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(54) **CRYSTALLIZER FOR CONTINUOUS CASTING AND METHOD FOR ITS PRODUCTION**
KRISTALLISATOR ZUM STRANGGIESSEN UND VERFAHREN ZU DESSEN HERSTELLUNG
CRISTALLISATEUR POUR COULÉE CONTINUE ET PROCÉDÉ POUR SA FABRICATION

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Description

FIELD OF THE INVENTION

[0001] The present invention concerns a crystallizer for continuous casting, usable in the iron and steel making industry to cast billets, blooms or other similar products, of any type and cross section. The invention also concerns the method for its production.

BACKGROUND OF THE INVENTION

[0002] Different crystallizers for continuous casting are known, suitable to cast billets, blooms or other iron and steel products, each having a tubular body provided with a through longitudinal cavity with a desired cross section, corresponding to the cross section of the product to be cast, for example circular, elliptical or polygonal, and in which the liquid casting metal is suitable to pass. On the wall or walls which define the tubular body of the crystallizer and which have a thickness of some tens of millimeters, a plurality of channels are normally made longitudinally, which are part of a closed cooling circuit in which a cooling liquid, for example water, is made to circulate.

[0003] Some examples of crystallizers for continuous casting and corresponding production methods are described in the Italian applications for patents of industrial invention UD2102A000192 and UD2013A000013 filed by the present Applicant, which are incorporated here as reference.

[0004] Another example of a crystallizer for continuous casting is described in the document EP-A-1.468.760 and comprises a first tubular body, or internal tubular body, which defines a casting channel for the liquid metal, and a second tubular body, or external tubular body, which is associated externally to the first tubular body.

[0005] In particular, the internal tubular body is provided, on its external contact surface with the external tubular body, with support ribs and connection ribs alternating with the support ribs.

[0006] The support ribs and the connection ribs protrude toward the outside and extend along the axial extension of the crystallizer.

[0007] The function of the support ribs is to maintain the external tubular body distanced from the internal one, while the connection ribs are inserted in attachment seatings made on the internal surface of the external tubular body, defining a fixed-joint mechanical coupling, making the internal tubular body able to be disassembled from the external tubular body.

[0008] Moreover, the connection ribs and the support ribs define, between the internal tubular body and the external tubular body, a plurality of hollow spaces in which a cooling fluid flows.

[0009] The fixed-joint mechanical coupling between the internal tubular body and the external tubular body does not guarantee a hydraulic seal of the cooling fluid in the hollow spaces, since the support ribs have only a

distancing function for the external tubular body and are not able to guarantee the hydraulic seal between adjacent hollow spaces.

[0010] This disadvantage is linked to the rigidity, and the geometric and dimensional tolerances of each of the two tubular bodies and to the fact that the latter are not intimately coupled to each other.

[0011] In particular, document EP-A-1.468.760 provides that the internal tubular body is made of metal material, for example copper, while the external tubular body is made of a metal or non-metal material, a composite for example, such as laminate carbon.

[0012] Moreover, it is known that traditional crystallizers are affected by a series of disadvantages due to the variation in the internal concavity of the crystallizer, at least around the meniscus zone. Indeed, mainly in this zone, there is a tendency to expand toward the outside, due to the heat stresses deriving from the contact temperature between the liquid steel and the wall of the crystallizer. This causes a reduction in concavity between meniscus and upper entrance section, and a greater concavity than the specification concavity in the lower segment of the crystallizer, always with respect to the meniscus zone. This causes a deterioration in the quality of the cast product because of the alteration in the functioning conditions and consequent poor heat conduction between the skin of the steel and the cooled wall of the crystallizer itself.

[0013] Consequently, the probability of leakages of liquid steel from the skin, also called "breakout", is increased, following the lack of heat conduction which causes the skin to stick to the walls of the crystallizer, called "sticking".

[0014] One purpose of the present invention is to make a crystallizer for continuous casting, with cooling channels incorporated in the walls, which overall has an increased structural rigidity without increasing the thickness of its walls, in order to guarantee an increased casting efficiency and an increased quality of the product exiting from the crystallizer.

[0015] Another purpose of the present invention is to make a crystallizer for continuous casting, of the type indicated above, that is simple in construction and at the same time has a reduced cost compared to known crystallizers, even when the crystallizer has large sizes, for example a diameter or width equal to or more than 800 mm, reducing to a minimum the use of metal, for example copper, needed to make the walls of its tubular body.

[0016] It is also a purpose of the present invention to make a crystallizer for continuous casting that allows to obtain cast metal products of high quality, keeping the specification concavity substantially unvaried, when both hot and cold.

[0017] Another purpose of the present invention is to make a crystallizer for continuous casting, of the type indicated above, that can be easily used, without any contraindication, in association with a mechanical agitator, also called stirrer.

[0018] Another purpose of the present invention is to

make a crystallizer for continuous casting, of the type indicated above, that is reliable and can be used, without any contraindication and with maximum efficiency, even with a radioactive rod used to detect the level of liquid metal inside the crystallizer during casting.

[0019] Another purpose of the present invention is to perfect a method to make a crystallizer for continuous casting, of the type indicated above, that allows to reduce production costs without reducing the characteristics of structural rigidity, safety, reliability and thermal and thermo-mechanical efficiency of the crystallizer itself.

[0020] Another purpose of the present invention is to perfect a method that allows to make a crystallizer for continuous casting, of the type indicated above, easily and with simple work steps, that can have any shape and cross section, for example circular, elliptical or polygonal.

[0021] The Applicant has devised, tested and embodied the present invention to overcome the shortcomings of the state of the art and to obtain these and other purposes and advantages.

SUMMARY OF THE INVENTION

[0022] The present invention is set forth and characterized in the independent claims, while the dependent claims describe other characteristics of the invention or variants to the main inventive idea.

[0023] In accordance with the above purposes, a crystallizer for continuous casting, according to the present invention, comprises a tubular body with at least a wall that defines a through longitudinal casting cavity and a plurality of longitudinal grooves made at least on a part of an external surface of the at least one wall and open toward the outside thereof.

[0024] According to one characteristic of the present invention, a covering binding, comprising one or more overlapping layers of fiber material, is irremovably wound around the external surface of the at least one wall, so as to create an indivisible whole between the at least one wall with the longitudinal grooves and the covering binding.

[0025] Here and hereafter in the description and in the claims, by covering binding we mean a material comprising a plurality of fibers adjacent to each other to define one or more bands that, once in position, cover at least part of the external surface of the wall.

[0026] The layers of fiber can be impregnated with a polymer material, which, once the covering binding has been wound around the external surface of the wall, is polymerized and determines the solid and irremovable attachment of the covering binding to the wall.

[0027] This allows to obtain a crystallizer for continuous casting that maintains its specification conicity unchanged whether it is hot or cold, thanks to the reinforcement structure that the external covering binding achieves for the walls of the crystallizer.

[0028] Indeed the covering binding, wound tightly around the crystallizer in a direction mainly transverse to

its longitudinal direction, limits the deformations and movements of the walls, maintaining the internal conicity, while allowing the longitudinal dilation due to heat phenomena for example between 0 and 4 mm.

[0029] According to a first form of embodiment of the present invention, the covering binding is in direct contact with the external surface of the at least one wall and closes the longitudinal grooves. Corresponding cooling channels are thus obtained, configured to make a cooling liquid flow inside them, for example water, suitable to cool the tubular body of the crystallizer.

