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Tool for Processing Meltable Substances

The invention relates to a tool for processing, in particular for cutting and spreading, meltable substances, especially fat-based substances, such as vegetable or animal fats.

Knives are known that can hold hot water inside their handle, which is in thermal contact with the knife blade. In this way, the knife blade can be kept sufficiently hot over a certain period of time to cut and spread a chilled and therefore relatively hard fat mass, such as butter from a refrigerator, without requiring much effort.

There are also known knives that can accommodate an electric battery inside their handle, which is connected in a heating circuit together with an electric heating element. The electric heating element is in thermal contact with the knife blade. This allows the knife blade to be kept sufficiently hot for a certain period of time so that it can be used to cut and spread a chilled and therefore relatively hard fat, such as butter from a refrigerator, without much effort.

For knives with hot water inside the handle, the time during which the knife blade can be kept sufficiently hot is relatively short. Therefore, the water inside the handle must be reheated after a relatively short time.

In knives with a battery inside the handle, the time during which the knife blade can be kept sufficiently hot is significantly longer. However, the battery inside the handle must be replaced or recharged after a certain period of time. This is cumbersome and costly.

The invention is based on the objective of providing a tool for processing meltable substances, in which a metallic structure of the tool can be maintained at a high and constant temperature over a long period of time, in order to enable the tool to process—in particular, to cut and spread—meltable substances, especially chilled and correspondingly hard fat mixtures, over a long period of time.

To solve this problem, the invention provides a tool (10) for processing—in particular, cutting or spreading—meltable substances, particularly fat mixtures such as vegetable or animal fats, wherein the tool (10) comprises a metallic structure (11, 12) and a handle (14) connected to the metallic structure (11, 12), wherein the metal structure (11, 12) has a first major surface (12a), a second major surface (12b) facing away from the first, and at least one edge (12c, 12d), characterized in that the handle (14) comprises a cavity (16) containing a phase-change material (18), into which a region (13) of the metal structure (11, 12) protrudes and contacts the phase-change material (18).

The metallic structure may be a **metallic tube (11)**. This is suitable for cutting out portions of a meltable mass, wherein the portion size is determined by the internal volume of the metallic tube as well as by the depth to which the metallic tube penetrates the meltable mass.

The metallic structure may be a **metallic blade (12)**. This is suitable for cutting and spreading the meltable mass.

The phase-change material in the cavity of the handle can be brought into a higher-energy state by heating it to a temperature just above the phase-change temperature, in which, in addition to the sensible heat resulting from the temperature increase, the latent heat resulting from the phase change—also known as phase-change heat—is stored. The latent heat stored in a phase-change material is typically many times greater than the sensible heat stored therein. The portion of the metal blade that extends into the phase-change material and contacts it within the cavity of the handle absorbs heat from the phase-change material, thereby heating the entire metal blade.

The heated blade then allows for extended cutting and spreading of chilled and correspondingly hard fat mixtures. In the process, heat continuously flows from the phase-change material via thermal conduction and radiation into the portion of the metal blade that extends into the phase-change material, and then spreads via thermal conduction along the metal blade to its tip. The blade temperature at the tip of the metal blade is only slightly below the temperature of the phase-change material, and the blade temperature averaged over the length of the metal blade is also only slightly below the temperature of the phase-change material.

When cutting and spreading a chilled and correspondingly hard fat mixture, heat continuously transfers from the metal blade into the fat mixture via thermal conduction and

thermal radiation; the temperature of the fat mixture is then raised sufficiently, primarily in the area of contact between the metal blade and the fat mixture, causing the fat mixture to soften in that contact area. This greatly facilitates the cutting and spreading of the fat mass. Since fat masses generally have relatively low thermal conductivity, heat transferred by thermal conduction in the contact area penetrates only a shallow depth into the fat mass. This means that, at least through thermal conduction, only a relatively small amount of heat enters the fat mass.
In other words: the heat from the metal blade creates a softened or molten lubricating layer in the contact area between the metal blade and the fat mass, thereby facilitating the cutting and spreading of the fat mass using the metal blade of the tool according to the invention.

Preferably, the metal structure (11, 12) has at least one opening (12e, 12f) that extends from the first major surface (12a) to the second major surface (12b). The number and size—i.e., cross-sectional area—of these through-openings in the metal blade can be selected to be larger or smaller as needed. If the number and/or cross-sectional area of the openings is large, little heat is transferred from the metal blade to the fat mixture during cutting or spreading. If the number and/or cross-sectional area of the openings is small, a great deal of heat is transferred from the metal blade to the fat mixture during cutting or spreading.

Preferably, the tool has an edge (12c, 12d) on the metal structure that is designed as a cutting edge. The edge of the metal structure, in particular the cutting edge, may be straight or slightly curved. A cutting edge is suitable, for example, for cutting or spreading fat mixture.

Preferably, the tool has an edge (12c, 12d) on the metal structure that is formed as a blunt edge or a rounded edge. A rounded edge is suitable, for example, for spreading the fat mixture.

Preferably, the tool has an edge (12d) on the metal structure that is formed as a serrated edge. This can be a serrated edge with sawtooth profiles. Such an edge allows, for example, the creation of patterns on the spread, applied, or distributed fat mixture when spreading the fat mixture.

Preferably, the metallic structure contains a steel alloy at least in the region of an edge (12c, 12d). As a result, the metallic structure with the steel alloy can also be used to cut conventional materials or substances that, unlike fat masses, do not soften or soften less easily when heated, such as starch, cellulose, keratin, collagen, etc.

Preferably, the metallic structure contains, in the region of an edge (12d), a metallic alloy comprising at least aluminum, copper, silver, or gold. These metals or their alloys have high thermal conductivity, thereby enabling strong heat transfer from the phase-change material along the metallic blade.

Preferably, the metallic structure is composed of multiple layers.
Preferably, the layers lie flat against one another. This enables good heat transfer from layer to layer in a direction transverse to the layer or perpendicular to the longitudinal direction of the metallic blade.

It is particularly advantageous if, during the manufacture of the metallic structure, the multiple layers are applied one after another using an **additive process**.

