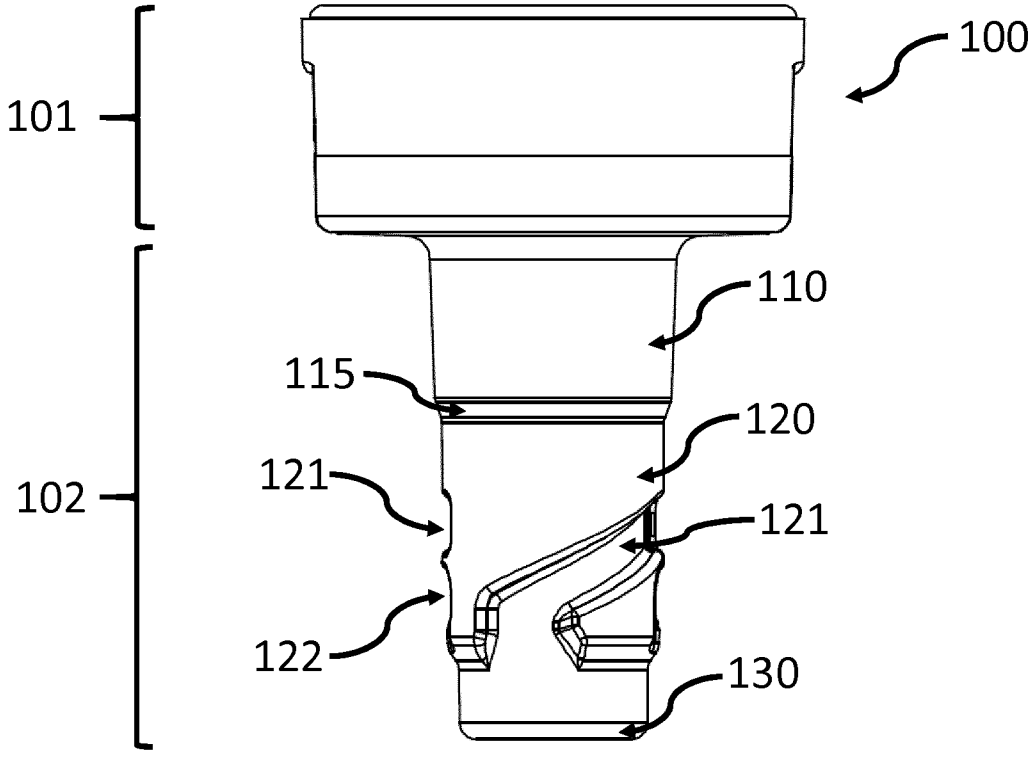
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Fig. 2b

