

FILLING METHOD AND FILLING DEVICE

TECHNICAL FIELD

[0001] The present disclosure relates to a filling method and a filling device.

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BACKGROUND

[0002] Patent literature (PTL) 1 describes a syringe for a dispenser and a paste adhesive. The syringe for a dispenser described in Patent Literature 1 consists of a cylinder containing silver paste that is a paste adhesive, a nozzle cap detachably attached to a nozzle formed on the cylinder, a head cap detachably attached to the cylinder, and a piston for pressure feeding silver paste, the piston being disposed inside the cylinder and movable. The nozzle cap has a blocking portion that blocks a passage for discharging the paste adhesive at the nozzle of the cylinder. Screw fastening is described as a preferred method of securing the nozzle cap to the nozzle cap attachment portion of the cylinder.

[0003] PTL 1 further describes a problem that air or gas accumulated in a cavity of the passage of the nozzle formed in the cylinder, when present in the passage as is, when silver paste is used, may cause an empty shot, and may impair uniformity and application workability of the silver paste. Therefore, a problem is described that after the silver paste is filled into the cylinder, a cavity in the passage in the nozzle must be filled with the silver paste. Further, after filling the passage of the nozzle with the silver paste, air or gas gets mixed into the silver paste inside the cylinder through a small gap between the nozzle and the nozzle cap, which, when silver paste is used, may cause an empty shot, and may impair the uniformity and the application workability of the silver paste. Therefore, according to the syringe for a dispenser described in Patent Document 1, the nozzle cap is provided with a needle-shaped protrusion that serves as the blocking portion to block the passage for discharging the silver paste at the nozzle of the cylinder.

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CITATION LIST

Patent Literature

[0004] PTL 1: JP 2003-175353 A

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SUMMARY

(Technical Problem)

[0005] As described in PTL 1, suppressing entry of air into the nozzle of a syringe filled with silver paste or the like is important. Therefore, there is demand for a filling method and a filling device for a syringe that are able to suppress entry of air into the nozzle, that is, mixing of air bubbles into the nozzle, during paste filling.

[0006] When a syringe with air entered into the nozzle is defoamed using a centrifugal force defoamer or the like to defoam the syringe for use, a dispersion state of the silver paste or the like may become non-uniform (for example, uneven distribution of silver particles).

[0007] Further, when the nozzle cap is provided with a needle-shaped protrusion that serves as a blocking portion to block the passage for discharging silver paste at the nozzle of the cylinder, as in the syringe for a dispenser described in PTL 1, air may be mixed into the nozzle when the nozzle cap is removed from the nozzle. Therefore, there is demand for a filling method and a filling device for a syringe that are able to suppress mixing of air bubbles into the nozzle during use.

[0008] In view of the above situation, it would be helpful to provide a filling method and a filling device for a syringe that are able to suppress mixing of air bubbles into the nozzle.

(Solution to Problem)

[0009] A filling method according to the present disclosure is:

a filling method for filling a syringe with paste, the syringe including a body, a nozzle, and a cap to be filled with the paste, the body having a cylindrical shape, the nozzle being provided to a tip of the body and having a cylindrical shape thinner than the body, and the cap being externally fitted over the tip of the nozzle and having a bottomed cylindrical shape, the syringe being configured to discharge the paste from an opening of the tip of the nozzle, the filling method comprising:

a filling process of discharging the paste from a filling nozzle and filling an interior space of the body and the nozzle with the paste, wherein

in the filling process, discharging the paste from the filling nozzle is started in a state where the filling nozzle has been inserted into a cylinder interior of the nozzle.

[0010] The filling method according to the present disclosure may further comprise:

an insertion process of inserting the filling nozzle into the cylinder

interior of the nozzle via a cylinder interior of the body, wherein

the filling process is performed after the insertion process is completed.

[0011] The filling method according to the present disclosure may be further defined such that:

5 in the insertion process, the filling nozzle is inserted into the cylinder interior of the nozzle until a tip of the filling nozzle protrudes from the opening of the tip of the nozzle, and

 in the filling process, discharging the paste from the filling nozzle is started when the tip of the filling nozzle is protruding from the opening of the
10 tip of the nozzle.

[0012] The filling method according to the present disclosure may be further defined such that:

the filling process includes,

 a first filling process in which the paste is discharged from the
15 filling nozzle at a first discharge rate while the filling nozzle is pulled out of the nozzle at a first withdrawal rate, and

 a second filling process in which the paste is discharged from the filling nozzle at a second discharge rate while the filling nozzle is pulled out of the nozzle or the body at a second withdrawal rate, wherein

20 the second withdrawal rate is slower than the first withdrawal rate, and
 the second discharge rate is the same as or faster than the first discharge rate.

[0013] The filling method according to the present disclosure may be further defined such that:

25 the second withdrawal rate is increased as the filling nozzle is withdrawn from the nozzle.

[0014] The filling method according to the present disclosure may be further defined such that:

 in the insertion process, the tip of the filling nozzle is inserted along
30 an inner wall of the nozzle.

[0015] A filling device according to the present disclosure is:

 a filling device configured to fill a syringe with paste, the syringe including a body, a nozzle, and a cap to be filled with the paste, the body having a cylindrical shape, the nozzle being provided to a tip of the body and having
35 a cylindrical shape thinner than the body, and the cap being externally fitted over the tip of the nozzle and having a bottomed cylindrical shape, the syringe

being configured to discharge the paste from an opening of the tip of the nozzle, the filling device comprising:

a filling nozzle configured to discharge the paste and fill an interior space of the body and the nozzle with the paste; and

5 a controller configured to control the discharge of the paste by the filling nozzle, wherein

the controller is configured to cause the discharge of the paste from the filling nozzle to start in a state where the filling nozzle has been inserted into a cylinder interior of the nozzle, in order to fill the interior space of the body
10 and the nozzle with the paste.

[0016] The filling device according to the present disclosure may be further defined such that:

the controller is configured to cause insertion of the filling nozzle into the cylinder interior of the nozzle via a cylinder interior of the body until a tip
15 of the filling nozzle protrudes from the opening of the tip of the nozzle, and to cause the discharge of the paste from the filling nozzle to start when the tip of the filling nozzle is protruding from the opening of the tip of the nozzle, in order to fill the interior space of the body and the nozzle with the paste.

(Advantageous Effect)

20 **[0017]** The filling method and the filling device for a syringe that are able to suppress mixing of air bubbles into the nozzle are provided.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] In the accompanying drawings:

25 FIG. 1 illustrates a configuration of a syringe;

FIG. 2 is a diagram for explanation of a configuration of a filling device according to an embodiment;

FIG. 3 is a partial magnification for explanation of a structure of a syringe tip;

30 FIG. 4 is an illustrative diagram of a filling nozzle inserted into a syringe;

FIG. 5 is a function block diagram of a filling device according to an embodiment;

35 FIG. 6 is an illustrative diagram of a filling method according to an embodiment;

FIG. 7 is a time chart in a filling method according to an embodiment;

FIG. 8 is an illustrative diagram of a filled state of a filled syringe;

FIG. 9 is an illustrative diagram of a nozzle of a filled syringe with a cap removed;

FIG. 10 is a diagram for explanation of a configuration of a filled syringe with a rear end opening sealed; and

FIG. 11 is another time chart of a filling method according to an embodiment.

