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(54) CONNECTION ELEMENT FOR THE BUILDING INDUSTRY, METHOD FOR CONSOLIDATING A STRUCTURAL AND NON-STRUCTURAL ELEMENT, AND RELATED INSTALLATION KIT

(57) A connection element (12) in composite material comprising a bundle of fibres (14) and a binding agent. The connection element (12) further comprises an insertion portion (16) having two ends (18, 20). The insertion portion (16) comprises a section of said bundle of fibres embedded in said binding agent to form a monolithic structure; at at least one of the ends (18, 20) a fixing portion (22, 24) is provided. The fixing portion (22, 24) comprises fibres (14) overhanging from the insertion portion (16) and partially embedded in the monolithic structure. The fibres are predisposed with anchorage means (26, 28) adapted to realize an anchorage between said fibres (14) of the fixing portion (22, 24) and a plaster and/or a reinforcement element.

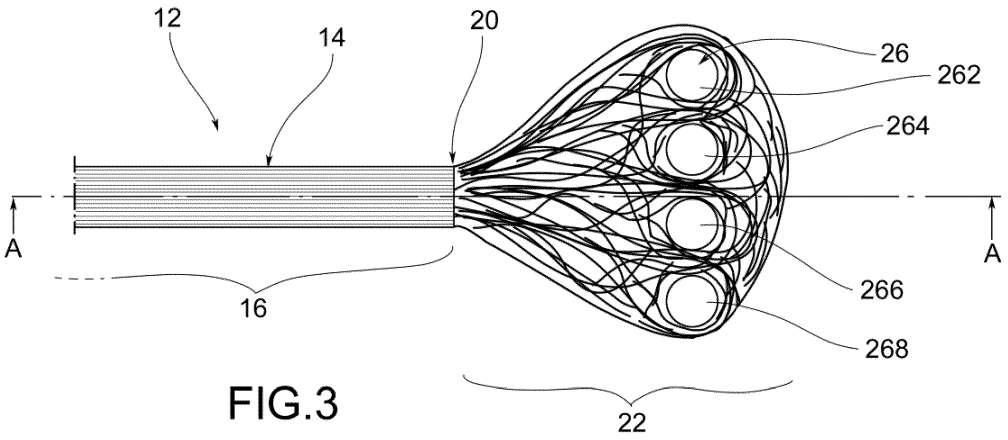

FIG.3

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Description

FIELD OF APPLICATION

[0001] The present invention relates to a connection element for the building industry, a method for consolidating a structural and non-structural element, and a related installation kit. In particular, the present invention relates to a method for consolidating a structural and non-structural element such as, for example, structures made of masonry, concrete, wood, steel, etc. with a connection element for the building industry and a related installation kit.

BACKGROUND ART

[0002] As known, there are many techniques for consolidating architectural structures or the safety thereof. In particular, there are techniques which use rigid meshes in composite material made with fibres incorporated in a binding agent, such as, for example, a thermosetting resin.

[0003] In this disclosure, the term matrix and the term binding agent will be used indifferently to indicate the same material.

[0004] In some applications, the meshes are embedded inside a mortar with binding agents, which may be of different types, and are used for consolidating existing structures (masonry, concrete, etc.) creating a reinforced plaster to be applied on the surfaces, or as slabs for manufacturing load bearing floor slabs.

[0005] The mesh may be blocked in position by means of the use of junction elements inserted in holes made in the masonry. The preformed junction elements or connectors are generally made of metal and have an L-shape, in which the two sides are substantially perpendicular to each other. In use, once an anchoring resin has been distributed inside the hole, one side is inserted into the hole obtained in the masonry, while the other side is arranged parallel to the surface of the masonry. Mesh and junction elements are therefore embedded inside a plaster with binding agents which may be of different types.

[0006] If the mesh is positioned on both surfaces of a masonry, it is possible to block each mesh in position, making a through hole so that the two meshes may be connected to each other with two junction elements: a first junction element inserted at one surface, and a second junction element inserted at the opposite surface.

[0007] As an alternative to the type of junction elements mentioned, connection elements made with preformed bars of composite material comprising fibres and hardened resin are known.

[0008] The bar is obtained by means of a method called pultrusion, in which the fibres are picked up and passed through a resin impregnation bath. At the exit of the impregnation area, the impregnated fibres pass through a die so as to give the manufactured item a specific cross section, compacting the fibres together. The impregnated fibres are then passed inside a curing furnace which provides heat so that the resin may polymerize and therefore harden.

[0009] Downstream of the plant, a so-called pulling device is there, which provides the impregnated fibres with the traction necessary to move through the stations mentioned above.

[0010] The method is therefore free from downtime, since the pulling device allows the manufactured item being processed to move between the various stations of the apparatus.

[0011] Downstream of the pulling device, an area may be arranged for the automated cutting of the pultruded bars.

[0012] Bars made of composite material offer many advantages. For example, with respect to bars made of metal, they are lighter and are not subject to oxidation.

[0013] The main limitation of the pultruded bars is that they may not be bent on site, for example in the case in which an anchorage is to be made through the masonry between two reinforcement plates.

[0014] The only way to obtain bent pultruded bars is to produce them directly bent, in a dedicated plant. However, the production of these elements, even if they are manufactured already bent, fails to ensure the dimensional and inclination flexibility which would instead be necessary.