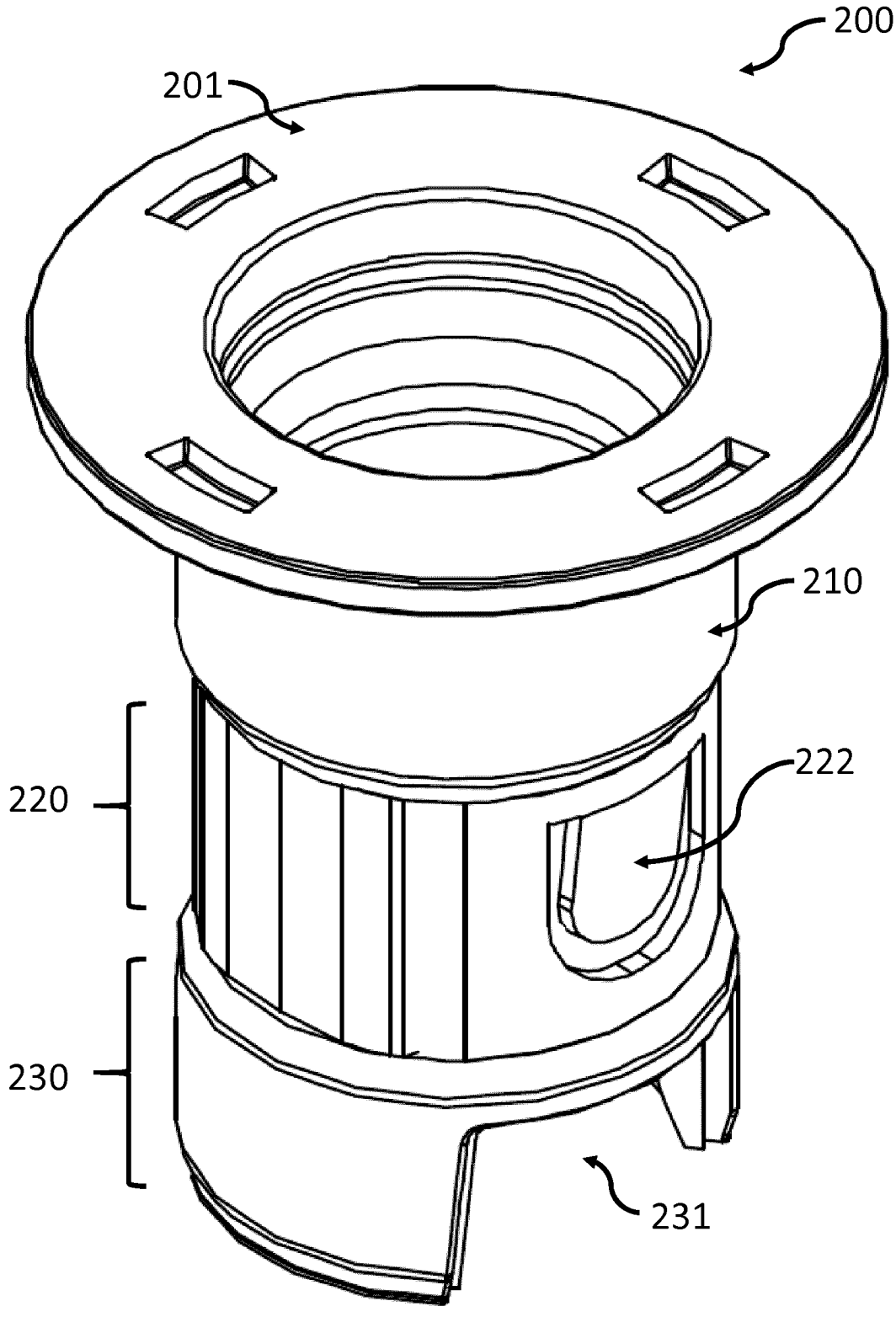


Fig. 3

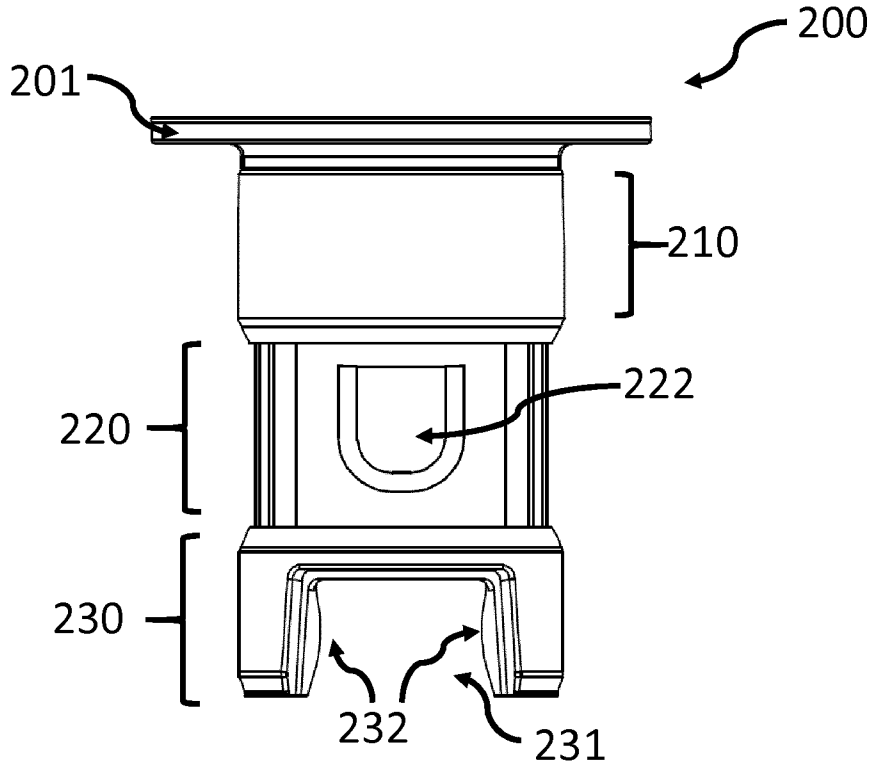


Fig. 4a

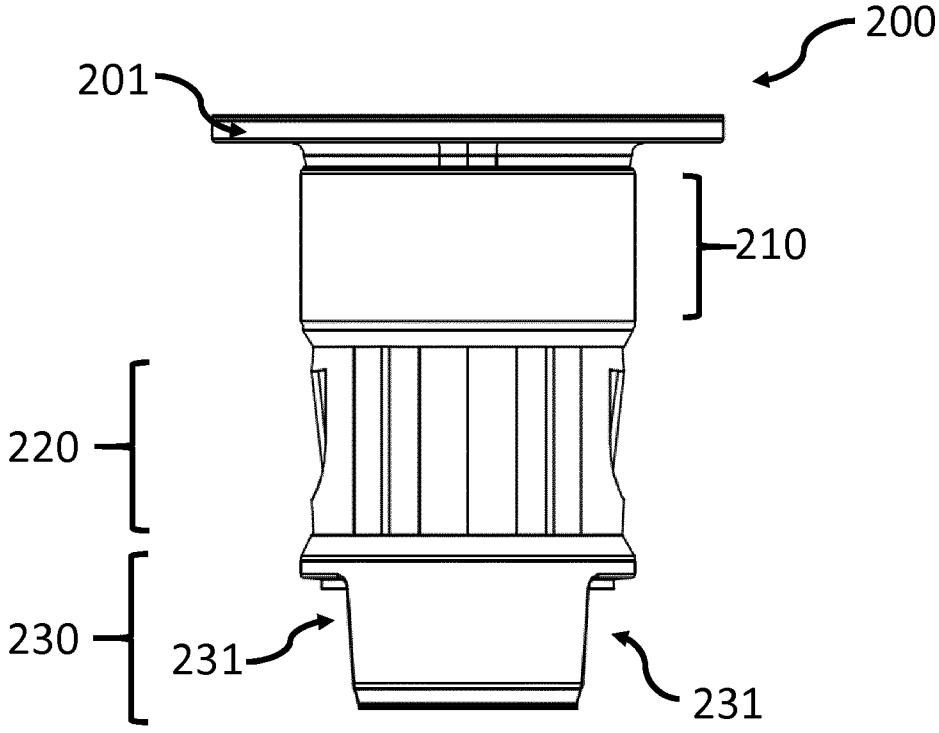


Fig. 4b

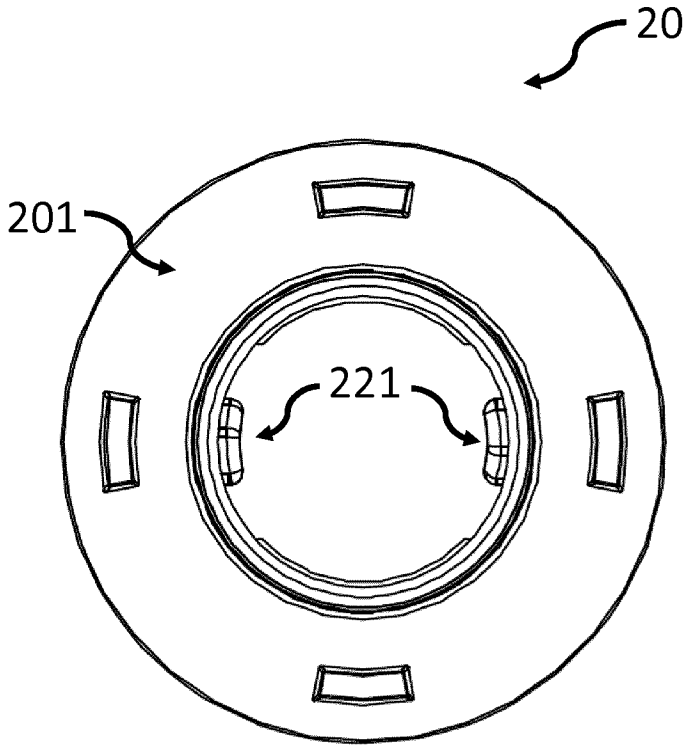


Fig. 5a