DETAILED DESCRIPTION

[0019] Filling methods and filling devices according to embodiments of the present disclosure are described with reference to the drawings.

[0020] (Overview)

FIG. 1 illustrates a syringe 1 as a container using a filling method according to the present embodiment. FIG. 2 illustrates a filling device M that implements the filling method according to the present embodiment.

[0021] The syringe 1 is a container that may be filled with a paste P and is able to discharge the paste P that is filled, as illustrated in FIG. 1. The specific shape of the syringe 1 illustrated in FIG. 1 is only an example to illustrate the present embodiment. This filling method according to the present embodiment may be implemented even when dimensions and dimensional ratios of components of the syringe 1 are different from those illustrated in FIG. 1. Further, the filling device M is able to implement the filling method according to the present embodiment by adding variations to accommodate the dimensions, shapes, and the like of the syringe 1.

[0022] The syringe 1 includes a body 10 that is cylindrical into which the paste P is filled, a nozzle 11 that is cylindrical and thinner than the body 10, provided to a tip of the body 10, and a cap 2 that is bottomed, cylindrical, and externally fitted to the tip of the nozzle 11.

[0023] The syringe 1 is able to discharge the paste P from an opening of the tip of the nozzle 11 in a state where the cap 2 is removed from the nozzle 11.

[0024] The syringe 1 may be fitted with a plunger 18 that is inserted into the cylinder of the body 10. When the syringe 1 is used to discharge the paste P, after removing the cap 2, the plunger 18 is pushed into the cylinder interior of the body 10 to push the paste P filled in the cylinder interior of the body 10 to discharge from the nozzle 11.

[0025] The paste P is filled into the body 10 after the nozzle 11 is sealed by

the cap 2 so that there is no gap between the nozzle 11 and the cap 2, as described below.

5 **[0026]** In the following description, in the syringe 1, viewed from the body 10, the nozzle 11 side is defined as a tip and the opposite side is defined as a rear end.

10 **[0027]** FIG. 2 illustrates the filling device M. The filling device M is a device that fills the syringe 1 with the paste P. FIG. 2 illustrates the syringe 1 attached to the filling device M. FIG. 2 illustrates a case in which a clip 10b that is the rear end of the body 10 is disposed toward an upper side in the vertical direction, and the nozzle 11 that is the tip of the body 10 is disposed toward a lower side in the vertical direction. The filling device M is able to fill the body 10 of the syringe 1, the nozzle 11 of the body 10, and the cap 2 with the paste P.

15 **[0028]** The filling device M includes a filling nozzle 6 that discharges the paste P and fills an interior space S (see FIG. 1) of the body 10 and the nozzle 11 of the syringe 1, and a controller 9 that controls the discharge of the paste P by the filling nozzle 6.

20 **[0029]** According to the present embodiment, the filling device M further includes a tank 3 that stores the paste P to be supplied to the syringe 1, a liquid volume adjuster 4 that adjusts the amount of the paste P supplied from the tank 3 to the filling nozzle 6, a lifter 5 that raises and lowers the filling nozzle 6, a holder 7 that holds the syringe 1, and a support 8 composed of a column and the like that supports the lifter 5 and the holder 7.

25 **[0030]** In the following explanation, when describing the vertical orientation of the filling device M, upward orientation in the vertical direction is defined as up or upper and downward orientation is defined as down or lower. In the case of FIG. 2, the tip of the syringe 1 corresponds to the lower side of the filling device M, and the rear end of the syringe 1 corresponds to the upper side of the filling device M.

30 **[0031]** The controller 9 causes the paste P to start discharging from the filling nozzle 6 in a state where the filling nozzle 6 has been inserted into the cylinder interior of the nozzle 11 of the syringe 1, and causes filling of the interior space S (see FIG. 1) of the body 10 and the nozzle 11 of the syringe 1 with the paste P.

35 **[0032]** (Detailed explanation)

As illustrated in FIG. 1, the body 10 is a resin container made of

polyolefin or the like. The body 10 has the interior space S that may be filled with the paste P.

[0033] The body 10 includes: a straight body portion 10a that is cylindrical; the nozzle 11 formed at the tip of the straight body portion 10a; a sleeve 12
5 formed at the tip of the straight body portion 10a, fitted outside the nozzle 11, having a cylindrical shape, and having a threaded portion 13 on a cylinder wall surface; and a clip portion 10b formed at the rear end of the straight body portion 10a. The straight body portion 10a, the nozzle 11, the sleeve 12, and the clip portion 10b are integrally molded by injection molding or the like. The
10 body 10 is preferably transparent to make the state of the paste P visually observable from outside and so that whether the paste P is properly filled or not may be checked from outside. The present embodiment describes a case in which the body 10 is transparent. Hereinafter, in the interior space S, space inside the cylinder of the straight body portion 10a is also referred to as space
15 S1 (see FIG. 3).

[0034] The straight body portion 10a, as an example, has an outer diameter from 10 mm to 20 mm. Further, length in the direction along the axial center Y is about 60 mm to 120 mm. Further, wall thickness is from 0.5 mm to 2 mm. The outer diameter, the length, and the wall thickness are only examples of
20 shape and size of the straight body portion 10a, and the present embodiment is not limited to these examples of shape and size.

[0035] The clip portion 10b has a rib shape at the rear end of the straight body portion 10a, extending radially outward from the body 10. The clip portion 10b is formed to improve the ease of use of the syringe 1 (usable for gripping and
25 supporting the syringe 1 during use) and may be omitted from the syringe 1.

[0036] The nozzle 11 is a cylindrical member that discharges the paste P filled in the body 10. The nozzle 11 is slightly tapered from the rear end to the tip. The outer diameter of the nozzle 11 is smaller than that of the straight body portion 10a. The cylinder interior of the nozzle 11 is connected to the cylinder
30 interior of the straight body portion 10a. Hereinafter, in the interior space S, space inside the cylinder of the nozzle 11 is also referred to as space S2 (see FIG. 3).

[0037] The nozzle 11 according to the present embodiment is formed to extend in the direction of the axial center Y from the tip of a tapered portion 10c
35 formed on the tip of the straight body portion 10a, as illustrated in FIG. 3. The nozzle 11 has a slightly decreasing outer diameter from the rear end to the tip,

and the tip is narrowed. The axial center X of the nozzle 11 is aligned with the axial center Y of the straight body portion 10a. As an example, according to the present embodiment, the axial center X overlaps with the axial center Y and is coaxial.

5 **[0038]** The nozzle 11 has an outer diameter from 3 mm to 6 mm, for example. Further, the inner diameter is from 2 mm to 4 mm. Further, length in the direction along the axial center X is about 8 mm to 15 mm. Further, wall thickness is from 0.5 mm to 2 mm. The outer diameter and the like are only examples of shape and size of the nozzle 11, and the present embodiment is not
10 limited to these examples of shape and size. According to the present embodiment, the inner diameter of the nozzle 11 is 2.4 mm, as an example.

