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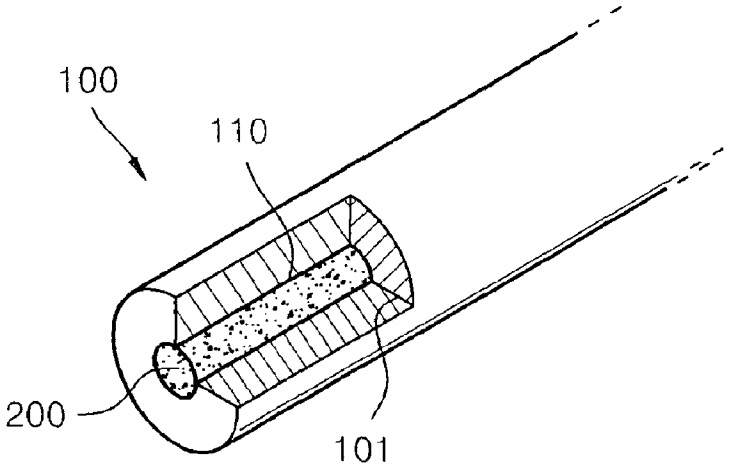
(54) **Titre : MOUSSE, DISPOSITIF SERVANT A PREPARER LA MOUSSE, PROCEDE ET DISPOSITIF SERVANT A PREPARER DE LA MOUSSE METALLIQUE AU MOYEN DE CETTE MOUSSE**
(54) **Title: FOAM, APPARATUS FOR PREPARING THE FOAM, AND METHOD AND APPARATUS FOR PREPARING METAL FOAM USING THE FOAM**



(57) **Abrégé/Abstract:**
A foamed body for continuously supplying a foaming agent to a molten metal is disclosed, the foamed body includes a strip- or rod-shaped matrix made of the same material as the molten metal to form foamed metals, and a foaming agent injected into an injector formed in the matrix lengthwise. Therefore, the present invention can be effectively used for producing qualified foamed metals by supplying the foaming agent while the matrix is melted by supplying the foamed body to the molten metal.

Abstract of the Disclosure

A foamed body for continuously supplying a foaming agent to a molten metal is disclosed, the foamed body includes a strip- or rod-shaped matrix made of the same material as the molten metal to form foamed metals, and a foaming agent injected into an injector formed in the matrix lengthwise. Therefore, the present invention can be effectively used for producing qualified foamed metals by supplying the foaming agent while the matrix is melted by supplying the foamed body to the molten metal.

FOAM, APPARATUS FOR PREPARING THE FOAM, AND METHOD AND APPARATUS FOR PREPARING METAL FOAM USING THE FOAM

Background of the Invention

1. Field of the Invention

The present invention relates to a foamed body and a method for producing foamed metals using the same. More particularly, the present invention relates to a foamed body, which allows continuous production of foamed metals by continuously supplying the foamed body prepared by coating or injecting the foamed body into a molten metal, a method for producing the foamed body, and a method and an apparatus for producing foamed metals using the foamed body.

2. Description of the Related Art

In general, foamed metals contain a number of foams in a metal matrix. Since foamed metals contain lots of foams, they are very light and are excellent in sound absorption, sound insulation and shock absorption.

Accordingly, foamed metals are widely used as an interior finish for construction material for sound absorption and a sound absorption material. In addition, the foamed metals are useful as a material in the manufacture of automobiles, vehicles, ships, etc., using properties of shock absorption and lightness.

Examples of the foamed metals include foamed aluminums. Foamed aluminum commonly has a porosity of above 90%, its specific gravity is within the range of from 0.2 to 1.0. Thus, the foamed metals exhibit superior fire resistance, heat resistance, strength, and workability. Due to these properties, it is expected that the foamed metals can be used as a promising functional material.

Foamed metals are generally produced by injecting gas and a foaming agent to foam a molten metal prepared by heating and melting metal to dispersing foams, and cooling the molten metal with the dispersed foams.

A conventional method and apparatus for continuously producing foamed metals is disclosed in Korean Patent Registration No. 0592533. In the disclosed method and apparatus, the apparatus comprises a viscosity-enhancing furnace

storing molten metal and a viscosity-enhancing agent, an agitator installed at an upper portion of the viscosity-enhancing furnace, for agitating the molten metal and the viscosity-enhancing agent, a foaming furnace for foaming the molten material conveyed from the viscosity-enhancing furnace, a gas pipe for injecting gas into the foaming furnace through a membrane, an electronic agitating device for dispersing/atomizing the gas injected into the foaming furnace, an extruder for extruding the molten metal discharged from a discharge hole of the foaming furnace, and cooling means for cooling the molten metal extruded by the extruder.

In addition, Korean Patent Registration No. 2002-0034327 discloses a method and apparatus for low-pressure continuous production of foamed metals.

The disclosed apparatus includes a viscosity-enhancing furnace, an agitator installed in the viscosity-enhancing furnace, a foaming furnace, a gas pipe for injecting gas into the foaming furnace through a membrane, an extruder and cooling means. The apparatus further includes a gas agitator provided in the foaming furnace to allow the gas injected through the membrane to be uniformly dispersed.

The conventional process has limitations that controlling a gas injection pressure is quite sophisticated because the pressure of gas injected through a membrane must be higher than a pressure of a molten metal applied to the membrane and molten metal must have uniformity in type and size. In addition, it is quite difficult to apply a gas pressure to the entire surface of the membrane.

Accordingly, there has been proposed a process in which gas is supplied to a molten metal with a pressure exceeding a predetermined level and the supplied gas is uniformly dispersed using a gas agitator and an electronic agitating device in a gas supplied state.

However, the agitation still has a limitation in homogenously dispersing gas into a molten metal. In addition, since the conventional apparatus requires increased components, including a separate gas agitator and an electronic agitating device, the apparatus may become complex in configuration and process.

The foaming agent injected into the molten metal with the gas may not be smoothly discharged through fine pores of the membrane. In addition, even if the

foaming agent is injected into molten metal, there is a limitation in homogenously dispersing the foaming agent.

In view of the above, the inventors filed an application for improvement of the method and apparatus for continuous production of foamed metals, as disclosed in Korean Patent Application No. 2008-007941.

Brief Summary of the Invention

Certain exemplary embodiments provide a foamed body for continuously supplying a foaming agent to a molten metal, comprising: a plurality of foamed slabs and cover slabs alternately stacked one on the other; where the centrally disposed foamed slabs includes a matrix having a plurality of embossed grooves formed on a surface thereof, and a foaming agent filling the embossed grooves; and where the matrix is made of the same material as the molten metal to form foamed metals.

Other certain exemplary embodiments provide an apparatus for producing a foamed body, comprising: bending means for bending a strip-shaped matrix made of the same material as a molten metal to form foamed metals in a wave form, the bending means installed at opposite sides of the matrix; injecting means for

injecting a foaming agent; and coating forming means for forming a coating made of the same material as the matrix to prevent the foaming agent from being separated from the matrix.

