

The invention relates to a closure device as described in the introductory clause of Claims 1 and 2.

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In a known closure device - in accordance with EP-A-129 029 - with respect to which the independent Claim 1 is defined, an open front side of an evacuable cylindrical housing is closed by a cap encompassing this front side and by a sealing device arranged therein. The sealing device is perforable and has a sealing face which is associated with an inner bearing surface of the cylindrical housing. Adjacent to this sealing face in the direction of the longitudinal axis, a coupling device is arranged between the cap and the sealing device. The coupling parts of this coupling device are formed by a flange-like locking extension, projecting radially outwards over the sealing face and by two extensions. These extensions are arranged at a distance from a front wall of the cap, arranged on the side of the sealing device lying opposite the evacuable cylindrical housing. The front wall of the cap is provided with a perforation opening for the needle for puncturing into the sealing device. Thereby, between the front wall of the cap and the sealing device, a receiving chamber is created for fluids emerging from the sealing device.

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In this closure device, the inserting of the sealing device into the evacuated cylindrical housing is only possible with difficulty without damaging the sealing face.

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Another known closure device according to EP-A- 102 851, with respect to which the independent Claim 2 is defined, describes a closure device for a cylindrical housing, which has a closed end and an open front side lying opposite thereto. The open front side can be closed a cap surrounding it. In a front wall, the cap has a bore, in which a perforable sealing device is arranged. The sealing device is provided with a surrounding flange-like extension, which projects over the surrounding sealing face in the region of a front face of the cylindrical housing approximately by the wall thickness of the housing. With this flange-like extension, the sealing device is supported on a projection of the cap. A disadvantage is that on inserting the sealing device into the cylindrical housing or respectively on withdrawing the needle used for filling the housing or respectively for drawing off fluids from the housing, the sealing device can be drawn out of the cap.

In addition, a closure device is known for a cylindrical housing, in particular a blood

sample tube - in accordance with AT-B-379 069 and EP-A-0 150 172 of the same applicant - which is formed by a cap encompassing an open front side of the cylindrical housing. A bore is arranged in the cap and between the latter and an interior space of the cylindrical housing a sealing device is provided. In the bore or respectively in a tubular extension adjoining thereto, projections protruding over the surface of the cap are provided, which are covered by the sealing device. Depending on the power of adhesion between the sealing device and the cylindrical housing, an opening of the closure device without an escape of medicine or body fluids contained therein can not always be ensured.

In addition, a plurality of closure devices for cylindrical housings, in particular to keep medicine or body fluids, have become known, in which caps in one piece or in several parts were used with sealing devices. Thus it is known to close the open front sides of the cylindrical housing with plug-like sealing devices, which in turn are secured in these encompassing caps, such as, for example, in accordance with US -B- 4,465,200 and 4, 205,754 and 4,089,432, and EP-A- 257 498. A disadvantage in these closure devices is that in part very strong forces must be applied in the longitudinal direction of the cylindrical housing in order to overcome the powers of adhesion between the sealing device and the cylindrical housing, so that escapes of medicine or respectively body fluids stored in these cylindrical housings, and hence burns or respectively infections can occur again and again, especially in the processing of blood infected with Aids. It is also a disadvantage in these closure devices that on piercing the sealing device with a needle for the removal of the contents, an unintentional opening of the closure device may occur.

The object of the present invention is to create a closure device for a cylindrical housing, in particular a blood sample tube, with which a secure, gas-tight closure of the interior space of such a cylindrical housing can be maintained even over a lengthy period of storage, and which, on the one hand is to effectively prevent a relative movement between the closure device and the cylindrical housing in longitudinal direction thereof and to make possible a careful opening. Furthermore, an escape of the contents from the cylindrical housing in a sudden burst is also to be prevented.

This object of the invention is solved by the features in the characterizing clause of Claim 1. The surprising advantage of this arrangement lies in that a clear motional connection can be achieved between the sealing device and the cap in both directions of movement, i.e. both, on inserting the sealing device into the cylindrical housing and

also on withdrawal therefrom. Additionally, a fixed coupling is likewise created between the sealing device and the cap, which on piercing, i.e. on piercing a needle in to fill the housing or to remove the contents from the housing, or respectively also on withdrawing this needle from the sealing device, rules out an unintentional detaching of the sealing device from the cap. In addition to this, through this design of the coupling device on inserting the sealing device into the cap, the risk of damage to the sealing faces, and a subsequent permeability or reduced vacuum tightness of the sealing device, along with this, is ruled out. The surprising advantage of this solution, however, lies in that the sealing device can be inserted into the cap from any desired side. However, this also makes possible a more simple, fully automatic production of such closure devices in the course of a manufacturing or assembly process which runs fully automatically.

Another embodiment of a closure device is also advantageous, as described in the introductory clause of Claim 2.

This embodiment is characterized by the features in the characterizing clause of Claim 2. Through this solution, it is achieved in a surprisingly simple manner, that the opening process at least at the beginning and end, has a considerable component in peripheral direction, whereby a looping or spiral-shaped opening process is brought about, and hence a jerky withdrawal of the sealing device out of the cap is prevented. Through a jerky emergence of the sealing device out of the cylindrical housing being prevented, the risk is reduced of the contents, such as a medicine or blood, spurting out on opening the cylindrical housing.

Another embodiment variant is described by Claim 3. Through the sealing device being compressed more intensely in the region of the ribs on insertion into the tubular insert, a better bracing of the sealing device in the tubular projection results, and a clutching of the ribs in the surface of the sealing device, so that the latter is carried along without difficulty in the direction of the longitudinal axis of the cap. Through the longitudinal corrugation on the inner surface of the tubular projection, formed by the ribs, however, an entrainment of the sealing device in circumferential direction is also improved, because the projecting ribs act in the manner of teeth and hence via these teeth reliably entrain the sealing device on rotations of the cap in circumferential direction.

Another further development is characterized in Claim 4, whereby the sharp-edged

ends act in the manner of barbs and thereby also in the case of high tractive forces a problem-free entrainment of the sealing device with the cap is ensured.

5 An embodiment according to Claim 5 is also advantageous, because thereby the position of the sealing device can be maintained exactly not only, for example, on withdrawal of the cap but also on pressing in and closing the cylindrical housing.

10 Another embodiment variant is characterized in Claim 6, whereby the ribs, especially on withdrawal of the sealing device out of the cylindrical housing, clutch particularly well therein and thereby a reliable removal from the cylindrical housing is achieved.

15 An embodiment according to Claim 7 is also advantageous, because for such sealing devices, experience with regard to medicine and compatibility of body fluid has already been present for many years and moreover, corresponding experience with regard to dimensioning is available, in order on the one hand to achieve gas-tightness and on the other hand to make possible a piercing with hollow needles.

20 A further development according to Claim 8 is also possible. Thereby it is ensured that the high level of gas-tightness, which can be achieved with the closure devices constructed according to the invention, can also be ensured in the remaining area of the cylindrical housing, so that in all a long storage period of such cylindrical housings, evacuated or filled with medicine or body fluids, is possible.

25 A further embodiment is described in Claim 9. Thereby, the sealing device of the closure device can withstand an axial load, such as occurs on piercing with a needle which has a larger diameter. Furthermore, the fluid which is stored in the capillary tube can also be removed from the capillary tube, e.g. can be sucked out, without the closure device having to be opened.

30 Another embodiment variant is provided in accordance with Claim 10. Through the coupling parts arranged at a distance on the circumference, the mounting of the sealing device in the cap is facilitated. This embodiment is particularly advantageous where automated assembly methods are used for closing the cylindrical housing.