Preferably, at least one layer of the metal structure is formed from a steel alloy or an aluminum alloy. Both the steel alloy and the aluminum alloy are relatively hard. The aluminum alloy also has relatively high thermal conductivity.

Preferably, at least one layer is a metallic layer containing aluminum, copper, silver, or gold. Although these are all relatively soft, they have very high thermal conductivity. Preferably, these layers lie flat against one another and are connected by form fit and/or friction fit and/or material bond. This enables good heat transfer from layer to layer in a direction transverse to the layer or perpendicular to the longitudinal direction of the metallic structure.

To create a bond by material adhesion between two adjacent metallic layers, it is particularly advantageous for the metallic layers to be applied gradually using an additive process.

Preferably, at least one layer is a layer containing graphite or graphene. Although both of these are very soft, they are highly thermally conductive. Preferably, these layers lie flat against one another and are connected to one another by form fit and/or friction fit and/or material bond. Preferably, the layer containing graphite or graphene is enclosed within the metallic structure, i.e., the metallic structure completely surrounds the layer containing graphite or graphene. This enables good heat transfer or good thermal conductivity from layer to layer in a direction transverse to the layer or perpendicular to the longitudinal direction of the metallic structure.

In a particularly advantageous embodiment, the metallic structure has at least one layer containing a steel alloy or an aluminum alloy, as well as at least one layer containing aluminum, copper, silver, or gold. Preferably, these layers lie flat against one another and are connected to one another by form fit and/or friction fit and/or material bond.
This ensures, on the one hand, the structural stability and hardness of the metallic structure and, on the other hand, enables good heat transfer or thermal conductivity from layer to layer in a direction transverse to the layer or perpendicular to the longitudinal direction of the metallic structure. This results in very good thermal conductivity along the longitudinal direction of the metallic structure.

In a further particularly advantageous embodiment, the metallic structure has at least one layer containing a steel alloy or an aluminum alloy, as well as at least one layer containing graphite or graphene. Preferably, these layers lie flat against one another and are connected to one another by form fit and/or friction fit and/or material bond.
This ensures, on the one hand, the structural stability and hardness of the metallic structure and, on the other hand, enables good heat transfer or thermal conductivity from layer to layer in a direction transverse to the layer or perpendicular to the longitudinal direction of the metallic structure. This results in very good thermal conductivity along the longitudinal direction of the metallic structure.

Preferably, the portion of the metallic structure that extends into the phase-change material also contains at least one layer comprising a steel alloy or an aluminum alloy, as well as at least one layer comprising aluminum, copper, silver, gold, graphite, or graphene. Preferably, these layers or coatings lie flat against one another and are joined together by form fit and/or friction fit and/or material bond.
On the one hand, this ensures the structural stability and hardness of the metallic structure, and on the other hand, it enables good heat transfer or thermal conductivity from layer to layer in a direction transverse to the layer or perpendicular to the longitudinal direction of the metallic structure. This results in very good thermal conductivity along the longitudinal direction of the metallic structure.

Preferably, the phase-change material (18) has a phase-change temperature or a phase-change temperature range that lies between 40°C and 200°C. This allows the tool, or at least its metallic structure, to be placed in boiling water to effect the phase transition from the lower-energy to the higher-energy state of the PWM. When using a phase-change material with a phase-change temperature of more than approximately 100°C, the tool can also be placed in a conventional pressure cooker, where water temperatures of up to 200°C can be generated under elevated pressure, thereby enabling the phase transition from the lower-energy to the higher-energy state even for such phase-change materials.

Preferably, the tool has a **grip sleeve (20)** that can be fitted onto or removed from the handle (14) by a form fit and/or a friction fit.
Preferably, there are protrusions in the form of ridges, nubs, or ribs on the inner surface of the grip sleeve and/or on the outer surface of the handle. This creates an air gap between the fitted grip sleeve and the handle.
Preferably, the grip sleeve contains a heat-insulating material, in particular a textile made of plant or animal fibers, wood, ceramic, paper, cardboard, etc. As a result, very little heat from a phase-change material in its higher-energy state ("charged" PWM) inside the handle reaches the surface of the grip sleeve.

In a first type of phase-change material (18), a transition from solid to solid can occur when the phase-change temperature or phase-change temperature range is crossed.

In a second type of phase-change material (18), a transition from solid to liquid can occur when the phase-change temperature or phase-change temperature range is reached.

Preferably, the handle (14) has a closable opening (15) that leads into the cavity (16). This allows for easy, one-time filling of the cavity with molten PWM. In most cases, the volume of the PWM decreases during the liquid-to-solid transition. In some cases, the volume of the PWM increases during the liquid-to-solid transition. Depending on the type of PWM used, the cavity may be completely filled with the molten PWM, or it may be filled only partially with molten PWM.

Preferably, the phase-change material (18) has a phase-change temperature or a phase-change temperature range that lies between 50°C and 100°C. Wax, in particular beeswax, paraffin, etc., can be used for this purpose. The phase-change temperatures of waxes and paraffins, typically above 50°C, are significantly higher than the phase-change temperatures of vegetable or animal fats, such as butter, cocoa butter, etc. To induce the solid-to-liquid phase transition in the PWM, the metal structure of the mold can be immersed in boiling water to achieve complete melting of the PWM.

Preferably, the cavity (16) is filled with a three-dimensional metal wire structure (19) that makes contact with the portion (13) of the metallic structure (11, 12) protruding into the cavity (16). This metal wire structure may be metal wool, a metal mesh, etc. This greatly increases the thermal conductivity between the metallic structure (11, 12) and the interior of the PWM, so that a sufficient amount of heat is transferred by thermal conduction into the metallic structure (11, 12).

Preferably, a plurality of metallic projections (13a, 13b, 13c, 13d) extend from the portion (13) of the metallic structure (11, 12) protruding into the cavity (16) into the cavity (16). Preferably, the projections are designed as ribs, ridges, pins, or nubs, etc. This, too, greatly increases the thermal conductivity between the metallic structure (11, 12) and the interior of the PWM, so that a sufficient amount of heat is transferred by thermal conduction into the metallic structure.

