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(54) **CAPPING MACHINE AND METHOD FOR CLOSING RECEPTACLES**

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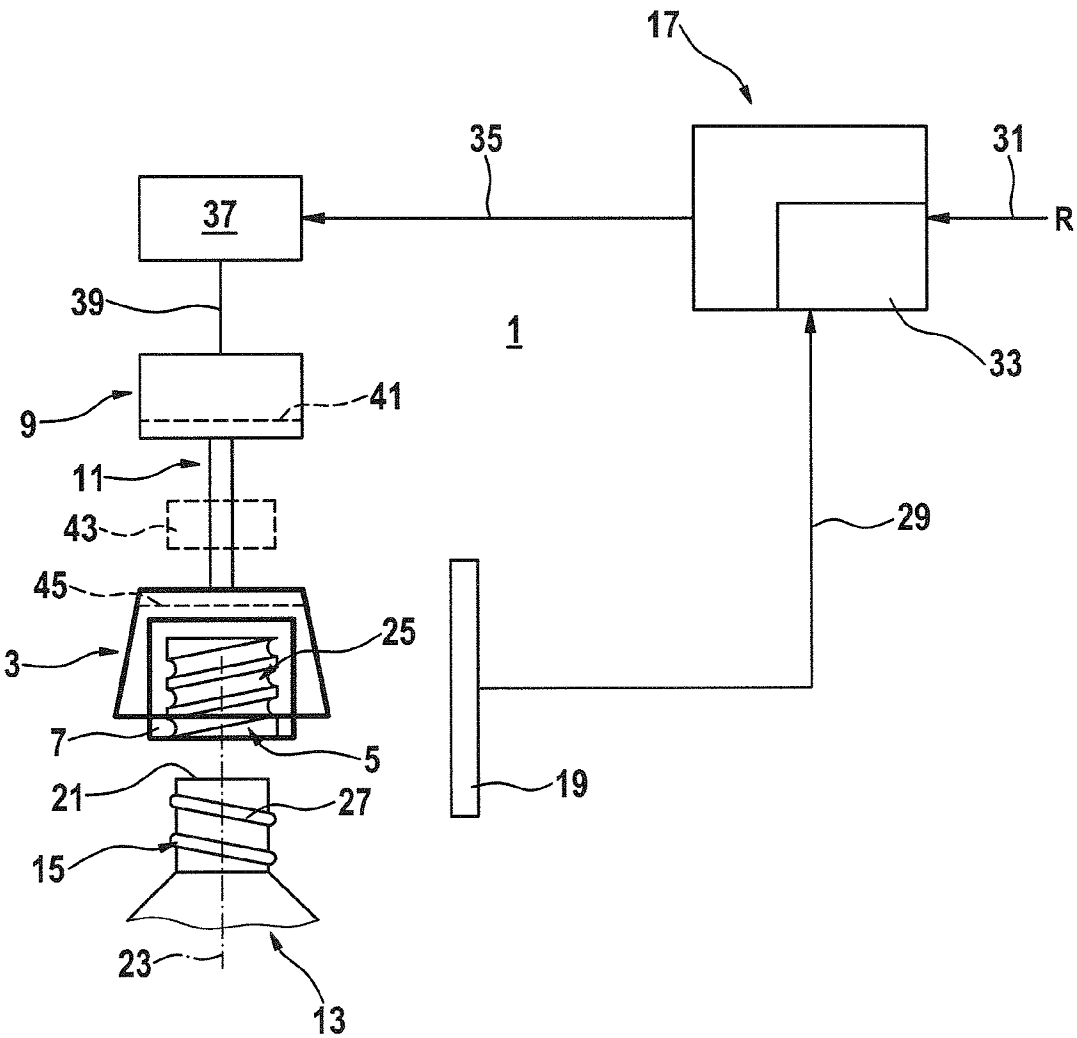
(57) **ABSTRACT**

A capping machine for closing a receptacle with a cap having a preformed internal thread, the capping machine including a capping head, a drive shaft, a drive, a shifting device, at least one sensor and at least one control device. The at least one sensor senses the position of the cap relative to the receptacle once the cap has been placed on the receptacle. The shifting device includes a comparing unit in which the sensed position and the reference position are compared. A direction of rotation of the drive is defined by the control device via the shifting device in accordance with the comparison.