35 However, an embodiment according to Claim 11 is also possible. Through the spaced arrangement of the coupling parts, distributed on the circumference, a reliable motional connection of the sealing device in the closure device is achieved.

An embodiment according to Claim 12 is also advantageous. Thereby, in a surprisingly simple manner, a connection of the sealing device in the cap is achieved, which is secure with regard to torsion.

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Another embodiment variant is characterized in Claim 13. Thereby, the joining of the sealing device and the cap 5 can be facilitated.

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A further development according to Claim 14 is also advantageous. Thereby it is possible to design the tools for the production of parts provided with such extensions in a simpler manner.

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However, a embodiment variant according to Claim 15 is also possible. Thereby, in a surprisingly simple manner, it is possible to exchange the sealing device after removal of the attachment parts which are secured in the snap device.

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A construction according to Claim 16 is also advantageous. Through the opening in the attachment part, it is, in addition, possible to pierce the sealing device with, for example, a needle for removal of the medicine or the body fluid out of the cylindrical housing.

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Another embodiment variant is described in Claim 17. The C-shaped spring ring is a surprisingly simple component for the effective mounting of the sealing device against undesired axial displacements relative to the cap. Furthermore, it makes possible the use of a hard casing arranged on the periphery of the sealing device. In this embodiment, additionally, the exchange of the sealing device is possible in a surprisingly simple manner.

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An embodiment according to Claim 18 is also advantageous. The advantage of the design of the sealing arrangement from a composite material lies in that a core region of the cylindrical sealing device can be constructed so as to be highly elastic, whereby a reliable seal also exists after the sealing device has been pierced with a needle. At the same time, through the hard casing of the sealing device, a problem-free fixing and mounting of the sealing device can be ensured between the locking extensions arranged in the cap or formed on the cap.

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A further development according to Claim 19 is also advantageous. In this embodi-

ment, with a graduated hardness between the core and the casing, the high elasticity in the core region is achieved, which makes possible the elastic closing of the sealing device after piercing. Furthermore, through the harder construction of the coupling parts, in a surprisingly simple manner, the fixing of the sealing device against the effects of forces in axial and radial direction is ensured.

Another embodiment variant is characterized in Claim 20. Thereby it is achieved in an advantageous manner that the guide extensions disengage from the grooves formed between the webs and can be turned as desired in circumferential direction, without the closure device being opened. Only through the cap being moved in longitudinal direction of the axis of the cylindrical housing away therefrom, do the webs or respectively the grooves situated therebetween, come into engagement with the guide extensions, and thereafter through further turning, the closure device can be opened. Thereby, in a simple manner, a safety closure is achieved, through which an unintentional opening of the cylindrical housing is reliably avoided.

Another embodiment is described in Claim 21. Thereby, it is possible, even when the guide extensions are not arranged immediately in the region of the front end of the cylindrical housing, for the guide extensions, in the closed state, to be able to be freely turned in circumferential direction, without an unintentional opening of the closure device occurring.

Another advantageous further development is characterized in Claim 22, whereby it is ensured in a simple manner that after the adjusting of the guide extensions, the cylindrical housing is reliably closed so as to be gas-tight or respectively opened. Hence, no further checking by the operator is required, but rather it is ensured that after closing with a free full rotation of the cap with respect to the cylindrical housing, the gas-tight closure is achieved.

Another embodiment is characterized in Claim 23, whereby the path of the webs and the opening movement can be matched simply to the type of sealing faces or respectively sealing devices which are used, for example O-rings, stoppers or caps or the like.

Another further development is provided according to Claim 24, because thereby jamming on opening and closing can be prevented between the cylindrical housing and the cap.

Another embodiment is provided according to Claim 25, whereby the cap itself can be used both for sealing and also for mechanical fixing on the cylindrical housing, and the sealing device or respectively the sealing element can be matched with the sealing face running vertically to the longitudinal axis of the cylindrical housing to the additionally necessary medical requirements, such as sufficient gas-tightness even after piercing by a hollow needle or the like.

A further development according to Claim 26 is also possible, whereby both in longitudinal direction of the longitudinal axis of the cylindrical housing and also in circumferential direction, a connection, which is secure with respect to movement, is created between the sealing device and the cap. This makes it possible to loosen the cap from the cylindrical housing through a combined longitudinal and rotational movement in the manner of a spiral line. Above all, the relatively high adhesion existing after a lengthy transportation can be secured by the connection, which is secure with regard to rotation, between the cap or respectively the sealing device in the cylindrical housing through a rotation of the sealing device relative to the cylindrical housing, and thereby the removal of the cap can be made possible with less expenditure of force in the direction of the longitudinal axis of the cylindrical housing.

However, an embodiment variant according to Claim 27 is also possible. This solution has the advantage that the cap usually consists of plastic which is mechanically more resistant or respectively more capable of carrying a load, so that in this embodiment, higher torsional and tractive forces can be transferred reliably to the sealing device. The lower loading capacity of the mostly elastic sealing device with respect to traction or pressure can be balanced out here in that the transfer faces between the carrier and the sealing device are produced with a correspondingly larger cross-section.

Another embodiment variant is provided according to Claim 28. It is possible thereby that a single sealing device, which has both the circumferential sealing face and also at the same time the sealing face running vertically to the longitudinal axis, is enough to get by with. Through the tubular extension, it is, moreover, possible to produce a desired pre-stressing or respectively surface pressure between the circumferential sealing face and the inner surface of the cylindrical housing, when an external diameter of the sealing device is greater than an internal diameter of the cylindrical housing. Through the strength of the tubular extension or respectively its elasticity, the contact pressure can be established in radial direction between the sealing device and the inner surface of the cylindrical housing and can be maintained over a longer period even when the

material of the sealing device shrinks due to the higher elasticity.

5 A further development according to Claim 29 is also advantageous, because the adhesion forces which may bring about an adhesion of the sealing face to the inner surface of the cylindrical housing, are smaller owing to the smaller contact surface. Nevertheless, a very good seal can also be achieved against gas leakage.

10 In addition, an embodiment according to Claim 30 is also possible, whereby the gas-tightness can be matched to the respective requirements and can be brought about with minimal extra expenditure.

However, a further development according to Claim 31 is also possible, whereby a simple construction of the cap and also of the sealing device is achieved.

15 An embodiment variant according to Claim 32 is also possible, whereby a sufficient bearing of the tubular projection on the inner surface of the cylindrical housing and hence, a sufficient seal, both against the leakage of fluid and also the leakage or respectively entry of gases is achieved.

20 An embodiment variant according to Claim 33 is also advantageous, whereby by means of a predetermined difference, the bearing pressure of the sealing faces against the inner surfaces of the cylindrical housing can be established in a simple manner. Through this bearing pressure, however, at the same time the desired gas- and fluid-tightness can also be ensured.

25 However, an embodiment according to Claim 34 is also possible. Through the elastic adjustability of the locking extensions, which are constructed in the manner of detent pawls, in a surprisingly simple manner, sealing devices can also be used which consist for example of composite materials with a highly elastic core and a resistant annular casing.

30 A further development according to Claim 35 is also advantageous, whereby no additional parts are required for the mounting of the sealing device in the cap. The cap can therefore be produced at a favourable cost in a single process, e.g. by injection moulding in multiple arrangement in jet moulds.

Another embodiment variant is characterized in Claim 36. Thereby, the elasticity of

the finger-like extensions can be matched simply to requirements specific to usage through the selection of the elastic force of the metal springs.