Yet other certain exemplary embodiments provide an apparatus for producing a foamed body, comprising: a pressing roller having a plurality of pressing protrusions formed on its outer circumferential surface to form a plurality of embossed grooves on a surface of a strip-shaped matrix made of the same material as a molten metal to form foamed metals; injecting means for injecting a foaming agent into the embossed grooves formed in the matrix; and an extruding roll for alternately stacking and coupling a plurality of foamed straps formed by filling the matrix with the foaming agent.

In order to overcome the above-mentioned shortcomings, the present invention provides a foamed body, which allows continuous production of foamed metals by continuously supplying the foamed body prepared by coating or injecting the foamed body into a molten metal to homogenously form and disperse foams in the molten metal, a method for producing the foamed body, and a method and an apparatus for producing foamed metals using the foamed body.

The present invention also provides a foamed body, which allows continuous production of foamed slabs or strips made of foamed metals by continuously supplying a foaming agent into a molten metal to homogenously form

and disperse foams in the molten metal, thereby noticeably reducing the production cost of the foamed metals, a method for producing the foamed body, and a method and an apparatus for producing foamed metals using the foamed body.

According to an aspect of the invention, there is provided a foamed body including a strip- or rod-shaped matrix made of the same material as the molten metal to form foamed metals, and a foaming agent injected into an injector formed in the matrix lengthwise.

In the present invention, the injector formed in the matrix may include grooves formed lengthwise on an outer circumferential surface of the matrix, the grooves injected with the foaming agent, and a coating may be formed on the outer circumferential surface of the matrix, the coating made of the same metal as the matrix. The injector may be formed by bending the matrix in a wave form.

According to another aspect of the invention, there is provided a foamed body for continuously supplying a foaming agent to a molten metal, including a strip-shaped matrix made of the same material as the molten metal to form foamed

metals; and a plurality of foamed slabs sandwiched one on another, the foamed slabs including a foaming agent injected into a plurality of embossed grooves formed in the matrix.

According to still another aspect of the invention, there is provided a method for producing a foamed body, comprising the steps of melting a metal to be foamed; foaming a molten metal while melting the matrix by continuously supplying a foamed body including a strip- or rod-shaped matrix made of the same material as the molten metal, and a foaming agent injected in an injector formed in the matrix lengthwise; and forming the foamed metals.

The foaming of the metal may further include supplying the foaming agent into the molten metal while the matrix is melted when the foamed body is supplied into the molten metal.

According to a further aspect of the invention, there is provided an apparatus for producing a foamed body, including a melting furnace for melting a metal to form foamed metals; a reaction furnace for supplying the molten metal from the melting furnace; a foamed body supply portion for supplying a foamed

body including a matrix made of the same material as a molten metal to carry out a foaming reaction of the molten metal and a foaming agent injected into an injector formed in the matrix; and an extruder for cooling and rolling the foamed molten metal discharged from the reaction furnace, wherein the reaction furnace includes a body having an inlet through which the molten metal is introduced, an outlet through which the molten metal foamed using the foaming agent is discharged, and a flow channel which connects the inlet and the outlet and through which the molten metal is foamed by the foaming agent contained in the foamed body while the molten metal is conveyed; and a heating member installed in the body and heating the molten metal conveyed through the flow channel before being discharged through the outlet so as not to be solidified.

Advantageous Effects

As described above, since the foamed body according to the present invention allows a foaming agent to be continuously and efficiently supplied into a molten metal, the productivity of foamed metals can be improved.

According to the present invention, the foaming agent is homogenously dispersed into a molten metal to be foamed, thereby advantageously producing higher quality foamed metals of than the conventional foamed metals.

Further, since the foaming agent is injected into molten metal using the foamed body filled with a foaming agent without supplying the foaming agent in forms of particulates, continuous production of foamed metals is allowed and production equipment can be simplified.

Brief Description of the Drawings

The objects, features and advantages of the present invention will be more apparent from the following detailed description in conjunction with the accompanying drawings, in which:

FIG. 1 is a perspective view of a foamed body according to the present invention;

FIGS. 2 to 7 and 9 are perspective views illustrating other example embodiments of the foamed body according to the present invention;

FIGS. 8 and 10 are a cross-sectional view and a conceptual diagram of an apparatus for producing the foamed body according to the present invention;

FIG. 11 is a block diagram of a method for producing foamed metals using the foamed body according to the present invention; and

FIGS. 12 and 13 are conceptual diagrams of a method for producing foamed metals according to the present invention.

Best Mode for Carrying Out the Invention

Hereinafter, embodiments of the present invention will be described in detail with reference to the accompanying drawings.

The foamed body according to the present invention supplies a foaming agent into a molten metal to obtain foamed metals using aluminum, magnesium, an aluminum alloy, and a magnesium alloy, and an example embodiment of the foamed body is illustrated in FIGS. 1 to 4.

The foamed body 100 according to the present invention is formed by coating or injecting a foaming agent 200 lengthwise into a strip- or rod-shaped

matrix 101 having a predetermined cross section and made of the same metal as the molten metal. The foamed body 100 supplies the foaming agent to the molten metal while the matrix is melted when the foamed body 100 is supplied to the molten metal.

As shown in FIG. 1, the foamed body 100 includes an injector 110 formed lengthwise on the strip- or rod-shaped matrix 101, and the foaming agent 200 filled in the injector 110. The injector 110 may include one or more hollows formed lengthwise on the matrix 101.

As shown in FIGS. 2 and 3, the injector 110 may include at least one groove 112 formed lengthwise on the outer circumferential surface of the matrix 101. Here, the groove 112 filled with the foaming agent 200 may be spirally formed on the outer circumferential surface of the matrix 101, as shown in FIG. 4.

As described above, in a case where the groove 112 is formed on the outer circumferential surface of the matrix 101 and filled with the foaming agent 200, in order to prevent the foaming agent 200 from being supplied from a surface layer of the molten metal before the matrix 101 is melted, a coating 113 may be

formed on the matrix 101 so that the foaming agent 200 filling the groove may not be exposed. Here, the coating 113 may be made of the same material as the matrix 101, but not limited thereto. A thickness of the coating 113 may be adjusted in consideration of a melting time of the molten metal.

Another example embodiment of a foamed body according to the present invention is illustrated in FIGS. 5 and 6.

Referring to FIG. 5, a foamed body 150 may be formed by coating a foaming agent 200 on a rod- or strip-shaped matrix 151 having a polygonal cross section. The matrix 151 has a coating 152 formed on a circumferential surface of the matrix. An outer circumferential surface of the matrix 161 may have an increased surface area on which the foaming agent 200 is coated by forming unevenness thereon, as shown in FIG. 6. Here, in order to prevent the foaming agent 200 from being intensively supplied from a surface layer when a molten metal for forming foamed metals is supplied, the matrix 161 coated with the foaming agent 200 may be configured to have a coating 162 formed on a circumferential surface of the matrix, like in the previous embodiment.

FIG. 7 illustrates still another example embodiment of a foamed body 180

according to the present invention.

Referring to FIG. 7, the foamed body 180 includes an injector 182 formed on a surface of a strip-shaped matrix 181 made of the same material as a molten metal using unevenness formed on the matrix 181 and a foaming agent 200 filled in the injector 182. The matrix 181 has a coating 183 for preventing the foaming agent 200 from being separated from the injector 182. The coating 183 may be made of the same material as the matrix 181, but not limited thereto. The foaming agent injector 182 may be formed by bending the strip-shaped matrix 181 in a wave form. Here, the foaming agent 200 injected into the injector 182 may include mercury, metal hydroxide, and so on.