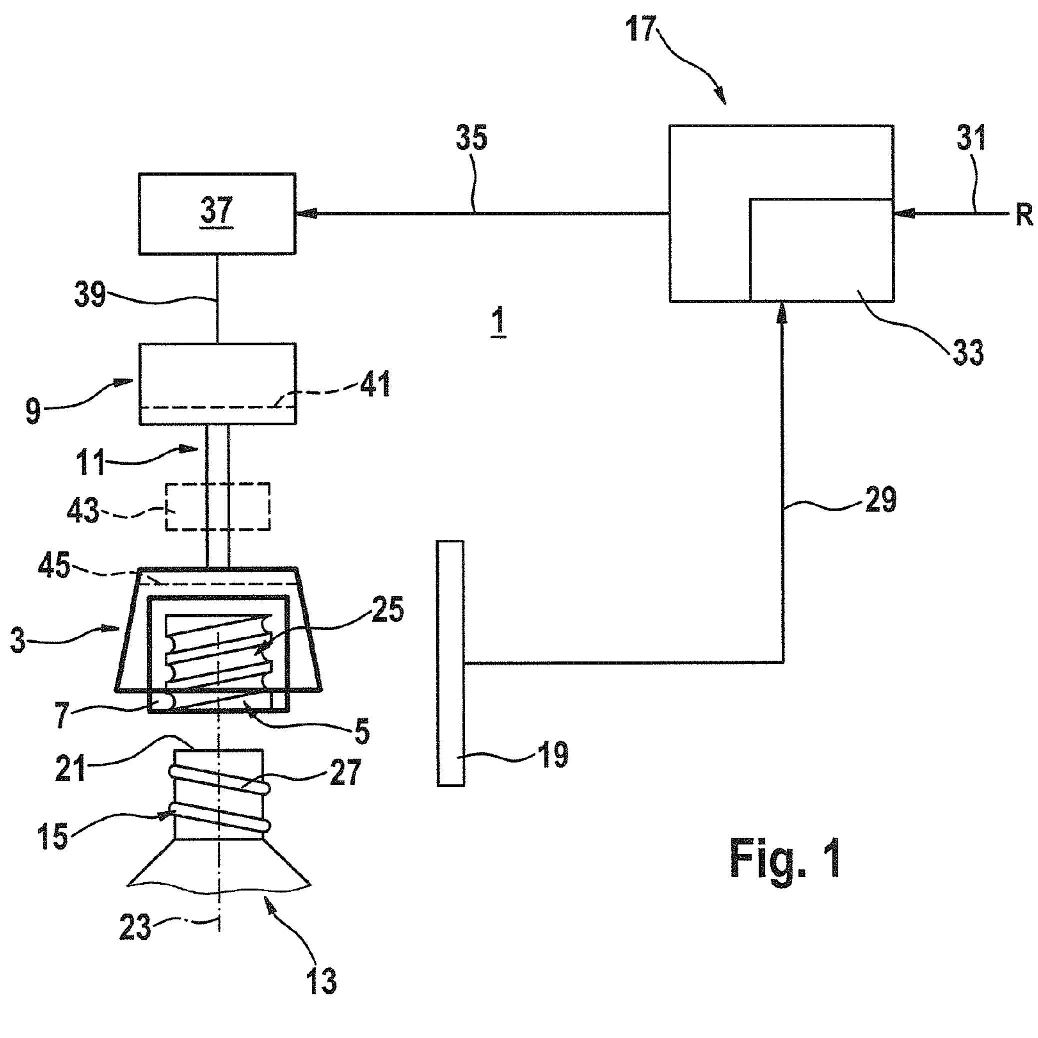


Fig. 1

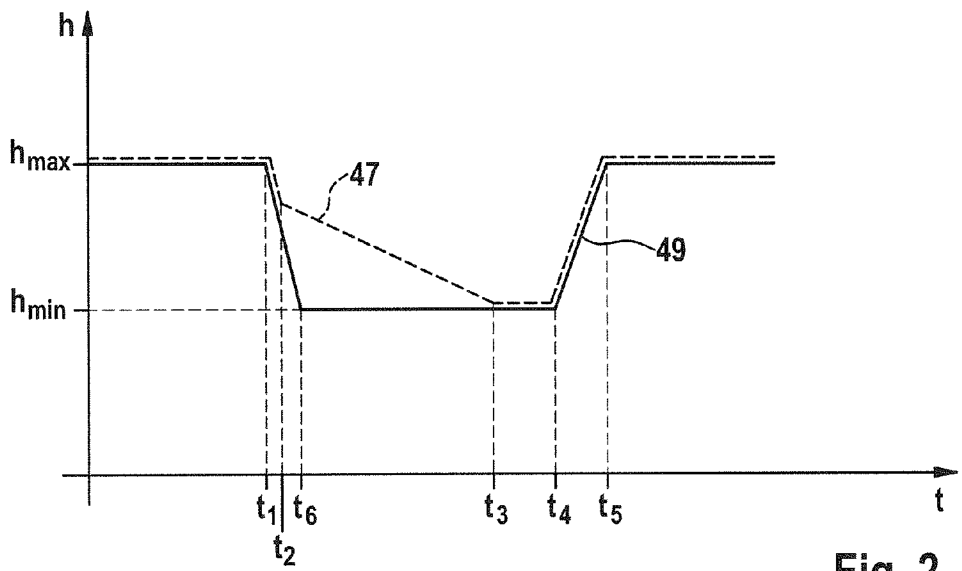


Fig. 2

CAPPING MACHINE AND METHOD FOR CLOSING RECEPTACLES

[0001] The invention relates to a capping machine for closing receptacles, in particular bottles, in accordance with the preamble of claim **1**, as well as a method for capping receptacles, particularly bottles, in accordance with claim **14**.

[0002] Capping machines and methods of the type addressed here have been known. A cap provided with a preformed internal thread is placed on a receptacle provided with an external thread and subsequently tightened in closing direction. A relative rotation between the closure and the receptacle is required for the closing process. Usually, the capping head is rotated via a drive, while the receptacle does not rotate. Sensors are commonly used that monitor the closing process and for example sense the torque applied to the cap and/or the rotation angle of the cap relative to the receptacle. A control device analyzes the signals of the sensors and controls the drive via a shifting device in such a way that predetermined torques and/or rotation angles are reached but not exceeded. During the closing process the capping head holding the cap follows a closing curve. This means that it is moved synchronously with the container along a trajectory of advancement and simultaneously lowered relative to the receptacle, with the lowering movement adapted to the geometry of the internal thread in the cap or of the external thread of the receptacle. Such a lowering movement may also be provided for capping machines which comprise a stationary capping head and cap individual receptacles. It turned out that faulty closings may occur during the closing process, where the cap is slanted on the receptacle and a firm seal of the receptacle content cannot be guaranteed.

[0003] It is therefore the task of the invention to create a capping machine of the type mentioned above, by means of which faulty closings can be reduced to a minimum.