For a better understanding of the invention, it is explained hereinafter in further detail
5 by means of the example embodiments illustrated in the drawings, in which:

Fig. 1 shows a closure device, constructed in accordance with the invention according to Claim 2, of a cylindrical housing with coupling devices constructed according to the invention, arranged between the cap and the sealing device and the cylindrical housing, as an exploded drawing in side view, in section;
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Fig. 2 shows the closure device according to Fig. 1, in top view, in section, along the lines II - II in Fig. 1;
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Fig. 3 shows another embodiment variant of a coupling device between the cap and a sealing device with reference to a closure device in accordance with the invention according to Claim 2, in side view, in section;

20 Fig. 4 shows a further design of a closure device according to Claim 2, in side view, in section, with a coupling device constructed according to the invention between the cap and the sealing device;

Fig. 5 shows a further embodiment variant of a closure device constructed in accordance with the invention according to Claim 2, with a coupling device between the cap and the sealing device, in side view, in section;
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Fig. 6 shows a further embodiment of a closure device in accordance with the invention according to Claim 2, in side view, in section;

30 Fig. 7 shows a closure device constructed in accordance with the invention according to Claim 2, with a coupling device between the cap and the cylindrical housing, with cap lifted from the cylindrical housing, in diagrammatic representation, partly sectioned;

35 Fig. 8 shows an embodiment of a coupling device in accordance with the invention, between a cap and a cylindrical housing, according to Claim 2, in side view, in section;

- Fig. 9 shows the coupling device in top view, in section, along the lines IX - IX in Fig. 8;
- 5 Fig. 10 shows another embodiment of the coupling device in accordance with the invention according to Claim 2, having webs running with different pitch, in side view, in section;
- 10 Fig. 11 shows another embodiment variant of a closure device constructed in accordance with the invention according to Claim 2, having the coupling device allocated to it between the cap and the cylindrical housing, in side view, in section;
- Fig. 12 shows another construction of a closure device in accordance with the invention according to Claim 2, having a coupling device between the cap and the sealing device and the cylindrical housing, in side view, in section;
- 15 Fig. 13 shows another embodiment of a closure device in accordance with the invention according to Claim 2;
- Fig. 14 shows a construction of a closure device according to Claims 1 and 2, having a coupling device constructed in accordance with the invention between the cap and the sealing device, in side view, in section;
- 20 Fig. 15 shows a further embodiment variant of a closure device constructed in accordance with the invention according to Claims 1 and 2 with a coupling device between the cap and the sealing device, in side view, in section;
- 25 Fig. 16 shows the closure device according to Fig. 15, in top view;
- Fig. 17 shows a closure device constructed in accordance with the invention according to Claim 1 with a coupling device between the cap and the sealing device, in diagrammatic representation;
- 30 Fig. 18 shows the closure device according to Fig. 17, in side view, in section;
- Fig. 19 shows a further embodiment variant of a closure device in accordance with the invention according to Claim 1, having a coupling device, in side view, in section;
- 35 Fig. 20 shows a further embodiment variant of a closure device according to Claim 1 with

an attachment, in side view, in section.

Fig. 1 shows a closure device 1 for closing an open front side 2 of a cylindrical housing 3. This cylindrical housing 3 can be used, for example, as a blood-sample tube 4. To close the open front side 2 the closure device 1 consists of a cap 5, encompassing this open front side 2, and a sealing device 6. The cap 5 is provided with a bore 8 running concentrically to a longitudinal axis 7. Joining on to this in this exemplary embodiment is a tubular extension 9 which extends from a front wall 10 in the direction of an open front end 11 of the cap 5 and thus parallel to a cap shell 12.

A coupling device 13 between the cap 5 and the sealing device 6 consists of a tubular extension 9, a groove 14 arranged in the sealing device and also locking extensions 16 arranged on an inner surface 15 of the tubular extension 9. In this exemplary embodiment, the sealing device 6 is designed as a sealing cap 17 and has a circumferential sealing face 18 and a sealing face 20 running perpendicularly to the longitudinal axis 7 of the cap 5 and also to a longitudinal axis 19 of the cylindrical housing 3. The circumferential sealing face 18 is associated with a bearing surface 21 in the interior of the cylindrical housing 3. Furthermore, this cylindrical housing 3 is provided with guide extensions 22, 23 which protrude on the periphery beyond a surface 24 of the cylindrical housing 3, and are arranged in the region of the open front side 2 of the same. These guide extensions 22, 23 together with webs 25, 26 are arranged on an inner side 27 of the cap shell 12 and run spirally. They form a coupling device 28 between the cap 5 and the cylindrical housing 3.

Fig. 2 shows that the guide extensions 22, 23 are arranged so as to be distributed over the periphery of the cylindrical housing 3 approximately by an angle 29 of about 180°. The webs 25 and 26 extend over an opening angle 30, which is less than 180°. Before the cylindrical housing 3 is closed with the closure device 1, the sealing device 6 is inserted into the cap 5. To this end, the sealing cap 17 is pushed onto the extension 9, so that the latter penetrates the groove 14. When being pushed onto the extension 9, the sealing cap 17 is deformed when pushed over the locking extensions 16 which are constructed as ribs 31. As can be seen, these ribs 31, on their end facing the front wall 10, are provided with front faces 32 running approximately perpendicularly to the longitudinal axis 7. Consequently, the sealing cap 17, which can be formed, for example, of rubber, in particular bromobutyl rubber, silicone rubber, thermoplastic rubber or the like, slips over the sharp-edged front faces 32 when being pushed in, and in the process the locking extensions 16 fasten like barbs in the sealing cap 17. This ensures that, under high tensile forces exerted via the cap 5, the sealing cap 17, even if it is held by high adhesion forces

between the sealing face 18 and the bearing surface 21 in the cylindrical housing 3, can be pulled out of the latter without being detached from the cap 5. Furthermore, as can be seen better from Fig. 2, the sealing cap 17 is deformed like a toothed wheel by the ribs 31 arranged so as to be distributed over the periphery of the inner surface 15. Consequently, relatively high torsional forces can also be transmitted with the cap 5 to the sealing cap 17, without the latter rotating relative to the cap 5. This construction of the coupling device 13 makes it now possible, even if a sealing cap 17 adheres firmly to the bearing surface 21 during insertion, owing to residues of medicines or body fluids, that said sealing cap is released from the cylindrical housing 3 by a combined rotational and longitudinal movement in the direction of the longitudinal axis 19.

In order to facilitate this opening movement, the closure device 1 also has a further coupling device 28, which, however, need not necessarily be arranged in conjunction with the illustrated embodiment of the cap 5. The function of this coupling device 28 is such that the webs 25, 26 run onto the guide extensions 22, 23 when the cap 5 is pushed in the direction of the longitudinal axes 7 and 19 onto the open front side of the cylindrical housing 3 while being appropriately turned clockwise. The cap is then pushed onto the cylindrical housing 3 by the combined rotational and longitudinal movement on account of the guidance of the webs 25, 26 along the guide extensions 22 and 23. This displacement movement is continued until the guide extensions 22, 23 are displaced from a lower transverse plane 33, in which, in each case, a start 34 of the webs 25, 26 is located, into the region of an upper transverse plane 35 in which the ends 36 of the webs 25 or 26 respectively are located.