Meanwhile, an apparatus 300 for producing the foamed body includes bending means 310 for bending a rod- or strip-shaped matrix 181 made of the same material as a molten metal to form foamed metals in a wave form, the bending means 310 installed at opposite sides of the matrix 181, injecting means 320 for injecting a foaming agent into an injector 182 of the bent matrix 181, and coating forming means 330 for forming a coating 181 made of the same material

as the matrix 181 to prevent the foaming agent from being separated from the matrix 181.

The bending means 310 includes forming rollers 313 and 314 installed at opposite sides of the matrix 181 wound around a roll and continuously supplied, and having teeth 311 and 312 engaged with each other. At least one of the forming rollers 313 and 314 is driven by a motor (not shown).

The injecting means 320 includes a hopper 322 having a nozzle 321 through which the matrix 181 passes. The hopper 322 is filled with a foaming agent. While the wave-like bent matrix 181 passes through the hopper 322 and the nozzle 321, the foaming agent 200 is injected into the injector 182 formed in the matrix 181.

The coating forming means 330, which attaches a coating member 331 made of the same material as the matrix 181 to the matrix 181, includes pressing rollers 334 and 335 for attaching the coating member 331 unwound from the rolls 332 and 333 having an adhesive layer (not shown) to the matrix 181 released through the nozzle 321.

However, the coating is not limited to the illustrated coating member 331, and may be formed by adhering or welding a thin plate having a predetermined thickness to opposite sides of the matrix 181.

FIGS. 9 and 10 illustrate an apparatus and method for producing the foamed body according to still another embodiment of the present invention.

The foamed body 190 according to the embodiment of the present invention includes foamed slabs 191b and 191c and cover slabs 191a and 191d alternately stacked one on the other. The centrally disposed foamed slabs 191b and 191c include a matrix 193 having a plurality of embossed grooves 192 formed on a surface thereof, and a foaming agent 200 filling the embossed grooves 192.

Although not shown, the embossed grooves 192 are formed by means of pressing rollers pressing the surface of the strip-shaped matrix 193. The pressing rollers have pressing protrusions for forming the embossed grooves 192 formed on outer circumferential surfaces thereof. When the matrix 193 passes between two pressing rollers, the surface of the matrix 193 may be pressed by the pressing rollers to form the embossed grooves 192. The embossed grooves 192.are filled

with the foaming agent 200, thereby forming the foamed slabs 191b and 191c.

The foamed slabs 191b and 191c are thin plates made of the same material as the matrix 193 and may serve as a coating member of the previous embodiment. The foamed slabs 191b and 191c may prevent the foaming agent 200 from reacting on a surface layer of the molten metal.

Since the foamed body 190 according to the embodiment of the present invention is formed by stacking a plurality of foamed slabs, an amount of the foaming agent 200 injected can be adjusted.

That is to say, in the embodiment of the present invention, two foamed slabs are stacked to form the foamed body 190. However, the more the foamed slabs stacked, the more the foaming agent 200 injected into the molten metal, thereby increasing the porosity of foamed metal. On the contrary, the fewer the foamed slabs, the less the foaming agent 200 injected into the molten metal,

Thereby decreasing the porosity of foamed metal. Therefore, the foamed body 190 can be produced by increasing or decreasing the number of foamed slabs stacked according to the porosity of foamed metal.

As shown in FIG. 10, in a method for producing foamed metals using the foamed body 190 according to the embodiment of the present invention, cover slabs191a and 191d and foamed slabs 191b and 191c are extruded from a cover roll 195 and a foaming roll 196 around which the cover slabs191a and 191d and the foamed slabs 191b and 191c are wound, respectively, to then be stacked one on the other using a plurality of guide rolls 197 and pressed using a extruding roll 198. The pressed foamed body 190 is wound around a winding roll 199, thereby continuously injecting the foamed body 190 into the molten metal in the production of foamed metals.

A method for producing formed metals according to the present invention using the foamed body is provided to foam a molten metal while melting the foamed body by supplying the foamed body formed by coating or injecting a foaming agent into the molten metal to be foamed.

The method for producing foamed metals according to the present invention includes the steps of (S1) melting a metal for production of a porous metal, such as aluminum, magnesium, an aluminum alloy, or a magnesium alloy,

and (S2) injecting a viscosity-enhancing agent into the molten metal and agitating the molten metal so as to impart a predetermined level of viscosity to the molten metal.

In the step of melting a metal (S1), an electric furnace may be used to dissolve a metal for production of porous foamed metals. In the step of injecting the viscosity-enhancing agent (S2), the viscosity of the molten metal is increased to a predetermined level of viscosity by injecting calcium (Ca) or calcium-aluminum (Ca-Al) as the viscosity-enhancing agent. After injecting the viscosity-enhancing agent, agitating means may further be provided for agitating the viscosity-enhancing agent and the molten metal. The step of agitating may be performed using an agitator provided with a blade at ends of a rotation shaft rotated by a motor. The number of rotations of the agitator may be maintained at 80 to 200 RPM.

In the step of injecting the viscosity-enhancing agent (S2), the viscosity of the molten metal is increased. The step of injecting the viscosity-enhancing agent (S2) may be performed by lowering the temperature of the molten metal in

consideration of the viscosity of the molten metal. If the viscosity of the molten metal is sufficiently high, the step of injecting the viscosity-enhancing agent (S2) may be skipped.

After the viscosity of the molten metal is adjusted in the above-described manner, the method for producing foamed metals according to the present invention further includes the step of (S3) foaming the molten metal by supplying a plurality of strip- or rod-shaped foamed bodies to melt the matrix (101, 151,161, or 181) with the molten metal and supplying the molten metal with a foaming agent 200 injected or coated on the matrix 101, 151,161, or 181. In the foaming step (S3), the foamed body 190 includes the foaming agent 200 injected lengthwise into an injector made of a hollow, thereby preventing the foaming agent 200 from being intensively supplied from a surface of the molten metal. In particular, in a case where a coating 113, 183 is formed on an outer surface of the matrix of the foamed body 150, 160, 180, since the foamed body 150, 160, 180 is not exposed until the coating is melted, it is possible to prevent the foaming agent 200 from being intensively supplied from the surface of the molten metal. In the foaming step (S3),

the plurality of foamed bodies 100, 150, 160 and 180 molten metal are continuously supplied to then be dissolved, lowering the temperature of the metal, resulting in an increase of the viscosity. Accordingly, the method for producing foamed metals according to the present invention may further include the step of heating.

After the foaming step (S3) is completed in the above-described manner, the step of forming the foamed metals (S4) is performed.

As described above, according to the present invention, since the foaming agent is supplied to the molten metal using the foamed body having a coating formed thereon, poor foaming due to non-uniformity in the amount of the molten metal injected on a surface layer of the molten metal and into the molten metal can be prevented. Further, according to the present invention, the production equipment can be simplified and the productivity of foamed metals can be enhanced.

FIGS. 12 and 13 illustrate an apparatus for producing foamed metals according to an exemplary embodiment of the present invention using the foamed

body.