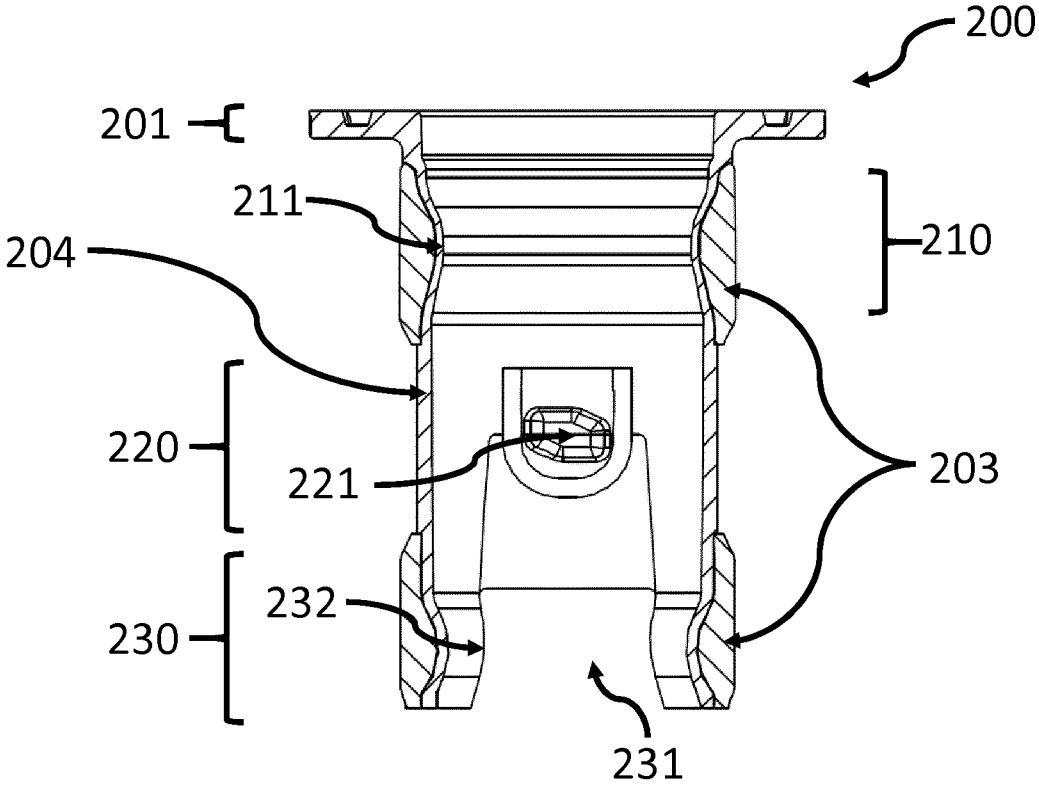


Fig. 5b

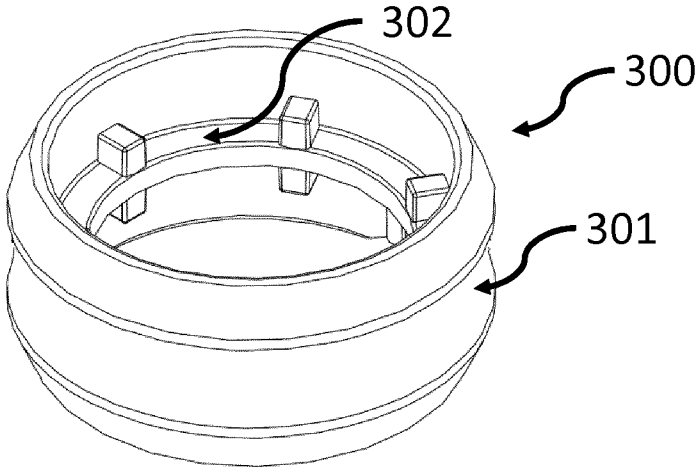


Fig. 6a

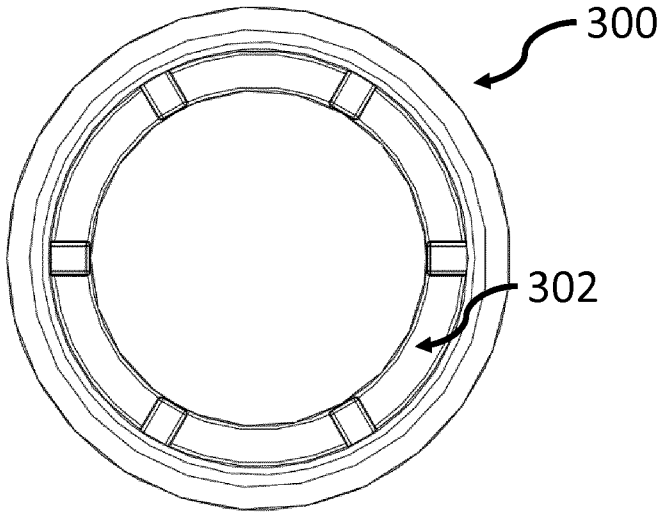


Fig. 6b

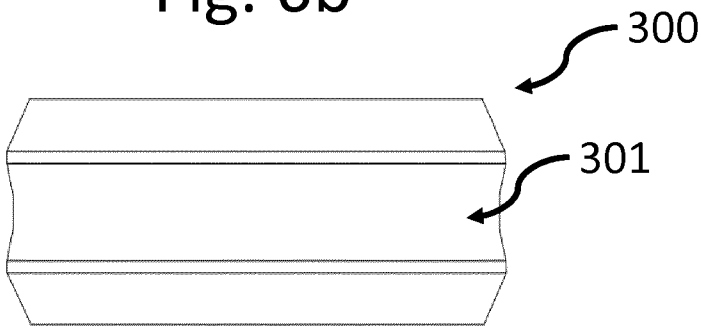


Fig. 6c

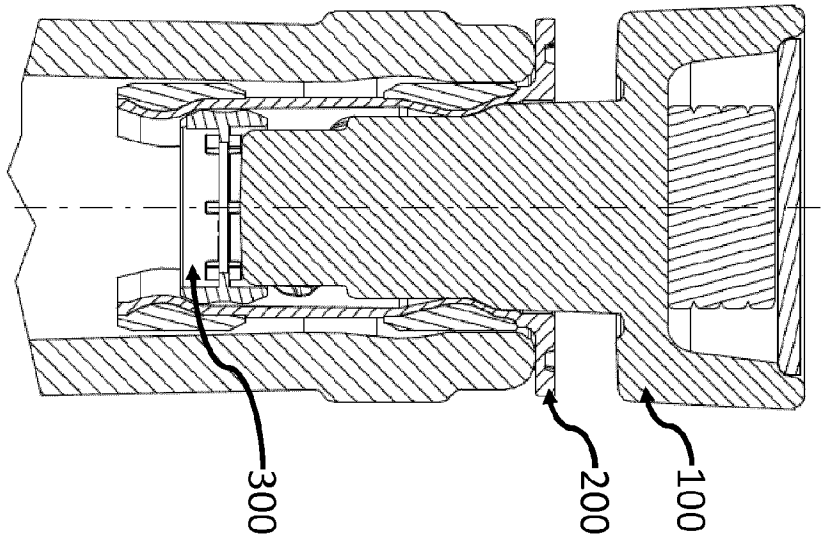