[0004] To solve this task, a capping machine comprising the features suggested in claim **1** is disclosed. This machine is characterized by a sensor which senses the position of the cap relative to the receptacle, namely immediately after the cap has been placed on the receptacle. The sensed position is identified as actual position. The actual position is compared with the reference position (R), which is measured or determined once the cap has been optimally placed on the receptacle, namely on its opening. An optimal position has been reached when the internal thread of the cap and the external thread engage around the opening of the receptacle, and the flight lands do not rest on top of one another. In the latter case it frequently happens that the cap is slanted relative to the receptacle. If, given such an initial position of the cap relative to the receptacle, the closing process is initiated, thus the cap is tightened on the receptacle, the cap on the receptacle may get jammed and mostly cannot be brought into its final position, in which the receptacle is firmly closed. Thus, the content of the receptacle can leak and/or spoil. The capping machine defined here provides that the control device comprise a comparing unit, which is supplied with the sensed actual position of the cap relative to the receptacle and the reference position (R). The two positions are compared here. In accordance with the comparison, the direction of rotation of the drive is determined by the control device via the shifting device: If the cap sits correctly on top of the receptacle, thus the two threads engage with one another, the closing process can immediately be initiated. If, in the alternative, the lands of the internal threads in the cap sit atop of the lands of the external thread of the receptacle, and thus the cap sits higher on the receptacle, the actual position and the reference position (R) do not match. In this case the cap is first rotated against the closing direction until the threads engage. Only then the cap is rotated in closing direction and tightened. Since this makes it impossible for the cap to be slanted on the receptacle during the closing process, faulty closings are reduced to a minimum, if not completely eliminated. Additional embodiments result from the subclaims.