[0030] According to a second form of embodiment of the present invention, as an alternative to the first, the covering binding is in direct contact with a metal layer made with electrolytic deposition techniques; the metal layer, in its turn, is in contact with the external surface of the at least one wall and closes the longitudinal grooves to form a corresponding plurality of cooling channels.

[0031] Therefore, unlike the technical solution described in EP-A-1.468.760, which provides to use electrolytic deposition as a solution to oxidation phenomena, the present invention describes the use of electrolytic deposition with the purpose of creating sealed cooling channels on the external surface of the walls of the crystallizer.

[0032] In this way, the covering binding makes rigid the whole made by the at least one wall of the crystallizer and the metal layer associated thereto.

[0033] According to a third form of embodiment of the present invention, alternative to the first two, it is provided that the longitudinal grooves are closed by at least a plate associated to the external surface of the at least one wall so as to define a corresponding plurality of cooling channels inside which a cooling liquid flows.

[0034] In this case, the covering binding is in direct contact with the at least one plate so as to reinforce and increase the security of the connection between the at least one plate and the at least one wall.

[0035] According to a fourth form of embodiment of the invention, it is provided that the longitudinal grooves are closed by at least a lamina made of a fiber-reinforced polymer material, fiberglass for example, associated to the external surface of the at least one wall to define a corresponding plurality of cooling channels inside which a cooling liquid flows. The covering binding, in this case, is located in direct contact with the lamina of fiber-reinforced polymer material in order to make rigid the whole made by the at least one wall and the lamina of fiber-reinforced polymer material.

[0036] The covering binding can be wound around the wall defining even variable thicknesses in a longitudinal direction in the most stressed zones, for example the meniscus zone. The variation in thickness in a longitudinal direction of the covering binding can even be some millimeters. Merely by way of example the covering binding, in the non-thickened zone, has a thickness comprised between 1mm and 8mm.

[0037] The variable thickness of the fibers which sur-

round the crystallizer, after complete polymerization of the covering binding, allows to work with machine tools on the external containing surface so as to obtain seatings for housing packings or break-pins.

[0038] The method to make a crystallizer for continuous casting, according to the present invention, comprises a step in which a tubular body is made, of metal for example, more specifically of copper, with at least a wall that defines a through longitudinal casting cavity and a plurality of longitudinal grooves made at least on one part of the external surface of the at least one wall and open toward the outside thereof.

[0039] According to another characteristic of the present invention, the method according to the present invention also comprises a step in which a covering binding, comprising one or more layers of fiber material, is associated to the external surface of the at least one wall.

[0040] In particular, the covering binding comprises a band made using at least a fiber, impregnated or pre-impregnated with for example a volumetric ratio of fibers of 60%, such as carbon, and glue or polymer resin of 40%. The polymer material is the type resistant to high temperatures, that is, equal to or more than 100°C, such as a polymer for example chosen from the group comprising polyamide, epoxy or polyester resins.

[0041] The fibers can be chosen from a group comprising carbon fibers, glass fibers, aramid fibers or similar.

[0042] The covering binding in fiber, which becomes rigid when the polymer solidifies by polymerizing, can be applied using any known technique, including the filament winding technique.

[0043] The polymerization of the polymer can occur through heat polymerization steps, that is, reticulation of the resin, called curing.

[0044] During the curing step, the crystallizer is heated to a temperature comprised between 30°C and 120°C and kept at this temperature for a period comprised between 20 and 200 minutes. These conditions determine the reticulation of the polymer resin and therefore a solidification of the binding to the wall or walls.

[0045] This allows to guarantee better characteristics of resistance and heat consolidation depending on the type of resin applied.

[0046] In possible forms of embodiment, after the curing step, a post-curing step can be provided during which the crystallizer is heated to a temperature comprised between 80°C and 200°C and kept at this temperature for a period comprised between 1 hour and 20 hours.

[0047] In possible forms of embodiment, for the whole duration of the curing and/or post-curing steps, the crystallizer is kept in rotation around its own axis.

[0048] According to one possible implementation, the crystallizer, after the curing and possibly post-curing steps, can be subjected to a forced cooling.

[0049] The operation of winding the covering binding on the wall can include the installation, on a suitable apparatus and by means of a dedicated apparatus, of the

wall in rotating mode around an axis of rotation and subsequent winding of the covering binding perpendicularly to the axis of longitudinal development, or with a winding angle comprised between 0° and 10°, preferably between 0° and 5°, with respect to the perpendicular to the axis of longitudinal development of the crystallizer.

[0050] The winding operation can occur with a controlled tension of the fibers, for example from 1N and 50N per fiber.

[0051] The solution of using the covering binding, in particular of fiber, around the tubular body of the crystallizer, which is new and original, allows to obtain at least the following advantages:

- increasing the rigidity of the hollow tubular body of the crystallizer;
- maintaining the internal conicity of the crystallizer both when hot and when cold;
- maximizing the efficiency of a possible radioactive rod associated to the crystallizer, given that the covering binding is transparent to radiations;
- containing the costs of production of crystallizers of any shape, or with any cross section, for example polygonal, circular, or elliptical, and even of considerable sizes, for example with diameters, or widths, equal to or more than 800mm;
- reducing to a minimum the thickness of the walls which define the tubular body of the crystallizer and therefore minimum use of metal, for example copper, of which they are made;
- prolonging the life of the crystallizer;
- improving the quality of the cast product;
- possibility of working with machine tools on the solidified covering binding, for example to define grooves for sealing rings or holes for the insertion of break-pins.

[0052] According to possible solutions of the method according to the present invention, before winding the one or more layers of fiber material it provides to fill the longitudinal grooves with disposable material, for example wax, to deposit a metal layer on the external surface of the at least one wall by electrolytic deposition techniques, in order to close the longitudinal grooves, and to subsequently remove the disposable material from the longitudinal grooves so as to define corresponding cooling channels.

BRIEF DESCRIPTION OF THE DRAWINGS

[0053] These and other characteristics of the present invention will become apparent from the following description of some forms of embodiment, given as a non-restrictive example with reference to the attached drawings wherein:

- fig. 1 is a perspective and schematized view of a crystallizer for continuous casting according to a first

form of embodiment of the present invention;

- fig. 2 is an enlarged detail of the crystallizer in fig. 1;
- fig. 3 is a perspective and schematized view of a detail of a crystallizer according to a second form of embodiment of the present invention;
- fig. 4 is a schematized view of a detail of a crystallizer according to a third form of embodiment of the present invention;
- figs. 5 and 6 are schematized views of possible variants of the crystallizer according to the present invention.

[0054] To facilitate comprehension, the same reference numbers have been used, where possible, to identify identical common elements in the drawings. It is understood that elements and characteristics of one form of embodiment can conveniently be incorporated into other forms of embodiment without further clarifications.

DETAILED DESCRIPTION OF SOME FORMS OF EMBODIMENT OF THE

PRESENT INVENTION

[0055] With reference to figs. 1 and 2, a crystallizer 10 for continuous casting according to the present invention, in a first form of embodiment, comprises a tubular body 11 with a wall 12, for example made of copper or its alloys, which defines a through longitudinal casting cavity 13. The thickness of the wall 12 is for example comprised between 10 mm and 50 mm.

[0056] There is a plurality of longitudinal grooves 14 on at least an external part of the wall 12. Each longitudinal groove 14 is open toward the outside of the wall 12.