[0039] The sleeve 12 is a fixed seat for fixing the cap 2, as illustrated in FIG. 3. The sleeve 12 is cylindrical in shape and is provided to the tip of the straight body portion 10a, with the nozzle 11 in position to fit inside the cylinder of the
15 sleeve 12. The sleeve 12 is formed to be coaxial with the axial center X of the nozzle 11. According to the present embodiment, the outer diameter of the sleeve 12 is formed to be smaller than that of the straight body portion 10a, but the outer diameter of the sleeve 12 may be larger than that of the straight body portion 10a. The inner circumferential surface of the cylinder of the sleeve 12
20 has, as an example, a threaded portion 13 formed as a double thread (a female thread according to the present embodiment).

[0040] The cap 2 is a resin bottomed cylindrical lid member made of polyolefin or the like. The cap 2 is transparent according to the present embodiment. The cap 2 is preferably transparent so that the state of the paste
25 P may be visually monitored from the outside, but the cap 2 is not limited to being transparent.

[0041] The cap 2 includes a cap portion 20 that is a bottomed cylinder that seals a tip 11a of the nozzle 11, and an engagement portion 21 that serves as a knob for attaching and detaching the cap 2 and engaging with a device for
30 detaching the cap 2 or the like. The cylinder interior of the cylinder of the cap portion 20 may be shaped so that the inner diameter decreases slightly from the rear end to the tip and the tip is narrow, or conversely, the inner diameter may increase from the rear end to the tip. The inner circumferential surface of the cylinder of the cap portion 20 is formed to align with the outer
35 circumferential surface of the nozzle 11.

[0042] As an example, a cap-side thread 23 is formed on the outer

circumferential surface of the cap portion 20, which may be screwed into the threaded portion 13 of the sleeve 12. The cap-side thread 23 is a double thread (a male thread according to the present embodiment). According to the present embodiment, the cap 2 may be screwed into the sleeve 12 and secured to the body 10 by a screw connection to the sleeve 12. The cap 2 is externally fitted over the tip of the nozzle 11 in such a screwed connection or similar, to seal the opening of the tip of the nozzle 11.

[0043] In a sealed state in which the cap 2 is externally fitted over the tip of the nozzle 11, the nozzle 11 fits inside the cylinder of the cap portion 20. In this case, the inner circumferential surface of the cylinder of the cap portion 20 contacts at least partially with the outer circumferential surface of the nozzle 11 to seal the tip 11a of the nozzle 11.

[0044] In the sealed state in which the cap 2 is externally fitted over the tip of the nozzle 11, the tip 11a of the nozzle 11 and a cylinder bottom 20a in the cylinder of the cap portion 20 are separated from each other. According to the present embodiment, the tip 11a of the nozzle 11 and the cylinder bottom 20a are separated by a distance h greater than an inner diameter d of the tip 11a of the nozzle 11. According to the present embodiment, the distance h between the tip 11a and the cylinder bottom 20a is defined as the maximum distance from the tip 11a to the cylinder bottom 20a in the direction along the axial center X . The distance h is preferably greater than or equal to the inner diameter d of the nozzle 11, as described below. The distance h being three times or less than the inner diameter d is usually sufficient. According to the present embodiment, the distance h is 3.0 mm and the inner diameter d is 1.5 mm. A tip surface of the nozzle 11 (in FIG. 3, the tip side surface of the tip 11a, the end surface of the cylinder of the nozzle 11) is separated from the inner surface of the cap portion 20 of the cap 2. Between the tip 11a and the cylinder bottom 20a, a cap space $S3$ is formed.

[0045] One example of the paste P illustrated in FIG. 1 is a thermally conductive electrically conductive adhesive in which fine silver particles are dispersed in a solvent, base resin, or the like as a conductive filler. Such silver paste is used, for example, as a bonding material (die bond material) to adhere semiconductor devices to lead frames, substrates, or the like. The paste P as a thermally conductive electrically conductive adhesive contains, as an example, a base resin such as epoxy resin, acrylic resin, or the like, a curing agent for the base resin, a thermoplastic resin, organic solvent, and the like in addition

to fine silver particles. An example of the average particle size of the fine silver particles (average of the circle-equivalent particle size calculated from the area of each particle determined by electron microscope image analysis) is from 10 nm to 50 μ m. The particle size distribution of the fine silver particles may be one peak or two or more peaks. The particle size distribution of the fine silver particles may, for example, have peaks in less than submicron (300 nm) ranges and greater than 1 μ m ranges. The shape of the fine silver particles is not limited to a specific shape and may be spherical, a rugby ball shape, a needle shape, a flake shape, or other irregular shape. Silver pastes may contain metal oxide particles other than fine silver particles, such as zinc oxide, tin oxide, indium oxide, composite oxides of tin and bismuth, and the like. The paste P is, for example, a particle dispersion of the fine silver particles having a viscosity of about 5 Pas to 90 Pas and a thixotropy of about 1.0 to 11.5.

[0046] The viscosity of the paste P may be measured by a regular viscosity torque (RVT) viscometer, a high viscosity torque (HVT) viscometer or a cone-plate (E-type) viscometer. When the viscosity of the paste P is 50 Pas or more, a value measured by an HVT viscometer or an E-type viscometer is preferably adopted, and the viscosity may be measured at 25 °C with the rotor speed at 10 rpm. The thixotropy may be obtained by dividing a value of viscosity measured at 25 °C with the rotor speed at 10 rpm by a value of viscosity measured at 25 °C with the rotor speed at 50 rpm. When the viscosity of the paste P is 5 Pas or more and less than 50 Pas, a value measured by an E-type viscometer is preferably adopted, and the viscosity may be measured at 25 °C with the rotor speed at 5 rpm. The thixotropy may be obtained by dividing a value of viscosity measured at 25 °C with the rotor speed at 0.5 rpm by a value of viscosity measured at 25 °C with the rotor speed at 5 rpm.

[0047] As illustrated in FIG. 2, the syringe 1 is filled with the paste P in the body 10 and the cap 2 by the filling device M after the opening of the tip of the nozzle 11 is sealed by screwing the cap 2 to the sleeve 12. According to the present embodiment, as described below, the paste P is filled into the space S1, the space S2, and the cap space S3 of the syringe 1 illustrated in FIG. 3.

[0048] According to the present embodiment, after filling the syringe 1 with the paste P, the plunger 18 and a sealing lid 19 are inserted in this order from a rear end opening to seal the rear end opening, as illustrated in FIG. 1. The syringe 1 thus becomes a paste-filled container and may be used as a supply container (also referred to as a cartridge) for the paste P in an application

machine, adhesive device, or the like that uses the paste P. A filling state of the paste P in the syringe 1 is described below.

[0049] As illustrated in FIG. 2, the filling device M includes: the controller 9 as a central control mechanism; the holder 7 that holds the syringe 1 to which the paste P is supplied; the lifter 5 equipped with a cylinder 50 that may be lifted and lowered along the axial center Y of the straight body portion 10a of the body 10; a position detector 59 that detects a lift position of the cylinder 50; the filling nozzle 6 that is lifted and lowered by the cylinder 50 and supplies the paste P into the syringe 1 to fill the syringe 1; the tank 3 that stores the paste P to be supplied to the filling nozzle 6; a liquid volume adjuster 4 that supplies the paste P from the tank 3 to the filling nozzle 6 and adjusts the amount of the paste P supplied; a pressure detector 49 that detects the pressure of the paste P supplied from the liquid volume adjuster 4; and a support 8 that supports these components.