[0005] To solve this task, a method of the type described above is also disclosed, which comprises the features mentioned in claim **13** and is characterized in that the actual position is first sensed and compared with a reference position R once a cap has been placed on a receptacle. Only if the cap has been properly placed on the receptacle, thus the threads engage, the closing process is promptly initiated. If the flight lands rest on top of one another, the cap is first rotated against the direction of rotation, until the sensor determines that the two threads engage. Only then the closing process is initiated. This way, faulty closings, resulting from slanted caps relative to the receptacle, can be reduced to a minimum, if not completely eliminated.

[0006] Additional embodiments of the method result from the assigned subclaims.

[0007] The invention is described in detail based on the drawing below:

[0008] FIG. **1** shows a schematic diagram of a capping machine and

[0009] FIG. **2** shows a diagram with two closing curves, in which the ˆ height of the capping head is applied to the receptacle above the time.

[0010] FIG. **1** shows a capping machine **1** with a capping head **3**, which serves to accommodate a cap **7** provided with an internal thread. The capping head **3** is rotated by a drive **9** via a drive shaft **11**, so that the cap **7** can be screwed on a receptacle **13**. It is intended that the internal thread **5** in the cap **7** is tightly screwed to an external thread **15** of the receptacle **13**.

[0011] The capping machine **1** comprises a control device **17**, which controls the closing process.

[0012] The capping machine **1** comprises a sensor **19**, which serves to sense the position of the cap **7** relative to the receptacle **13**. It is important here that the correct position of the cap **7** on the receptacle **13** be sensed immediately after the cap **7** is attached. The result is that the cap **7**, if optimally attached to the receptacle **13**, can be slid further over the opening **21** of the receptacle **13** in the direction of the center axis **23** of cap **7** and receptacle **13** indicated here. In this case, the flight lands **25** of the internal thread **5** in the cap **7** engage in the flight lands **27** of the external thread **15** of the receptacle **13**. If the flight lands **25** and **27** rest on top of each other, the cap **7**—viewed in the direction of the center axis **23**—cannot be lowered quite as far towards the opening **21** of the receptacle **13**.

[0013] The position of the cap **13** measured in the direction of the center axis **23** is referred to as actual position. The measured value captured by the sensor **19** is conducted to a control device **17** via a conduit **29**, if need be also via radio or other transmission paths. A reference signal, which corresponds to the optimal position of the cap **7** on the receptacle **13** when first attached, is supplied to the control device **17** via a suitable conduit **31** or via a different transmission path. This reference value is referred to as reference position R.

[0014] The initial signal of the sensor **19** corresponding to the actual position is compared with the value in a comparing unit corresponding to the reference position R. In accordance with the comparison conducted here, a control signal is emitted via a conduit **35** to a shifting device **37**, which controls the drive **9** of the capping head **3** via a conduit **39**.

[0015] It must be pointed out here that the conduits **35** and **39** may very well also be substituted through other transmission paths, be it radio or Blue Tooth, or the like. In all cases it is only important that a suitable connection between the elements of the capping machine **1** is ensured.

[0016] If, by comparing the initial signal of the sensor **19** with the reference position R, it is determined in the comparing unit **33** that the actual position corresponds to the reference position R, a suitable signal is emitted from the control device **17** to the shifting device **37**, so that the latter activates the drive **9** such that it rotates the capping head **3** in closing direction so that the cap **7** held by the capping head **3** is screwed to the receptacle **13**.

[0017] To cap the receptacle **13**, the capping head **3** is lowered in the direction of center axis **23** relative to the receptacle **13**. It is automatically clear that the receptacle **13** could also be elevated relative to the capping head **3**. Only the relative movement between these two parts matters.

[0018] The capping head **3** is lowered relative to the receptacle **13** along a so-called closing curve.

[0019] The capping machine **1** may be provided with a gear **41**, which may be part of the drive **9**. It is however also possible to provide a gear **43** in the area of the drive shaft **11**. Finally, it is also conceivable to design such a gear **45** as part of the capping head **3**.

[0020] FIG. **2** shows a diagram with two closing curves, in which the time t is shown on an x-coordinate and the height h of the capping head **3** relative to the receptacle **13** on a y-axis.

[0021] The progression of a capping head **3** relative to a receptacle **13** is drawn in with a dotted line **47**, as selected with conventional capping machines. A continuous line **49** shows how the height h of the capping head **3** of the capping machine **1** according to the invention changes relative to the receptacle **13** over the time t.