Preferably, a plurality of metallic projections (13a, 13b, 13c, 13d) extend from the at least one layer containing aluminum, copper, silver, or gold into the cavity (16). This greatly increases the thermal conductivity between the metallic structure (11, 12) and the interior of the PWM, so that a sufficient amount of heat is transferred into the metallic structure by thermal conduction.

Preferably, at least some of the metallic projections (13-1, 13-2, 13-3, 13-4, ..., 13-14) are integral with the layer containing aluminum, copper, silver, or gold. This ensures good thermal conductivity and heat transfer between the Al/Cu/Ag/Au layer and the metallic projections.

Preferably, a plurality of metallic projections (13a, 13b, 13c, 13d) extend from the at least one layer comprising graphite or graphene into the cavity (16). This greatly increases the thermal conductivity between the metallic structure (11, 12) and the interior of the PWM, so that a sufficient amount of heat is transferred to the metallic structure via thermal conduction.

Preferably, at least some of the metallic projections (13a, 13b, 13c, 13d) are pressed together with the layer containing graphite or graphene. This ensures good thermal conductivity or heat transfer between the layer containing graphite or graphene and the metallic projections.

Preferably, the handle (14) of the tool (10) is transparent, at least in certain areas of the handle (14). A user of the tool can therefore see and determine the state of the phase-change material (18), namely whether it is liquid or molten, or whether it is solid or solidified. In the molten state, most solid-to-liquid phase-change materials (e.g., wax) are transparent, whereas in the solidified state they are opaque.

According to a first embodiment, the handle (14) may have a transparent section in the form of a viewing window. By looking through the viewing window, the user of the tool can see and determine the state of the phase-change material (18).

According to a second embodiment, the handle (14) may consist largely—more than 80%, and in particular 100%—of a transparent material.

The user can immerse the tool (10) in a pot of hot, particularly boiling, water, whereby at least the metallic structure (11, 12) must protrude into the hot or boiling water. Heat is thereby supplied to the initially solid or solidified phase-change material (18) inside the handle (14) via the metal structure (11, 12), primarily through thermal conduction, causing the phase-change material (18) to gradually become liquid or melt. The visual change from opaque to transparent during the melting of the phase-change material (18) is clearly visible to the user due to the handle being transparent at least in some areas.

Preferably, the non-transparent or opaque portion of the handle (14) comprises a heat-insulating material, in particular a textile made of plant or animal fibers, wood, ceramic, paper, cardboard, etc. As a result, very little heat from a phase-change material in its higher-energy state ("charged" or molten PWM) inside the handle reaches the outer surface of the handle, thereby increasing user comfort.

List of Reference Symbols

10 Tool

11, 12 metallic structure

11 Metal tube

12 Metal blade

12a First large surface

12b second major surface

12c First edge

12d Second edge

12e First opening

12f Second opening

13 Area of the metal blade (protrudes into PWM)

13a Metal protrusion

13b Metal projection

13c metal protrusion

13d metal protrusion

13-1, 13-2, 13-3, 13-4, ..., 13-14 metallic projections

14 Handle

15 Lockable opening

16 Cavity

18 Phase-change material (PCM)

19 Metal wire structure

20 Handle sleeve

S1 First layer (steel alloy)

S2 Second layer (aluminum, copper, silver, gold, graphite, graphene)

S3 third layer (steel alloy)

Further advantages, features, and possible applications of the invention are evident from the exemplary embodiments shown in the drawing, which are not to be construed as limiting, wherein:

Fig. 1 is a side view of a first embodiment of the tool according to the invention;

Fig. 2 is a side view of a second embodiment of the tool according to the invention;

Fig. 3 is a side view of a third embodiment of the tool according to the invention;

Fig. 4 is a side view of a fourth embodiment of the tool according to the invention;

Fig. 5 is a side view of a fifth embodiment of the tool according to the invention;

Fig. 6 is a side view of a sixth embodiment of the tool according to the invention;

Fig. 7A is a sectional view along the X-X section line of Figures 1 through 6 of the six embodiments of the tool of the invention;

Fig. 7B is a sectional view along the Y-Y section line of Fig. 1 of the first embodiment of the tool according to the invention;

Fig. 7C is a sectional view along the Y-Y section line of Fig. 2 of the second embodiment of the tool according to the invention;

Fig. 7D is a sectional view along the Y-Y section line of Fig. 3 of the third embodiment of the tool according to the invention;

Fig. 7E is a sectional view along the Y-Y section plane of Fig. 4 of the fourth embodiment of the tool according to the invention;

Fig. 7F is a sectional view along the Y-Y section plane of Fig. 5 of the fifth embodiment of the tool according to the invention;

Fig. 7G is a sectional view along the Y-Y section plane of Fig. 6 of the sixth embodiment of the tool according to the invention;

Fig. 8 is an enlarged cross-sectional view corresponding to Fig. 7A along a cross-sectional plane X-X of a seventh embodiment of the tool according to the invention; and

Fig. 9 is a side perspective view of an eighth embodiment of the tool according to the invention.

Claims

1. A tool (10) for processing, in particular cutting or spreading, meltable masses, in particular fat masses such as vegetable or animal fats, wherein the tool (10) comprises a **metallic structure (11, 12)** and a handle (14) connected to the metallic structure (11, 12), wherein the metal structure (11, 12) has a first major surface (12a), a second major surface (12b) facing away from the first, and at least one edge (12c, 12d),
characterized in that the **handle (14)** comprises a cavity (16) containing a phase-change material (18), into which a region (13) of the metallic structure (11, 12) protrudes and contacts the phase-change material (18).

2. A tool according to claim 1, characterized in that the metallic structure is a **metallic tube (11)**.

3. A tool according to claim 1, characterized in that the metallic structure is a **metallic blade (12)**.

4. A tool (10) according to any one of claims 1 through 3, characterized in that the metallic structure (11, 12) has at least one opening (12e, 12f) extending from the first major surface (12a) to the second major surface (12b).

5. A tool (10) according to any one of claims 1 through 4, characterized in that the metal structure (11, 12) has an edge (12c, 12d) that is configured as a cutting edge.