Referring to FIGS. 12 and 13, the apparatus 400 for producing foamed metals includes a melting furnace 410 for melting a metal, a reaction furnace 420 having a flow channel to allow a foaming reaction to be carried out by the foamed body 190 while the molten metal is conveyed, a foamed body supply portion 430 for supplying the foamed body 190 to the reaction furnace 420, and a roller 440 for cooling and rolling the foamed molten metal discharged from the reaction furnace 420.

The melting furnace 410 continuously melts and supplies a metal to form foamed metals. According to the embodiment of the present invention, the melting furnace 410 has an RF furnace 411 and a warming furnace 412 combined therein.

If a material to be melted is injected into the RF furnace 411, the material is melted in the course of passing through the RF furnace 411 to then be injected into the warming furnace 412. A discharge hole 413 through which the molten metal is discharged is provided at one side of the warming furnace 412, and the molten metal discharged through the discharge hole 413 is injected into the reaction furnace 420.

The reaction furnace 420 includes a body 421, and a heating member 425 installed in the body 421.

The body 421 has an inlet 422 and an outlet 423 installed at upper and lower ends thereof. A flow channel 424 is formed by connecting the inlet 422 and the outlet 423, and the molten metal is conveyed through the flow channel 424.

The heating member 425 may include a heating wire installed inside the body 421 so as to surround the flow channel 424. The heating member 425 allows the internal temperature of the flow channel 424 to be maintained at greater than a predetermined level and prevents the molten metal from coagulating in the flow channel 424.

In addition, the reaction furnace 420 includes a foamed body protecting pipe 426 extending into the flow channel 424 by a predetermined length.

The foamed body protecting pipe 426 is made of a material having a higher melting point than the molten metal. When the foamed body 190 is injected into the reaction furnace 420, the foaming agent may not react with the molten metal at the upper end of the reaction furnace 420. That is to say, when the molten metal contacts the foamed body 190 at the inlet 422 and the outlet 423 of the reaction

furnace 420 without the foamed body protecting pipe 426, the foaming agent contained in the foamed body 190 reacts with the molten metal at the upper end of the reaction furnace 420, and the molten metal is foamed. Foams produced as the result of the foaming reaction tends to move upward. Thus, the foams move upward and burst, thereby making it impossible to sufficiently form pores in the molten metal.

Therefore, in order to allow the foamed molten metal to be discharged through the outlet 423 in a stable manner by the foaming reaction taking place at a location spaced a predetermined distance apart from the upper end of the reaction furnace 420, the foamed body protecting pipe 426 is installed to define a contact region between the foamed body 190 and the molten metal.

An extending length of the foamed body protecting pipe 426 may be appropriately determined in consideration of the location where foaming of the molten metal using the foaming agent is carried out.

The foamed body supply portion 430 supplies the foamed body 190 including a foaming agent into the reaction furnace 420.

The foamed bodies according to the above-described embodiments may be continuously supplied to the reaction furnace 420. The foamed body supplied by the foamed body supply portion 430 according to the present embodiment corresponds to the foamed body 190 shown in FIG. 9.

The foamed body supply portion 430 may be configured of the apparatus 300 for producing the foamed body shown in FIG. 10. Although the foamed body 190 shown in FIG. 10 is wound around a winding roller 199, the foamed body 190 extruded by an extruding roll 198 may be directly injected into the reaction furnace. Alternatively, the foamed body 190 wound around the winding roller 199 may also be continuously supplied to the reaction furnace 420.

The extruder 440 is formed by cooling and extruding the foamed molten metal discharged from the reaction furnace 420 into a strip-shaped slab, which is the same as a general cooling extruder and a detailed explanation will be omitted.

The present invention is very useful in the overall fields of industry associated with production of foamed metals.

Claims:

1. A foamed body for continuously supplying a foaming agent to a molten metal, comprising:

a plurality of foamed slabs and cover slabs alternately stacked one on the other;

where the centrally disposed foamed slabs includes a matrix having a plurality of embossed grooves formed on a surface thereof, and the foaming agent filling the embossed grooves; and

where the matrix is made of the same material as the molten metal to form foamed metals.

2. An apparatus for producing a foamed body, comprising:

a pressing roller having a plurality of pressing protrusions formed on its outer circumferential surface to form a plurality of embossed grooves on a surface of a strip-shaped matrix made of the same material as a molten metal to form foamed metals;

injecting means for injecting a foaming agent into the embossed grooves formed in the matrix; and

an extruding roll for alternately stacking and coupling a plurality of foamed straps formed by filling the matrix with the foaming agent.