[0022] The following results from the closing curve according to the prior art shown in FIG. **2**, which is reproduced here as dotted line **47**:

[0023] At the time t_1 the capping head **3** is first lowered along the center axis **23** to the receptacle **13** beginning from a height h_{max}, until the cap **7** touches the opening **21** of the receptacle **13** at the time t_2. During the closing process the internal thread **5** of the cap **7** engages further and further into the external thread **15** of the receptacle **13**. While the cap **7** is screwed on, the capping head **3** is continuously lowered along the dotted line **47** to the height h_{min}, until the cap **7** is completely screwed onto the receptacle **13**. This occurs at the time t_3. In the progression of the dotted line **47** shown here the capping head **3** follows the slope of the external thread **15** at the receptacle **13** until the time t_3. Either immediately, or—as here—at the time t_4, the capping head **3** is subsequently raised again, until it reaches its initial height h_{max} at the time t_5.

[0024] It becomes clear from FIG. **2** and the progression of the curve of the dotted line **47** in the time period t_2 to t_3 that the capping head **3** is lowered preferably linearly relative to the receptacle **13**. The incline or the decline of the curve of the dotted line **47** depends on the type of thread provided for the cap **3** and, accordingly, for the receptacle **13**. Incidentally, it must be adapted precisely to the type of thread used, so that the contact pressure of the capping head **3** or of the cap **7** on the receptacle **13** is not too high during the closing process. This occurs to prevent uneven tracking of the cap **7** through twisting or jamming on the receptacle **13** during the closing process, since otherwise tight closing of the receptacle **13** by the cap **7** cannot be guaranteed.

[0025] Lowering the capping head **3** during the closing process relative to the receptacle **13** is decisive for the progression of the closing curve in accordance with the dotted line **47**. The amount of time between t_3 and t_4 may be left up to the discretion of a person skilled in the art to decide.

[0026] In the following the closing curve, which is chosen by means of the capping machine **1** in accordance with FIG. **1** and which is depicted with a continuous line **49**, will be addressed.

[0027] It is apparent here that the capping head **3**, beginning from the initial position h_{max}, is quickly lowered to the lowest level h_{min} in the time period t_1 to t_6 and is located at maximum approximation relative to the receptacle **13**—measured in the direction of the center axis **23**. It is possible that the capping head **3** is lowered even further than shown in FIG. **2**.

[0028] The minimum height h_{min} is maintained at least during the entire closing process between the time period t_6 and t_3. It is independent of the type of thread, which is provided for the cap **7**. Thus, this minimal height is maintained during the time period t_6 to t_3 for threads with single-start or multiple-start screw threads.

[0029] As is evident from the continuous line **49**, in the embodiment of the capping machine **1** according to FIG. **1** and during the implementation of the method for capping receptacles **13**, the capping head **3** can be lowered very rapidly relative to the receptacle **13**. A high, at least higher closing pressure, namely contact pressure of the cap **7** on the receptacle **13**, may very well be accepted, since before initiating the closing process the cap **7** is correctly aligned with the receptacle **13**, which will be addressed in detail below.

[0030] Moreover, it may preferably also be provided that the cap **3** is pressed on the receptacle **13** with resilient force. This may be realized by providing suitable spring elements in the capping head **3**.

[0031] Preferably, the drive shaft **11** may also be supplied with spring power, for example telescopic. Finally, the drive **9** along with the drive shaft **11** and the capping head **3** may be lowered along the center axis **23** and mounted in an elastically spring-loaded manner, in order to exert a resilient contact force on the cap **7**, by means of which the latter is pressed onto the receptacle **13**.

[0032] In the following the function of the capping machine **1** and also the method for capping receptacles **13** will be addressed in detail:

[0033] The capping machine **1** is characterized in that the correct alignment of the capping head **3** or the cap **7** on the receptacle **13** is controlled by means of a sensor **19** before the actual closing process evident from FIG. **2** is started. After attaching the cap **7**, the latter's axial actual position measured in the direction of the center axis **23** is sensed relative to the receptacle **13**. The maximum approximation between the cap **7** and the receptacle **13** occurs when the internal thread **5** of the cap **7** engages in the external thread **15** of the receptacle **13**, thus when the end of the flight land **25** in the cap **7** does not rest on the flight land **27** of the receptacle **13**, but engages directly in the opening of the external thread **15** of the receptacle **13**. Thus, in this case, the cap **7** can be slid onto the opening **21** of the receptacle **13** to the maximum possible.