[0057] A covering binding 15, which in this case comprises one or more layers of a band 16 of fiber, impregnated or pre-impregnated with a polymer resistant to high temperatures (that is, equal to or higher than 100°C), is in direct contact with the external surface of the wall 12 and closes the longitudinal grooves 14 from the outside. In this way corresponding channels 17 are made, configured to make a cooling liquid, for example water, flow inside them. In this specific case, it is provided that the band 16 defines a plurality of layers wound on the external surface of the wall 12 of the crystallizer 10.

[0058] In a second form of embodiment, a crystallizer 110 (fig. 3) according to the present invention comprises, interposed between the covering binding 15 and the wall 12, a metal layer 18 made with electrolytic deposition techniques, for example as described in the application for a patent of industrial invention UD2013A000013 cited above.

[0059] In this case, it is the metal layer 18 that hermetically closes the longitudinal grooves 14 from the outside of the wall 12 and defines the plurality of cooling channels 17.

[0060] Therefore, in this second form of embodiment, the covering binding 15 is in direct contact with the metal

layer 18, in order to make rigid the whole made up of the latter and the wall 12. This allows to have a very contained thickness of the metal layer 18, for example in the range of one or two millimeters. The covering binding 15 in this case has a containing function of the metal layer 18 and guarantees the seal of the latter even at high working pressures of the cooling fluid circulating in the channels 17.

[0061] According to the form of embodiment in fig. 6, the metal layer 18 can be replaced by a lamina 23 made of a fiber-reinforced polymer material which, closing the longitudinal grooves 14 from the outside, defines the corresponding plurality of cooling channels 17. The covering binding 15 is wound intimately in direct contact with the lamina 23 to make rigid the whole constituted by the wall 12 and the lamina 23.

[0062] According to a third form of embodiment, a crystallizer 210 (fig. 4) according to the present invention comprises a tubular body 211 provided with a plurality of walls 212 defining a longitudinal casting cavity 213. The longitudinal grooves 14, open toward the outside, are made on the external surface of the walls 212, by removing material. At least one plate 219, in this specific case four plates 219, are associated to the external surface of the tubular body 211, for example welded or glued, and are provided to close the longitudinal grooves 14 made on the walls 212 of the tubular body 211 from the outside and to define the cooling channels 17.

[0063] The plates 219 can be associated to the external surface of the tubular body 211, for example, by braze welding or structural gluing, in the same way as described in the Italian application for a patent of industrial invention UD2012A000193 in the name of the Applicant.

[0064] In this case too, as in the first form of embodiment, the covering binding 15 is in direct contact with the surface of the plates 219 that is external during use, to reinforce them and increase the secure seal of the braze welding.

[0065] Forms of embodiment of the present invention provide that the covering binding 15 has a constant thickness along the longitudinal extension of the tubular body 11, 211.

[0066] Other forms of embodiment, one of which is shown in fig. 5, provide that the covering binding 15 is provided with a thicker portion 20 that has a greater thickness than the thickness along the longitudinal extension of the tubular body 11 or 211. In this way it is possible to generate zones of the crystallizer 10 with variable resistance and rigidity along its longitudinal extension that are determined, for example, depending on a variable development of the pressure of the cooling fluid in the cooling channels 17 or on different conditions of mechanical and/or heat stress to which it can be subjected during normal use.

[0067] According to other forms of embodiment of the present invention, shown for example in fig. 6, mechanical workings, for example to define circumferential seatings 21 for housing sealing rings or holes 22 for the in-

section of break-pins, can be made on the covering binding 15.

[0068] The method for producing each of the crystallizers 10, 110, 210 for continuous casting described heretofore comprises a step in which the tubular body 11, 211 is made, with the wall 12 or walls 212 that define the longitudinal cavity 13, 213 and the plurality of longitudinal grooves 14, made for example by removing material, such as milling, at least on one part of the wall 12 or walls 212, and open toward the outside thereof.

[0069] The method also comprises a step in which a covering binding 15, as described heretofore, is associated to the external surface of the wall 12 or walls 212.

[0070] In particular, the binding 15 comprises the band 16 made with one or more overlapping layers, using at least a fiber impregnated or pre-impregnated with a polymer resistant to high temperatures, as indicated above, that is chosen for example from a group comprising polyamide, epoxy or polyester resins.

[0071] It can be provided, for example, that the wall 12 or walls 212 is or are installed on a winding machine, for example by means of clamps or specific equipment to allow the subsequent winding operation of the fibers around it.

[0072] The fibers can be polymerized in different curing passes, for example a curing at 30-120°C for 20-200 minutes, followed by a post-curing at 80-200°C for 1-20 hours depending on the resin applied.

[0073] For example the covering binding 15 can be applied using the filament winding technique.

[0074] It is clear that modifications and/or additions of parts may be made to each of the crystallizers 10, 110, 210 for continuous casting as described heretofore. The invention is, however, only defined by the scope of the appended claims.

Claims

1. Crystallizer for continuous casting comprising a tubular body (11, 211) having at least one wall (12, 212) which defines a through longitudinal casting cavity (13, 213) and a plurality of longitudinal grooves (14) made at least on one part of said at least one wall (12, 212) and open toward the outside thereof, **characterized in that** a covering binding (15), comprising one or more layers of a band (16) of fiber material impregnated or pre-impregnated with a polymer material, is irremovably wound and polymerized around said external surface of said at least one wall (12, 212).
2. Crystallizer as in claim 1, **characterized in that** said fiber material is wound in a direction mainly transverse to the longitudinal development of the wall (12, 212).
3. Crystallizer as in any claim hereinbefore, **character-**

ized in that said fiber is chosen from a group comprising carbon fibers, glass fibers, aramid fibers or combinations thereof, and said polymer is chosen from a group comprising polyamide, epoxy or polyester resins.

4. Crystallizer as in any claim hereinbefore, **characterized in that** said covering binding (15) is wound around and in direct contact with said external surface of said at least one wall (12, 212) and closes said longitudinal grooves (14) thus obtaining corresponding cooling channels (17) configured to make a cooling liquid flow inside them.
5. Crystallizer as in any claim from 1 to 3, wherein said longitudinal grooves (14) are closed by a metal layer (18) made using electrolytic deposition techniques that thus defines a corresponding plurality of cooling channels (17) configured to make a cooling liquid flow inside them, **characterized in that** said covering binding (15) is wound around and in direct contact with said metal layer (18) to make rigid the whole consisting of said at least one wall (12) and said metal layer (18).
6. Crystallizer as in any claim from 1 to 3, **characterized in that** said longitudinal grooves (14) are closed by a lamina (23) made of fiber-reinforced polymer material to define a corresponding plurality of cooling channels (17) configured to make a cooling liquid flow inside them, said covering binding (15) being wound around and in direct contact with said lamina (23) made of fiber-reinforced polymer material in order to make rigid the whole consisting of said at least one wall (12) and said lamina (23) made of fiber-reinforced polymer material (18).
7. Crystallizer as in any claim from 1 to 3, wherein said longitudinal grooves (14) are closed by at least a plate (219) associated to the external surface of said at least one wall (212) to define a corresponding plurality of cooling channels (17) configured to make a cooling liquid flow inside them, **characterized in that** said covering binding (15) is wound around and in direct contact with said at least one plate (219) to reinforce and increase the safety of the connection of the at least one plate (219) with said at least one wall (212).
8. Crystallizer as in any claim hereinbefore, **characterized in that** said covering binding (15) has a thickness constant along the longitudinal extension of said tubular body (11, 211).
9. Crystallizer as in any claim from 1 to 7, **characterized in that** said covering binding (15) has a variable thickness along the longitudinal extension of said tubular body (11, 211) to define zones of variable re-

sistance and rigidity.