[0050] In the filling device M, from the upper side to the lower side, the lifter 5 and the tank 3, the liquid volume adjuster 4, and the filling nozzle 6 are arranged in this order.

[0051] The controller 9 is a functional unit that controls the operation of the filling device M and serves as a central control mechanism of the filling device M. The controller 9 receives information pertaining to operation status and detection status from each component and sensor of the filling device M, and sends operation commands to each component to control operations. Details of the controller 9 are described below.

[0052] The holder 7 is a jig that holds the syringe 1 to which the paste P is supplied. The holder 7, for example, is cylindrical in shape and holds the syringe 1 by insertion of the body 10 of the syringe 1 into the cylinder interior of the holder 7. According to the present embodiment, the holder 7 holds the syringe 1 so that the axial center Y of the straight body portion 10a of the body 10 is along the vertical direction.

[0053] The lifter 5 is a lifting mechanism for lifting and lowering the filling nozzle 6. The lifter 5 includes, as an example, a drive mechanism such as an air cylinder, electric actuator, servo motor, other motor, and the like. According to the present embodiment, the lifter 5 includes the cylinder 50 that may be driven by the drive mechanism to lift and lower the straight body portion 10a of the body 10 in a direction along the axial center Y of the body 10 (according to the present embodiment, the vertical direction). The cylinder 50 is, for

example, a slide mechanism that is driven by the drive mechanism described above, to adjust and control the lift position, and which achieves lifting and lowering operations through sliding motion. According to the present embodiment, the cylinder 50 is driven up and down by an air cylinder, as an example. As described below, the filling nozzle 6 is lifted and lowered via the tank 3 fixed to the cylinder 50 and the liquid volume adjuster 4 fixed to the tank 3.

[0054] The position detector 59 is a measurement device such as a position sensor that detects the lift position of the filling nozzle 6 due to the lifter 5.

The position detector 59 may be optical, use pressure, or use any other position detection principle. According to the present embodiment, the position detector 59 includes an optical position sensor, detects the lift position (distance traveled) of the cylinder 50, and sends position information based on the results of the detection to the controller 9. The controller 9 is able to calculate the lift position of the filling nozzle 6 based on the position information sent from the position detector 59 and is able to control the lift position of the filling nozzle 6 with the lifter 5. The controller 9 is able to calculate the lifting rate of the filling nozzle 6 based on the position information and is able to control the lifting rate of the filling nozzle 6 with the lifter 5.

[0055] The filling nozzle 6 is a nozzle device for discharging the paste P to fill the syringe 1 with the paste P. The filling nozzle 6 is connected downstream of the liquid volume adjuster 4. The filling nozzle 6 is detachably fixed and, for example, suspended from the liquid volume adjuster 4. According to the present embodiment, the filling nozzle 6 includes a nozzle base 60 that is connected to the liquid volume adjuster 4 and suspended and fixed to the liquid volume adjuster 4, and a needle 61 that is nozzle shaped and connected to the lower end of the nozzle base 60.

[0056] The nozzle base 60 is a cylindrical member inside which the paste P is able to flow. The nozzle base 60 supplies the paste P supplied from the liquid volume adjuster 4 to the needle 61. The nozzle base 60 has, for example, a straight cylindrical shape.

[0057] As illustrated in FIG. 4, the needle 61 discharges the paste P supplied from the nozzle base 60 into the straight body portion 10a of the body 10, the nozzle 11 of the body 10, and the cap 2, filling the interiors with the paste P. The needle 61 is, for example, a straight cylindrical shape. The outer diameter of the cylinder of the needle 61 is narrower than the outer diameter of the

nozzle base 60. The outer diameter of the cylinder of the needle 61 is narrower than the inner diameter of the cap portion 20 of the cap 2. The needle 61 is, for example, fixed to the nozzle base 60.

5 **[0058]** The filling nozzle 6 may be prepared in advance by combining various sizes and shapes of the nozzle base 60 and the needle 61. An appropriate size and shape of the filling nozzle 6 may be selected according to the size and shape of the syringe 1.

10 **[0059]** The filling nozzle 6 is lifted and lowered by the lifter 5 and the needle 61 is inserted into the cylinder interior of the body 10 from the rear end of the body 10, as illustrated in FIG. 2. The filling nozzle 6 is lifted and lowered by the lifter 5, allowing a tip 62 of the needle 61 to protrude further than the tip 11a of the nozzle 11 and into the cylinder of the cap portion 20, as illustrated in FIG. 4. In other words, the tip 62 is able to advance and withdraw in a range from the opening at the rear end of the body 10 to the inside of the cylinder of
15 the cap portion 20.

20 **[0060]** According to the present embodiment, various lengths and thicknesses (inner or outer diameter) of the needle 61 of the filling nozzle 6 may be attached, detached, and replaced at will, relative to the nozzle 11. In other words, the needle 61 is arbitrarily interchangeable to correspond to the dimensions and shape of the syringe 1.

25 **[0061]** The needle 61, as an example, has an outside diameter from 1.5 mm to 2.5 mm. Further, the inner diameter is from 1.0 mm to 2.0 mm. Further, wall thickness is from 0.15 mm to 0.40 mm. The outer diameter and the like are only examples of shape and size of the needle 61, and the present embodiment is not limited to these examples of shape and size. The length of the needle 61 along the axial direction of the cylinder is longer than the length along the axial center X of the nozzle 11 and, for example, is from 130 % to 250 % of the length along the axial center X of the nozzle 11. According to the present embodiment, the needle 61 is described as having an inner diameter of 1.5 mm.

30 **[0062]** As illustrated in FIG. 2, the tank 3 is a storage container that stores the paste P to be supplied to the syringe 1 by the filling nozzle 6. Supply of the paste P from the tank 3 to the filling nozzle 6 may be performed by pressure feeding using, for example, compressed air pressure or the like supplied from a compressor A. Compressed air supplied from the compressor A is supplied to
35 the tank 3, with pressure and flow adjusted by a regulator 41 and a regulator 42, described below. The tank 3 supplies the paste P to the filling nozzle 6 via

the liquid volume adjuster 4. According to the present embodiment, the tank 3 is fixed to the cylinder 50, which is lifted and lowered by liquid pressure by the lifter 5.

5 **[0063]** The liquid volume adjuster 4 is a supply volume adjustment mechanism that adjusts the amount of the paste P supplied from the tank 3 to the filling nozzle 6. The liquid volume adjuster 4 includes a valve 40, such as an aperture adjustment valve, that is able to switch between allowing and prohibiting the supply of the paste P from the tank 3 to the filling nozzle 6, and is also able to
10 6. According to the present embodiment, the liquid volume adjuster 4 further includes the regulator 41 that reduces the pressure of compressed air supplied from the compressor A and the regulator 42 that adjusts the flow rate or the pressure of compressed air supplied from the compressor A to the tank 3.

15 **[0064]** The valve 40 adjusts the feed pressure of the paste P supplied from the tank 3 to the filling nozzle 6. According to the present embodiment, the valve 40 adjusts the amount of the paste P supplied to the filling nozzle 6 by reducing the feed pressure of the paste P pressure fed from the tank 3. As examples, an adjustable aperture diaphragm valve or a needle valve may be used as the valve 40.