The cap 5 is opened or pulled off the cylindrical housing 3 in exactly the opposite manner, and in fact the webs 25 and 26 are removed from a closed end 37 of the cylindrical housing 3 by lifting the cap 5, so that the guide extensions 23 and 22 now no longer rest on an upper side 38 of the webs 25, 26, but these webs, with an underside 39, rest on the guide extensions 22, 23. By further turning of the cap 5 anti-clockwise - arrow 40 - the cap 5 is now pulled off the cylindrical housing 3 by a combined rotational and pressure movement. This combined rotational and pressure movement has the effect that the sealing face 18 is not pulled off the bearing surface 21 at exactly the same time, but rather obliquely, so that the cross-section of the front side 2 of the cylindrical housing 3 is not released suddenly but in a sliding manner. A negative or positive pressure contained in the cylindrical housing is thus discharged gradually at the start in the course of the opening movement so that spurting out of medicines or body fluids can be held back as far as possible. Furthermore, the guidance of the cap 5 in a direction perpendicularly or transversely to the longitudinal axis 7 or respectively 19 prevents, even for a large opening force, that the latter can be applied only parallel to the longitudinal axes 7, 19 when the

sealing face 18 separates from the bearing surface 21, so that the risk of sudden separation of these two surfaces is reduced. In the known closure devices this sudden separation comes about in particular when the tensile force exerted on the cap 5 has been so high that the negative pressure contained in the cylindrical housing has been overcome suddenly or respectively the adhesion forces present, have been exceeded. This can result in an instantaneous relative movement between cap and cylindrical housing, which usually leads to the contents of the cylindrical housing spurting out.

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10 The cylindrical housing 3 can be made of glass or an appropriate plastic, for example polyethylene terephthalate or its co-polymers. To obtain an adequate gas-tightness of this cylindrical housing, it is also possible, inter alia, to apply to the outer surface 24 a gas-barrier layer 41, which can be formed for example, from a polyvinylidene chloride. This gas-barrier layer is to be applied to the cylindrical housing 3 in the direction towards the open front side to such an extent that the bearing surface 21 or respectively sealing face 18 and this gas-barrier layer 41 overlap. By the sealing cap 1, in this exemplary embodiment, being formed in one piece and comprising the circumferential sealing face 18 and the perpendicular sealing face 20, this sealing cap at the same time also forms the gas-barrier layer for an inner space 42 of the cylindrical housing 3.

20 To enable the cap 5 to be fully turned freely after it has been firmly mounted onto the cylindrical housing 3, a distance 43 between the front wall 10 and the transverse plane 35 nearer to it, is made larger than a length 44 of the guide extensions 22, 23 parallel to the longitudinal axis 19 of the cylindrical housing 3.

25 As can be further seen from the diagrammatic representation, in particular in Fig. 1, a thickness 45 of the annular ring of the sealing cap 17 located between the groove 14 and the sealing face 18 is greater than half the difference between an outside diameter 46 of the extension 9 and an inner diameter 47 of the cylindrical housing 3. Since an outside diameter of the groove 14 essentially corresponds to the outside diameter 46 of the extension 9, the sealing cap 17 cannot give way to the inside when the sealing cap 17 is pressed into the cylindrical housing 3. The oversize of the sealing cap 17 resulting from the greater thickness 45 therefore must be accommodated by an elastic deformation of the sealing cap 17, as a result of which a correspondingly high surface pressure is built up between the sealing face 18 and the bearing surface 21, which also makes possible a gas-tight closure of the inner space 42 over a lengthy period of time.

35 Fig. 3 shows an embodiment variant of the coupling device 13 in which coupling openings 48 are arranged in a cap 5 for closing a cylindrical housing 3. Engaging into these coupling openings

nings 48 are coupling arms 49, which protrude upwards above the sealing device 6. The coupling openings 48, like the coupling arms 49 on the sealing device 6, are arranged so as to be distributed at the same angular distance over the periphery of the cap 5. When the sealing device 6 is released, a distance 50 between the sealing face 18 and the inner side 27 of the cap 5 is smaller than a wall thickness 51 of the cylindrical housing 3. When the cap 5 is pushed onto the cylindrical housing 3, the sealing device 6, as shown in solid lines, is thereby compressed and deformed so that a gas-tight closure is produced between the inner space 42 and the surrounding air. As shown further schematically, the sealing face 18 of the sealing device 6 can be provided with longitudinal slots 52. The latter have the effect that air can already enter through the longitudinal slots 52 into the interior space 42 and a pressure compensation takes place before the sealing device 6 comes out of the cylindrical housing. If the sealing device 6 is then pulled completely out of the cylindrical housing, the medicine or the body fluid does not spurt out.

This arrangement of the longitudinal slots 52 can of course be used in all other exemplary embodiments and sealing devices shown in connection with the present description and is not bound to the embodiment illustrated.

By the use of the coupling arms 49 engaged into the coupling openings 48, the sealing device 6 is firmly connected to the cap 5 both in the direction parallel to the longitudinal axis 7 of the cap 5 and also in the peripheral direction.

Even with combined rotational and pulling movements, an exact motional connection between the cap 5 and the sealing device 6 is achieved and the opening or respectively removal of the closure device 1 is thereby facilitated.

Fig. 4 shows an embodiment variant in which the cylindrical housing 3 is again sealed by the interaction between the cap 5 and the sealing device 6. In this case, the cap 5 is provided with a tubular extension 9, as already shown, for example with reference to the representations in Figs. 1 and 2. The sealing device 6 is pushed over the tubular extension 9 and is designed approximately like a sealing cap 17. Furthermore, the coupling device 13, between the cap 5 and the sealing device 6, comprises locking extensions 16 which are designed like barbs 53. Specifically, they essentially consist of points which are directed towards the front wall 10 of the cap 5 and which, when the sealing device 6 is pushed in the direction of the front wall 10 onto the tubular extension 9, bore their way into the interior of the sealing device 6 and thus, unmistakably secure the position of the sealing device 6 relative to the cap 5.

Fig. 5 shows another embodiment variant of the coupling device 13 between the cap 5 and the sealing device 6. Here, locking extensions 16 into which a coupling disk 54, the anchoring means 55 of which is injected or poured into the sealing device 6, engages, are arranged on an end of the tubular extension 9 projecting in the direction of the open front end 11 of the cap 5.

5 It is thereby possible, by pushing the coupling disk 54 onto the extension 9 and by subsequently turning it, that the coupling disk 54 is fixed in its position relative to the extension 9, both against movements in the longitudinal direction parallel to the longitudinal axis 7 and also in the peripheral direction.

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10 Fig. 6 shows an embodiment variant, in which the sealing device 6 is formed by two different sealing elements 56 and 57. The sealing elements 57 form the circumferential sealing face 18, while the sealing element 56 forms the sealing face running perpendicularly to the longitudinal axis 7. As schematically indicated, the grooves 58, which mount the sealing elements 57 designed as O-rings, can be provided with transverse ribs 59 or respectively a corrugation so that
15 when they are clamped between the cylindrical housing 3 and the tubular extension 9 of the cap 5, they then turn along with the cap 5 when the latter is turned.