10. Method to obtain a crystallizer (10, 110, 210) for continuous casting, comprising a step of making a tubular body (11, 211) having at least one wall (12, 212) which defines a through longitudinal casting cavity (13, 213) and a plurality of longitudinal grooves (14) made at least on one part of an external surface of said at least one wall (12, 212) and open toward the outside thereof, **characterized in that** it also comprises a step in which a covering binding (15), comprising a band (16) of one or more layers of fiber material impregnated or pre-impregnated with a polymer material, is irremovably wound and polymerized around said external surface of said at least one wall (12, 212). 5
11. Method as in claim 10, **characterized in that** said band (16) is first wound around said external surface of said at least one wall (12, 212) and then the polymerization of said polymer material being provided in order to solidly attach said covering binding (15) with respect to said wall (12, 212). 10
12. Method as in claim 10 or 11, **characterized in that** after said winding of said covering binding (15), it comprises a curing step during which said crystallizer (10, 110, 210) is heated to a temperature comprised between 30°C and 120°C and kept at this temperature for a period comprised between 20 and 200 minutes. 15
13. Method as in claim 12, **characterized in that** after said curing step a post-curing step is provided during which said crystallizer (10, 110, 210) is heated to a temperature comprised between 80°C and 200°C and kept at this temperature for a period comprised between 1 hour and 20 hours. 20
14. Method as in any claim from 10 to 13, **characterized in that** said covering binding (15) is applied using the filament winding technique. 25
15. Method as in any claim from 10 to 14, **characterized in that**, before the winding of said one or more layers of fiber material, it provides to fill said longitudinal grooves (14) with disposable material, to deposit a metal layer (18) on the external surface of said at least one wall (12, 212) by means of electrolytic deposition techniques, in order to close said longitudinal grooves (14), and to subsequently remove said disposable material from said longitudinal grooves (14) so as to define corresponding cooling channels (17). 30
16. Method as in any claim from 10 to 14, **characterized in that**, before the winding of said one or more layers of fiber material, it provides to close said longitudinal grooves (14) with at least one lamina (23) made of 35

a fiber-reinforced polymer material to define a plurality of cooling channels (17), **and in that** during said winding, said fiber material is wound around and in direct contact with said lamina (23) made of fiber-reinforced polymer material.

17. Method as in any claim from 10 to 14, **characterized in that**, before the winding of said one or more layers of fiber material, it provides to close said longitudinal grooves (14) with at least a plate (219) associated to the external surface of said at least one wall (212) so as to define a corresponding plurality of cooling channels (17). 40
18. Method as in any claim from 10 to 17, **characterized in that** said fiber material is wound around said wall (12; 212) at a winding angle comprised between 0° and 10°, preferably between 0° and 5°, with respect to the perpendicular to the axis of longitudinal development of the crystallizer (10). 45
19. Method as in any claim from 10 to 18, **characterized in that** said covering binding (15) comprises a band made using at least a fiber impregnated or pre-impregnated with glue or polymer resin, said covering binding (15) having a volumetric ratio of fibers of 60%, and glue or polymer resin of 40%. 50
20. Method as in any claim from 10 to 19, **characterized in that** during the winding of said fiber material, fibers making up said covering binding (15) are wound at a controlled tension between 1N and 50N. 55

Patentansprüche

1. Kristallisator zum Stranggießen umfassend einen rohrförmigen Körper (11, 211) mit zumindest einer Wand (12, 212), die einen durchgehenden längsverlaufenden Gießhohlraum (13, 213) definiert, und einer Vielzahl von längsverlaufenden Nuten (14), die zumindest an einem Teil der zumindest einen Wand (12, 212) ausgebildet sind und in Richtung auf das Äußere derselben offen sind, **dadurch gekennzeichnet, dass** eine Deckbindung (15), die eine oder mehrere Schichten eines Bandes (16) aus einem Fasermaterial umfasst, das mit einem Polymermaterial getränkt oder vorgetränkt ist, in nicht abnehmbarer Weise um die Außenfläche der zumindest einen Wand (12, 212) gewickelt und polymerisiert ist.
2. Kristallisator nach Anspruch 1, **dadurch gekennzeichnet, dass** das Fasermaterial in einer Richtung gewickelt ist, die hauptsächlich zum Längsverlauf der Wand (12, 212) querlaufend ist.
3. Kristallisator nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die Faser

aus einer Gruppe ausgewählt ist, die Kohlenstofffasern, Glasfasern, Aramidfasern oder Kombinationen davon umfasst, und das Polymer aus einer Gruppe ausgewählt ist, die Polyamid-, Epoxid- oder Polyesterharze umfasst.

4. Kristallisator nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die Deckbindung (15) um die Außenfläche der zumindest einen Wand (12, 212) herum und in direktem Kontakt damit gewickelt ist und die längsverlaufenden Nuten (14) schließt, wodurch entsprechende Kühlungskanäle (17) erhalten werden, die dafür ausgelegt sind, eine Kühlungsflüssigkeit in ihrem Inneren fließen zu lassen.
5. Kristallisator nach einem der Ansprüche 1 bis 3, worin die längsverlaufenden Nuten (14) durch eine Metallschicht (18) geschlossen sind, die unter Verwendung von elektrolytischen Abscheidungstechniken hergestellt ist, die somit eine entsprechende Vielzahl von Kühlungskanälen (17) definiert, die dafür ausgelegt sind, eine Kühlungsflüssigkeit in ihrem Inneren fließen zu lassen, **dadurch gekennzeichnet, dass** die Deckbindung (15) um die Metallschicht (18) herum und in direktem Kontakt damit gewickelt ist, um das Ganze bestehend aus der zumindest einen Wand (12) und aus der Metallschicht (18) zu versteifen.
6. Kristallisator nach einem der Ansprüche 1 bis 3, **dadurch gekennzeichnet, dass** die längsverlaufenden Nuten (14) durch eine Platte (23) geschlossen sind, die aus einem faserverstärkten Polymermaterial besteht, um eine entsprechende Vielzahl von Kühlungskanälen (17) zu definieren, die dafür ausgelegt sind, eine Kühlungsflüssigkeit in ihrem Inneren fließen zu lassen, wobei die Deckbindung (15) um die Platte (23) aus faserverstärktem Polymermaterial herum und in direktem Kontakt damit gewickelt ist, um das Ganze bestehend aus der zumindest einen Wand (12) und aus der Platte (23) aus faserverstärktem Polymermaterial (18) zu versteifen.
7. Kristallisator nach einem der Ansprüche 1 bis 3, worin die längsverlaufenden Nuten (14) durch zumindest eine Platte (219) geschlossen sind, die der Außenfläche der zumindest einen Wand (212) zugeordnet ist, um eine entsprechende Vielzahl von Kühlungskanälen (17) zu definieren, die dafür ausgelegt sind, eine Kühlungsflüssigkeit in ihrem Inneren fließen zu lassen, **dadurch gekennzeichnet, dass** die Deckbindung (15) um die zumindest eine Platte (219) herum und in direktem Kontakt damit gewickelt ist, um die Sicherheit der Verbindung der zumindest einen Platte (219) mit der zumindest einen Wand (212) zu verstärken und zu erhöhen.