20 **[0065]** The liquid volume adjuster 4 is fixed to the lower end of the tank 3. The filling nozzle 6 is fixed to the lower end of the liquid volume adjuster 4. The tank 3, the liquid volume adjuster 4, and the filling nozzle 6 are integrally lifted and lowered by the cylinder 50 of the lifter 5.

25 **[0066]** The pressure detector 49 is a pressure sensor or other pressure detection device that detects the pressure of the paste P flowing from the liquid volume adjuster 4 to the filling nozzle 6. The pressure detector 49 may be piezoelectric, diaphragmatic, or use any other pressure detection principle. According to the present embodiment, the pressure detector 49 includes a piezoelectric pressure sensor, detects pressure of the paste P downstream of the valve 40 (upstream
30 of the filling nozzle 6) (feed pressure), and sends pressure information based on the detection result to the controller 9. The controller 9 controls the liquid volume adjuster 4 based on the pressure information output by the pressure detector 49 to control the feed pressure of the paste P, thereby adjusting the amount of the paste P discharged from the filling nozzle 6. According to the
35 present embodiment, the amount of the paste P discharged from the filling nozzle 6 is determined by the length and the inner diameter of the cylinders of

the nozzle base 60 and the needle 61, in addition to the feed pressure. Therefore, according to the present embodiment, the controller 9 adjusts the amount of the paste P discharged from the filling nozzle 6 by taking into account information about the length and the inner diameter of the cylinders of the nozzle base 60 and the needle 61 in addition to the pressure information.

[0067] The controller 9 is realized as hardware or software by a central processing unit (CPU) or a program (software) that causes the CPU to realize control of the filling device M (control to implement the filling method described below). According to the present embodiment, the controller 9 is realized by a computer C, such as a personal computer or programmable logic controller (PLC), and control software stored in a memory 90, as illustrated in FIG. 5. The controller 9 is connected to the liquid volume adjuster 4, the lifter 5, the pressure detector 49, the position detector 59, and the like through a communication channel N, which consists of ports, buses, wired or wireless networks (including the Internet), and the like. As the memory 90, any storage device or storage medium that may be used in the computer C, including flash memory such as Universal Serial Bus (USB) memory, a hard disk, a solid-state drive (SSD), an optical disk such as a compact disc read-only memory (CD-ROM), or the like may typically be used.

[0068] The following is a description of a program stored in the memory 90 illustrated in FIG. 5, with reference to FIG. 1 through FIG. 4.

[0069] The memory 90 stores a program that causes the CPU (the controller 9) of the computer C or the like to realize a control causing execution of a filling process in which the liquid volume adjuster 4 causes discharge of the paste P from the filling nozzle 6 to fill the interior space S of the body 10 (the straight body portion 10a) and the nozzle 11 with the paste P, and a control such that, in the filling process, discharging the paste P from the filling nozzle 6 is started in a state where the filling nozzle 6 has been inserted into the cylinder interior of the nozzle 11.

[0070] Further, the memory 90 stores a program that causes the CPU (the controller 9) of the computer C or the like to realize a control causing execution of an insertion process in which the lifter 5 inserts the filling nozzle 6 into the cylinder interior of the nozzle 11 via the cylinder interior of the body 10 (the straight body portion 10a) based on position information, and a control causing execution of the filling process described above after the insertion process is completed.

[0071] Further, the memory 90 stores a program that causes the CPU (the controller 9) of the computer C or the like to realize a control causing execution of the insertion process described above such that the filling nozzle 6 is inserted into the cylinder interior of the nozzle 11 until the tip (the tip 62) of the filling nozzle 6 protrudes from the opening of the tip 11a of the nozzle 11, and a control such that, in the filling process described above, the discharge of the paste P from the filling nozzle 6 is started when the tip (the tip 62) of the filling nozzle 6 is protruding from the opening of the tip 11a of the nozzle 11.

[0072] Further, the memory 90 stores a program that causes the CPU (the controller 9) of the computer C or the like to realize a control causing execution of the filling process described above, such that, based on position information, a first filling process is executed in which the paste P is discharged from the filling nozzle 6 at a first discharge rate while the filling nozzle 6 is pulled out of the nozzle 11 at a first withdrawal rate, and a second filling process is executed in which the paste P is discharged from the filling nozzle 6 at a second discharge rate while the filling nozzle 6 is pulled out of the nozzle 11 at a second discharge rate. The second withdrawal rate is controlled to be slower than the first withdrawal rate, and the second discharge rate is controlled to be the same as the first discharge rate or slower than the first discharge rate, based on the pressure information.

[0073] Further, the memory 90 stores a program that causes the CPU (the controller 9) of the computer C or the like to realize the execution of control of the second withdrawal rate described above to increase the second withdrawal rate as the filling nozzle 6 is withdrawn from the nozzle 11.

[0074] (Explanation of filling method)

Filling of the paste P into the syringe 1 is performed by executing each of the following processes performed by the filling device M.

[0075] First, as illustrated in FIG. 6, the controller 9 executes an insertion process in which the lifter 5 inserts the filling nozzle 6 into the cylinder interior of the nozzle 11 via the cylinder interior of the body 10 (the cylinder interior of the straight body portion 10a). According to the present embodiment, the filling nozzle 6 is inserted into the cylinder interior of the nozzle 11 until the tip 62 of the needle 61 of the filling nozzle 6 protrudes from the opening of the tip 11a of the nozzle 11 (point A in FIG. 6). The tip 62 preferably protrudes from the opening of the tip 11a of the nozzle 11 by 16.7 % or more and 90 % or less of the distance h. The tip 62 preferably protrudes from the opening of

the tip 11a of the nozzle 11 by a distance that is 33.4 % or more of the inner diameter d of the nozzle 11. According to the present embodiment, the tip 62 protrudes 2.5 mm from the opening of the tip 11a of the nozzle 11. The needle 61 is preferably inserted into the nozzle 11 with the longitudinal direction of the needle 61 aligned with the axial center X of the nozzle 11. The needle 61 is more preferably inserted into the nozzle 11 with the longitudinal direction of the needle 61 overlapping the axial center X of the nozzle 11.

[0076] After the insertion process described above is completed, the controller 9 causes the liquid volume adjuster 4 to start supplying the paste P and discharging the paste P from the filling nozzle 6 to fill the space S1, the space S2, and the cap space S3 of the syringe 1 with the paste P.

[0077] In the filling process, discharging of the paste P from the needle 61 is started in a state where the needle 61 of the filling nozzle 6 has been inserted into the cylinder interior of the nozzle 11. In the filling process according to the present embodiment, discharging the paste P from the filling nozzle 6 is started when the tip 62 of the filling nozzle 6 is protruding from the opening of the tip 11a of the nozzle 11. Accordingly, the interior space S and the cap space S3 may be filled with the paste P.

[0078] In the filling process, the controller 9 controls the lifter 5 to pull the filling nozzle 6 out of the body 10 while the liquid volume controller 4 discharges the paste P from the filling nozzle 6. Accordingly, the interior space S may be filled with the paste P. When the controller 9 causes the tip 62 of the filling nozzle 6 to be pulled to a defined position (point C in FIG. 6) in the straight body portion 10a of the body 10, the controller 9 causes the liquid volume adjuster 4 to stop supplying the paste P to the filling nozzle 6 and to stop discharging the paste P from the filling nozzle 6 (see FIG. 6).