Furthermore, it can also be seen from this representation that the cap 5 is provided with webs 25, 26 to enable a cylindrical housing 3 to be carefully opened and closed by means of this coupling device 28.
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Fig. 7 shows a construction of a coupling device 28 between a cap 5 and a cylindrical housing 3 in diagrammatic representation. It is apparent from this representation that the start 34 of the webs 25, 26 is arranged on a transverse plane 33, while the ends 36 are located on a transverse plane 35. The start of the web 25 or respectively 26 and the end 36 are each offset from one another by approximately 180° in the peripheral direction of the cap 5. The two webs 25 and 26 are associated with guide extensions 22 and 23, which protrude beyond an outer surface 24 of the cylindrical housing 3, for example a blood-sample tube 4. If the cap 5 is now pushed along the longitudinal axis 7 in the direction of an arrow 60 onto the cylindrical housing 3 and thereby slightly turned, the guide extensions 22 and 23, after the cap 5 has been pushed onto the cylindrical housing 3 up to the transverse plane 33, come into engagement with the webs 25 and 26. If the cap 5 is turned clockwise - arrow 61 - it is moved with its front wall 10 closer and closer to the guide extensions 22, 23, and in fact until the latter have passed the end 36 of the webs 25, 26 in the region of the transverse plane 35. In this position, the cap 5 can now be
30 turned as desired. As long as it is not removed from the cylindrical housing 3 and the guide extensions 22 and 23 come to bear on the underside 39 of the webs 25, 26, the cap 5 cannot be removed. On the other hand, if the guide extensions 22, 23 come to bear on the underside 39 of
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the webs 25, 26 and if the cap 5 is turned anti-clockwise, i.e. against the arrow 61, the front wall 10 of the cap 5 is moved away from the guide extensions 22 and 23, that is to say, the closure device 1 is opened. As already described in the above exemplary embodiments, the cap 5 also has a bore 8, through which access to the inner space 42 of the cylindrical housing 3 is made possible by means of an injection needle or the like. However, the bore can be omitted, in case that removal of the fluid should only be possible after the cap 5 has been opened. Likewise, via this bore 8 or in any other manner at all, the cap 5, according to the above described exemplary embodiments, can be coupled with a sealing device 6 with which an air-tight closure of the cylindrical housing is also possible.

Figs. 8 and 9 show an embodiment variant of a closure device 1 in which the coupling device 28 has three webs 25, 26 and 62. As now can be seen from the overall view of Figs. 8 and 9, the webs 25, 26 and 62 each extend over an angular range of approximately 270° . Each of the webs 25, 26, 62 is associated with a guide extension 22, 23 and 63, which is connected in one piece to the cylindrical housing 3, for example a blood-sample tube, or is integrally formed on the latter or is produced by special shaping, for example subsequent hot working. The individual guide extensions 22, 23 and 63 are offset in the peripheral direction by an angle 64 of approximately 120° . The same also roughly applies to the start 34 of the webs 25, 26 and 62. In this embodiment, the sealing device 6 which forms both the circumferential sealing face 18 and also the sealing face 20 running perpendicularly to the longitudinal axis 7, is connected to the cap shell 12 in a form-locking manner. This form-locking connection is achieved during the injection operation for producing the cap shell 12 with the front wall 10 by another plastic with highly elastic properties being injected into the mould to produce the sealing device 6. A fusion action consequently occurs between the two types of material in the region of a seam 65 indicated by a serrated line. It is of course also possible for the sealing device 6, after the cap 5 has been produced in a separate injection operation, to be injected or expanded into the bore 8 of the cap 5. Thus it is also possible, inter alia, for this sealing device 6 to be formed from a plastic foam, for example a polyvinylidene chloride foam or a polyurethane foam or the like. It is simply important for the plastic used to have an adequate gas-tightness and elasticity in order to permit a gas-tight closure of the cylindrical housing 3 or respectively the blood-sample tube 4.

Fig. 10 shows an embodiment in which a cap 5 is again provided with a sealing device 6 integrally formed on it. Arranged in the cap 5 are webs 25, 26 the start 34 of which, is arranged on a transverse plane 33 and the ends 36 of which are arranged on a transverse plane 35. Unlike the embodiment variants described above, however, a pitch angle 66, 67 of the webs 25, 26 varies over their path. Thus, the pitch angle 66 runs in a relatively flat manner in the start and end

region of the webs 25, 26, i.e. approximately perpendicularly to the longitudinal axis 7 of the cap 5, whereas it runs very steeply between these regions, in other words virtually parallel to the longitudinal axis 7. A relatively short rotational angle is thereby achieved for opening and closing the cap 5, whereby, however, it is also ensured in this case, that, before the sealing device 6 is finally pulled out of the blood-sample tube 4, a movement of the cap 5 exclusively parallel to the longitudinal axis 7 is prevented until the circumferential sealing face 18 of the sealing device 6 has been detached from the bearing surface 21 in the cylindrical housing. The pitch angle 66 as well as the length of the webs 25, 26 are dimensioned in such a way that this separation of the sealing face 18 from the bearing surface 21 is complete before the guide extensions 22, 23 have reached the end 36 of the webs 25, 26.

Fig. 11 shows a further embodiment of the invention in which three webs 25, 26 and 62 are arranged in a cap 5. The arrangement of webs as well as of their peripheral length over which these webs extend, can take place as shown, for example, with reference to the representation in Figs. 8 and 9. Associated with the webs 25, 26, 62 arranged in the cap 5 are guide extensions of which only the guide extension 22 on the cylindrical housing 3 can be seen. This guide extension 22 is arranged parallel to a longitudinal axis 19 of the cylindrical housing 3 in such a way as to be removed by a distance 68 from a front side 2 of the cylindrical housing 3. This distance 68 corresponds to a distance 69 between the front wall 10 of the cap 5 and the transverse plane 35 or respectively is slightly smaller. This ensures that, even when the transverse plane 35 is at a greater distance from the front wall 10, the circumferential sealing face 18 can be brought into engagement with the bearing surface 21 in the cylindrical housing 3 by a corresponding arrangement of the guide extensions 22, 23, 63. As can be further seen from this representation, two different sealing elements 70, 71 are arranged for producing the sealing face 20 running perpendicularly to the longitudinal axis and for producing the circumferential sealing face 18. The sealing element 71 is here designed like a stopper which, by appropriate configuration of the bore 8 in the front wall 10, is prevented from falling out in both directions when a force is applied from outside. The sealing element 71 is expanded or respectively sprayed, for example, onto a tubular extension 9 adjacent to the bore 8. This expansion or respectively spraying can be carried out at the same time as the cap 5 is produced or also separately therefrom. During such a separation of the sealing face 18 from the sealing face 20 and the use of two different sealing elements, care has to be taken to ensure that the tubular extension 9 is also of a corresponding gas-tight design or respectively is provided with a gas-barrier layer 41, so that ingress or escape of gas through the plastic of this part is adequately prevented.

Fig. 12 shows an embodiment in which the coupling device for connecting the cap 5 to the sealing device 6, which in this case has both the circumferential sealing face 18 and also the

sealing face 20 running perpendicularly to the longitudinal axis 19, is formed by means of coupling arms 72 which protrude from the front wall 10 of the cap 5 in the direction of its open front end 11 and engage in coupling openings 73 in the sealing device 6. The sealing device 6 is thereby connected immovably to the cap 5 when moving both in the direction of the longitudinal axis 19 and also in the peripheral direction. An inner space 42 is accessible via the bore 8 in the cap 5.

Indicated purely schematically in this embodiment is also the fact that a further coupling device 28 having webs 25, 26 for locking the cap 5 on a cylindrical housing 3, for example a housing of a syringe, or on a blood-sample tube 4 can be provided.

It is of course also possible within the scope of the invention to use the details described with reference to the individual exemplary embodiments selectively in the different exemplary embodiments and to arrange caps 5, both with the coupling device 13 between the sealing device 6 and the cap 5 and with coupling device 28 between the cap 5 and the cylindrical housing 3 or respectively the blood-sample tube 4 or a housing of a syringe or another vessel.

The two coupling devices 13 or respectively 28 respectively, can of course also be used completely separately from one another, even in each case only by themselves, on caps 5 or closures of this type for containers for accommodating medicines, foodstuffs, body fluids, cleansing agents or the like. In particular, the use of coupling devices of this type is advantageous wherever a gas-tight closure is to be obtained and there is the risk, on account of the gas-tight closure, of the contents spurting out, in particular during opening, and consequently contagion, infections or chemical burns can occur.