6. A tool (10) according to any one of claims 1 through 5, characterized in that the metallic structure (11, 12) comprises an edge (12c, 12d) that is formed as a blunt edge or a rounded edge.

7. A tool (10) according to any one of the preceding claims, characterized in that it comprises an edge (12d) configured as a serrated edge.

8. A tool (10) according to any of the preceding claims, characterized in that the metal structure (11, 12) comprises a steel alloy at least in the region of an edge (12c, 12d).

9. A tool (10) according to any of the preceding claims, characterized in that the metallic structure (11, 12) is composed of multiple layers (S1, S2, S3).

10. A tool (10) according to claim 8, characterized in that at least one layer (S1, S3) is formed of a steel alloy or an aluminum alloy.

11. A tool (10) according to claim 9 or 10, characterized in that at least one layer (S2) is a metallic layer comprising aluminum, copper, silver, or gold.

12. A tool (10) according to any one of claims 9 through 11, characterized in that at least one layer (S2) is a layer comprising graphite or graphene.

13. A tool (10) according to any one of the preceding claims, characterized in that the phase-change material (18) has a phase-change temperature or a phase-change temperature range that lies between 40°C and 200°C.

14. A tool according to any of the preceding claims, characterized in that it comprises a **grip sleeve (20)** that can be fitted onto or removed from the handle (14) by positive locking and/or frictional locking.

15. A tool (10) according to any of the preceding claims, characterized in that the phase-change material (18) undergoes a transition from solid to liquid when passing through the phase-change temperature or the phase-change temperature range.

16. A tool (10) according to any of the preceding claims, characterized in that the handle (14) comprises a closable opening (15) that opens into the cavity (16).

17. A tool (10) according to any of the preceding claims, characterized in that the phase-change material (18) has a phase-change temperature or a phase-change temperature range that lies between 50°C and 100°C.

18. A tool (10) according to any of the preceding claims, characterized in that the cavity (16) is filled with a three-dimensional metal wire structure (19) that contacts the portion (13) of the metal blade (12) extending into the cavity (16).

19. A tool (10) according to any of the preceding claims, characterized in that a plurality of metallic projections (13a, 13b, 13c, 13d) extend into the cavity (16) from the portion (13) of the metallic blade (12) that protrudes into the cavity (16).

20. A tool (10) according to claim 11, characterized in that a plurality of metallic projections (13a, 13b, 13c, 13d) extend into the cavity (16) from the at least one layer comprising aluminum, copper, silver, or gold.

21. A tool (10) according to claim 20, characterized in that at least a portion of the metallic projections (13-1, 13-2, 13-3, 13-4, …, 13-14) are integral with the layer (S2) comprising aluminum, copper, silver, or gold.

22. A tool (10) according to claim 12, characterized in that a plurality of metallic projections (13-1, 13-2, 13-3, 13-4, …, 13-14) extend into the cavity (16).

23. A tool (10) according to claim 22, characterized in that at least a portion of the projections (13a, 13b, 13c, 13d) are compressed together with the layer (S2) comprising graphite or graphene.

24. A tool (10) according to any of the preceding claims, characterized in that the handle (14) is transparent at least in certain areas of the handle (14).

25. A tool (10) according to claim 24, characterized in that the handle (14) has a transparent portion in the form of a viewing window.

26. Tool (10) according to claim 24, characterized in that the handle (14) is formed largely—by more than 80%, and in particular completely (100%)—from a transparent material.

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Abstract

The invention relates to a tool (10) for processing, in particular cutting or spreading, meltable masses, in particular fat masses such as vegetable or animal fats, wherein the tool (10) comprises a **metallic structure (11, 12)** and a handle (14) connected to the metallic structure (11, 12). The metal structure (11, 12) has a first major surface (12a), a second major surface (12b) facing away from the first, and at least one edge (12c, 12d). The handle (14) has a cavity (16) containing a phase-change material (18), into which a region (13) of the metal structure (11, 12) protrudes and contacts the phase-change material (18).

(Figure 1)