[0079] In the filling process, the controller 9 executes an initial filling process, the first filling process, and the second filling process. FIG. 7 illustrates a time chart of operations performed by the filling device M. In FIG. 7, the horizontal axis indicates process time. The following explanation is provided with reference to FIG. 2 through FIG. 7.

[0080] The graph at the top of FIG. 7 indicates change over time of feed pressure of the paste P adjusted by the liquid volume adjuster 4.

[0081] The graph at the bottom of FIG. 7 indicates change over time of the position of the tip 62 of the filling nozzle 6, which is advanced and withdrawn by the lifter 5. The position of the tip 62 in FIG. 7 is indicated by the distance

between the tip surface of the nozzle 11a and the tip surface of the tip 62, where the tip surface of the nozzle 11a and the tip surface of the tip 62 overlapping in the vertical direction is zero, the tip surface of the tip 62 being upward from the tip surface of the nozzle 11a in the vertical direction is positive, and the tip surface of the tip 62 being downward from the tip surface of the nozzle 11a in the vertical direction is negative. In FIG. 7, the point A is a distance indicated by a negative value, meaning that the needle 61 is in the nozzle 11 and the tip surface of the tip 62 is downward from the tip surface of the tip 11a in the vertical direction.

10 **[0082]** In the initial filling process, the controller 9 causes the tip 62 of the filling nozzle 6 to remain at the point A (a state in which withdrawal of the filling nozzle 6 is stopped), sets the paste P feed pressure to pressure p1 (an example of the first discharge rate) by the liquid volume adjuster 4, and causes discharging of the paste P from the filling nozzle 6 to start (time t0 in FIG. 7).
15 The controller 9 starts executing the first filling process when at least the cap space S3 is filled with the paste P and 20 % or more of a range of distance along the axial direction from the tip of the nozzle 11 of the interior space S is filled (time t1 in FIG. 7). An example of the time period during which the paste P is discharged from the filling nozzle 6 while the withdrawal of the filling
20 nozzle 6 is stopped (the time from time t0 to t1 in FIG. 7) is from 0.2 s or more to 0.5 s or less. According to the present embodiment, an example of 0.3 s is described.

[0083] According to the present embodiment, the paste P is discharged while the tip 62 is protruding from the opening of the tip 11a of the nozzle 11 by a
25 distance of 16.7 % or more to 90 % or less of the distance h and 33.4 % or more of the inner diameter d of the nozzle 11, and therefore the Paste P is filled while minimizing mixing of air bubbles in the interior space S and the cap space S3.

[0084] Further, according to the present embodiment, the controller 9 starts
30 executing the first filling process when at least the cap space S3 is filled with the paste P and 20 % or more of a range of distance along the axial direction from the tip of the nozzle 11 of the interior space S is filled, so that the tip 62 is embedded in the paste P, as described below.

[0085] Thus, when the cap space S3 is filled with the paste P, the tip 62 is
35 embedded in the paste P. This suppresses (including the concept of preventing; the same applies hereinafter) mixing of air bubbles into the paste P filled in

the process of filling the paste P and thereafter. The point A (see FIG. 6) is selected in a range between the tip 11a of the nozzle 11 and the cylinder bottom 20a of the cap portion 20 in the vertical direction. The pressure p1 is set to be 200 kPa or more and 500 kPa or less, as an example. An appropriate value of the pressure p1 and the range thereof depends on the shape of the flow path in the filling nozzle 6 (for example, the inner diameter and length of the needle 61) and may be changed as required. According to the present embodiment, the pressure p1 is set at 350 kPa as an example.

[0086] In the first filling process, the controller 9 causes the tip 62 of the filling nozzle 6 to be pulled from the point A to point B (see FIG. 6) at the first withdrawal rate by the lifter 5, while causing the paste P to be discharged from the filling nozzle 6 at the pressure p1. As illustrated in FIG. 7, the withdrawal rate of the filling nozzle 6 is indicated by the slope of the line L, which represents the change in position of the tip 62 of the filling nozzle 6. The first withdrawal rate corresponds to the slope of line L from time t1 to time t2. The point B is selected from a range of the cylinder interior of the nozzle 11 in the vertical direction. According to the present embodiment, the distance from the point A to the point B is 5 mm.

[0087] The first withdrawal rate is set to a rate at which the tip 62 remains embedded in the paste P, in relation to the viscosity and surface tension of the paste P. As illustrated in FIG. 6, maintaining a state in which the tip 62 is embedded in the paste P suppresses mixing of air bubbles into the paste P that is filled. The first withdrawal rate is preferably set to the same rate as the rate at which the liquid level of the paste P rises in the nozzle 11 during filling. An example of the first withdrawal rate is from 8 mm/s or more and 20 mm/s or less. According to the present embodiment, the first withdrawal rate is 15 mm/s, as an example.

[0088] In the second filling process, as illustrated in FIG. 7, the controller 9 causes the tip 62 of the filling nozzle 6 to be pulled from the point B to the point C (see FIG. 6) at the second withdrawal rate slower than the first withdrawal rate by the lifter 5, while causing the paste P to be discharged from the filling nozzle 6 at the pressure p1 (an example when the second discharge rate is the same as the first discharge rate). The second withdrawal rate corresponds to the slope of the line L from time t2 to time t3. When the tip 62 reaches the point C, the controller 9 ends filling (ends the filling process) (time t3). The syringe 1 when filling is complete becomes a filled container with the

paste P filling the space S1, the space S2, and the cap space S3, as illustrated in FIG. 6 and FIG. 8.

[0089] The second withdrawal rate is set to, for example, 50 % or more and 90 % or less of the first withdrawal rate. An example of the second withdrawal rate is 5 mm/s or more and 15 mm/s or less. According to the present embodiment, the second withdrawal rate is 15 mm/s, as an example. The second withdrawal rate is set to a rate at which the tip 62 remains embedded in the paste P, in relation to the viscosity and surface tension of the paste P. Maintaining a state in which the tip 62 is embedded in the paste P suppresses mixing of air bubbles into the filled paste P. The second withdrawal rate is preferably a rate that allows the tip 62 to remain embedded in the paste P until the filling process is completed. The second withdrawal rate is preferably set to, for example, the same rate as the rate at which the liquid surface of the paste P rises in the straight body portion 10a during filling, to ensure that the tip 62 remains embedded in the paste P until the filling process is completed.

[0090] According to the present embodiment, after the filling process is completed, for example, the withdrawal rate of the filling nozzle 6 is temporarily slower than the second withdrawal rate, and the tip 62 is slowly withdrawn from the filled paste P. Accordingly, dripping of the paste P from the tip 62 is suppressed, and mixing of air bubbles into the filled paste P is suppressed. Subsequently, the withdrawal rate may be accelerated to completely withdraw the filling nozzle 6 from the body 10. Processing time may be reduced by accelerating withdrawal.

[0091] The appropriate ranges of the first withdrawal rate and the second withdrawal rate depend on the size and shape of the syringe 1 (for example, the inner diameter of the body 10 and the nozzle 11), are not limited to the specific speed examples above, and may be set as appropriate for the size and shape of the syringe 1.