8. Kristallisator nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die Deckbindung (15) eine Dicke aufweist, die entlang der Längserstreckung des rohrförmigen Körpers (11, 211) konstant ist.
9. Kristallisator nach einem der Ansprüche 1 bis 7, **dadurch gekennzeichnet, dass** die Deckbindung (15) eine veränderliche Dicke entlang der Längserstreckung des rohrförmigen Körpers (11, 211) aufweist, um Bereiche mit einer veränderlichen Festigkeit und Steifigkeit zu definieren.
10. Verfahren zur Herstellung eines Kristallisators (10, 110, 210) zum Stranggießen, umfassend einen Schritt des Herstellens eines rohrförmigen Körpers (11, 211) mit zumindest einer Wand (12, 212), die einen durchgehenden längsverlaufenden Gießhohlraum (13, 213) definiert, und einer Vielzahl von längsverlaufenden Nuten (14), die zumindest an einem Teil einer Außenfläche der zumindest einen Wand (12, 212) ausgebildet sind und in Richtung auf das Äußere derselben offen sind, **dadurch gekennzeichnet, dass** es auch einen Schritt umfasst, in dem eine Deckbindung (15), die ein Band (16) aus einer oder mehreren Schichten eines Fasermaterials umfasst, das mit einem Polymermaterial getränkt oder vorgetränkt ist, in nicht abnehmbare Weise um die Außenfläche der zumindest einen Wand (12, 212) gewickelt und polymerisiert ist.
11. Verfahren nach Anspruch 10, **dadurch gekennzeichnet, dass** das Band (16) zuerst um die Außenfläche der zumindest einen Wand (12, 212) gewickelt ist und dann die Polymerisation des Polymermaterials vorgesehen ist, um die Deckbindung (15) an der Wand (12, 212) fest anzubringen.
12. Verfahren nach Anspruch 10 oder 11, **dadurch gekennzeichnet, dass** es nach der Wicklung der Deckbindung (15) einen Härtungsschritt umfasst, während dessen der Kristallisator (10, 110, 210) auf eine Temperatur zwischen 30 °C und 120 °C geheizt und bei dieser Temperatur für einen Zeitraum zwischen 20 und 200 Minuten gehalten wird.
13. Verfahren nach Anspruch 12, **dadurch gekennzeichnet, dass** nach dem Härtungsschritt ein Nachhärtungsschritt vorgesehen ist, während dessen der Kristallisator (10, 110, 210) auf eine Temperatur zwischen 80 °C und 200 °C geheizt und bei dieser Temperatur für einen Zeitraum zwischen 1 Stunde und 20 Stunden gehalten wird.
14. Verfahren nach einem der Ansprüche 10 bis 13, **dadurch gekennzeichnet, dass** die Deckbindung (15) unter Verwendung der Fadenwicklungstechnik appliziert wird.

15. Verfahren nach einem der Ansprüche 10 bis 14, **dadurch gekennzeichnet, dass** es, vor der Wicklung der einen oder mehreren Schichten aus Fasermaterial, vorsieht, die längsverlaufenden Nuten (14) mit Wegwerfmaterial zu füllen, eine Metallschicht (18) auf der Außenfläche der zumindest einen Wand (12, 212) durch elektrolytische Abscheidungstechniken abzuscheiden, um die längsverlaufenden Nuten (14) zu schließen, und anschließend das Wegwerfmaterial von den längsverlaufenden Nuten (14) zu entfernen, um somit entsprechende Kühlungskanäle (17) zu definieren.
16. Verfahren nach einem der Ansprüche 10 bis 14, **dadurch gekennzeichnet, dass** es, vor der Wicklung der einen oder mehreren Schichten aus Fasermaterial, vorsieht, die längsverlaufenden Nuten (14) mit zumindest einer Platte (23) aus einem faserverstärkten Polymermaterial zu schließen, um eine Vielzahl von Kühlungskanälen (17) zu definieren, **und dass** während der Wicklung das Fasermaterial um die Platte (23) aus faserverstärktem Polymermaterial herum und in direktem Kontakt damit gewickelt wird.
17. Verfahren nach einem der Ansprüche 10 bis 14, **dadurch gekennzeichnet, dass** es, vor der Wicklung der einen oder mehreren Schichten aus Fasermaterial, vorsieht, die längsverlaufenden Nuten (14) mit zumindest einer Platte (219) zu schließen, die der Außenfläche der zumindest einen Wand (212) zugeordnet ist, um eine entsprechende Vielzahl von Kühlungskanälen (17) zu definieren.
18. Verfahren nach einem der Ansprüche 10 bis 17, **dadurch gekennzeichnet, dass** das Fasermaterial um die Wand (12; 212) mit einem Wicklungswinkel zwischen 0° und 10°, vorzugsweise zwischen 0° und 5°, im Hinblick auf die Senkrechte zur Achse des Längsverlaufs des Kristallisators (10) gewickelt wird.
19. Verfahren nach einem der Ansprüche 10 bis 18, **dadurch gekennzeichnet, dass** die Deckbindung (15) ein Band umfasst, das unter Verwendung zumindest einer Faser hergestellt ist, die mit Klebstoff oder Polymerharz getränkt oder vorgetränkt ist, wobei die Deckbindung (15) ein volumetrisches Verhältnis von Fasern von 60% und von Klebstoff oder Polymerharz von 40% hat.
20. Verfahren nach einem der Ansprüche 10 bis 19, **dadurch gekennzeichnet, dass** während der Wicklung des Fasermaterials die Fasern, die die Deckbindung (15) bilden, mit einer gesteuerten Spannung zwischen 1 N und 50 N gewickelt werden.

Revendications

1. Cristallisateur pour coulée continue comprenant un corps tubulaire (11, 211) ayant au moins une paroi (12, 212) qui définit une cavité de coulée longitudinale traversante (13, 213) et une pluralité de rainures longitudinales (14) réalisées au moins sur une partie de ladite au moins une paroi (12, 212) et ouvertes vers l'extérieur de celle-ci, **caractérisé en ce qu'une** reliure de recouvrement (15), comprenant une ou plusieurs couches d'une bande (16) de matériau fibreux imprégné ou pré-imprégné d'un matériau polymère, est enroulée et polymérisée de manière inamovible autour de ladite surface externe de ladite au moins une paroi (12, 212).
2. Cristallisateur selon la revendication 1, **caractérisé en ce que** ledit matériau en fibres est enroulé dans une direction principalement transversale au développement longitudinal de la paroi (12, 212).
3. Cristallisateur selon l'une quelconque des revendications précédentes, **caractérisé en ce que** ladite fibre est choisie dans un groupe comprenant des fibres de carbone, des fibres de verre, des fibres d'aramide ou des combinaisons de celles-ci, et ledit polymère est choisi dans un groupe comprenant des résines polyamide, époxy ou polyester.
4. Cristallisateur selon l'une quelconque des revendications précédentes, **caractérisé en ce que** ladite reliure de recouvrement (15) est enroulée autour de ladite surface externe de ladite au moins une paroi (12, 212), et en contact direct avec celle-ci, et ferme lesdites rainures longitudinales (14), obtenant ainsi des canaux de refroidissement correspondants (17) configurés pour faire circuler un liquide de refroidissement à l'intérieur d'eux.
5. Cristallisateur selon l'une quelconque des revendications 1 à 3, dans lequel lesdites rainures longitudinales (14) sont fermées par une couche métallique (18) réalisée en utilisant des techniques de dépôt électrolytique, qui définit ainsi une pluralité correspondante de canaux de refroidissement (17) configurés pour faire circuler un liquide de refroidissement à l'intérieur d'eux, **caractérisé en ce que** ladite reliure de recouvrement (15) est enroulée autour de ladite couche métallique (18), et en contact direct avec celle-ci, pour rendre rigide l'ensemble constitué par ladite au moins une paroi (12) et ladite couche métallique (18).
6. Cristallisateur selon l'une quelconque des revendications 1 à 3, **caractérisé en ce que** lesdites rainures longitudinales (14) sont fermées par une feuille (23) faite d'un matériau polymère renforcé par des fibres pour définir une pluralité correspondante de