Fig. 7a

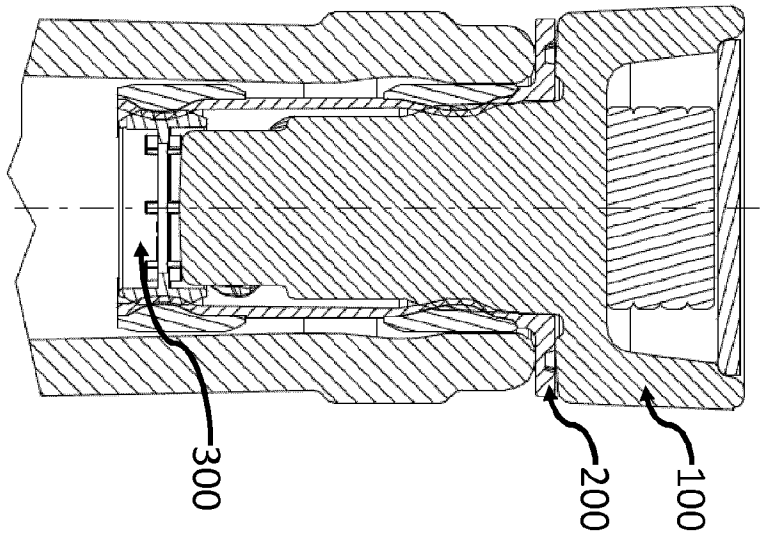


Fig. 7b

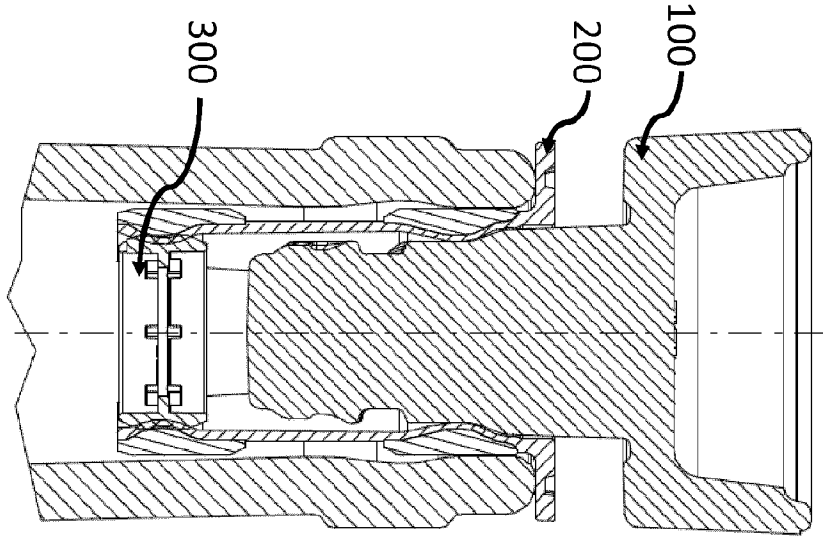


Fig. 7c

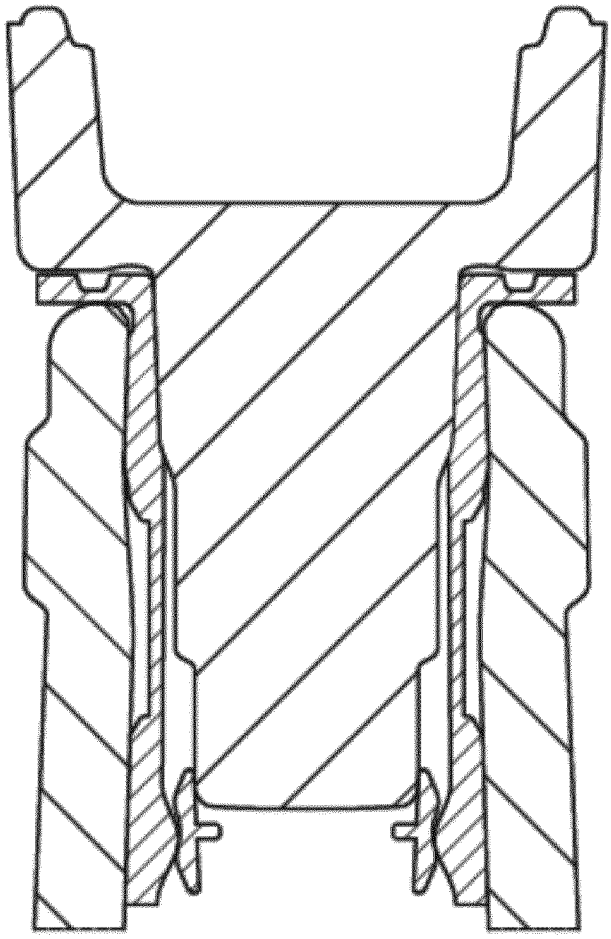


Fig. 8

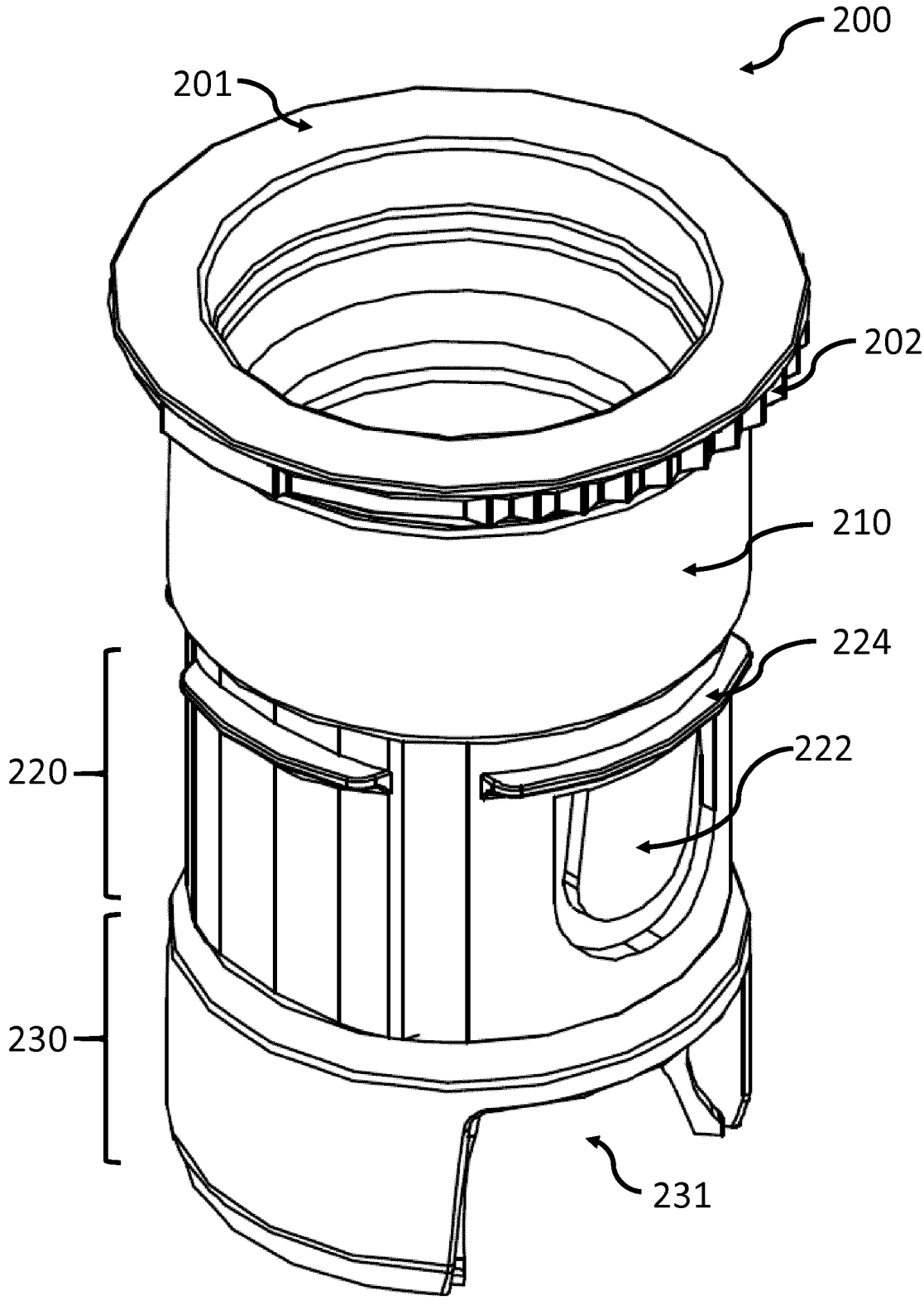