It is of course possible within the scope of the invention for the sealing device 6 or respectively the sealing elements 56, 57 or 70, 71 to be connected to the cap 5 by means of a layer of adhesive. Furthermore, it is also possible, for example, in the other exemplary embodiments shown, for the coupling arms 72 to be adhesively bonded in the coupling openings 73 or respectively for the coupling arms 49 to be adhesively bonded in the coupling openings 48.

Furthermore, Fig. 13 shows an embodiment in which the webs 25 or 26 and 62 are arranged on the cylindrical housing 3. During the production operation for the cylindrical housing 3, the webs can be directly formed integrally into this cylindrical housing 3 or can be produced by subsequent thermal deformation..

The guide extensions 22, 23 and 63 associated with these webs 25, 26 and 62 protrude inwards

beyond the cap shell 12. An inside diameter 74 of the cap shell 12 is thereby greater than a maximum outside diameter 75 of the cylindrical housing 3 in the region of the webs 25, 26 and 63.

5 A length 76 of the guide extensions 22, 23 and 63 protruding inwards beyond the cap shell 12 is less than half a difference between the inside diameter 74 and the outside diameter 75. This ensures that the guide extensions 22, 23, 63 and the webs 25, 26, 62 overlap one another so that the guide extensions 22, 23, 63 can be guided along the webs 25, 26 and 62.

10 The function of opening and closing the cylindrical housing 3 with the closure device 1 in the exemplary embodiment shown is as follows:

The cap 5, with the guide extensions 22, 23, 63 is moved towards the cylindrical housing 3 by a movement in the direction of the arrow 60, that is, in the direction of the longitudinal axis 19 of the cylindrical housing 3, and, with light application of force in the direction of the latter, is
15 turned in the direction of arrow 77. The guide extensions 22, 23, 63 thereby come to bear on the underside 39 of the webs 25, 26, 62. By a further turn in the direction of arrow 77, the cap 5 is pulled onto the cylindrical housing in the direction of arrow 60. If the ends 36 of the webs 25, 26, 62 have now been reached, the cap 5 can be turned further endlessly and, with its guide
20 extensions 22, 23, 63, rattles past the ends 36 of the webs 25, 26, 62.

If the closure device 1 is to be opened, the cap 5 has to be turned in the opposite direction of arrow 77 and in the process has to be moved in the opposite direction of arrow 60 relative to the cylindrical housing 3 or respectively lifted from the latter. Consequently, when the cap 5 is
25 turned relative to the cylindrical housing 3, the guide extensions 22, 23, 63 under a pre-tension force directed in the opposite direction of arrow 60, run onto the upper side 38 of the webs 25, 26, 62, and the cap is pulled out from the cylindrical housing 3 when turned further in the direction of arrow 77. If the selection of the sealing device 6, as already shown in Fig. 10, has now been made in such a way that an overlap region between the sealing face 18 and the bearing
30 surface 21 in the cylindrical housing 3 is smaller than a pitch between the transverse planes 33 and 35 mounting the starts and ends 34 and 36 respectively, the inner space 42 of the cylindrical housing is cleared as long as free movement of the cap 5 in the opposite direction of arrow 60 is not possible. This prevents the stopper from being pulled suddenly out of the cylindrical housing 3 by an instantaneous, powerful tensile force in the opposite direction of arrow 60 and
35 prevents the contents from spurting out under the resulting negative pressure.

Simply for the sake of order, it should be emphasized that a groove width 78 between the webs

25, 26, 62, which runs perpendicularly to the longitudinal axis 7 of the cap 5 or 19 of the cylindrical housing 3, is greater than a width 79 of the guide extensions 22, 23, 63, as can be better seen with reference to Figs. 8 and 9. If the width 79 is selected too large, jamming can occur between the guide extensions and webs during opening and closing. This jamming can be reduced when the edges of the extensions are rounded off or these extensions are designed, for example, in the shape of a spherical segment.

Fig. 14 shows an embodiment variant in which the cylindrical housing 3 is sealed by the sealing device 6 arranged in the cap 5 in the coupling part 80. The sealing device 6 is designed roughly like a bowl and has a coupling part 81, a flange-shaped locking extension 16 with a diameter 82 which is larger, roughly by twice the wall thickness 51 of the cylindrical housing 3, than a diameter 83 of a cylindrical sealing face 18 adjoining the locking extension. The tubular cap 5 accommodating the sealing device 6 has an inside diameter which essentially corresponds to the diameter 82 of the flange-shaped locking extension 16 and thus roughly corresponds to a diameter 84 of the cylindrical housing 3. In an end region of the tubular cap 5, coupling parts 81, for example, annular extensions 86, 87, are arranged so as to be spaced apart in the direction of the longitudinal axis 19 by the width 85 of the flange-shaped locking extension 16 of the sealing device 6, which coupling parts project beyond the cylindrical inner surface of the cap 5 in the direction of the longitudinal axis 19 and define a groove-shaped receiving region 88 for the locking extension 16. An inside diameter of an opening 89 of the extensions 86, 87 roughly corresponds to the diameter 83 of the cylindrical housing 3. In a vertical plane relative to the longitudinal axis 19, guide extensions 22 arranged uniformly on the periphery, e.g. at an angular distance of 120° , project beyond the diameter 84 of the cylindrical housing 3. As already described with reference to Fig. 1, spiral guideways 90 on the cylindrical inner surface of the cap 5 are associated with these guide extensions 22, which together form the coupling device 28 for the closure device 1 with the cylindrical housing 3. To remove a medicine or a body fluid from the cylindrical housing 3, the closure device 1 can be removed from the cylindrical housing 3 without jerky movement by turning the cap 5 and the sealing device 6 by the same amount in opposite directions according to arrows 91, 92. However, the contents of the cylindrical housing 3, after the sealing device 6 has been pierced through, can also be drawn off the cylindrical housing by means of a hollow needle 93 shown by broken lines. The axial forces occurring when the hollow needle 93 is pierced through and pulled out of the sealing device 6, are thereby absorbed by the flange-shaped locking extension 16 of the sealing device 6 and the extensions 86, 87 of the cap 5. The closure device 1 is thus especially suitable for automatic blood-analysis apparati as frequently used in laboratories and hospitals.

By the interlocking coupling parts 80, 81, namely the locking extension 16 and the groove-

shaped receiving region 88, a firm mounting between the cap 5 and the sealing device 6 is achieved in the direction of the longitudinal axis 19.

As can be seen further from the representation in Fig. 14, recesses can be provided on the periphery of the locking extension 16 in the direction of the longitudinal axis 19, to which rib-like connecting webs between the extensions 86, 87 are allocated, which form a toothed connection with the recesses in the locking extension 16. Thus, apart from the mounting in the direction of the longitudinal axis 19, a rotational connection is also achieved between the sealing device 6 and the cap 5, as a result of which, when the cylindrical housing 3 is opened by unscrewing the closure device 1, the sealing device 6 follows the rotational movement of the cap 5 and thus any sticking of the sealing faces 18 on the inner wall of the cylindrical housing 3 is released in such a way as to protect the sealing device 6.

Figs. 15 and 16 show another embodiment variant of the closure device 1 for a cylindrical housing 3. Here, coupling parts 94, formed by extensions 95, 96 of the cap 5 are associated with the flange-shaped locking extension 16 of the sealing device 6, which form the receiving region 88 for the flange-like locking extension 16 of the sealing device 6. The extensions 95, 96 are arranged so as to be distributed uniformly in an annular-segment shape on the inner periphery of the cap 5 and project in the direction of the longitudinal axis 19 and form a circular opening 89 having a diameter, which roughly corresponds to the inside diameter 83 of the cylindrical housing 3. The coupling parts preferably consist of four extensions 95 which are arranged at an angular distance of 90° and whose entire inner peripheral length is less than one eighth of the periphery of the circle which is circumscribed by the extensions 95, which corresponds to the inside diameter 83 of the cylindrical housing 3. The radial axes 97, 98 of the symmetry of the coupling parts 94 are arranged at an angular distance 99 corresponding to approximately 45° . The intermediate space formed by the described arrangement of the coupling parts 94 facilitates the fitting of the sealing device 6, but with the mounting of the flange-like locking extension 16 of the sealing device 6 against axial displacement as a result of an axial force acting through the adhesive force between a hollow needle 93 and the sealing device 6 being achieved.