canaux de refroidissement (17) configurés pour faire circuler un liquide de refroidissement à l'intérieur d'eux, ladite reliure de recouvrement (15) étant enroulée autour de ladite feuille (23) faite d'un matériau polymère renforcé par des fibres, et étant en contact direct avec celle-ci, afin de rendre rigide l'ensemble constitué par ladite au moins une paroi (12) et ladite feuille (23) faite d'un matériau polymère renforcé par des fibres (18).

7. Cristallisateur selon l'une quelconque des revendications 1 à 3, dans lequel lesdites rainures longitudinales (14) sont fermées par au moins une plaque (219) associée à la surface externe de ladite au moins une paroi (212) pour définir une pluralité correspondante de canaux de refroidissement (17) configurés pour faire circuler un liquide de refroidissement à l'intérieur d'eux, **caractérisé en ce que** ladite reliure de recouvrement (15) est enroulée autour de ladite au moins une plaque (219), et en contact direct avec celle-ci, pour renforcer et augmenter la sécurité de la connexion de ladite au moins une plaque (219) avec ladite au moins une paroi (212).
8. Cristallisateur selon l'une quelconque des revendications précédentes, **caractérisé en ce que** ladite reliure de recouvrement (15) a une épaisseur constante le long de l'extension longitudinale dudit corps tubulaire (11, 211).
9. Cristallisateur selon l'une quelconque des revendications 1 à 7, **caractérisé en ce que** ladite reliure de recouvrement (15) a une épaisseur variable le long de l'extension longitudinale dudit corps tubulaire (11, 211) pour définir des zones de résistance et de rigidité variables.
10. Procédé pour obtenir un cristallisateur (10, 110, 210) pour coulée continue, comprenant une étape de fabrication d'un corps tubulaire (11, 211) ayant au moins une paroi (12, 212) qui définit une cavité de coulée longitudinale traversante (13, 213) et une pluralité de rainures longitudinales (14) réalisées au moins sur une partie d'une surface externe de ladite au moins une paroi (12, 212) et ouverte vers l'extérieur de celle-ci, **caractérisé en ce qu'il** comprend également une étape dans laquelle une reliure de recouvrement (15), comprenant une bande (16) d'une ou plusieurs couches de matériau fibreux imprégné ou pré-imprégné d'un matériau polymère, est enroulée et polymérisée de manière inamovible autour de ladite surface externe de ladite au moins une paroi (12, 212).
11. Procédé selon la revendication 10, **caractérisé en ce que** ladite bande (16) est d'abord enroulée autour de ladite surface externe de ladite au moins une paroi (12, 212) et ensuite la polymérisation dudit matériau

polymère est réalisée afin de fixer solidement ladite reliure de recouvrement (15) par rapport à ladite paroi (12, 212).

12. Procédé selon la revendication 10 ou la revendication 11, **caractérisé en ce qu'**après ledit enroulement de ladite reliure de recouvrement (15), il comprend une étape de durcissement au cours de laquelle ledit cristallisateur (10, 110, 210) est chauffé à une température comprise entre 30°C et 120°C et maintenu à cette température pendant une période comprise entre 20 et 200 minutes.
13. Procédé selon la revendication 12, **caractérisé en ce qu'**après ladite étape de durcissement, il est prévu une étape de post-durcissement au cours de laquelle ledit cristallisateur (10, 110, 210) est chauffé à une température comprise entre 80°C et 200°C et maintenu à cette température pendant une période comprise entre 1 heure et 20 heures.
14. Procédé selon l'une quelconque des revendications 10 à 13, **caractérisé en ce que** ladite reliure de recouvrement (15) est appliquée en utilisant la technique de l'enroulement filamentaire.
15. Procédé selon l'une quelconque des revendications 10 à 14, **caractérisé en ce que**, avant l'enroulement de ladite une ou plusieurs couches de matériau fibreux, il prévoit de remplir lesdites rainures longitudinales (14) avec un matériau jetable, de déposer une couche métallique (18) sur la surface externe de ladite au moins une paroi (12, 212) au moyen de techniques de dépôt électrolytique, afin de fermer lesdites rainures longitudinales (14), et d'enlever ensuite ledit matériau jetable desdites rainures longitudinales (14) de manière à définir des canaux de refroidissement correspondants (17).
16. Procédé selon l'une quelconque des revendications 10 à 14, **caractérisé en ce que**, avant l'enroulement de ladite une ou plusieurs couches de matériau fibreux, il prévoit de fermer lesdites rainures longitudinales (14) avec au moins une feuille (23) faite en un matériau polymère renforcé de fibres pour définir une pluralité de canaux de refroidissement (17), et **en ce que**, pendant ledit enroulement, ledit matériau fibreux est enroulé autour ladite feuille (23) faite d'un matériau polymère renforcé de fibres, et en contact direct avec celle-ci.
17. Procédé selon l'une quelconque des revendications 10 à 14, **caractérisé en ce que**, avant l'enroulement de ladite une ou plusieurs couches de matériau fibreux, il prévoit de fermer lesdites rainures longitudinales (14) avec au moins une plaque (219) associée à la surface externe de ladite au moins une paroi (212) de manière à définir une pluralité correspon-

dante de canaux de refroidissement (17).

18. Procédé selon l'une quelconque des revendications 10 à 17, **caractérisé en ce que** ledit matériau fibreux est enroulé autour de ladite paroi (12 ; 212) selon un angle d'enroulement compris entre 0° et 10°, de préférence entre 0° et 5°, par rapport à la perpendiculaire à l'axe de développement longitudinal du cristallisateur (10).
19. Procédé selon l'une quelconque des revendications 10 à 18, **caractérisé en ce que** ladite reliure de recouvrement (15) comprend une bande réalisée en utilisant au moins une fibre imprégnée ou pré-imprégnée de colle ou de résine polymère, ladite reliure de recouvrement (15) ayant un rapport volumétrique de fibres de 60%, et de colle ou de résine polymère de 40%.
20. Procédé selon l'une quelconque des revendications 10 à 19, **caractérisé en ce que** pendant l'enroulement dudit matériau fibreux, les fibres constituant ladite reliure de recouvrement (15) sont enroulées à une tension contrôlée entre 1N et 50N.