DRAWINGS

Fig. 1

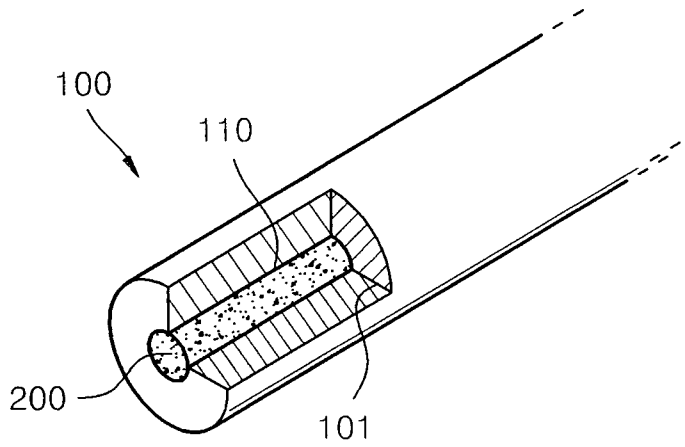


Fig. 2

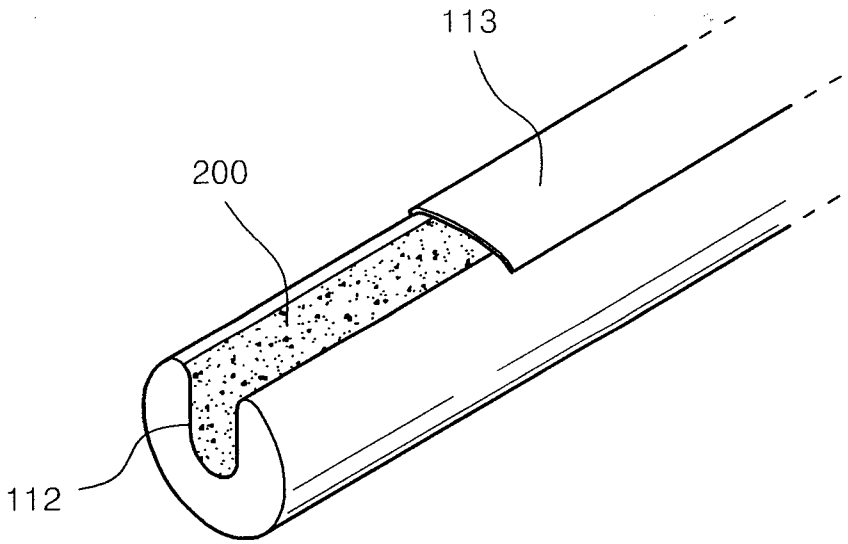


Fig. 3

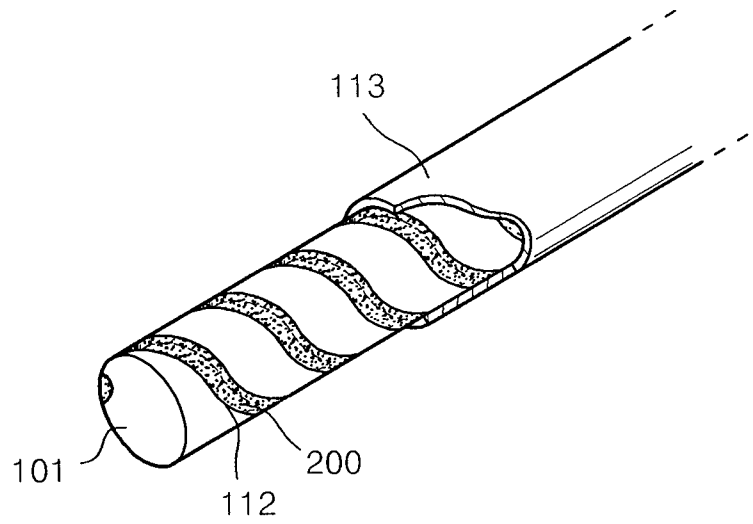


Fig. 4

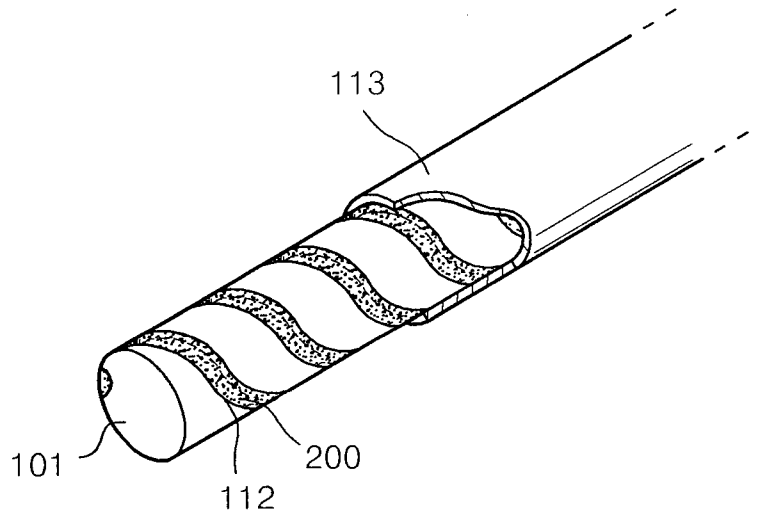


Fig. 5