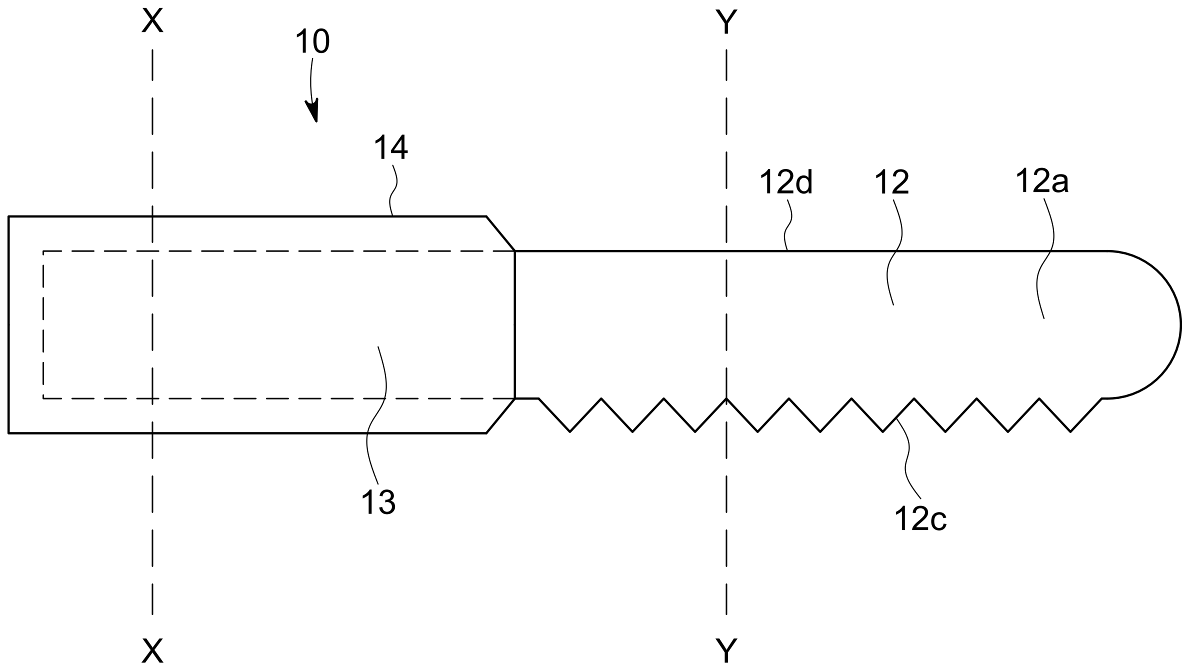

FIG. 1

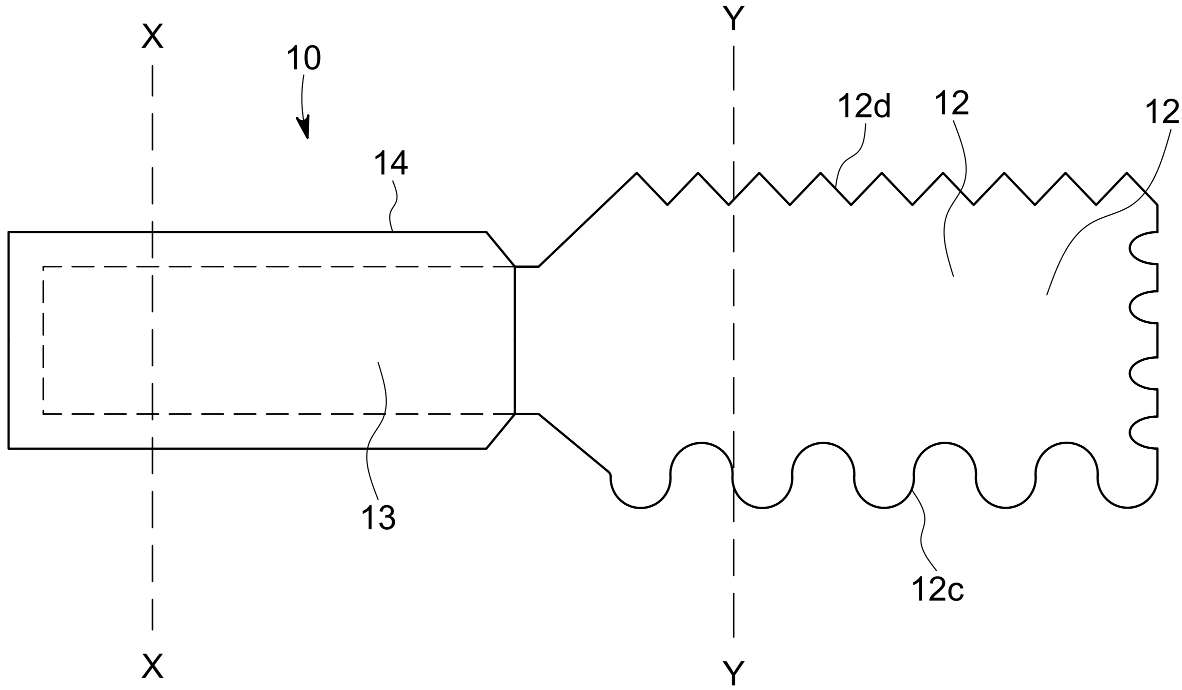

FIG. 2

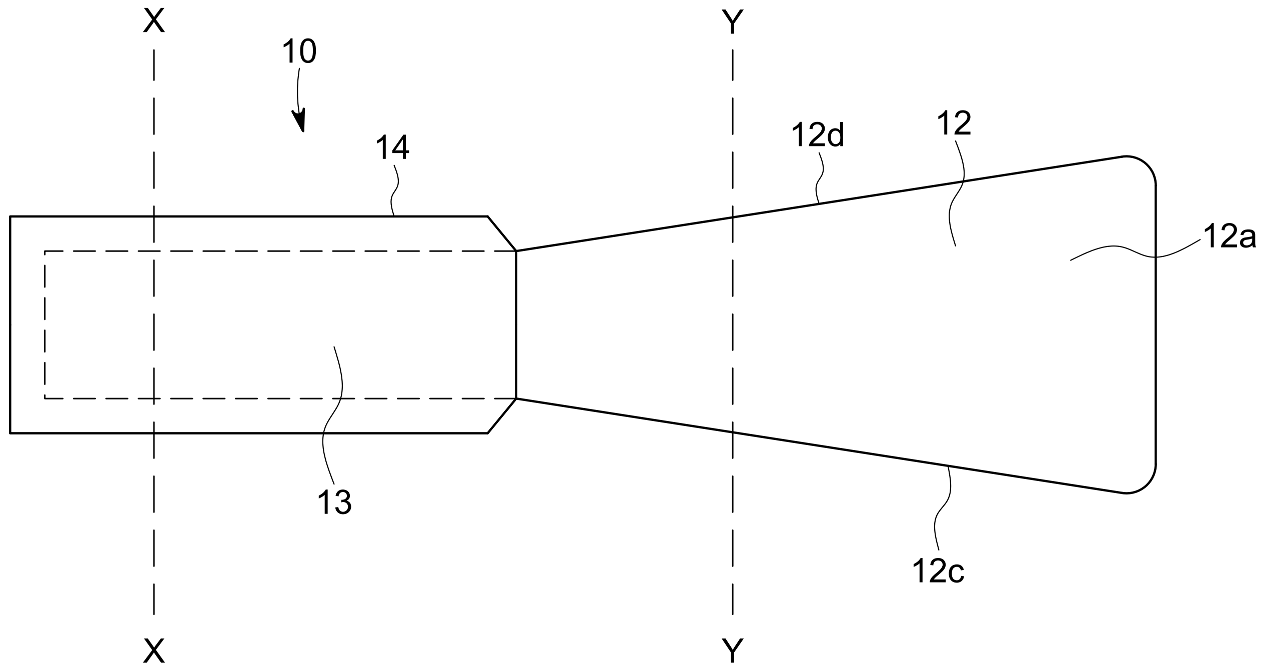

FIG. 3

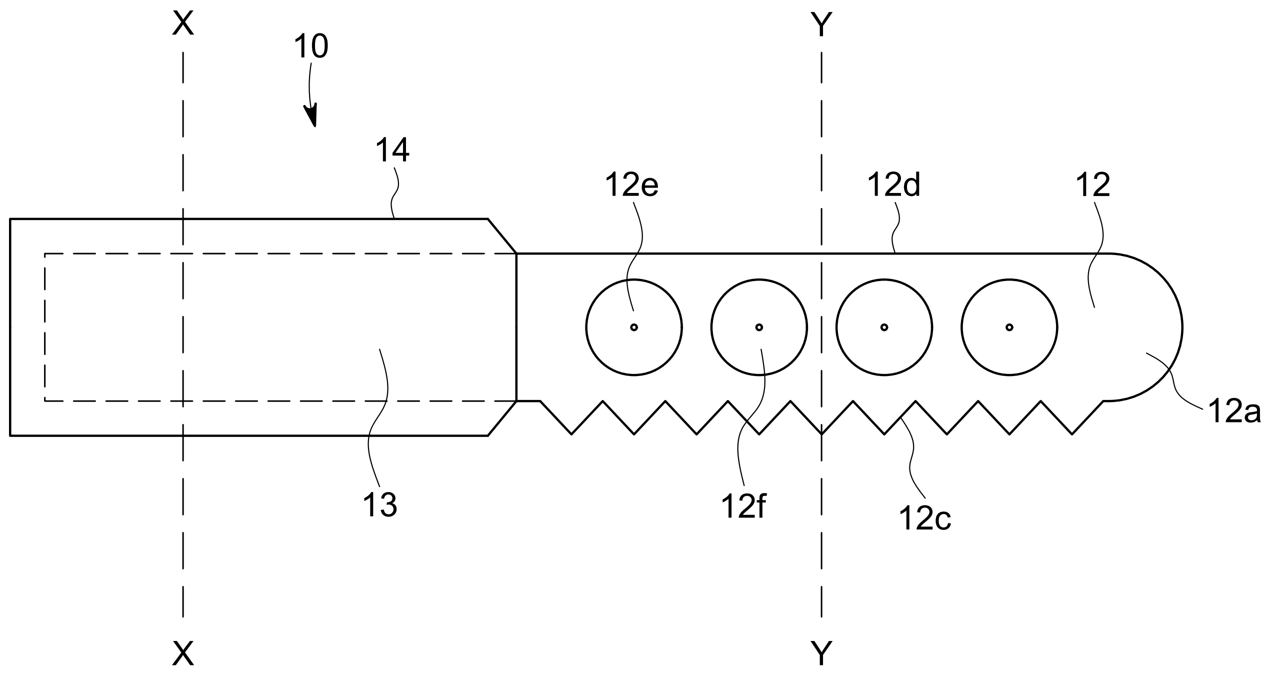

FIG. 4

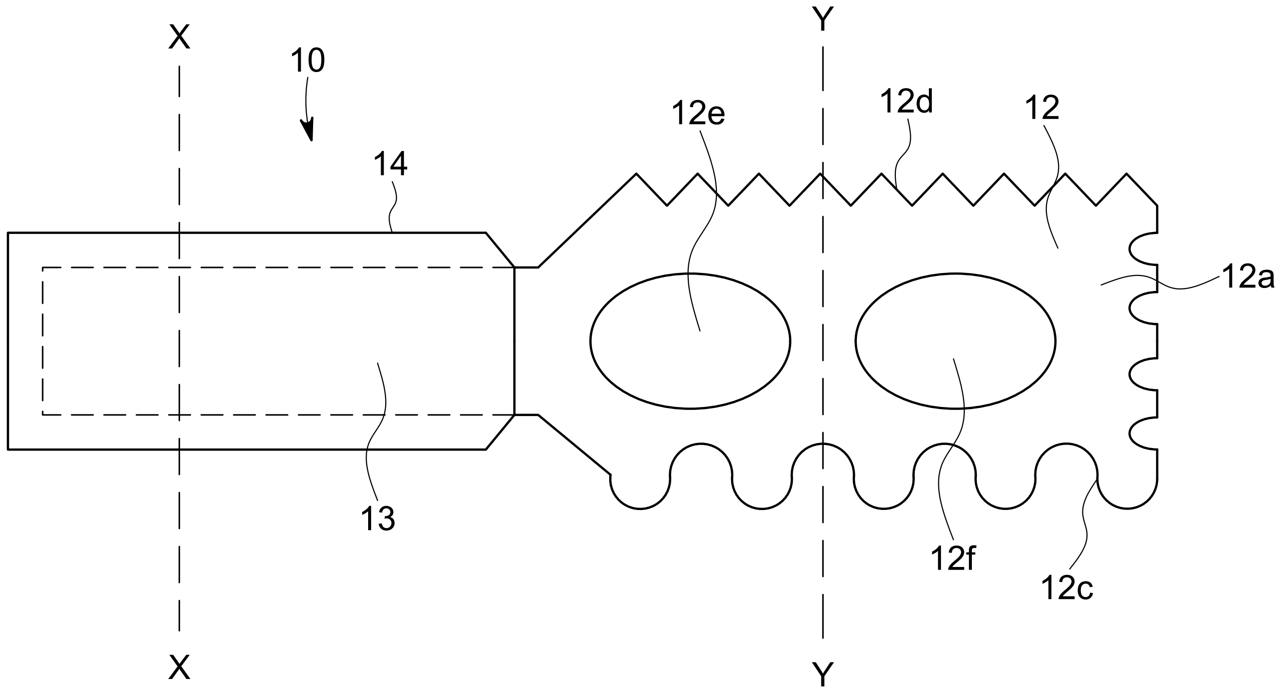