[0015] Furthermore, in the case of L-shaped connectors, precisely at the connecting portion between the two sides of the L, a decrease in strength and stiffness is there, with respect to the straight section.

[0016] Furthermore, to establish a connection between the two surfaces of a masonry through the masonry itself, it is necessary to use two distinct L-shaped elements, successively spliced, at the portions thereof inside the masonry.

[0017] The prior art has attempted to solve this issue by proposing pultruded bars subjected to a processing by means of which the fibres at one end of the bar are freed from the already hardened resin.

[0018] The end of the bar, after the pultrusion process, is subjected to a solvent bath and/or a pyrolysis at a high temperature to eliminate the resinous matrix and keep the fibre dry.

[0019] The bars thus obtained may be inserted inside a hole obtained in the masonry, while the end composed of free fibres is widened radially and embedded in the mortar with which the surface of the masonry is coated. Thereby, the unravelled end ensures the grip between the bar and the mortar.

[0020] Although it is widely appreciated and used, the prior art is not free from drawbacks.

[0021] In certain applications, the radial distribution is not sufficient to ensure an effective gripping of the fibres inside the binding agent used to coat the surface of the masonry.

[0022] Furthermore, the fibres which are freed from the hardened resin have different, in particular worse, prop-

erties with respect to the intact bar, but also with respect to the fibres before the impregnation step.

PRESENTATION OF THE INVENTION

[0023] Therefore, the need is felt to solve the drawbacks and limitations mentioned above with reference to the prior art.

[0024] In particular, the need is felt for a connection element for the building industry which allows for a sufficient grip to be provided, even in extreme conditions.

[0025] In addition, the need is felt to provide a connection element for the building industry, which may be adapted to different conditions of use.

[0026] Furthermore, the need is felt for a connection element for the building industry which may be easily used for joining, through a through hole in the masonry, two reinforcement plates arranged on the walls of the masonry.

[0027] Such needs are at least partially met by a connection element for the building industry according to claim 1, by a method for consolidating a masonry with a connection element for the building industry according to claim 9, and by a related installation kit according to claim 11.

DESCRIPTION OF THE DRAWINGS

[0028] Further features and advantages of the present invention will become more comprehensible from the following description of preferred embodiments thereof given by way of non-limiting examples, in which:

- Figure 1 diagrammatically shows a first embodiment of a connection element according to the present invention;
- Figure 2 diagrammatically shows an alternative embodiment of the connection element according to the present invention;
- Figure 3 diagrammatically shows a possible embodiment of a connection element according to the present invention;
- Figures 4 and 5 diagrammatically show two possible alternatives related to the section obtained with the plane A-A of Figure 3;
- Figure 6 diagrammatically shows a possible operating configuration of the connection element according to the present invention, the section of which is shown in Figure 5;
- Figure 7 diagrammatically shows a connection element according to the present invention in a possible condition of use;
- Figure 8 diagrammatically shows a component of a kit according to the present invention; and
- Figure 9 diagrammatically shows a longitudinal section of a component of a kit according to the present invention.

[0029] Elements or parts in common to the embodiments described will be indicated hereafter using the same reference numerals.

DETAILED DESCRIPTION

[0030] Figure 1 shows a connection element 12 according to the present invention.

[0031] The connection element 12 is made of composite material comprising a bundle of fibres 14 and a binding agent.

[0032] More in detail, the connection element 12 comprises an insertion portion 16 having two ends 18, 20. The insertion portion 16 comprises a section of the bundle of fibres embedded in the binding agent to form a monolithic structure. A fixing portion 22, 24 is provided at at least one of the ends 18, 20.

[0033] The fixing portion 22, 24 comprises fibres 14 overhanging from the insertion portion 16 and therefore partially embedded in the monolithic structure. The fibres 14 of the fixing portion 22, 24 are predisposed with anchorage means 26, 28 adapted to realize an anchorage between the fibres 14 of the fixing portion 22, 24 and a plaster and/or a reinforcement element and/or a binding agent-based matrix.

[0034] According to a possible embodiment, the fibres 14 in the fixing portion 22, 24 have been embedded in the binding agent and then released.

[0035] Advantageously, the fibres 14 in said fixing portion 22, 24 may be virgin or at least partially virgin.

[0036] In this disclosure, the expression virgin fibres means fibres and/or portions thereof which have not been embedded in the resin. In technical jargon, virgin fibres may also be defined as dry fibres. In particular, virgin fibres are fibres and/or portions thereof which have not been resin-embedded to form a monolithic structure.

[0037] The bundle of fibres may comprise synthetic organic fibres, natural organic fibres, inorganic fibres, and/or metallic fibres.

[0038] With reference to synthetic organic fibres, these may comprise, for example, aramid fibres, poly-paraphenyl benzobisoxazole (PBO), and/or polyester.

[0039] Natural organic fibres may comprise, for example: cotton, hemp, flax, sisal, etc.

[0040] The inorganic fibres may comprise, for example: glass, carbon, basalt, etc.

[0041] The metallic fibres may comprise, for example: stainless steel, carbon steel, copper, brass.

[0042] According to a possible embodiment of the present invention, the bundle of fibres may comprise fibres of different types in the same bundle.

[0043] The binding agent may be, for example, an organic or inorganic resin.