Furthermore, Figs. 17 and 18 show an embodiment variant in which the coupling part 81, designed as a flange-like locking extension 16 of the sealing device 6, is mounted in the cap 5 by finger-like extensions 100 which are distributed uniformly on the periphery, are arranged parallel to the longitudinal axis 19 of the cap 5, and serve as coupling parts 80. The tubular cap 5 has an annular shoulder 101, which projects from the cylindrical inner periphery of the cap in the direction of the longitudinal axis 19, an inside diameter of the opening 89 defined by the shoulder 101 roughly corresponding to the inside diameter 83 of the cylindrical housing 3, and

finger-like extensions 100 connected in one piece to the cap 5. Furthermore, the latter are defined by bearing surfaces 103 arranged on the shoulder 101, at a distance 102 roughly corresponding to the width of the flange-shaped locking extension 16 of the sealing device 6. The flange-like locking extension 16 of the sealing device 6 is mounted between the shoulder 101 and the bearing surface 103. An opening 104, enclosed by the finger-like extensions 100 and arranged concentrically to the longitudinal axis 19, is widened in the shape of a truncated cone in the direction of a front face 105 of the cap 5 facing away from the cylindrical housing 3, a diameter 106 roughly corresponding to the outside diameter of the flange-shaped locking extension 16. By the elasticity of the material of the cap 5 or respectively of the finger-like extensions 100 forming the coupling parts 80, 81, a radial elasticity of the extensions 100 is achieved. This substantially facilitates the insertion of the sealing device 6 into the receiving region 88 of the cap 5, as a result of which it is also easily possible to construct the sealing device 6 from a multi-component material, e.g. having a highly elastic core and a resistant harder casing, for example, in the area of the flange-like locking extension 16, and to press this sealing device 6, which is very resistant to axial displacement, into the receiving region 88. As likewise drawn in broken lines in Fig. 18, the radial elasticity of the finger-like extensions 100 can be achieved or respectively changed by a weakening in the material in the area of the shoulder 101 and by an annular spring element inserted in a groove at the outer periphery.

Fig. 19 shows a further embodiment variant of a closure device 1 having a sealing device 6. The sealing device 6 has a coupling part 81, e.g. a flange-shaped locking extension 16 to which a shoulder 101 projecting from the inner surface of the cap 5 in the direction of the longitudinal axis 19 is allocated as coupling part 80. In this embodiment variant, an annular front end 107, as drawn in broken lines in the representation, following the insertion of the sealing device 6, is formed like a flange in the direction of the longitudinal axis 19. This forming can take place thermally, e.g. in the case of a cap 5 made of a thermoplastic material. This forming produces the receiving region 88 for the flange-like locking extension 16 of the sealing device 6, which extension ensures the non-displaceable positioning in the axial direction. As likewise shown further in Fig. 19 by chain lines, the sealing device 6 can be axially secured by a spring ring 109 inserted in a groove 108 arranged in the cylindrical inner surface of the cap 5.

Fig. 20 shows another embodiment variant for a closure device 1. Thereby, a tubular cap 5 has a cylindrical receiving region 110 which is defined by the shoulder 101 at a distance 111 from the front end 107. The flange-shaped locking extension 16 of the sealing device 6 is arranged in this receiving region

110. The front end 107 of the cap 5 is surrounded by a roughly stirrup-shaped top part 112 which engages like a catch in receptacles 113 arranged diametrically opposite on the outer peri-

phery of the cap 5. The top part 112 has an opening 104 which is concentric to the longitudinal axis 19, whose diameter is smaller than the diameter of the flange-shaped locking extension 16 of the sealing device 6 and which roughly corresponds to the inside diameter 83 of the cylindrical housing 3. In this embodiment variant, too, it is possible to use a sealing device 6 made of a multi-component material having, for example, a hard resistant casing in the area of the flange-like locking extension 16, the top part 112, to be mounted subsequently, ensuring the axial non-displaceability of the sealing device 6, e.g. when pulling out the hollow needle 93 after removal of the contents from the cylindrical housing 3.

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Claims

1. Seal (1) for an open front side (2) opposite a closed end of a cylindrical housing (3) that , in particular can be evacuated, with a cap (5) encompassing the front side (2) of the cylindrical housing (3), with a front wall (10) in which a bore (8) is arranged, and with a surrounding sealing face (18) of a perforable sealing device (6) associated with the bore (8) and an inner bearing surface (21) of the cylindrical housing (3), whereby a flange-shaped locking extension (16) of the sealing device (6) is projecting in a radial direction outwardly of this sealing face, the locking extension being supported between two extensions (86, 87) of the cap (5), which form between the cap (5) and the sealing device (6) together with the locking extension (16) coupling parts (80) of a coupling device (13) , which is arranged in the direction of the longitudinal axis (19) adjacent to the sealing face (18), characterized in that only two extensions (86, 87) are arranged which project beyond the cylindrical inner face of the cap (5) in the direction of the longitudinal axis (19) and which form a groove-shaped receiving region (88) for the flange-shaped locking extension (16), whereby the extension (87) facing towards the housing (3) is arranged between the front side (2) of the housing (3) and the locking extension (16).
2. Seal (1) for an open front side (2) opposite a closed end of a cylindrical housing (3) that in particular can be evacuated, with a cap (5) encompassing the front side (2) of the cylindrical housing (3), with a front wall (10) in which a bore (8) is arranged, and with a surrounding sealing face (18) of a perforable sealing device (6) associated between the bore (8) and an inner bearing surface (21) of the cylindrical housing (3), characterized in that a coupling device (28) between the cap (5) and the cylindrical housing (3) comprises at least two webs (25, 26) running approximately spirally on an inner side (27) of the shell of the cap (12) and two guide extensions (22, 23) projecting peripherically beyond the surface of the cylindrical housing (3) in the region of an open front end, and that the webs (25, 26) extend from a transverse plane (35), which is closer to the front wall (10) running perpendicularly to the longitudinal axis of the cap (5), to a transverse plane (33), which is further away from said front wall and that the front end (34) of the two webs (25, 26) and the rear end (36) of the two webs (25, 26) are arranged in the direction of the periphery offset to one another by an opening angle (30) of approximately 180° and that the guide extensions (22, 23) are arranged on the periphery of the



cylindrical housing (3) offset by an angle (29) of approximately 180°.