[0034] When adjusting the capping machine **1**, a cap **7** is first placed on a receptacle **13** in such a way that the internal thread **5** of the cap engages in the external thread **15** of the receptacle, thus that the cap **7** can be slid onto the opening **21** to the maximum possible. This position is measured by means of the sensor **19**. The initial value of the sensor **19** is supplied to the control device **17** as a reference position R. It is also possible to determine the reference position R by means of other sensors or arithmetically.

[0035] The actual position after initially placing the cap **7** on the receptacle **13** is determined by means of the sensor **19**. Its output signal is supplied via the conduit **29** to the comparing unit **33**, where the actual position is compared with the reference position R.

[0036] If the two positions coincide, thus if the cap **7** has been optimally placed on the receptacle **13**, a suitable control signal of the control device **17** is emitted via the conduit **35** to the shifting device, which activates the drive **9** via the conduit **39**. In doing so, the drive **9** is actually activated in such a way that the capping head **3**, and thus the cap **7**, is screwed onto the receptacle **13** and thus screwed tightly. Thus, the closing process is initiated immediately.

[0037] If a comparison of the actual position with the predetermined reference position R in the comparing unit shows that the cap **7** does not rest optimally on the receptacle **13**, the drive **9** is initially rotated in the opposite direction via the shifting device **37**, so that the capping head **3** and the cap **7** are rotated in the opening direction. In this process a contract pressure is exerted with which the cap **7** is pressed on the receptacle **13**. In a single-start screw thread the cap **7** must be rotated by no more than 360° against the closing direction, until the internal thread **5** engages in the external thread **15** and the cap **7** can be somewhat slid onto the opening of the **21** of the receptacle **13**. This way it reaches an actual position, which corresponds to the reference position R. As soon as the sensor **19** determines that the desired initial position has been reached, the reverse turn of the capping head **3** terminates and the closing process is accomplished by turning the capping head **3** and thus the cap **7** in closing direction. This is achieved by means of suitable control signals of the control device **17** to the shifting device **37**, which reverses the direction of rotation of the drive **9** when the desired position is reached.

[0038] In order to limit the time for a closing process to a minimum, the rotation angle of the capping head **3** is preferably sensed by means of an angle of rotation sensor during the reverse turn opposite the closing direction. If in a thread with a single-start screw thread a rotation angle of 360° is reached, the process is canceled. In this case it is assumed that internal thread **5** of the cap **7** and/or the external thread **15** of the receptacle **13** is defect. Both parts are eliminated from the process in a suitable way, for example by means of a separating device.

[0039] If cap **7** and receptacle **13** are provided with a multiple thread, the rotation angle may be limited during the reverse turn, for example to 180°, if a two-start screw thread is involved.

[0040] In addition, the torque applied during the closing process can be sensed in a suitable way, for example by means of a torque sensor. If it exceeds certain predetermined value, this is an indication that the cap **7** is twisted on the receptacle **13** and jams. This may for example be the case if the external thread **15** of the receptacle **13** is defect. In this case, too, cap **7** and receptacle **13** may be separated.

[0041] The torque sensor may also determine that the torque declines before the desired closing torque is reached. This in an indication that the cap slips on the receptacle or that flight lands **25** and/or **27** are broken. Defects in the bracket for the receptacle **13** may also be present. Finally, also the opening of the receptacle may be torn off.

[0042] In all cases the device will make sure that the cap **7** and the receptacle **13** will be separated.

[0043] The operating mode of the capping machine **1** was explained such that a rotational movement of the cap **7** against the receptacle **13** in opening direction takes place, if need be. This was accomplished here by appropriately activating the drive **9**.

[0044] However, it also conceivable to provide a gear that causes a reversal of rotation direction, if necessary. In this connection, the gear may be a part of the drive **9** (see reference number **41**), part of the drive shaft **11** (see reference number **43**) or part of the capping head **3** (reference number **45**). It is crucial that for example, with constant rotational direction of the drive **9**, if need be, the gear **41**, **43** or **45** is switched, namely in response to an activation signal from the control device **17**, so that the capping head **3** and thus the cap **7** rotate opposite to the closing direction, until the internal thread **5** of the cap engages in the external thread **15** of the receptacle **13**.