Fig. 9

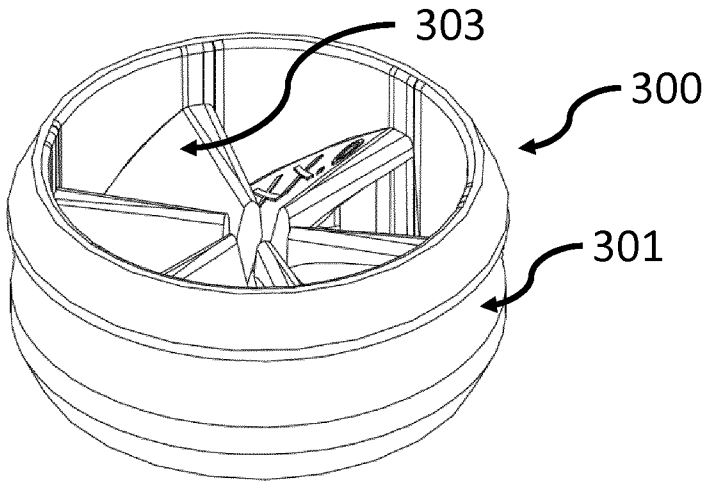


Fig. 10a

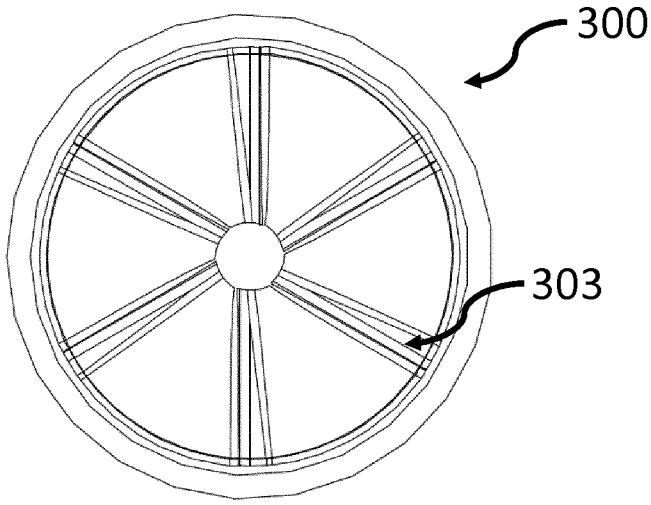


Fig. 10b

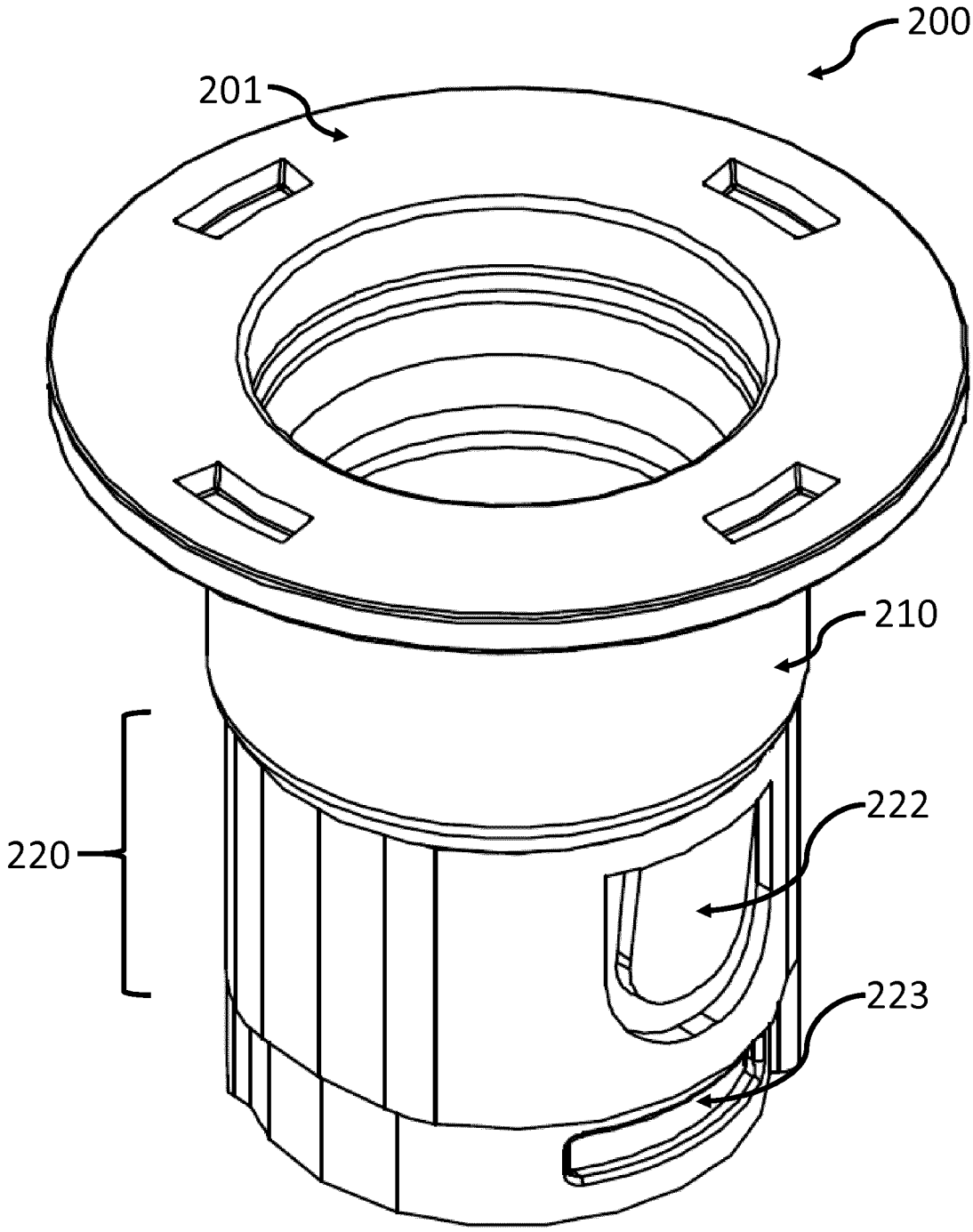


Fig. 11

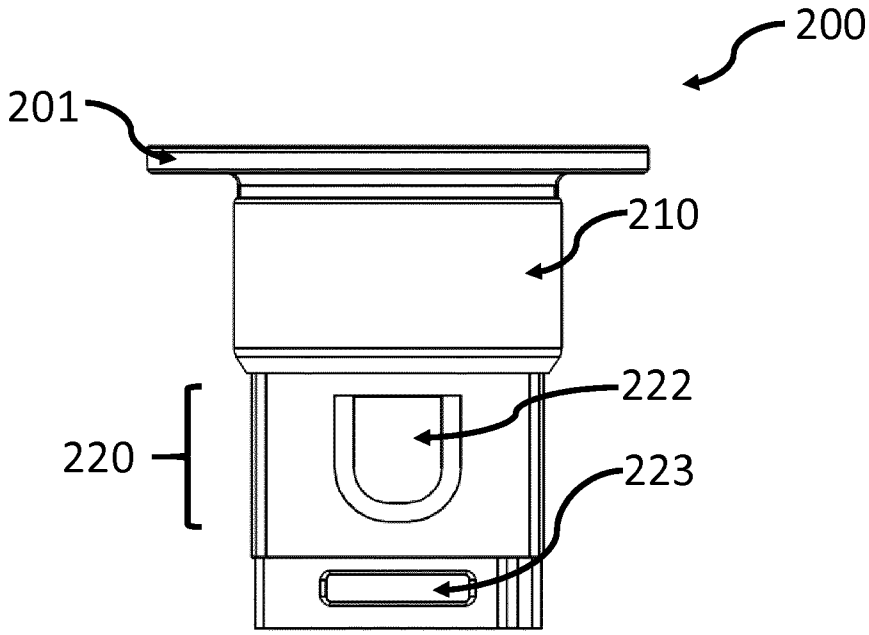


Fig. 12a