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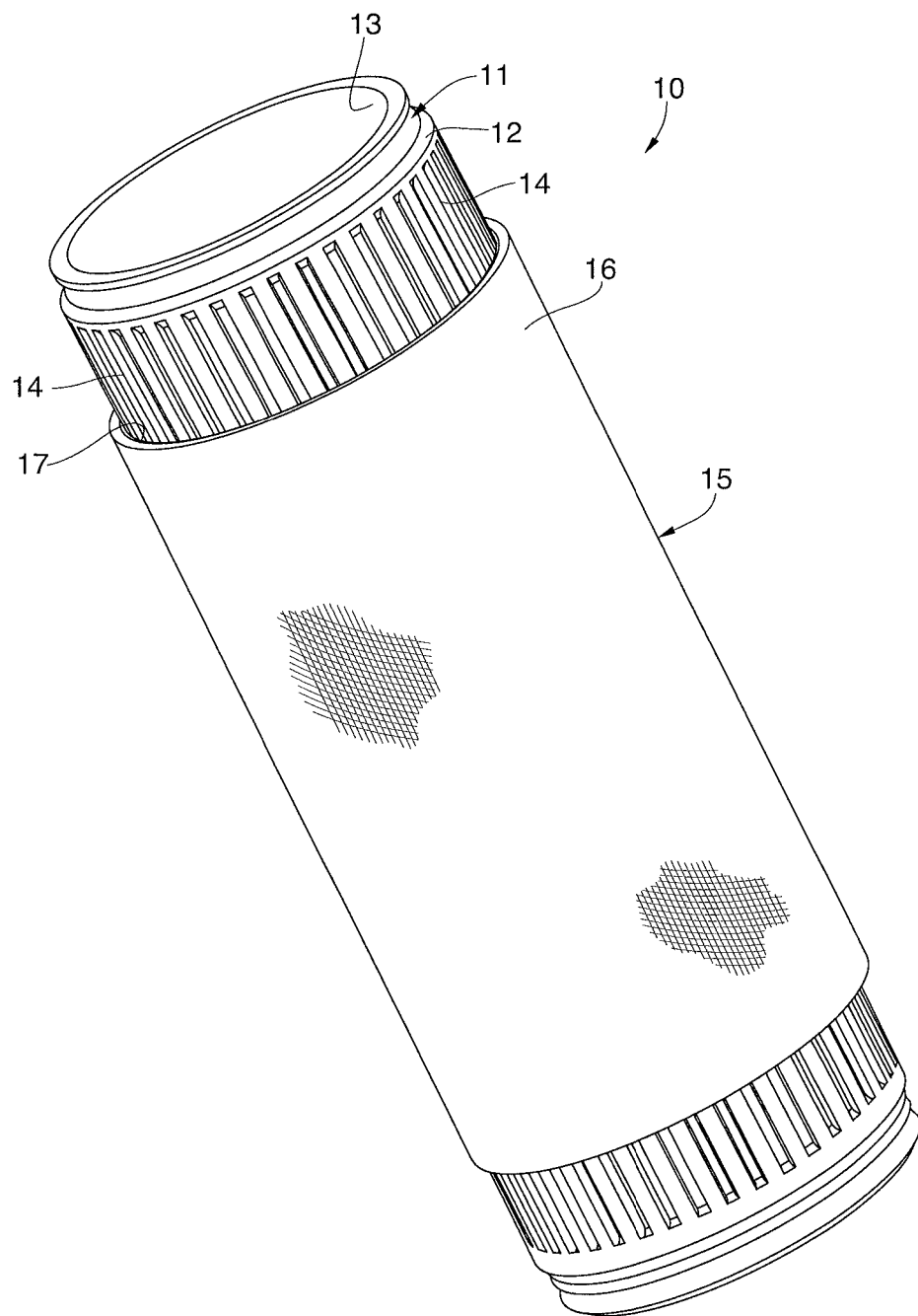