[0092] With reference to FIG. 8, the syringe 1 when pre-filled is described in detail as a pre-filled container. As described above, the syringe 1 is filled with the paste P in the space S1, the space S2, and the cap space S3. In the syringe 1 that is pre-filled, a space between the tip surface of the cylinder of the tip 11a and the cap 2 in the cap space 3, that is, a boundary portion 20b that is a space in proximity to a boundary between the tip 11a of the nozzle 11 and the inner cylindrical surface of the cap portion 20 (a portion where the tip 11a of the nozzle 11 and the cap portion 20 touch, or an intermediate position between

the tip 11a of the nozzle 11 and the cap portion 20), is also filled with paste P. Here, "in proximity", with respect to the definition of the boundary portion 20b, is a distance within the wall thickness of the cylinder of the tip 11a.

[0093] In the syringe 1, the space S2 and the cap space S3 are filled with the paste P, which suppresses mixing of air bubbles in the nozzle 11 when the syringe 1 is used (for example, when the syringe 1 with the cap 2 removed is mounted on an application device that uses the paste P from the syringe 1, and the nozzle part 11 is connected to the application device). Accordingly, when using the paste P in the syringe 1, the occurrence of problems such as empty shots and impairment of uniformity and application workability of the silver paste are suppressed. Further, operations such as pushing out and discarding a certain amount of the paste P in the nozzle 11 to remove air bubbles that have entered the nozzle 11 are no longer necessary, and the paste P may be used without waste. Therefore, in a case where the paste P is expensive, such as silver paste, the economic benefit is extremely large.

[0094] In the syringe 1, the paste P is particularly filled in the cap space S3, which suppresses mixing of air bubbles into the nozzle 11 when the cap 2 is removed. As illustrated in FIG. 9, in the syringe 1, when the paste P is filled in the cap space S3 and the cap 2 is removed, a portion P1 of the paste P in the cap space S3 remains protruding from the tip 11a of the nozzle 11 (adhered to and remaining on the tip 11a). Accordingly, mixing of air (air bubbles) into the cylinder of the nozzle 11 when the cap 2 is removed is suppressed.

[0095] In order to increase the effectiveness of the suppression of mixing of air (bubbles) into the cylinder of the nozzle 11 when the cap 2 is removed, the tip 11a of the nozzle 11 and the cylinder bottom 20a are preferably separated by the distance h equal to or more than the inner diameter d of the tip 11a of the nozzle 11, as illustrated in FIG. 3. Accordingly, the cap space S3 is large enough to secure a volume of the paste P to be filled into the cap space S3, thereby securing the formation of the portion P1 of the paste P (see FIG. 9) that remains protruding from the tip 11a of the nozzle 11 when the cap 2 is removed. The distance h, which is equal to or more than the inner diameter d of the tip 11a of the nozzle 11, promotes the formation of the portion P1 of the paste P that remains protruding from the tip 11a of the nozzle 11 when the cap 2 is removed. Accordingly, mixing of air (air bubbles) into the cylinder of the nozzle 11 when the cap 2 is removed is suppressed.

[0096] In the syringe 1 that is filled, in the cap space S3, the boundary portion

20b between the tip 11a of the nozzle 11 and the inner circumferential surface of the cap portion 20 is also filled with the paste P, which further ensures suppression of mixing of air (air bubbles) into the cylinder of the nozzle 11 when the cap 2 is removed. This is because when the cap 2 is removed, the
5 paste P in the boundary portion 20b moves to the inside of the nozzle 11, making entry of air (air bubbles) into the cylinder of the nozzle 11 less likely. The paste P in the boundary portion 20b also promotes the formation of the portion P1 of the paste P that remains protruding from the tip 11a of the nozzle 11. Accordingly, mixing of air (air bubbles) into the cylinder of the nozzle 11
10 when the cap 2 is removed is suppressed.

[0097] In particular, the paste P has a defined viscosity and thixotropy, and therefore when the cap 2 is removed, the paste P in the nozzle 11 (in the interior space S) does not flow out (drip), as illustrated in FIG. 9. With the movement of the paste P from the boundary portion 20b described above, the formation
15 of the portion P1 of the paste P protruding further from the tip than the tip 11a of the nozzle 11 is promoted. This action also suppresses mixing of air (air bubbles) into the cylinder of the nozzle 11 when the cap 2 is removed.

[0098] The syringe 1 that is filled is preferably shipped in a state where the rear end opening is sealed by insertion of the plunger 18 and the sealing lid 19
20 in this order from the rear end opening, as illustrated in FIG. 10. The syringe 1 is then used as a supply container for the paste P in an application machine, adhesive device, or the like that uses the paste P.

[0099] The syringe 1 that is filled does not require defoaming treatment (for example, using centrifugal force) in the application machine, adhesive device,
25 or the like that uses the paste P, because mixing of air bubbles is suppressed. Accordingly, work efficiency when in use is improved. Further, the occurrence of dispersion bias due to defoaming and resulting performance degradation may be avoided. In particular, preventing performance degradation caused by dispersion bias in highly blended paste P is a great advantage. For example,
30 the dispersion state of the paste P blended so that the particle size distribution of fine silver particles has two or more peaks is easily biased by a defoaming operation.

[0100] As described above, the filling method and the filling device for a syringe that are able to suppress mixing of air bubbles into the nozzle are
35 provided.

[0101] (Other embodiments)

(1) According to the embodiment described above, the paste P is discharged from the filling nozzle 6 at the pressure p1 in the second filling process. However, as illustrated in FIG. 11, in the second filling process, the paste P may be discharged from the filling nozzle 6 at a pressure p2 higher than the pressure p1 (an example in which the second discharge rate is faster than the first discharge rate). Accordingly, the processing time required to fill the syringe 1 may be reduced. The pressure p2 is set to be 300 kPa or more and 500 kPa or less, as an example. An appropriate value of the pressure p2 and the range thereof depends on the shape of the flow path in the filling nozzle 6 (for example, the inner diameter and length of the needle 61) and may be changed as required.

[0102] (2) According to an embodiment described above, an example is described where the axial center X of the nozzle 11 is aligned with the axial center Y of the straight body portion 10a, and in particular, an example is described where the axial center X is coaxial with the axial center Y. However, the axial center X need not be coaxial with the axial center Y, and may be only aligned with the axial center Y. Even when the axial center X is not coaxial with the axial center Y, the needle 61 is insertable into the nozzle 11 with the longitudinal direction thereof aligned with (for example, overlapping with) the axial center X of the nozzle 11.

[0103] (3) According to an embodiment described above, an example is described where the axial center X of the nozzle 11 is aligned with the axial center Y of the straight body portion 10a. However, the axial center X does not have to be aligned with the axial center Y. In such a case, filling is possible by making the needle 61 flexible, for example by forming the needle 61 from a flexible material, and inserting the needle 61 into the nozzle 11 along the inner wall of the nozzle 11 (for example, while sliding against the inner wall surface of the nozzle 11).

[0104] (4) According to an embodiment described above, an example is described where when the controller 9 causes the tip 62 of the filling nozzle 6 to be pulled to a defined position (the point C in FIG. 6) in the straight body portion 10a of the body 10, the controller 9 causes the liquid volume adjuster 4 to stop supplying the paste P to the filling nozzle 6 and to stop discharging the paste P from the filling nozzle 6. However, the timing to stop discharging the paste P is not limited to the timing when the tip 62 is pulled out to the point C. For example, a weight detection sensor may be provided to the holder 7 to

enable detection of the weight of the syringe 1, and the discharge of the paste P may be stopped when the weight of the syringe 1 filled with the paste P reaches a defined weight.