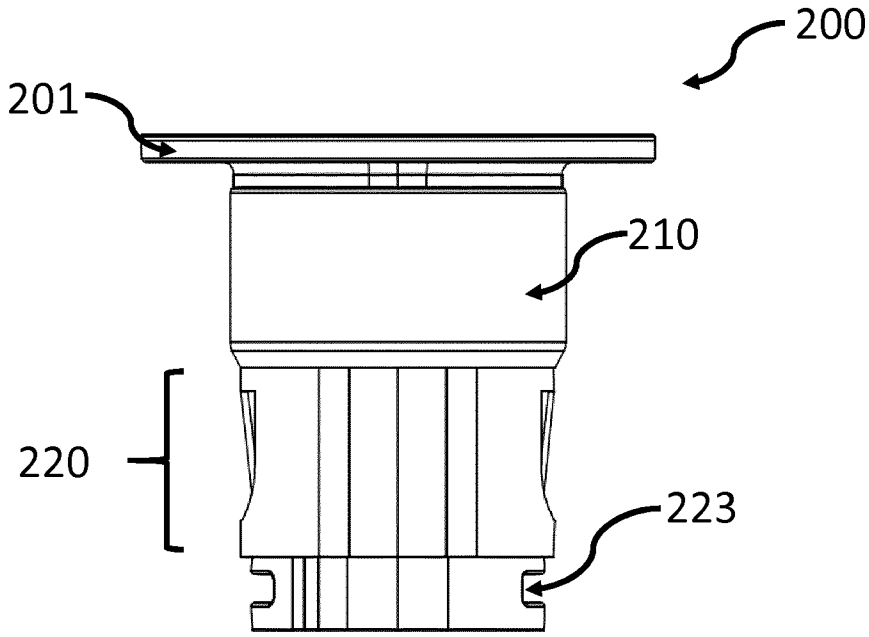


Fig. 12b

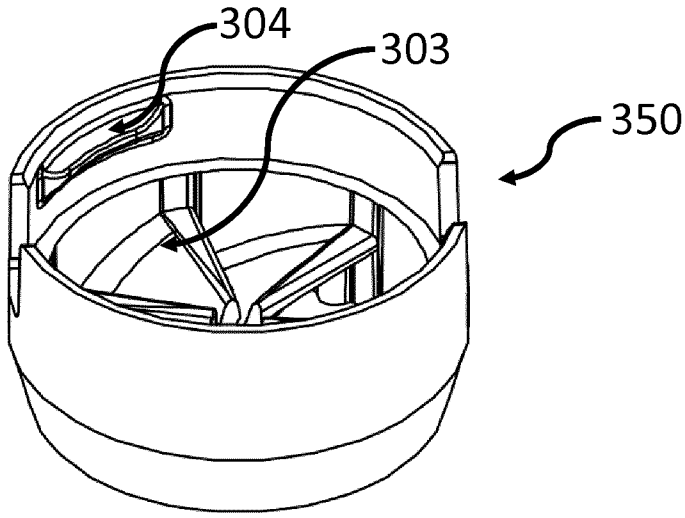


Fig. 13a

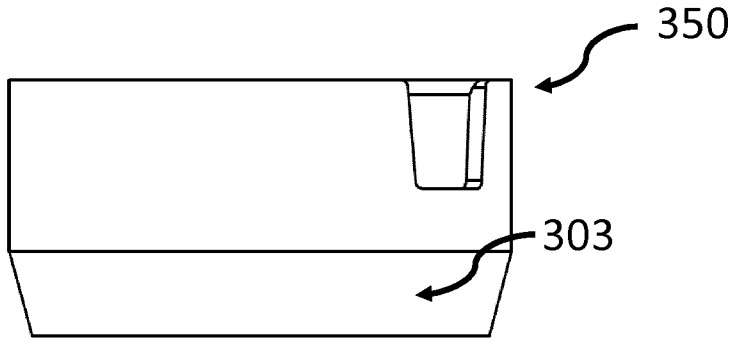


Fig. 13b

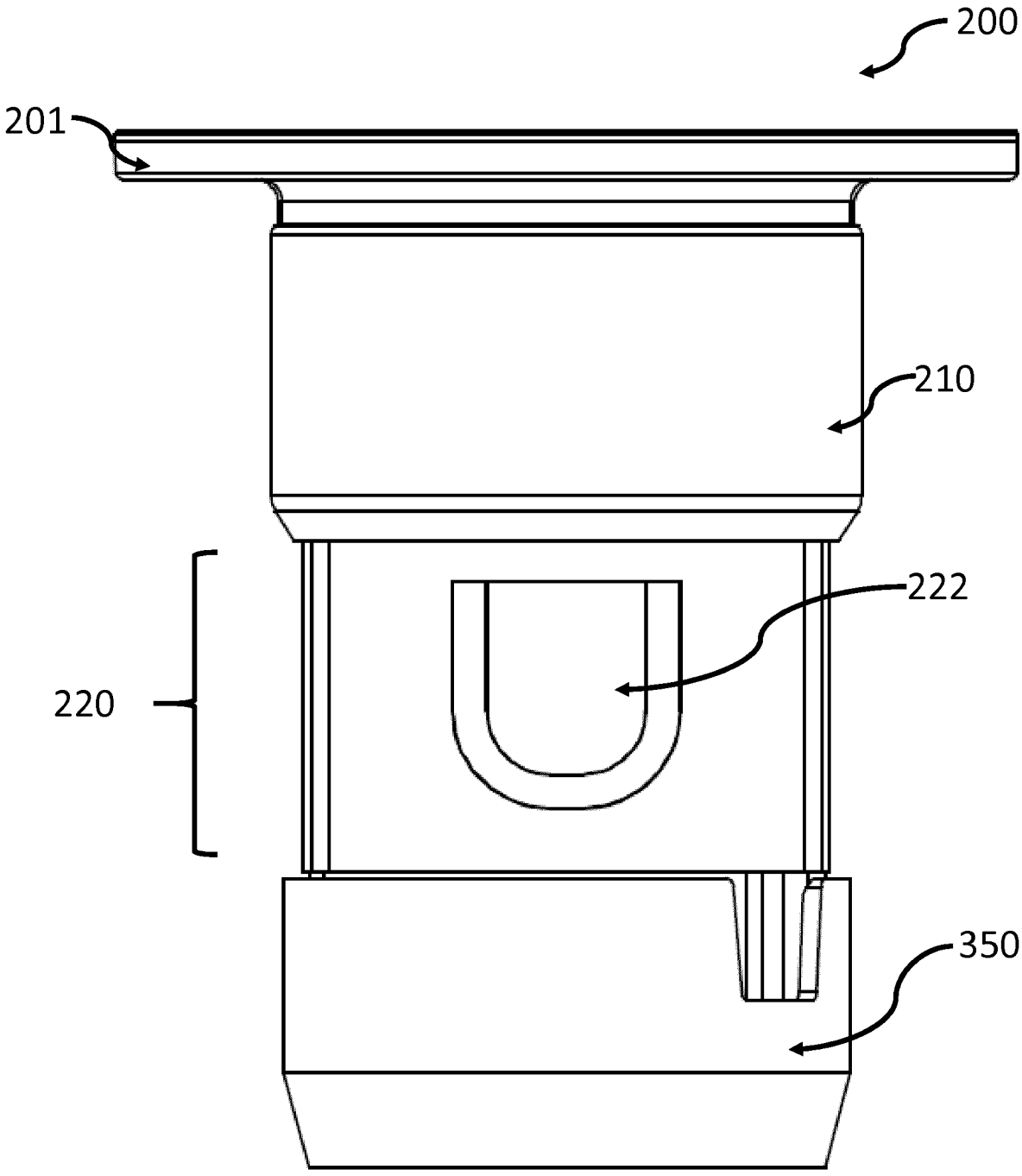


Fig. 14

Fig. 15a