X
10
Y
12e
12d
12
14
12a
13
12f
12c
X
Y

FIG. 5

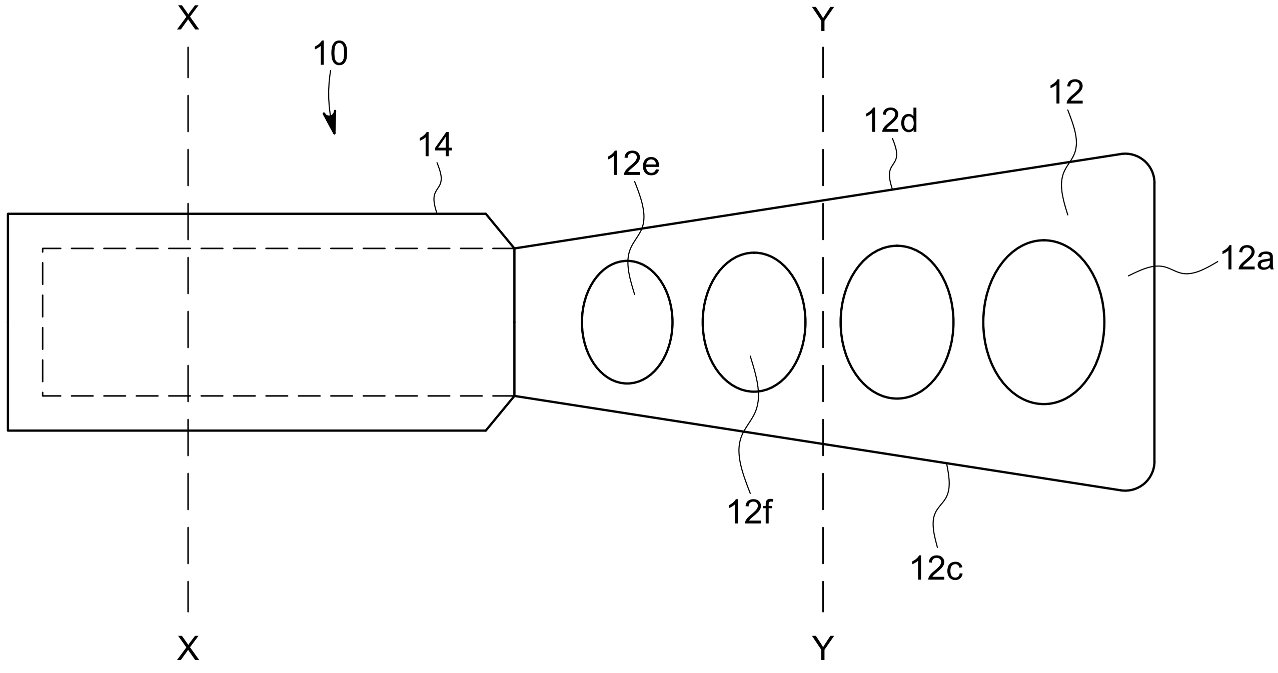
X
Y
10
12
12d
14
12e
12a
12f
12c
X
Y

FIG. 6

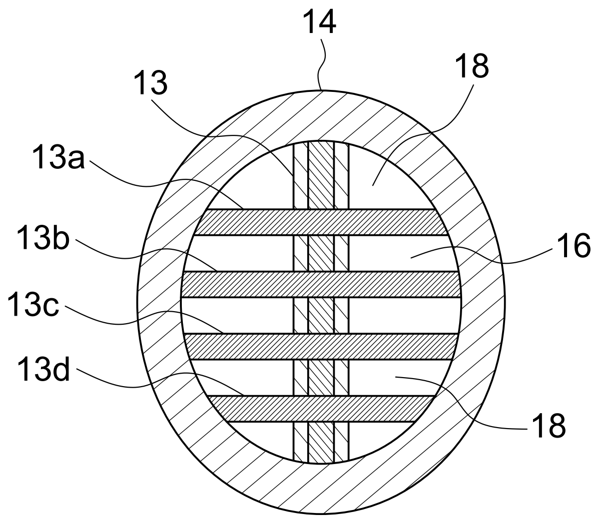

FIG. 7A

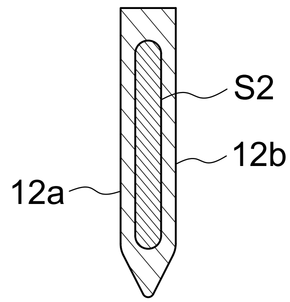