- 5 3. Seal according to claim 1, characterized in that the locking extensions (16) are formed by ribs (31) which are distributed over the periphery of the inner surface (15) of the tubular extension (9), protrude into the inner space, and run parallel to the longitudinal axis (19) of the cap (5).
- 10 4. Seal according to claim 3, characterized in that the ends of the ribs (31) are formed with sharp edges.
- 15 5. Seal according to any one of claims 3 or 4, characterized in that the locking extensions (16) are formed in a barb-shaped manner.
- 20 6. Seal according to any one of claims 3 to 5, characterized in that on the side facing towards the front wall (19) of the cap (5) the ribs (31) are provided with a front face (32) running approximately perpendicularly to the longitudinal axis (7) of the cap (5).
- 25 7. Seal according to one or more of claims 1 to 6, characterized in that the sealing device (6) with the sealing face (20), which runs perpendicularly to the cap (5) is formed from a silicone rubber or another gas-tight rubber such as from a bromine butyl rubber or a soft, elastic plastic material.
- 30 8. Seal according to one or more of claims 1 to 7, characterized in that an outer surface of the cylindrical housing (3) is coated with a gas barrier layer (41) from a closed end (37) of the cylindrical housing (3) into a region of a bearing surface (21) of the surrounding sealing face (18) of the sealing device (6).
- 35 9. Seal according to one or more of claims 1 to 8, characterized in that the coupling device (13, 28) has locking extensions (16) against contortion.
10. Seal according to claim 1, characterized in that the coupling parts (80) of the sealing device (6) are associated with several, preferably four ring segment shaped coupling parts (94) of the tubular cap (5), which are, arranged diametrically opposite and at a distance from one another on the inner periphery of the cap (5) and protruding from them.



- 5 11. Seal according to claim 1, characterized in that the coupling parts (81) of the coupling device (13) of the sealing device (6) are formed by recesses distributed over the periphery of said sealing device and at a distance from one another, and that extensions serving as coupling parts are associated with these recesses by a diametrically opposed arrangement.
- 10 12. Seal according to claim 1 or 11, characterized in that the groove-shaped receiving region (88) forming the coupling part (80) of the cap (5), is extending over an angle of less than 360°.
- 15 13. Seal according to any one of claims 1, 11 or 12, characterized in that the flange-shaped locking extension (16) forming the coupling part (81) of the sealing device (6), extends over an angle area which is less than 360° and preferably slightly smaller than an angle area of the groove of the cap (5) forming the coupling part (80).
- 20 14. Seal according to any one of claims 1 or 11 to 13, characterized in that the extensions (86, 87) in the direction of the longitudinal axis (19) are arranged in two perpendicular planes which are distanced from one another and the extensions (86, 87) which are arranged in these planes, are offset in the direction of the periphery.
- 25 15. Seal according to one or more of the claims 1 to 14, characterized in that the coupling part (80) is formed by a top part (112) put on the cap (5), which is fixed in the cap (5) by a snap-device.
- 30 16. Seal according to claim 15, characterized in that the top part (112) comprises an opening (104) which is smaller than a diameter of the sealing device (6).
- 35 17. Seal according to one or more of claims 1 to 16, characterized in that the coupling part is formed in a radial direction by an elastic, in particular C-shaped ring (109) having a width which is greater than a depth of a groove (108) provided on the side of the cap (5) facing towards the sealing device (6) in a plane arranged perpendicularly to the longitudinal axis.
18. Seal according to one or more of claims 1 to 17, characterized in that the sealing device (6) is made from composite material and that a very elastic core region is arranged in a ring-shaped envelope with a higher rigidity.



19. Seal according to one or more of claims 1 to 18, characterized in that the sealing device (6) has a Shore hardness of preferably 43° in the region of the core and the region enveloping the core, in particular the coupling parts, comprises a hardness exceeding a Shore hardness of 43°.

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20. Seal according to claim 2, characterized in that a distance (43) between the front wall (10) and the transverse plane (35) closer to it, oriented in a perpendicular direction of the longitudinal axis (7) is greater than a length (44) of the guide extensions (22, 23) in the direction of the longitudinal axis (7) of the cap (5) or the cylindrical housing (3).

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21. Seal according to claim 20, characterized in that the distance (43) between the front wall (10) of the cap (5) and the transverse plane (35) closer to it, extending perpendicular to the longitudinal axis (7) corresponds to the length (44) of the guide extensions (22, 23) parallel to the longitudinal axis (7) of the cap (5) or the cylindrical housing (3) in addition of a distance (68) between these guide extensions (22, 23) and the open front side (2) of the cylindrical housing (3).

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22. Seal according to one or more of claims 2 or 20, 21, characterized in that a distance between the open front side (2) of the cylindrical housing (3) and the surrounding sealing face (18) with guide extensions (22, 23) of the cylindrical housing (3) in the region of the transverse plane (33) which if further distanced from the the front wall (10), extending perpendicularly to the longitudinal axis (7), is less than a distance between the two transverse planes (33, 35) in which the webs (25, 26, 62) are starting and ending.

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23. Seal according to one or more of claims 2 or 20 to 22, characterized in that an angle of slope (66, 67) of the webs (25, 26, 62) is varying over their longitudinal course.

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24. Seal according to one or more of claims 2 or 20 to 23, characterized in that a width (79) of the guide extensions (22, 23, 63) in the direction of the periphery of the cylindrical housing (3) is less than a width (79) between the webs (25, 26, 62) of a transverse plane (33, 35) running perpendicularly to the longitudinal axis (7) of the cap (5).

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25. Seal according to claim 2, characterized in that the sealing element (71) presents a



surrounding sealing face (18) which forms part of the cap (5).

- 5 26. Seal according to claim 2, characterized in that a coupling device (13) is arranged between the cap (5) and the sealing device (6) and that it is preferably formed by protruding coupling arms (49) and coupling openings (48) arranged inside the cap, and that the coupling arms (49) are locked in the coupling openings (48).
- 10 27. Seal according to claim 26, characterized in that the coupling device (13) is formed by coupling arms (72) which are protruding over the front wall (10) of the cap (5) in the direction of the open front end (11) of said cap and by coupling openings (73) arranged in the sealing device (6).
- 15 28. Seal according to claim 26 or 27, characterized in that the coupling device (13) is inserted, through a tubular extension (9) positioned downstream of the bore (8) in the cap (5) extending parallel to the cylindrical cap shell (12) towards the open front end (11) of the cap (5) and a ring-shaped, concentrically to the extension (9) arranged groove (14) in the sealing device (6) and that an average diameter of the groove (14) and the extension (9) has about the same size than the extension (9) into the groove (14).
- 20 29. Seal according to claim 28, characterized in that the sealing device (6) with the surrounding sealing face (18) is formed by an O-ring, which is arranged on the side of the tubular extension downstream of the bore (8) in the front wall (10) of the cap (5) facing towards the cap shell (12), preferably in a groove (58) provided
- 25 in the extension.
- 30 30. Seal according to claim 29, characterized in that the surrounding sealing face (18) is formed by several O-rings which are arranged successively in the direction of the longitudinal axis (7) of the cap (5).
- 35 31. Seal according to claim 28, characterized in that the tubular extension (9) on its side facing away from the front wall (10) of the cap (5) is closed by a sealing cap (17) forming the sealing device (6), which is provided with the sealing face (18, 20) surrounding it and running perpendicularly to the longitudinal axis (19).
32. Seal according to claim 28, characterized in that a difference between a minimum inner diameter of a cap shell (12) and a maximum outer diameter (46) of the tubu-



lar extension (9) is less than a wall thickness (51) of the cylindrical housing (3).

33. Seal according to claim 2, characterized in that a difference between a minimum inner diameter of a cap shell (12) and a maximum outer diameter of the surrounding sealing face (18) is less than a wall thickness (51) of the cylindrical housing (3).

34. Seal according to claim 2, characterized in that the coupling parts (80) arranged in the region of a front side opening of the cap (5) are formed by several, finger-like, in radial direction elastic extensions (100), preferably distributed uniformly over the periphery and arranged parallel to the longitudinal axis (19) of the cap (5).

35. Seal according to claim 34, characterized in that the finger-like extensions (100) are moulded onto the cap (5) in one piece.

36. Seal according to claim 34 or 35, characterized in that the finger-like extensions (100) are connected with the tubular cap (5) via resilient supporting links such as metal springs.