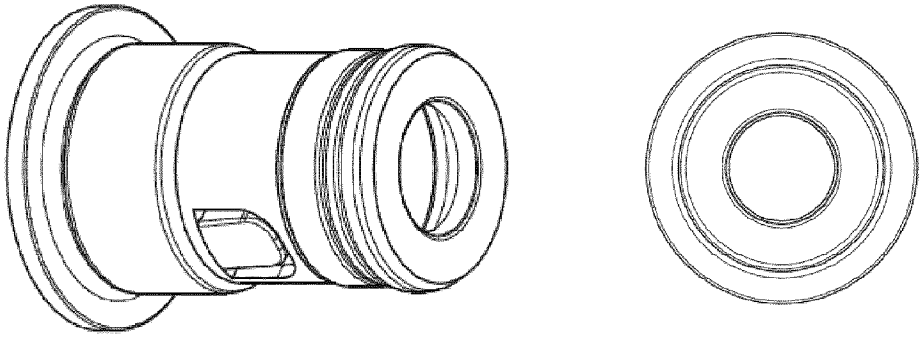


Fig. 15b

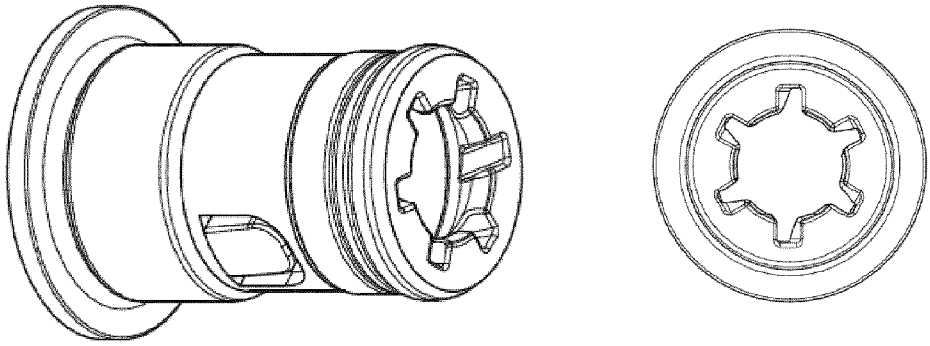


Fig. 15c

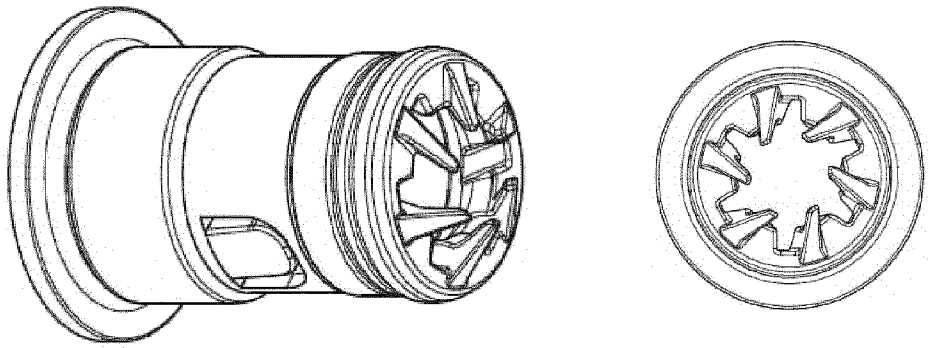
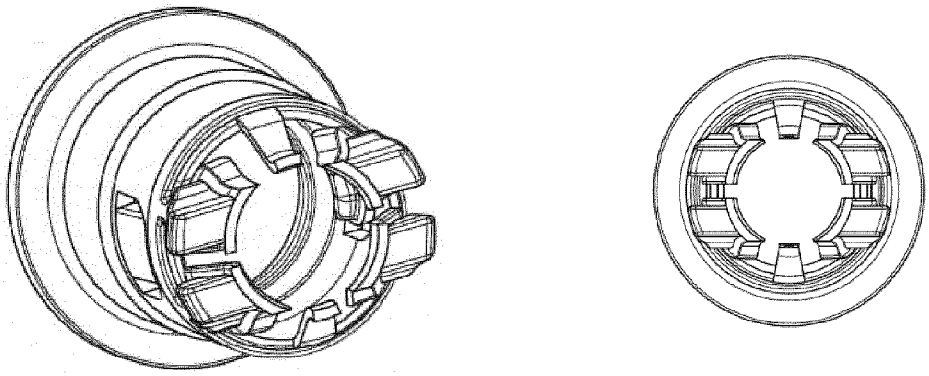
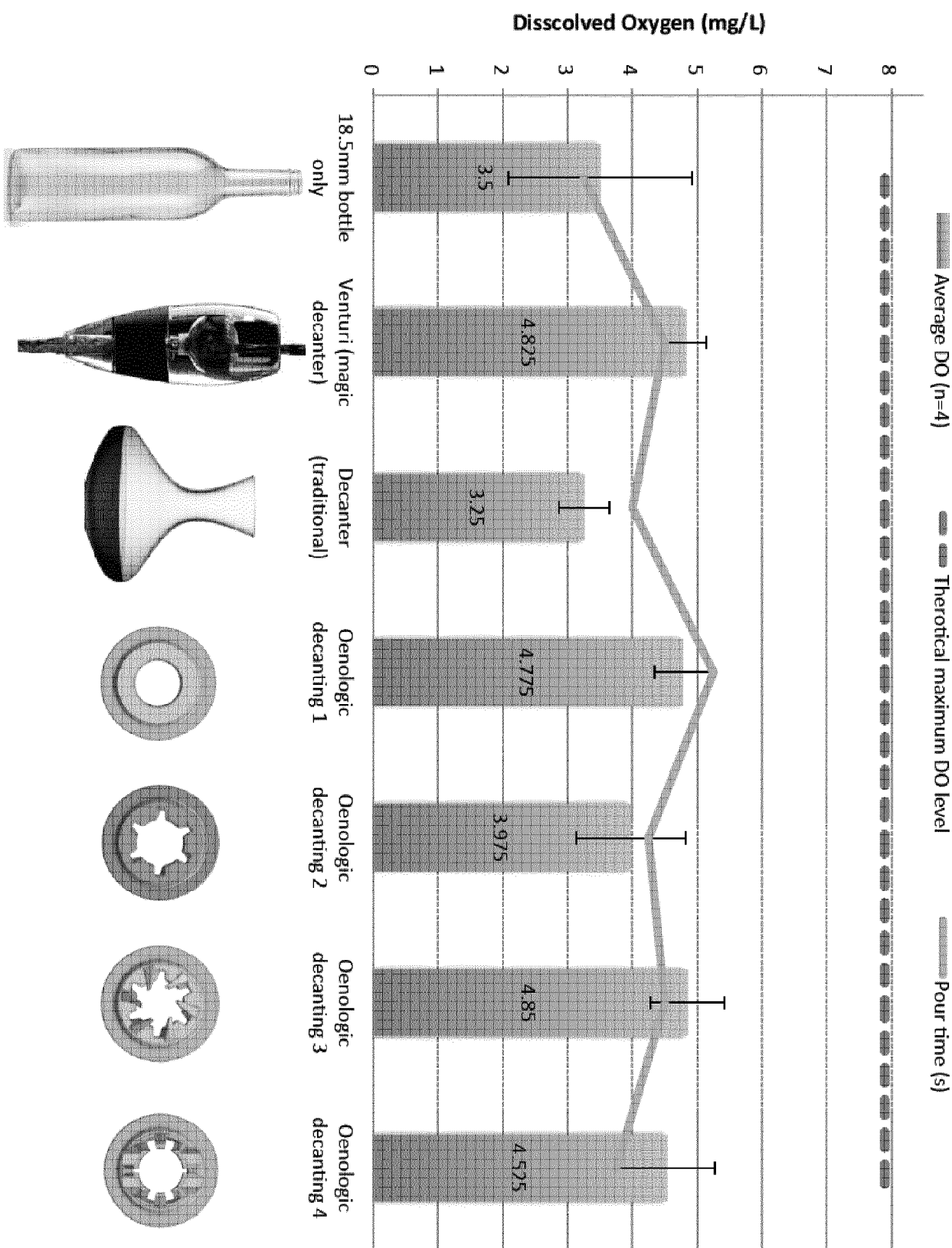