fig. 1

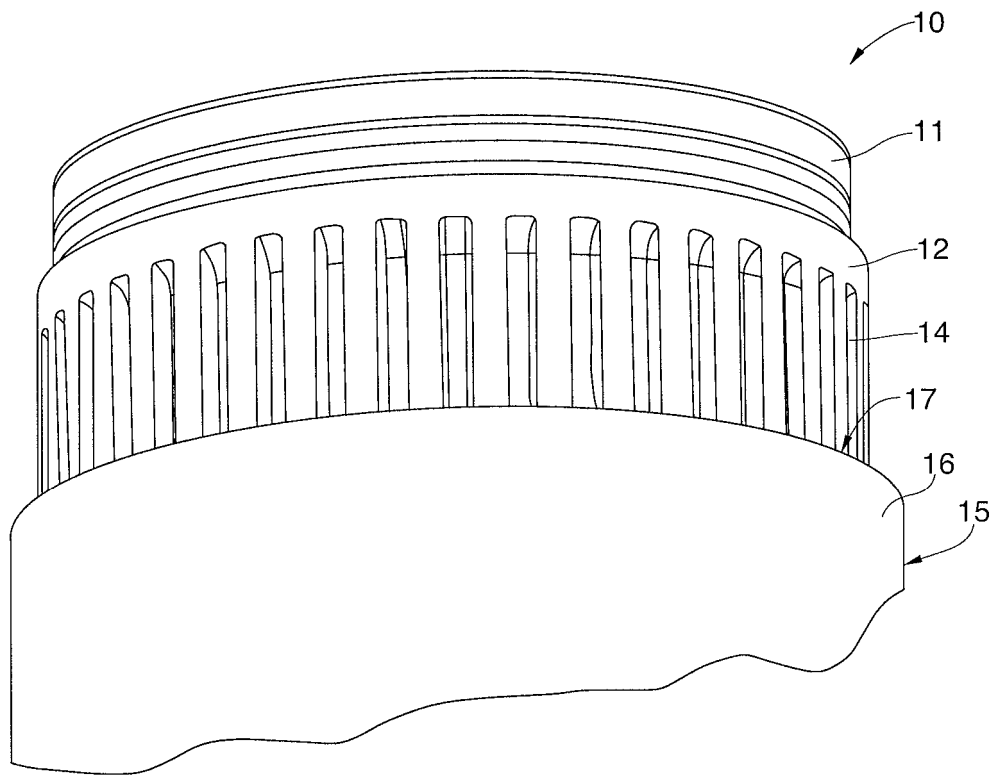


fig. 2

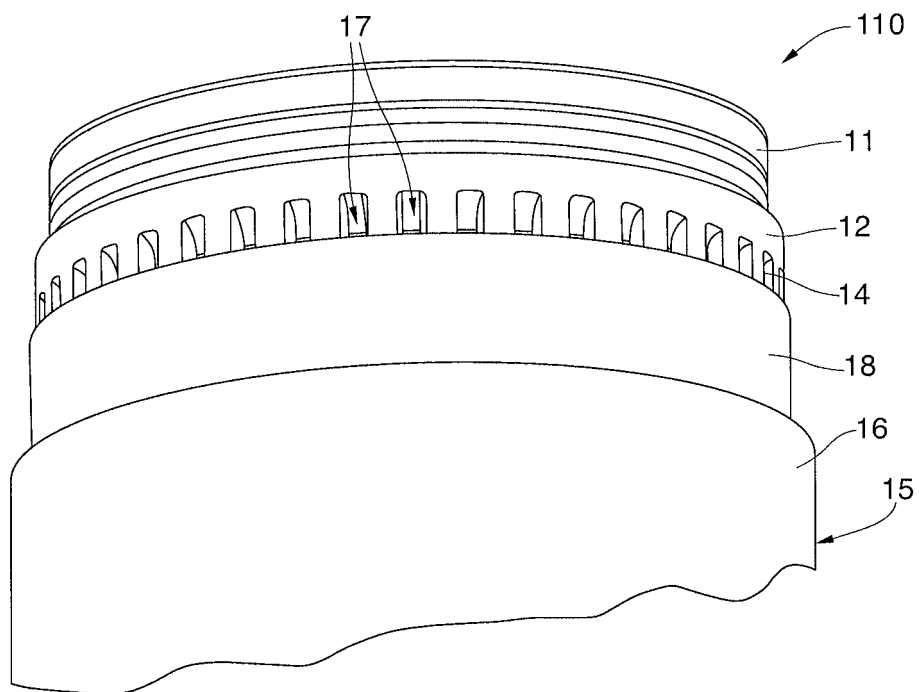


fig. 3

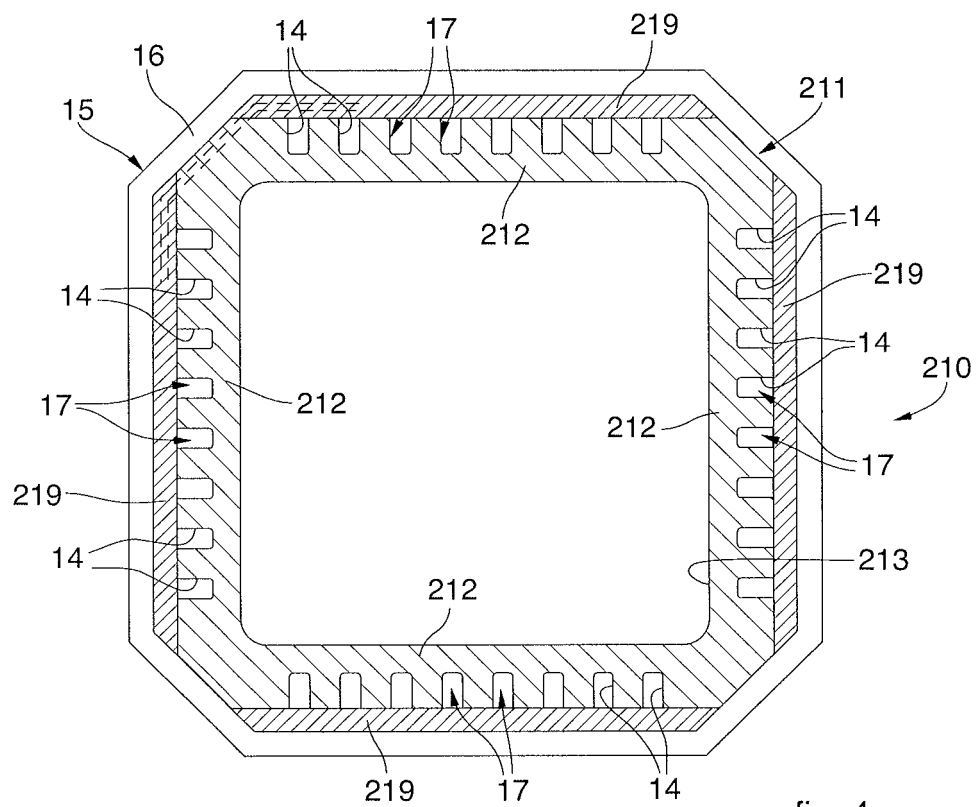


fig. 4

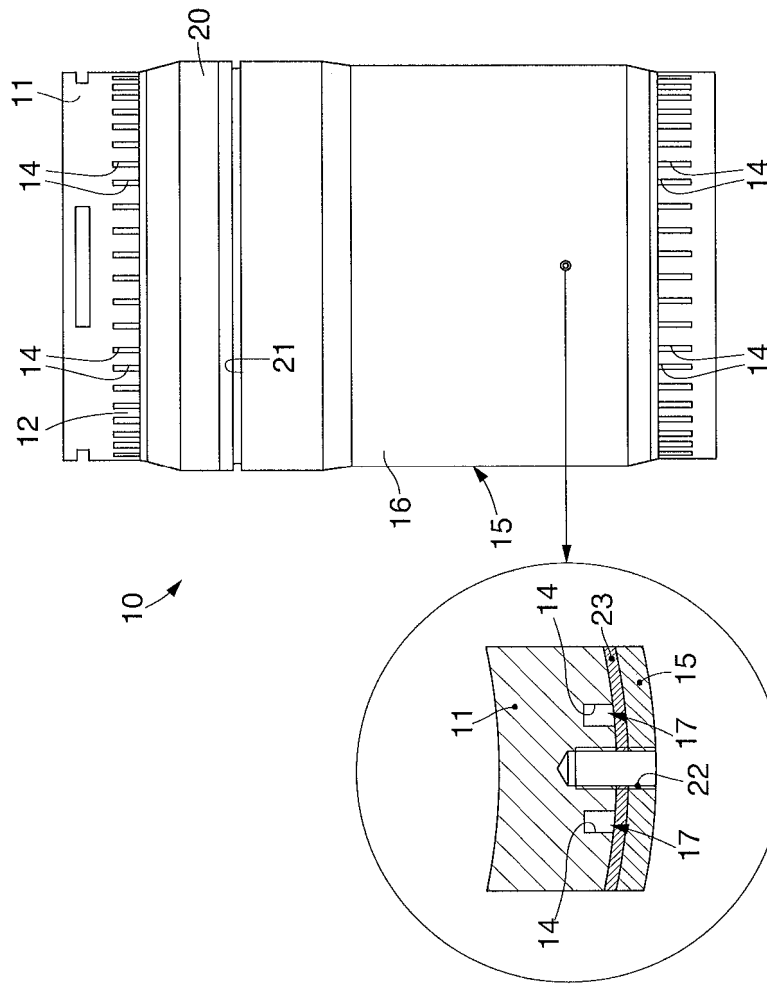


fig. 6

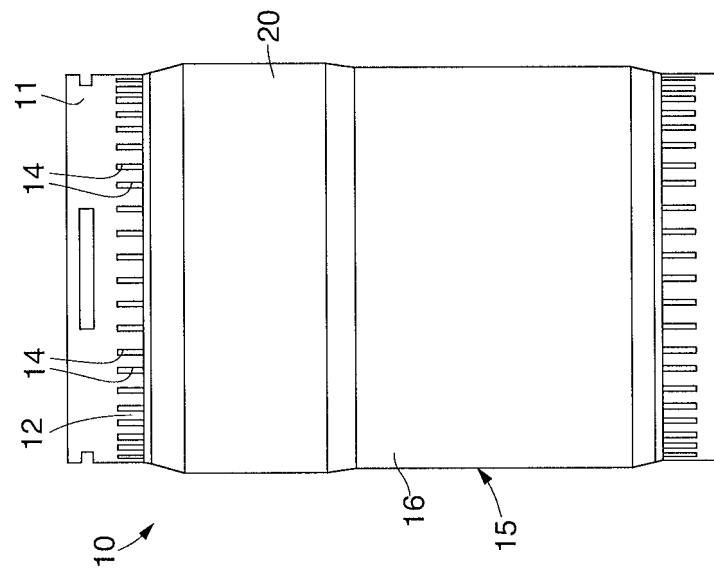


fig. 5

REFERENCES CITED IN THE DESCRIPTION

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