[0045] The capping machine **1** may preferably be designed such that a servomotor is used as drive **9**. Beyond that it is possible that the drive **9** also causes the lowering and lifting movement of the capping head **3**, so that the latter is moved along the closed line **49** of the closing curve in accordance with FIG. **2**.

[0046] It is important that during a closing process, namely after the cap **7** has been placed on the receptacle **13**, the position of the cap **7** on the receptacle **13** is sensed. Only if its internal thread **5** correctly engages in the external thread **15** of the receptacle **13**, thus only if the cap **7** can be slid furthest possible onto the opening **21**, the closing process is immediately begun: after being attached the cap **7** is promptly rotated in closing direction. In this connection it is immaterial whether or not a certain amount of time passes between the attachment and the beginning of the closing process. It is essential that rotating in the opposite direction may be eliminated.

[0047] Only in the case in which the internal thread **5** of the cap **7** rests on the external thread **15** of the receptacle **13**, thus if the cap **7** cannot be slid far enough onto the opening **21** of the receptacle **13**, a reverse turn of the cap **7** in the opposite direction of the closing direction is caused, until the cap **7** snaps onto the opening **21** of the receptacle and the internal thread **5** can engage in the external thread **15** of the receptacle **13**. In this case the cap **7** reaches the desired reference position R, which is captured by the sensor. The backward movement of the capping head **3** is stopped. The closing process can be started immediately or at a desired point in time.

[0048] This way it is assured in all likelihood that the cap **7** rests correctly on the opening **21** of the receptacle **13**, when the closing process if begun.

[0049] Thus, tracking the cap **7** unevenly is prevented in all likelihood, so that, unless there are other problems, the cap **7** can safely be attached to the receptacle **13**.

[0050] From this follows automatically that the receptacle **13** can preferably be a bottle, to which a suitable screw cap can be screwed tightly.

1-15. (canceled)

16. A capping machine for closing a receptacle with a cap having a preformed internal thread, the capping machine comprising:

a capping head;

a drive shaft;

a drive;

a shifting device including a comparing unit in which a sensed position, an actual position and a reference position are compared;

at least one sensor for sensing the position of the cap relative to the receptacle once the cap has been placed on the receptacle,

and a control device defining a direction of rotation of the drive via the shifting device in accordance with the comparison.

17. The capping machine in accordance with claim **16**, wherein the drive is a servomotor.

18. The capping machine in accordance with claim **16**, further comprising a torque sensor.

19. The capping machine in accordance with claim **16**, further comprising a sensor sensing a rotation angle.

20. The capping machine in accordance with claim **18**, wherein the control device is operative for analyzing a time change of torques and/or rotation angles.

21. The capping machine in accordance with claim **16**, further comprising a gear in the drive, the capping head and/or between both the drive and the capping head.

22. The capping machine in accordance with claim **21**, wherein the shifting device impacts the gear.

23. The capping machine in accordance with claim **21**, wherein a rotational speed, a direction of rotation and/or a torque impacting the cap is changed by the gear.

24. The capping machine in accordance with claim **22**, wherein a rotational speed, a direction of rotation and/or a torque impacting the cap is changed by the gear.

25. The capping machine in accordance with claim **21**, wherein a rotational speed, a torque and a direction of rotation of the drive are constant during the capping process.

26. The capping machine in accordance with claim **21**, further comprising a sensor for determining a reference position via the control device.

27. The capping machine in accordance with claim **16**, further comprising a device for sorting caps and/or receptacles.

28. The capping machine in accordance with claim **16**, wherein the capping head is displaceable along a capping curve relative to the receptacle.

29. A method for capping a receptacle with a cap having a preformed internal thread with a capping machine in accordance with claim **1**, the method comprising:

sensing a position of the cap relative to the receptacle once the cap has been placed on the receptacle;

comparing a sensed position of the cap with a reference position;

turning the cap against a closing direction until the reference position is reached if the sensed position and the reference position are different; and

turning the cap in the closing position when the sensed position and the reference position are common.

30. The method in accordance with claim **29**, further comprising separating the cap and/or the receptacle if the sensed position no longer matches the reference position after a rotation of no more than 360° against the closing direction.

31. The method in accordance with claim **29**, comprising displacing the capping head relative to the receptacle independent of the geometry of the internal thread of the cap along a capping curve.

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