Fig. 15d

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Pour time (seconds)
Average DO (n=4)
Therotical maximum DO level
Pour time (s)
3.5
4.825
3.25
4.775
3.975
4.85
4.525
18.5mm bottle only
Venturi (magic decanter)
Decanter (traditional)
Oenologic decanting 1
Oenologic decanting 2
Oenologic decanting 3
Oenologic decanting 4

Fig. 16

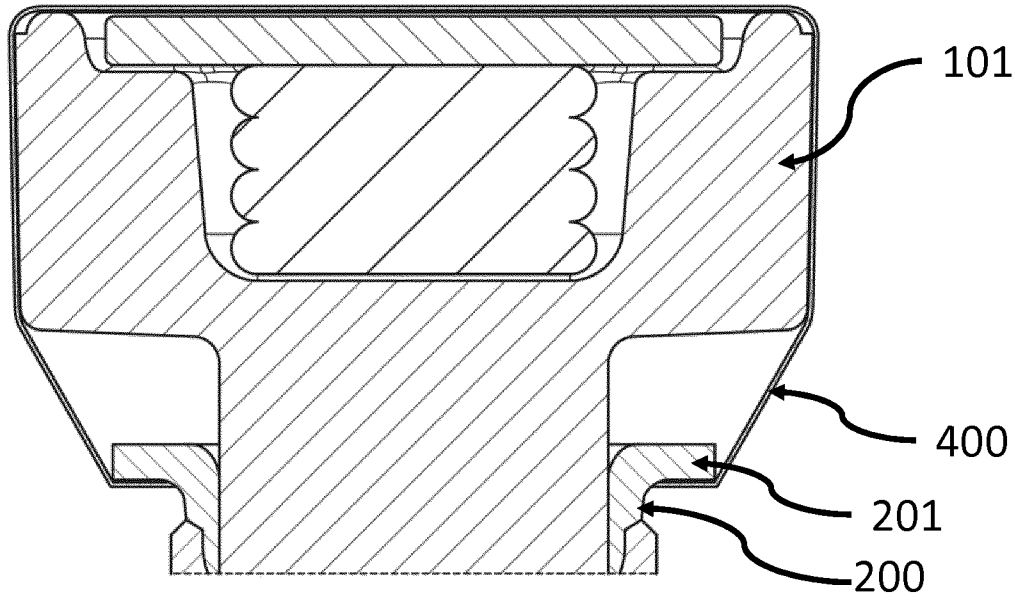

Fig. 17a

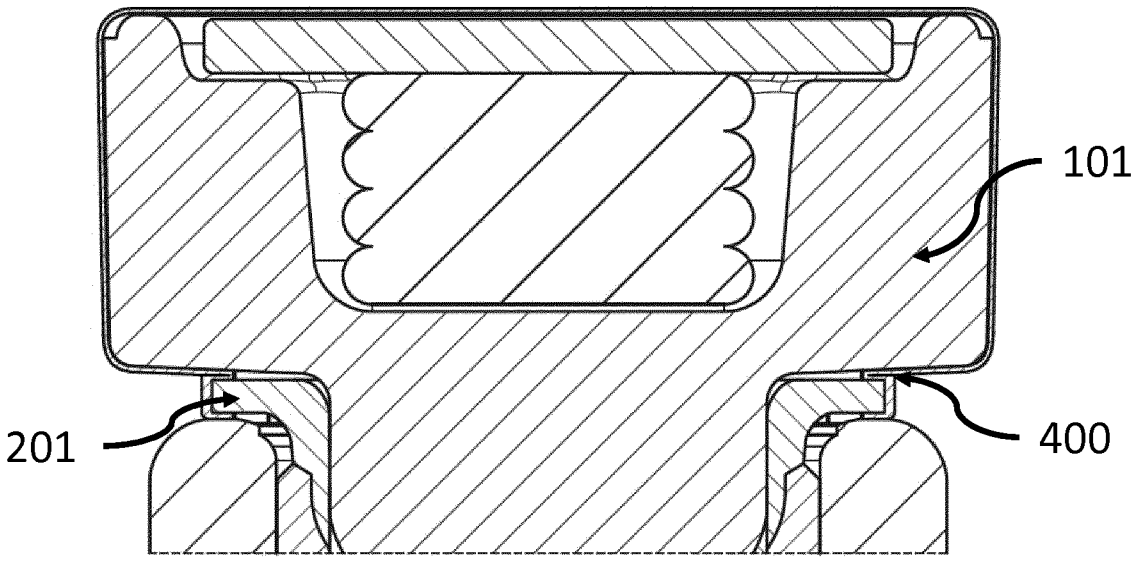

Fig. 17b

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2016/060621

A. CLASSIFICATION OF SUBJECT MATTER
INV. B65D39/12 B65D47/12
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B65D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 2 492 208 A1 (AGARKOV ANDREY VYACHESLAVOVICH [RU]) 29 August 2012 (2012-08-29) paragraphs [0025] - [0041]; figure 6	1,4
A	EP 2 692 657 A1 (QUIDING NV [CH]) 5 February 2014 (2014-02-05) cited in the application figures	1,10,14
X	US 3 638 821 A (GUALA PIERGIACOMO) 1 February 1972 (1972-02-01)	10,14
A	column 1, line 54 - column 2, line 68; figures	1
A	DE 20 2009 001032 U1 (KRAUS WILLIBALD [DE]) 28 May 2009 (2009-05-28) figures	1

-/--

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
29 August 2016	06/09/2016

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Fournier, Jacques

2

Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2016/060621

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	GB 2 280 895 A (VICTORY MALCOLM GORDON [GB]) 15 February 1995 (1995-02-15) figures	1
A	US 2003/062331 A1 (LIN SEN-YIH [TW]) 3 April 2003 (2003-04-03) figures	1
A	US 3 245 569 A (HELMUT ESSICH) 12 April 1966 (1966-04-12) figures	1

2

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2016/060621

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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