5 [0105] (5) According to an embodiment described above, an example is described where the liquid volume adjuster 4 includes the valve 40, such as an aperture adjustment valve, able to adjust the amount of the paste P supplied from the tank 3 to the filling nozzle 6 and prohibit the feeding of the paste P to the filling nozzle 6, the valve 40 being able to adjust the amount of the paste P supplied from the tank 3 to the filling nozzle 6 by adjusting the feed pressure
10 of the paste P. However, adjustment of the feed pressure of the paste P is not limited to the example described above.

[0106] For example, the liquid volume adjuster 4 may control only the supplying and stopping of the paste P at the valve 40, and adjustment of the feed pressure of the paste P may be performed by adjustment of the flow rate
15 or pressure of compressed air supplied to the tank 3 by the regulator 42, based on pressure information detected by the pressure detector 49. The method and manner of adjusting the feed pressure of the paste P by the liquid volume adjuster 4 is not limited to the embodiments described above.

[0107] (6) According to an embodiment described above, a case is described
20 where the filling nozzle 6 is inserted into the cylinder interior of the nozzle 11 until the tip 62 of the needle 61 of the filling nozzle 6 protrudes from the opening of the tip 11a of the nozzle 11, and discharging the paste P from the filling nozzle 6 is started when the tip 62 of the filling nozzle 6 is protruding from the opening of the tip 11a of the nozzle 11. However, the position at which
25 the paste P is started to be discharged is not limited to the above example. For example, the tip 62 of the needle 61 of the filling nozzle 6 may be inserted into the cylinder interior of the nozzle 11 (for example, the tip surface of the tip 62 is at the same position as the tip surface of the tip 11a in the direction along the axial center X), and discharging of the paste P from the filling nozzle 6
30 may be started in a state with the tip 62 of the filling nozzle 6 located in the cylinder interior of the nozzle 11. As long as the filling nozzle 6 is able to fill the interior space S and the cap space S3 with the paste P, mixing of air (air bubbles) into the cylinder of the nozzle 11 when the cap 2 is removed may be suppressed.

35 [0108] (7) According to an embodiment described above, a case is described where the paste P is a thermally conductive electrically conductive adhesive in

which fine silver particles are dispersed in a solvent, base resin, or the like as a conductive filler. However, the paste P is not limited to cases in which a conductive filler is dispersed. Further, the paste P is not limited to cases where the conductive filler is fine silver particles. Aside from fine silver particles, the filler of the paste P may be dispersed fine metallic particles such as platinum, ruthenium, rhodium, palladium, osmium, iridium, gold, copper, and the like, or fine particles of thermoplastic resins such as acrylic, polyethylene, polypropylene, polystyrene, polyester, and the like.

[0109] Each configuration described according to the above embodiments (including the other embodiments, the same applies hereinafter) may be applied in combination with a configuration described according to another embodiment, as long as no contradiction arises. The embodiments described herein are examples, the present disclosure is not limited to the described examples, and appropriate modifications may be made within a scope that does not depart from the spirit of the present disclosure.

INDUSTRIAL APPLICABILITY

[0110] The present disclosure is applicable to filling methods and filling devices.

REFERENCE SIGNS LIST

- [0111]** 1: Syringe
2: Cap
3: Tank
4: Liquid volume adjuster
5: Lifter
6: Filling nozzle
7: Holder
8: Support
9: Controller
10: Body
10a: Straight body portion
10b: Clip portion
10c: Tapered portion
11: Nozzle
11a: Tip

	12:	Sleeve
	13:	Threaded portion
	18:	Plunger
	19:	Sealing lid
5	20:	Cap portion
	20a:	Cylinder bottom
	20b:	Boundary portion
	21:	Engagement portion
	23:	Cap-side thread
10	40:	Valve
	41:	Regulator
	42:	Regulator
	49:	Pressure detector
	50:	Cylinder
15	59:	Position detector
	60:	Nozzle base
	61:	Needle
	62:	Tip
	90:	Memory
20	A:	Compressor
	C:	Personal computer
	L:	Line
	M:	Filling device
	N:	Communication channel
25	P:	Paste
	P1:	Portion
	S:	Interior space
	S1:	Space
	S2:	Space
30	S3:	Cap space
	X:	axial center
	Y:	axial center
	d:	Inner diameter
	h:	Distance
35	p1:	Pressure
	p2:	Pressure

CLAIMS

[Claim 1] A filling method for filling a syringe with paste, the syringe including a body, a nozzle, and a cap to be filled with the paste, the body having a cylindrical shape, the nozzle being provided to a tip of the body and having a cylindrical shape thinner than the body, and the cap being externally fitted over the tip of the nozzle and having a bottomed cylindrical shape, the syringe being configured to discharge the paste from an opening of the tip of the nozzle, the filling method comprising:

an insertion process of inserting a filling nozzle into a cylinder interior of the nozzle via a cylinder interior of the body; and

a filling process of discharging the paste from the filling nozzle and filling an interior space of the body and the nozzle with the paste, wherein

in the insertion process, the filling nozzle is inserted into the cylinder interior of the nozzle until a tip of the filling nozzle protrudes from the opening of the tip of the nozzle,

the filling process is performed after the insertion process is completed, and

in the filling process, discharging the paste from the filling nozzle is started when the tip of the filling nozzle is protruding from the opening of the tip of the nozzle.

[Claim 2] The filling method according to claim 1, wherein

the filling process includes,

a first filling process in which the paste is discharged from the filling nozzle at a first discharge rate while the filling nozzle is pulled out of the nozzle at a first

withdrawal rate, and

a second filling process in which the paste is discharged from the filling nozzle at a second discharge rate while the filling nozzle is pulled out of the nozzle or the body at a second withdrawal rate, wherein

the second withdrawal rate is slower than the first withdrawal rate, and

the second discharge rate is the same as or faster than the first discharge rate.

[Claim 3] The filling method according to claim 2, wherein the second withdrawal rate is increased as the filling nozzle is withdrawn from the nozzle.

[Claim 4] The filling method according to any one of claims 1 to 3, wherein in the insertion process, the tip of the filling nozzle is inserted along an inner wall of the nozzle.

[Claim 5] A filling device configured to fill a syringe with paste, the syringe including a body, a nozzle, and a cap to be filled with the paste, the body having a cylindrical shape, the nozzle being provided to a tip of the body and having a cylindrical shape thinner than the body, and the cap being externally fitted over the tip of the nozzle and having a bottomed cylindrical shape, the syringe being configured to discharge the paste from an opening of the tip of the nozzle, the filling device to be coupled with the syringe, comprising:

a filling nozzle configured to discharge the paste and fill an interior space of the body and the nozzle of the syringe with the paste; and

a controller configured to control the discharge of the paste by the filling nozzle,

wherein

the controller is configured to cause insertion of the filling nozzle into a cylinder interior of the nozzle via a cylinder interior of the body of the syringe until a tip of the filling nozzle protrudes from the opening of the tip of the nozzle of the syringe, and to cause the discharge of the paste from the filling nozzle to start when the tip of the filling nozzle is protruding from the opening of the tip of the nozzle of the syringe, in order to fill the interior space of the body and the nozzle of the syringe with the paste.