[0044] As for the resin, this may be of the thermosetting or thermoplastic type. In the case of a thermosetting resin, it may be chosen, for example, from the group comprising vinyl-ester resins, poly-ester resins, bisphenol resins, epoxy resins, etc.

[0045] Advantageously, the fibres may be treated with surface additives to improve the durability thereof and the adhesion thereof with the resin and/or the matrix, which may be organic, inorganic or of another type.

[0046] According to a possible embodiment of the present invention, the insertion portion 16, which in use is inserted inside a hole in the masonry, may have an outer surface with quartz sand and resin fillings, or an outer surface subjected to roughening by means of a mechanical processing or application of material.

[0047] The length of the insertion portion 16 may range from 10 mm to 20000 mm. Advantageously, the length of the insertion portion 16 may be decided based on the thickness of the structural or non-structural element in which it must be inserted.

[0048] The insertion portion 16 may have a substantially circular, rectangular, or square cross-section or a cross-section according to design specifications.

[0049] According to a possible embodiment, the insertion portion 16 may be hollow for geotechnical or structural applications in general, in order to facilitate any filling through the inner volume of the connector (injection of grout or structural materials which are primordially fluid or semi-fluid).

[0050] Advantageously, the diameter of the insertion portion 16 may range from 1 mm to 150 mm.

[0051] The fixing portion 22, 24 may be arranged at one or both ends 18, 20 of the insertion portion. In particular, the length of the fixing portion 22, 24 may range from 10 mm to 20000 mm.

[0052] In any case, as it will be obvious to the skilled in the art, such fibres 14 of the fixing portion 22, 24 may be, for example, preliminarily primed or soaked in an organic or inorganic matrix and/or a matrix of another type in order to improve the mechanical behaviour thereof.

[0053] The anchorage means 26, 28 may be arranged in a position distal with respect to the insertion portion (16).

[0054] As for the shape thereof, the anchorage means 26, 28 may comprise, for example, spherical, circular, cylindrical, drop-like, polyhedral shapes.

[0055] Furthermore, the anchorage means 26, 28 may also have generic shapes.

[0056] In addition, the surface of the anchorage means 26, 28 may be smooth or rough, to allow an adequate chemical and/or mechanical collaboration with the structural or non-structural element on which it is connected/inserted.

[0057] According to a possible embodiment, the anchorage means 26, 28 may be made of different materials depending on the purposes.

[0058] For example, they may be made of polymeric, binding, metallic material, etc.

[0059] According to alternative embodiments, the anchorage means may also be made of wood.

[0060] According to a possible embodiment of the present invention, the fixing portion 22, 24 comprises fibres 14 which may be folded so that the end thereof may also be spliced with at least one fibre 14 close to the insertion portion 16.

[0061] The junction may be made both in a continuous production line as well as, in a second step, for example, by crimping with plastic and/or metal rings, manual and/or automatic gluing.

[0062] This type of junction provides anchorage means 26, 28 which comprise anchoring rings 262, 264, 266, 268.

[0063] In accordance with a possible embodiment of the present invention, which may be seen in the example of Figure 4, which shows in section the fixing portion 22, 24, it may be substantially flat and lie substantially parallel to the anchoring rings 262 , 264, 266, 268.

[0064] In accordance with a possible embodiment which may be seen in the example of Figures 5 and 6, the fixing portion 22, 24 may be substantially flat, as in the previous case, but it may comprise two superimposed branches 221, 222. Advantageously, in use, the two branches 221, 222 may be spread apart from each other according to two different directions, as shown in the example of Figure 6.

[0065] In use, the insertion portion 16 is inserted inside a hole made in the structural and/or non-structural element, and the fixing portion 22, 24 is bent towards the masonry and embedded in the plaster so that the anchorage means 26, 28 exert an additional anchoring action with respect to that exerted only by the fibres of the prior art, when immersed in a matrix.

[0066] A method for making a connection element 12 out of composite material comprising fibres 14 and a resin-based binding agent according to the present invention will be described below. The method comprises the steps of:

- providing a bundle of fibres 14;
- impregnating the fibres 14 by means of a resin-based binding agent, carried out at predetermined sections of the bundle of fibres 14;
- passing the impregnated fibres 14 inside a die having a certain cross-section;
- hardening the binding agent inside the die or curing furnace;
- cutting the connection element 12, forming an insertion portion 16 having two ends 18, 20 and a fixing portion 22, 24 at at least one of the ends 18, 20; and
- arranging the anchorage means 26, 28 at at least one fixing portion 22, 24.

[0067] According to a possible embodiment of the present invention, the cutting may occur at a section of the bundle of fibres impregnated with resin, or at a section of the bundle of fibres 14 in which the fibres 14 comprise or consist of virgin fibres.

[0068] According to a possible alternative embodiment of the present invention, the method for manufacturing a connection element 12 may comprise the steps of:

- providing a bundle of fibres 14;
- impregnating the fibres 14 with a binding agent;
- passing the impregnated fibres 14 inside a die having a certain cross-section;
- hardening the binding agent inside the die or curing furnace;
- cutting of the connection element 12;
- possibly releasing a portion of the fibres, forming an insertion portion 16 having two ends 18, 20 and a fixing portion 22, 24 at at least one of the ends 18, 20
- arranging the anchorage means 26, 28 at at least one fixing portion 22, 24.