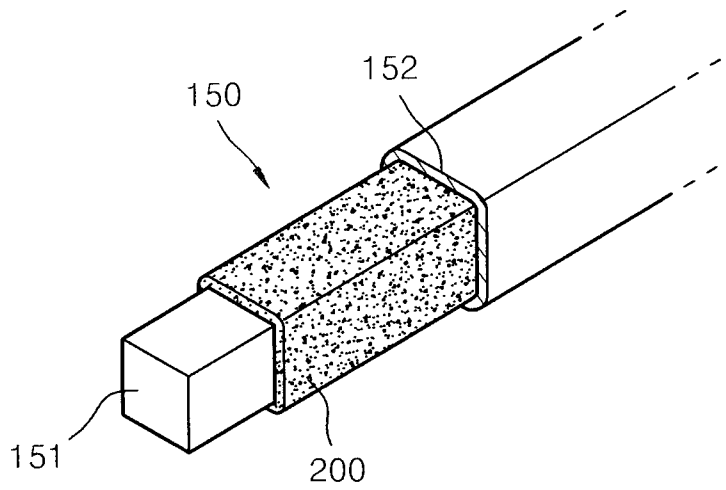


Fig. 6

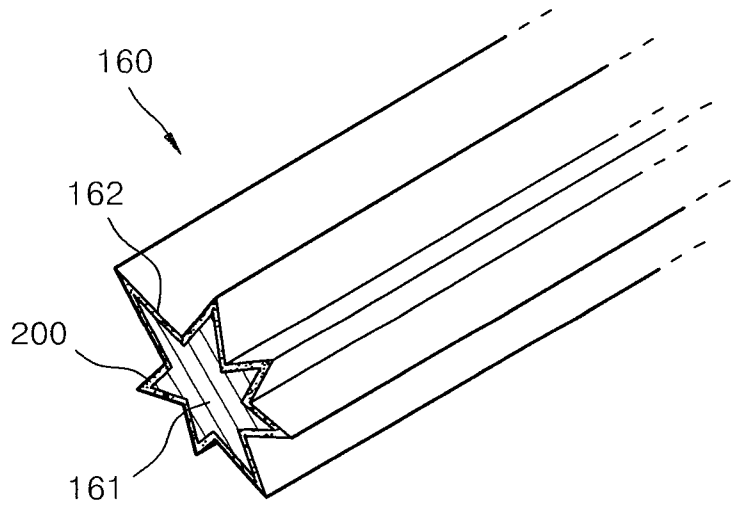


Fig. 7

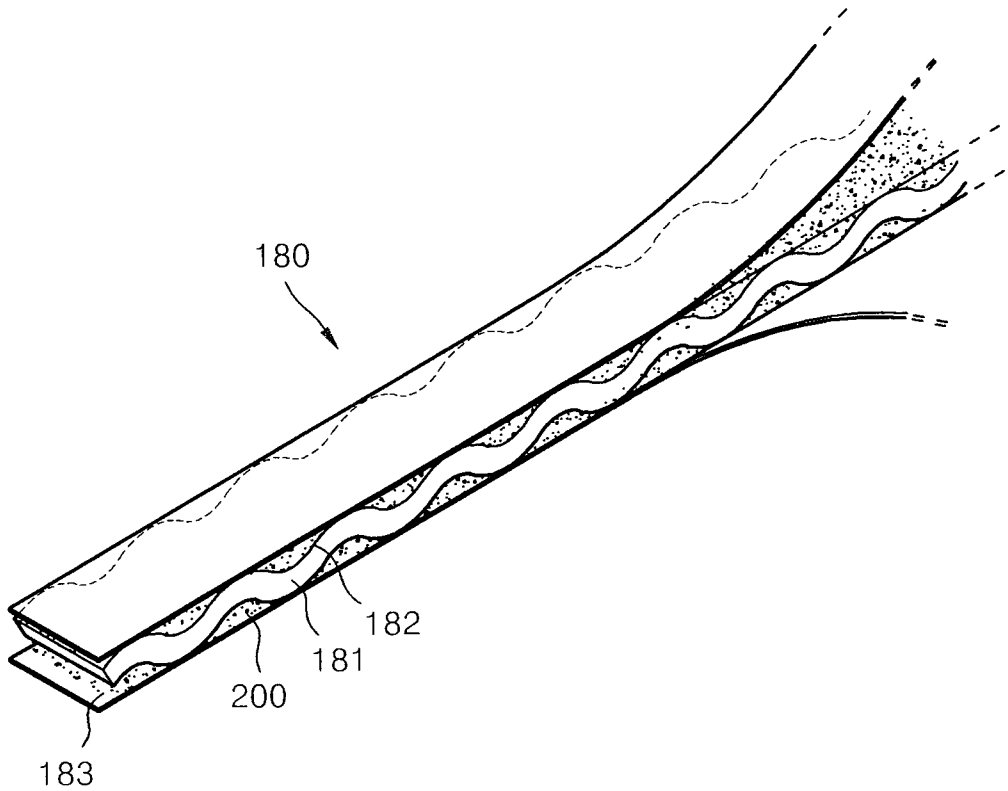


Fig. 8

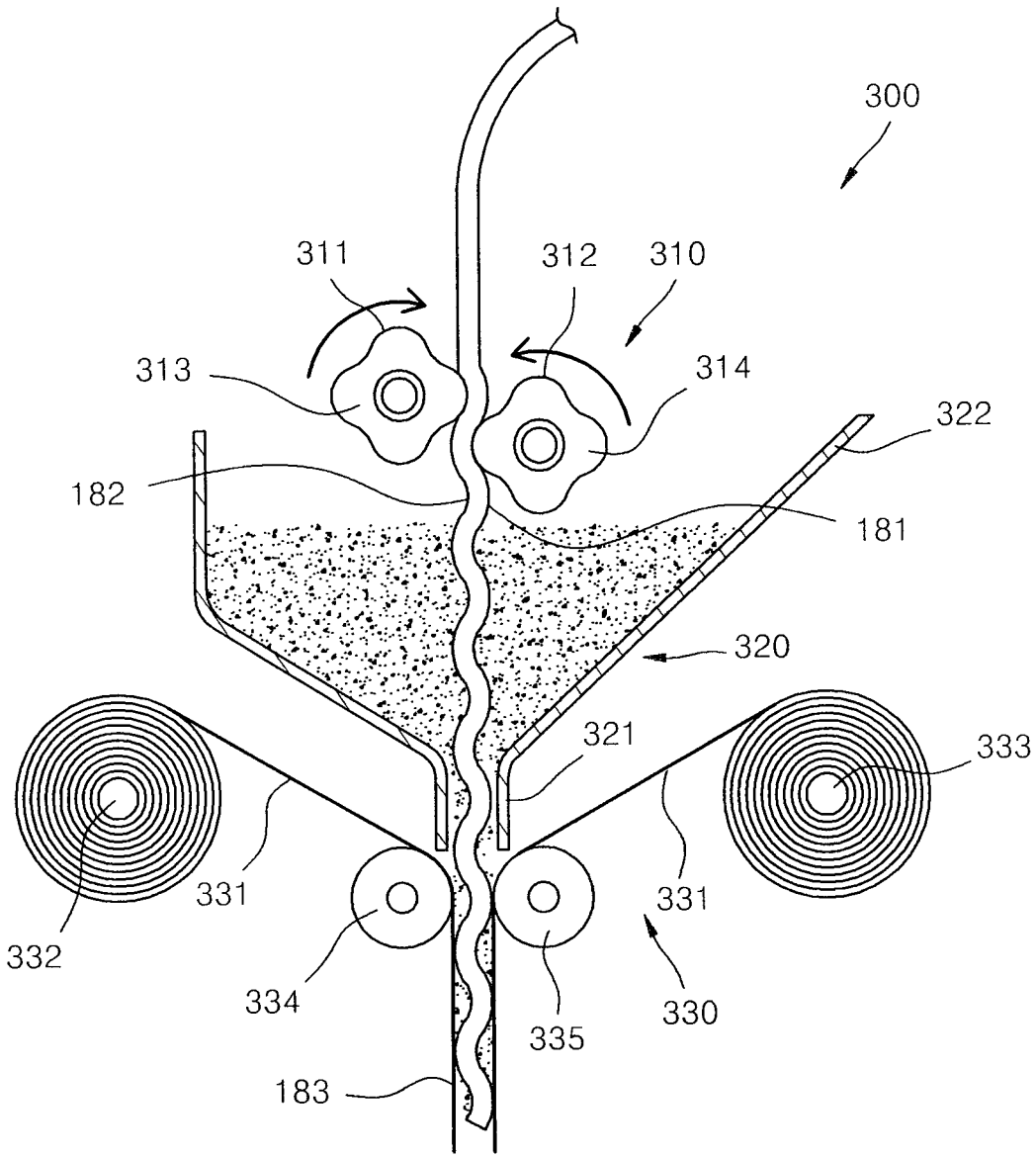

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Fig. 9