FIG. 7B

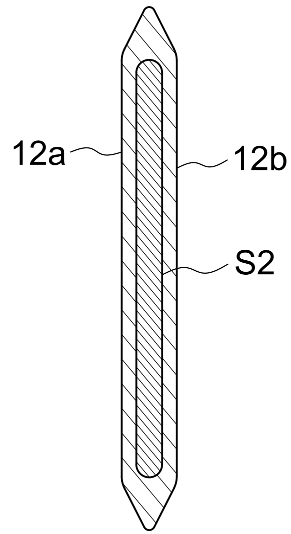

FIG. 7C

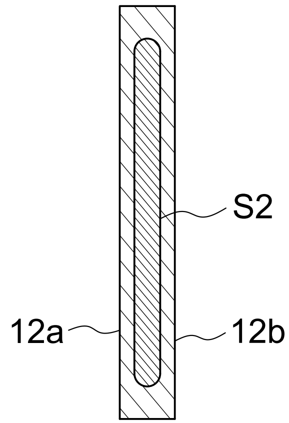

FIG. 7D

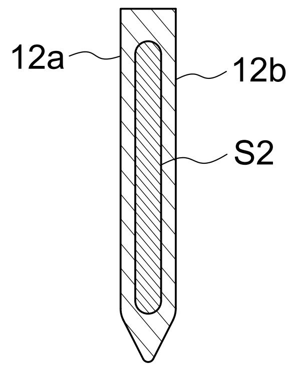

FIG. 7E

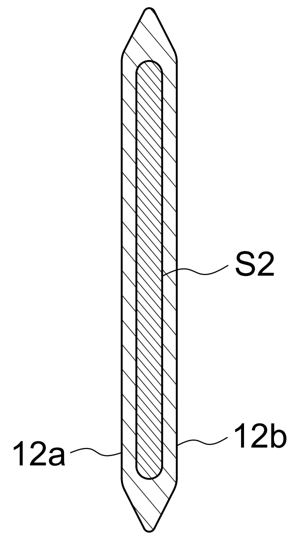

FIG. 7F