[0069] Advantageously, the step of impregnating with the binding agent may involve only some sections of the fibres, i.e., those which will constitute the insertion portion 16 of the connection element 12. In this case, the portions of the fibres which will form the fixing portions will be of the virgin type.

[0070] A method for consolidating/reinforcing a structural and/or non-structural element with a connection element according to the present invention will now be described.

[0071] With reference to Figure 7, the method for consolidating a masonry 54 with a connection element 12 of the present invention essentially comprises the steps of:

- preparing a hole 50 in a structural and/or non-structural element;
- arranging an anchoring resin inside the hole 50;
- inserting the insertion portion 16 of the connection element 12 in the hole 50; and
- preparing a plaster or a specific matrix or mixture of aggregates and binding agents 52 at the fixing portion 22 of the connection element 12.

[0072] According to a possible embodiment of the present invention, the method may comprise a step in which a reinforcement mesh is provided on the surface of the masonry.

[0073] The present invention also relates to an installation kit comprising an insertion funnel 40 adapted to facilitate the insertion of the connection element 12 inside a hole in a masonry.

[0074] Advantageously, the insertion funnel 40 may also be used to guide the virgin fibres of the fixing portion at the curving area on the surface of the structural and/or non-structural element.

[0075] Advantageously, the insertion funnel 40 may comprise a tubular portion 44, adapted to be inserted inside a hole, and a diverging portion.

[0076] The insertion funnel 40 may be useful for positioning the fixing portions 22, 24 in order to improve the mechanical behaviour of the connection element, for example, by improving and increasing the extraction force.

[0077] The advantages which may be achieved with a connection element according to the present invention, with the related installation method and with the installation kit are therefore now evident.

[0078] First, a single connection element has become available, which may be used to connect two plate-like resistant elements through a hole in a structural and/or non-structural element. In this case, the ends of the connector are both provided with a fixing portion.

[0079] By means of the anchorage means, embedded in the plaster or connected to reinforcement elements, such as, for example, a mesh in the resin, an anchorage is obtained, effectively ensuring a better performance of the tensile connector.

[0080] Furthermore, in the case where the ends of the connector are both provided with a fixing portion, the need to join two L-shaped elements inside the masonry has been eliminated.

[0081] The connection element according to the present invention may be used, for example, as a connection system between reinforcement elements for the wall/-resistant element which is required to increase the performance by means of a symmetrical or partially symmetrical reinforcement layout.

[0082] The connector also acts as a tie rod, bracing and/or nail for geotechnics or slope stabilization (geotechnical works in general), the dry terminals/free ends thereof being possibly made on site with any geometric shape, by means of pre-moulding in the factory or direct pre-application on site, with or without the application of a mat to facilitate the creation of a junction plate or finally by providing a light primer already in the production step to improve the application steps, with the bracing and/or tie rod elements.

[0083] Furthermore, it may be used as bracket or reinforcement in general, continuous or discontinuous, for structural or non-structural elements in reinforced concrete, completing the construction steps in the factory (co-moulding or similar techniques) or on site.

[0084] Furthermore, the particular production method allows to manufacture a product which maintains the mechanical resistance and stiffness properties of the connection in the anchorage area of the elements to be connected unaltered.

[0085] In order to meet specific needs, those skilled in the art will be able to make changes to the embodiments described above and/or replace the elements described with equivalent elements without departing from the scope of the appended claims.

Claims

1. Connection element (12) in composite material comprising a bundle of fibres (14) and a binding agent, said connection element (12) comprising an insertion portion (16) having two ends (18, 20); said insertion portion (16) comprising a section of said bundle of fibres embedded in said binding agent to form a monolithic structure; at least one of said ends

(18, 20) being provided with a fixing portion (22, 24); said connection element being **characterised in that** said fixing portion (22, 24) comprises fibres (14) overhanging from the insertion portion (16) and partially embedded in the monolithic structure, said fibres being predisposed with anchorage means (26, 28) adapted to realize an anchorage between said fibres (14) of said fixing portion (22, 24) and a plaster and/or a reinforcement element.

2. Connection element (12) according to claim 1, **characterized in that** the fibres (14) in said fixing portion (22, 24) are virgin.

3. Connection element (12) according to claim 1, **characterised in that** the fibres (14) in said fixing portion (22, 24) have been embedded in the binding agent and subsequently released.

4. Connection element (12) according to any one of the preceding claims, **characterized in that** said binding element is an organic or inorganic resin.

5. Connection element (12) according to any one of the preceding claims, **characterised in that** said anchoring means (20) comprise an element chosen from the group comprising: sphere, disc, cylinder, drop, and polyhedron.

6. Connection element (12) according to any one of the preceding claims, **characterized in that** said insertion portion (16) is prepared with a smooth, or rough surface to allow adequate chemical and/or mechanical collaboration with a structural or non-structural element in which it is inserted.

7. Connection element (12) according to any of the preceding claims, **characterized in that** said anchoring means (20) comprise fibres (14) of said fixing portion (22, 24) which are folded with one end spliced near the insertion portion (16).

8. Connection element (12) according to any one of the preceding claims, **characterized in that** said fibres (14) comprise synthetic organic fibres, natural organic fibres, inorganic fibres, and/or metallic fibres.