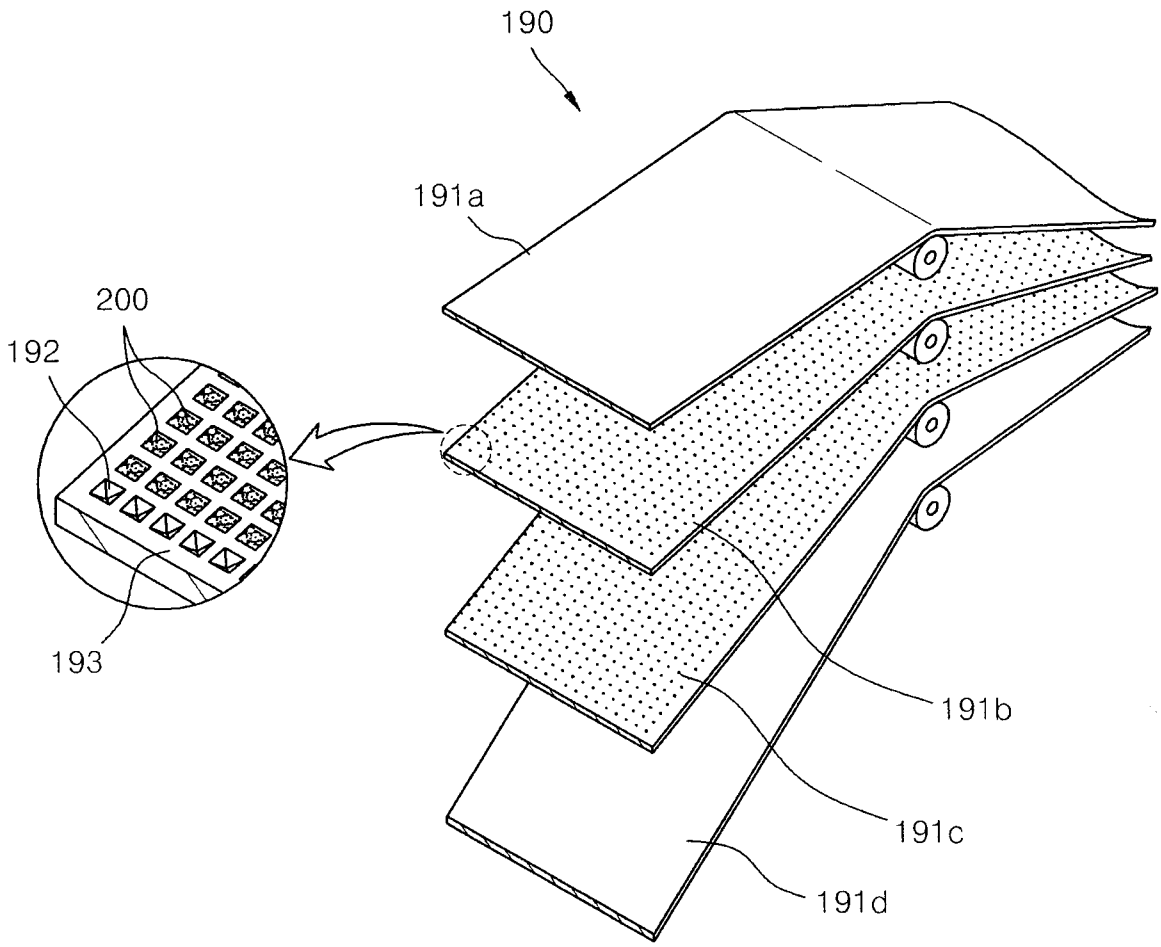


Fig. 10

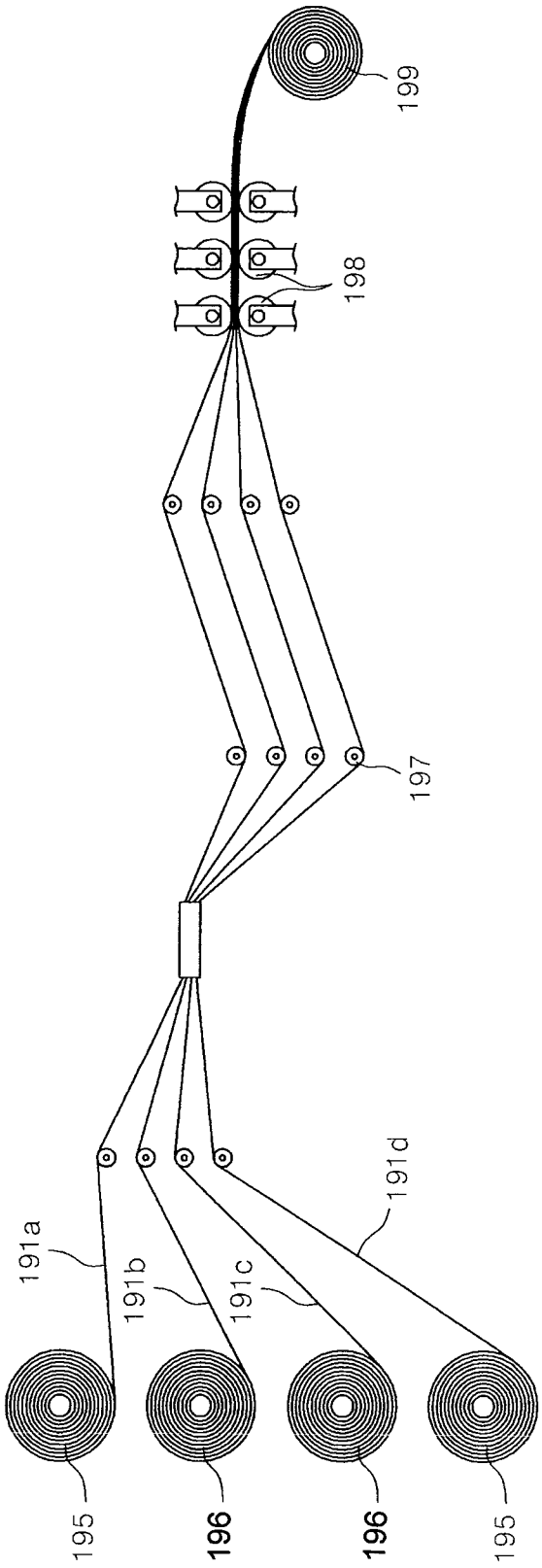


Fig. 11

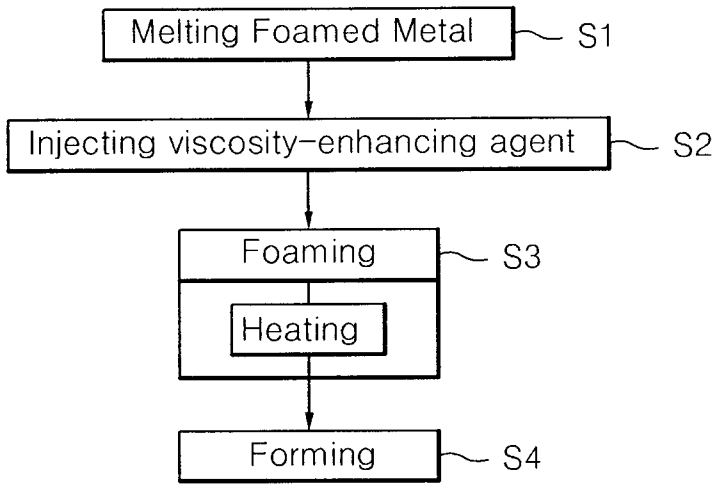

Melting Foamed Metal
S1
Injecting viscosity-enhancing agent
S2
Foaming
S3
Heating
Forming
S4