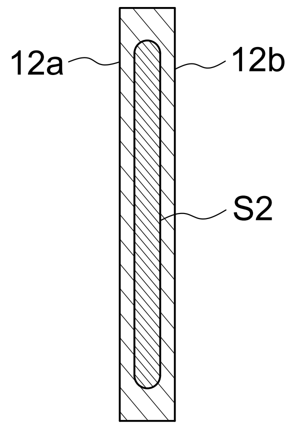

FIG. 7G

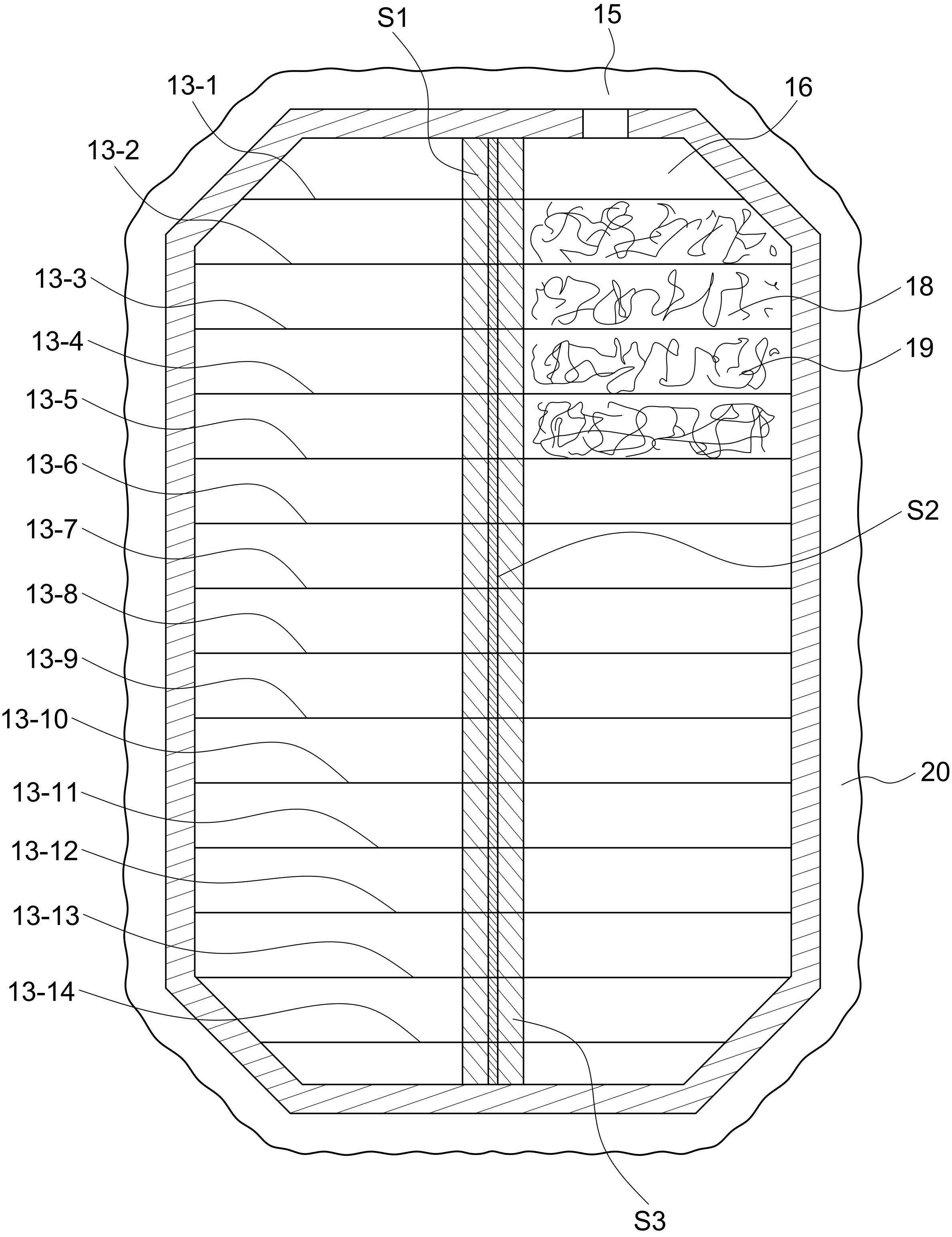
S1
15
13-1
16
13-2
13-3
18
13-4
19
13-5
13-6
13-7
S2
13-8
13-9
13-10
20
13-11
13-12
13-13
13-14
S3

FIG. 8

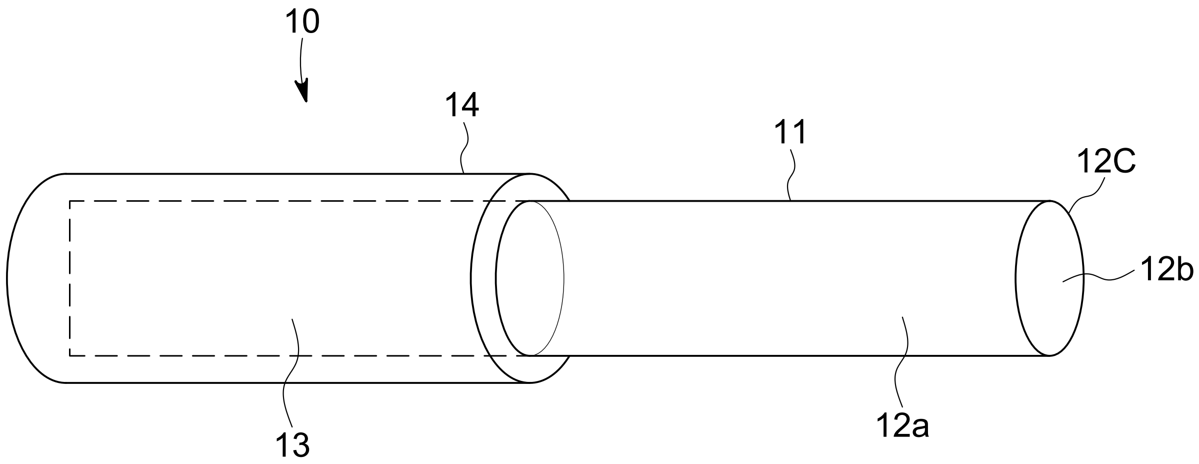

FIG. 9