9. Method for consolidating a structural and/or non-structural element (54) with a connection element (12) according to any one of the claims 1-8, comprising the steps of:

- preparing a hole (50) in said structural and/or non-structural element (54);
- arranging an anchoring resin inside the hole (50);
- inserting the insertion portion (16) of the connection element (12) in the hole (50); and
- preparing a plaster (52) at the fixing portion.

10. Method according to the preceding claim, **characterized in that** it comprises a step in which a reinforcement mesh is arranged on the surface of the structural and/or non-structural element.

11. Installation kit of a connection element (12) comprising a connection element according to any one of the claims 1-8, and an insertion funnel (40) adapted to facilitate the insertion of the connection element (12) inside a hole of a structural or non-structural element.

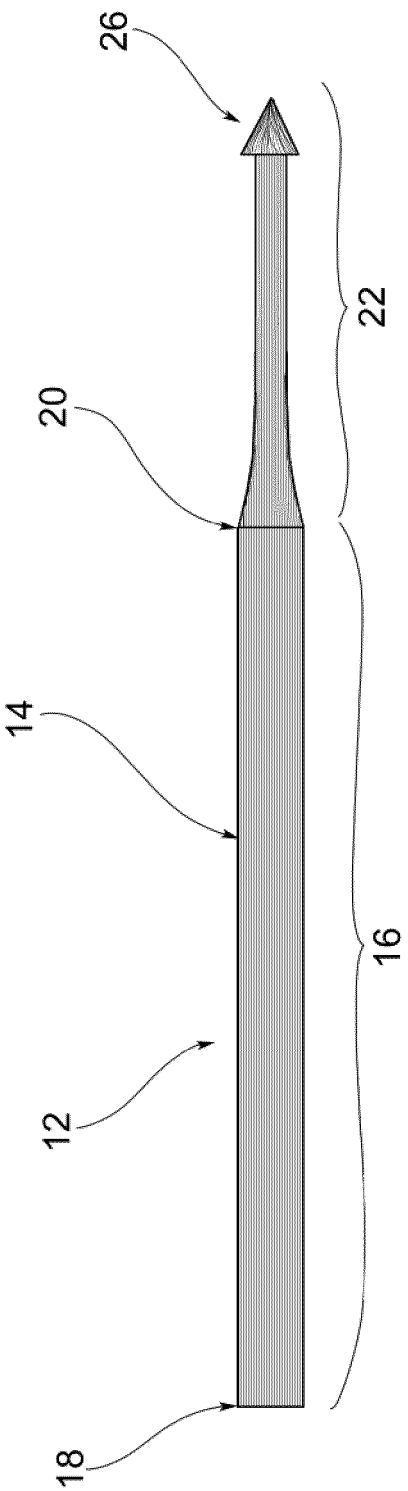

FIG.1