Fig. 12

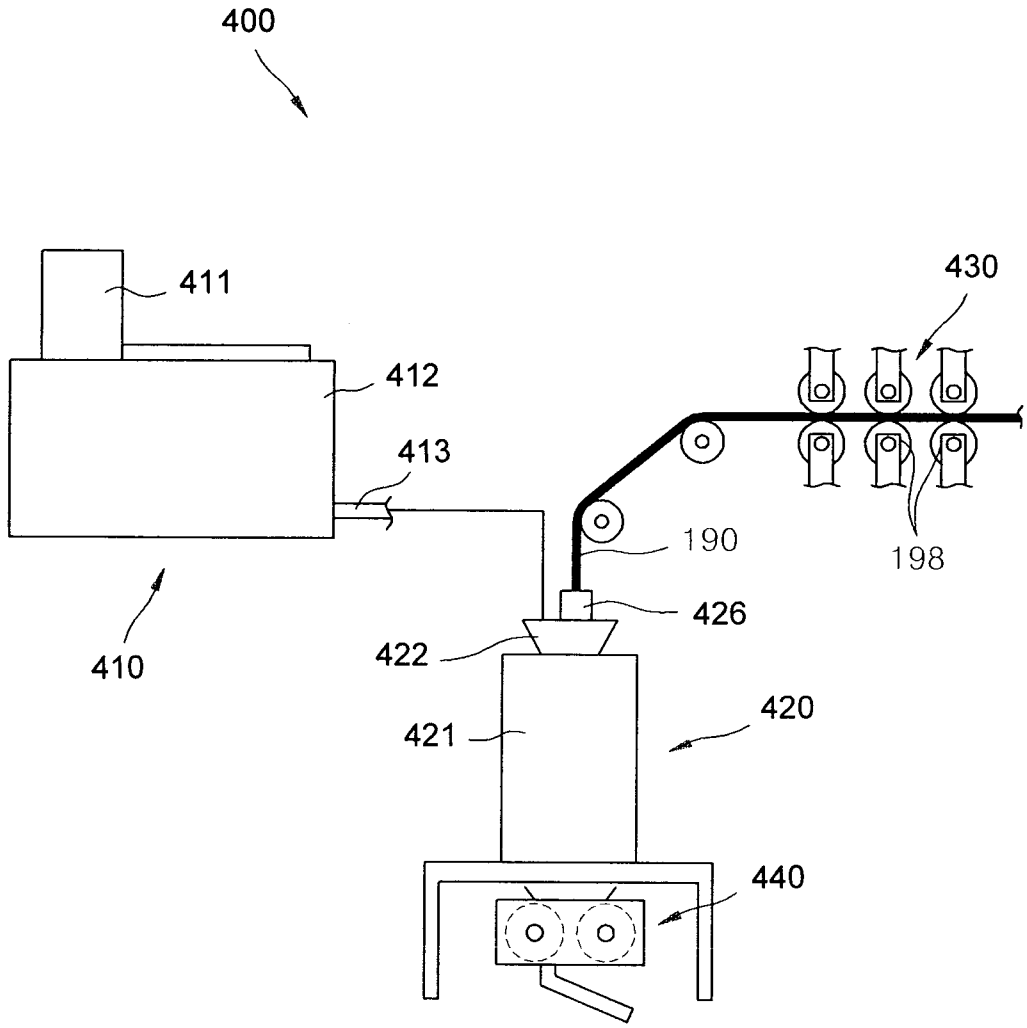
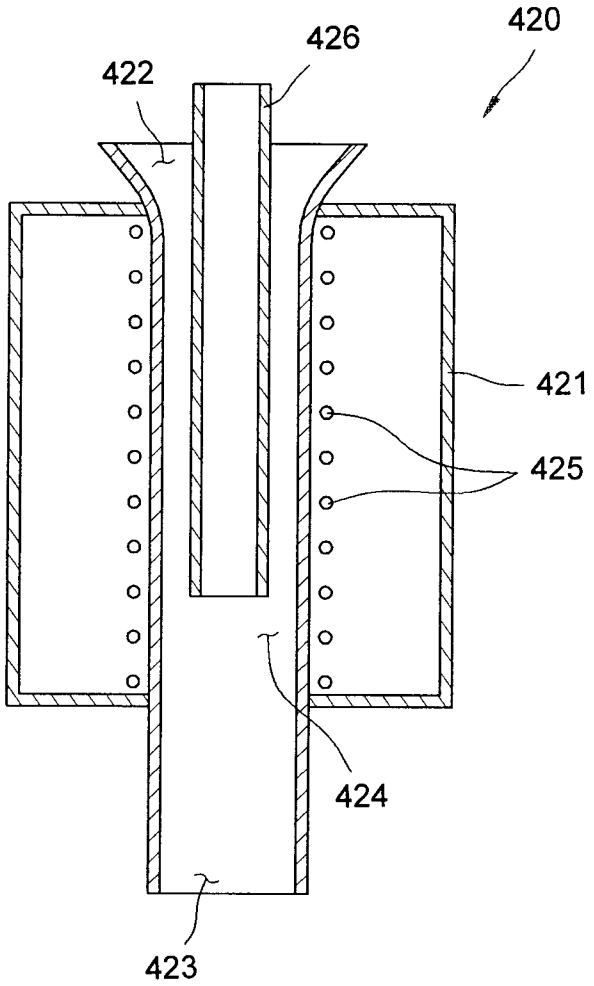
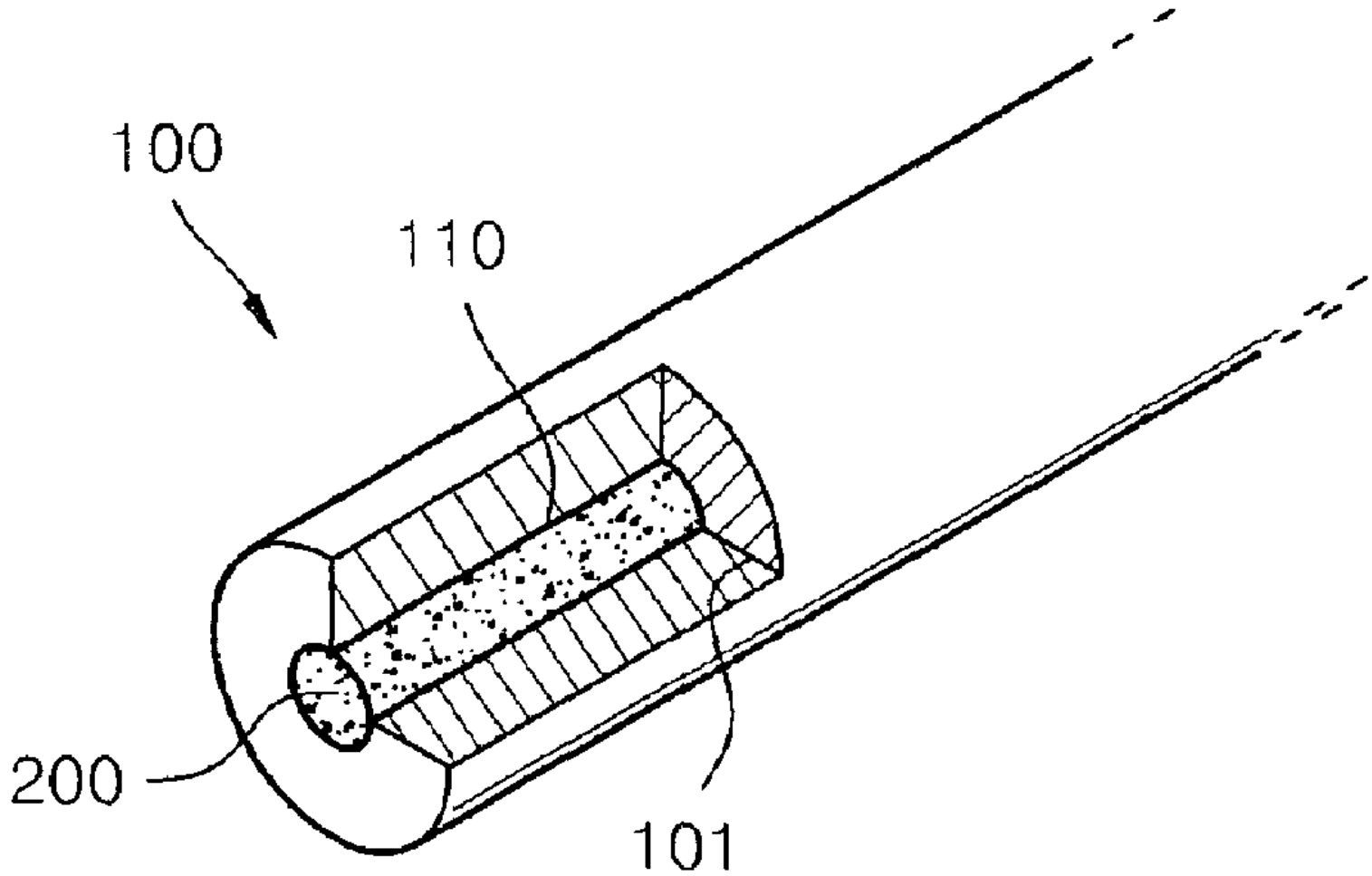


Fig. 13

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101