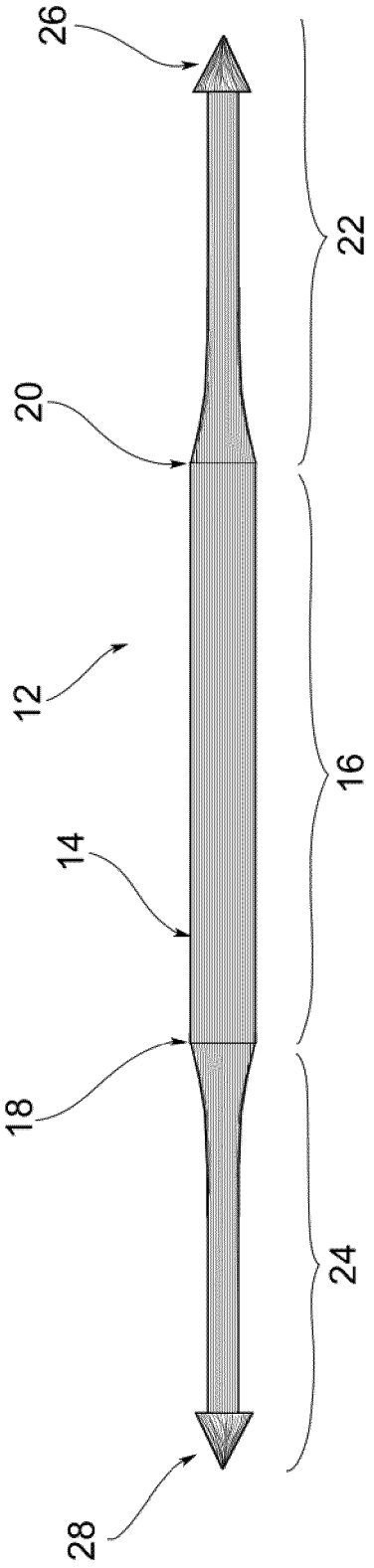

FIG.2

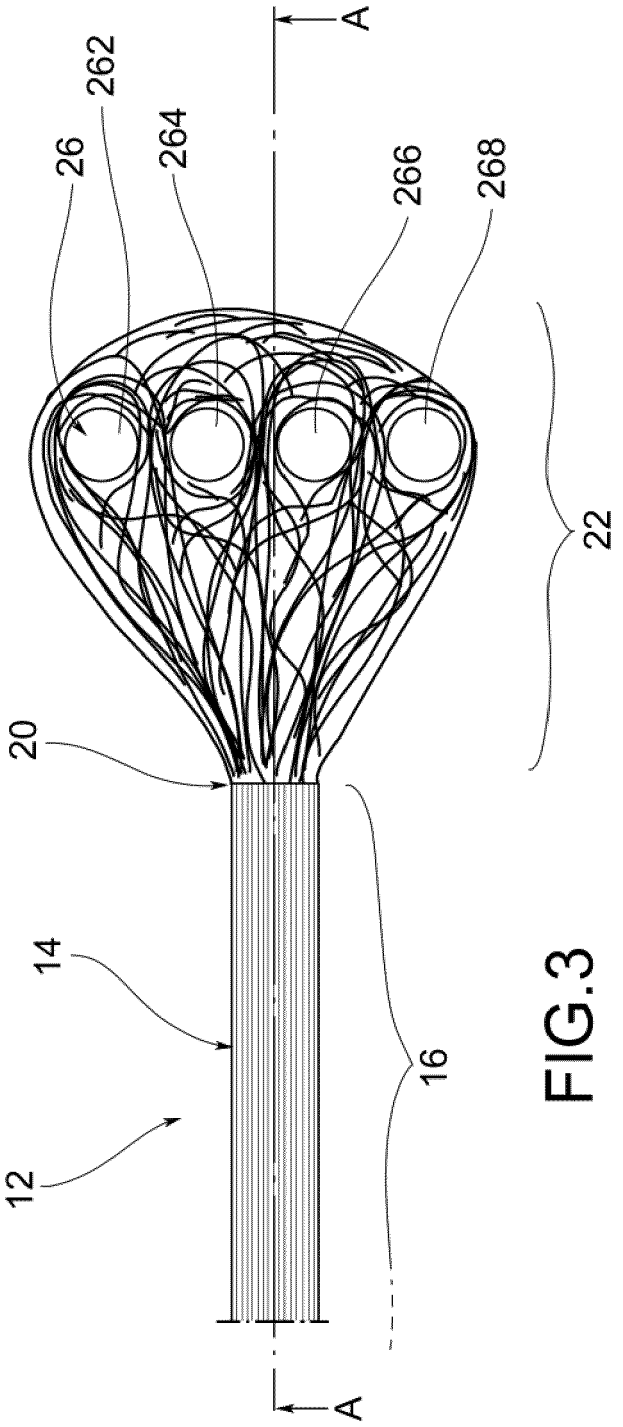

FIG.3

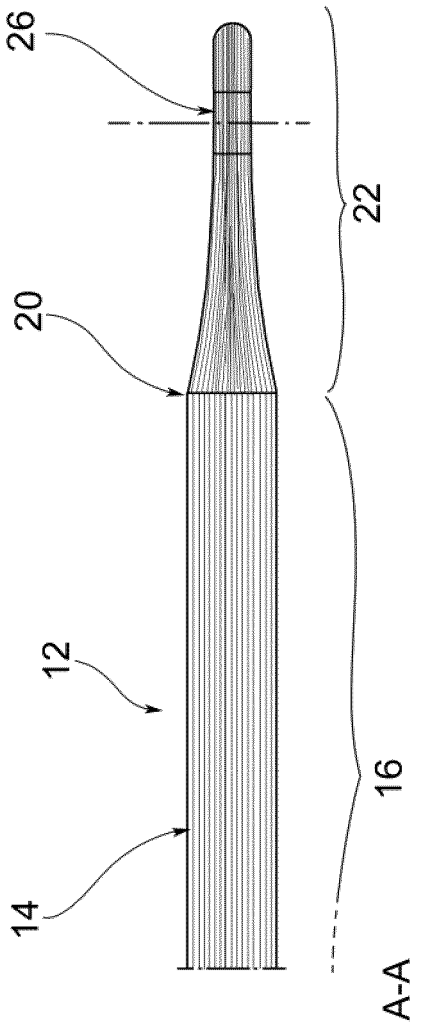

FIG.4

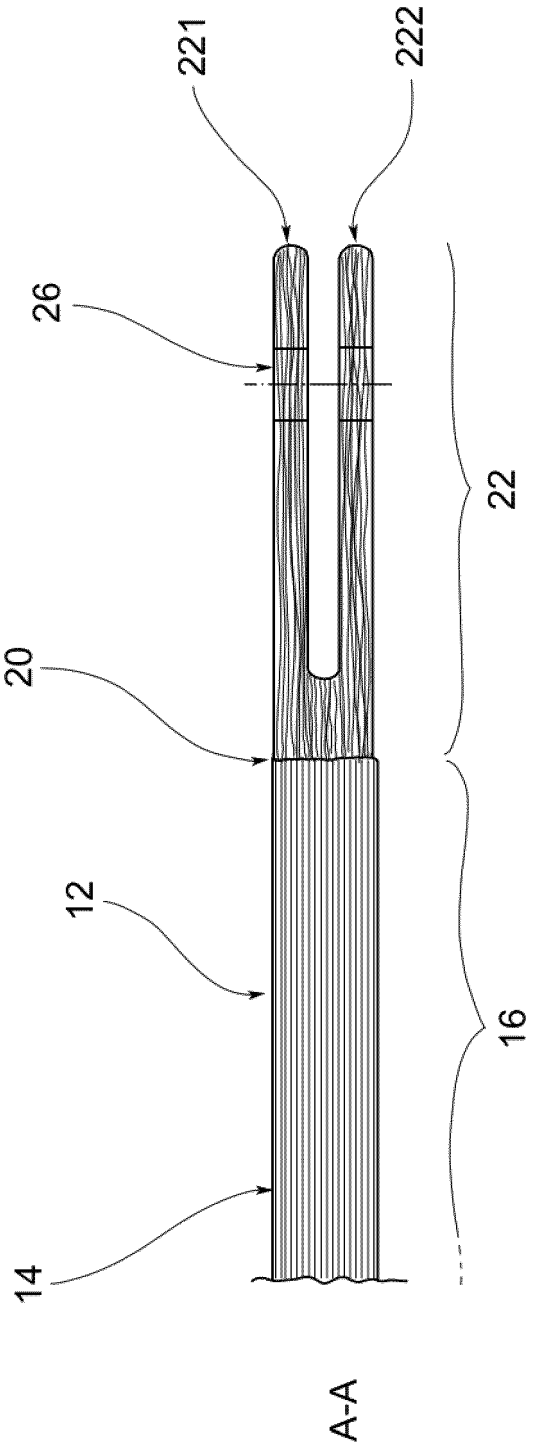

FIG.5

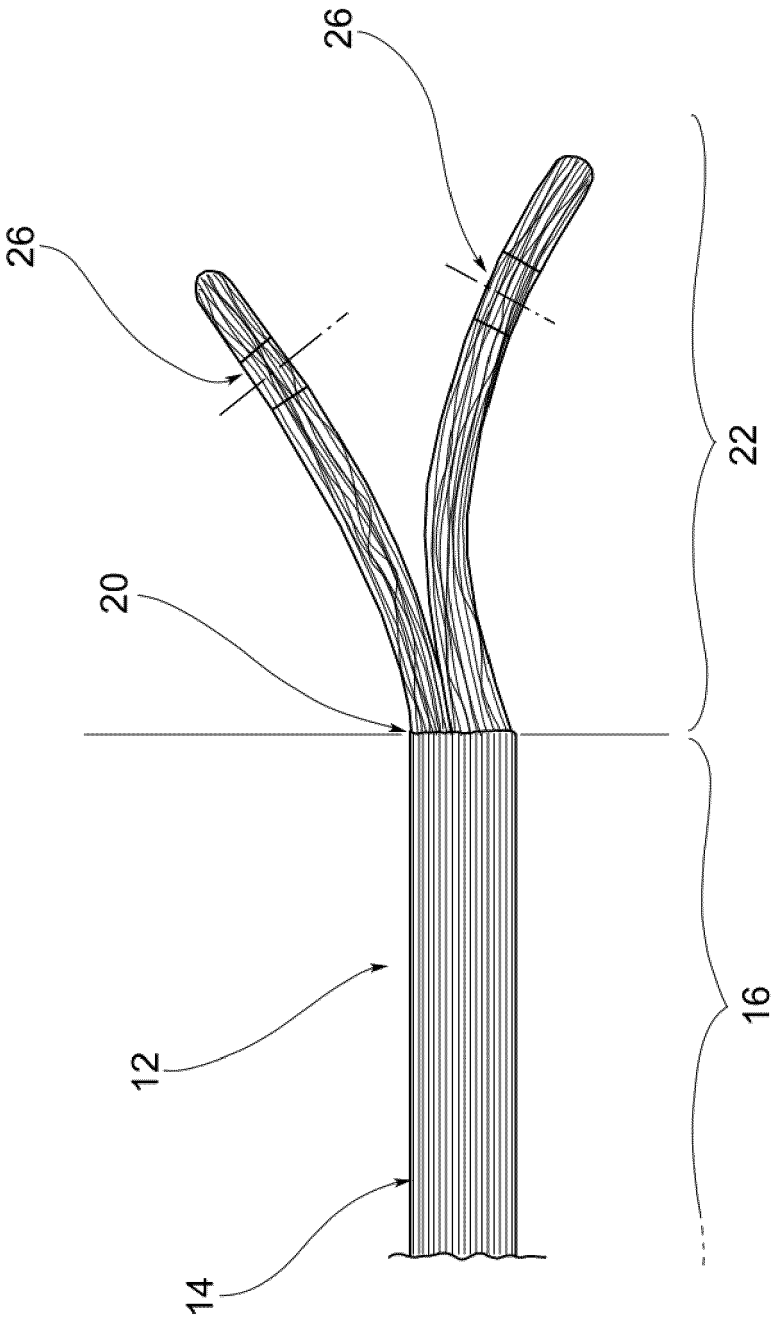

FIG.6

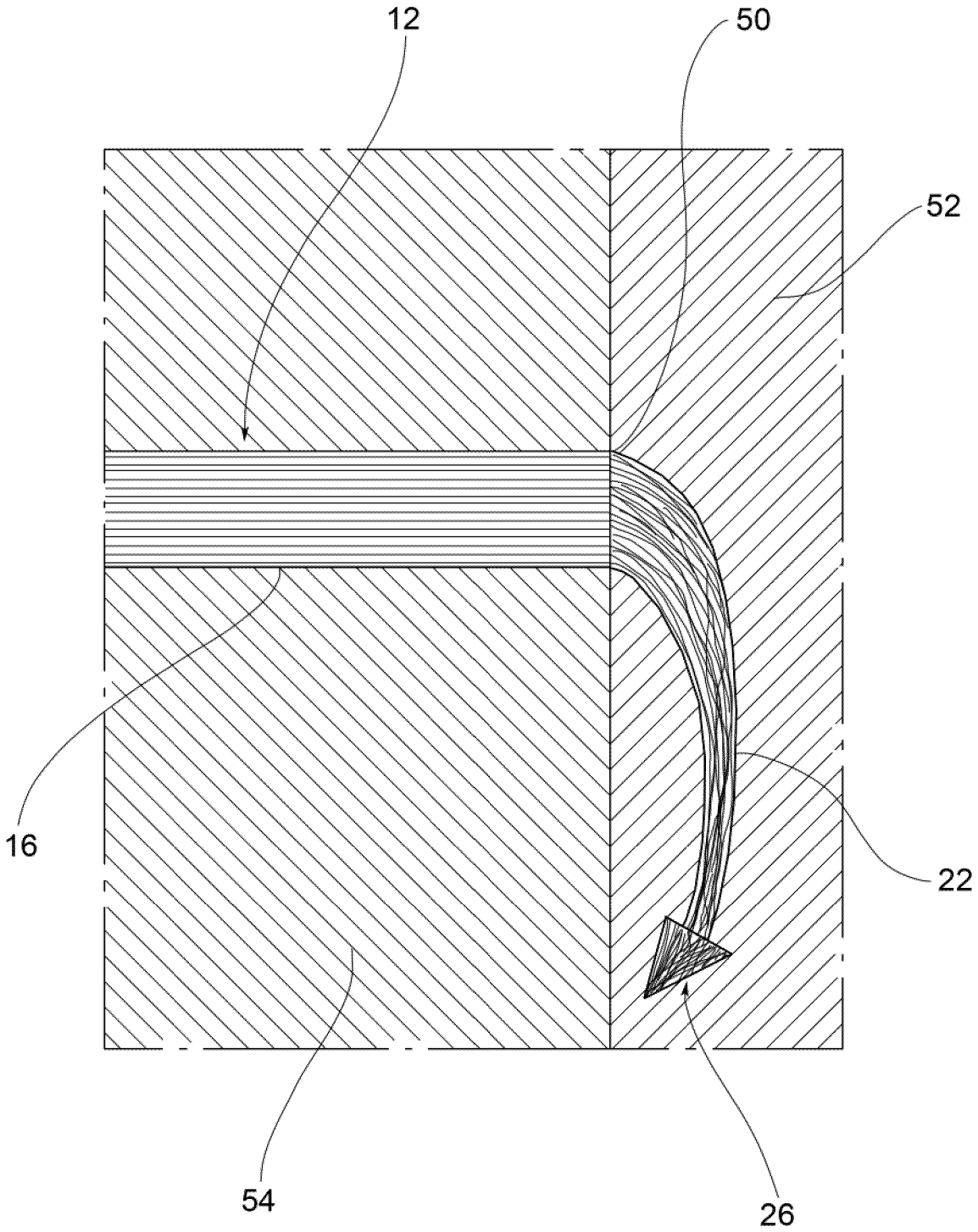

FIG.7

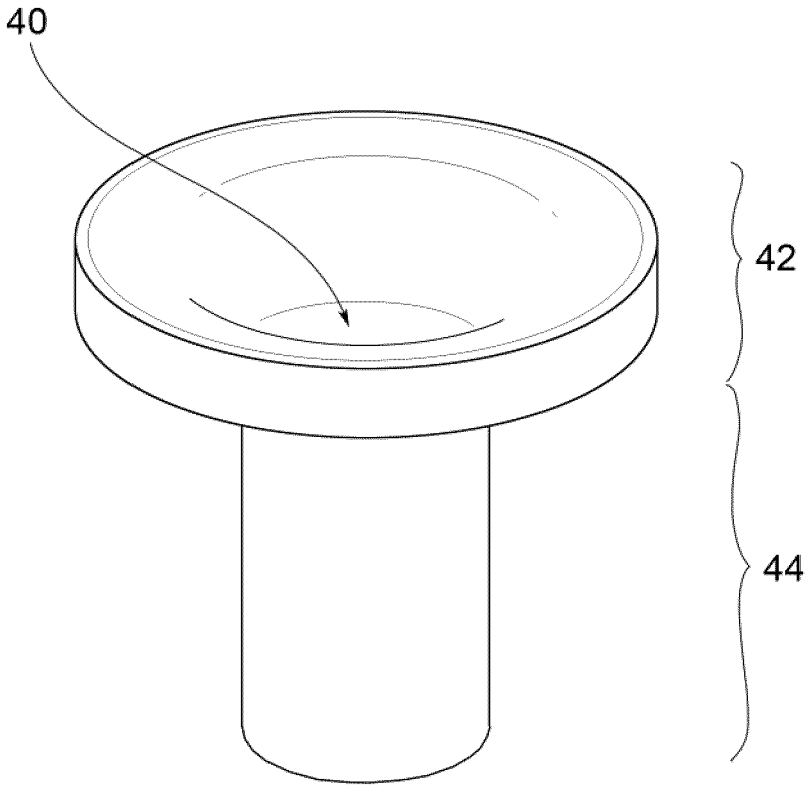

FIG.8

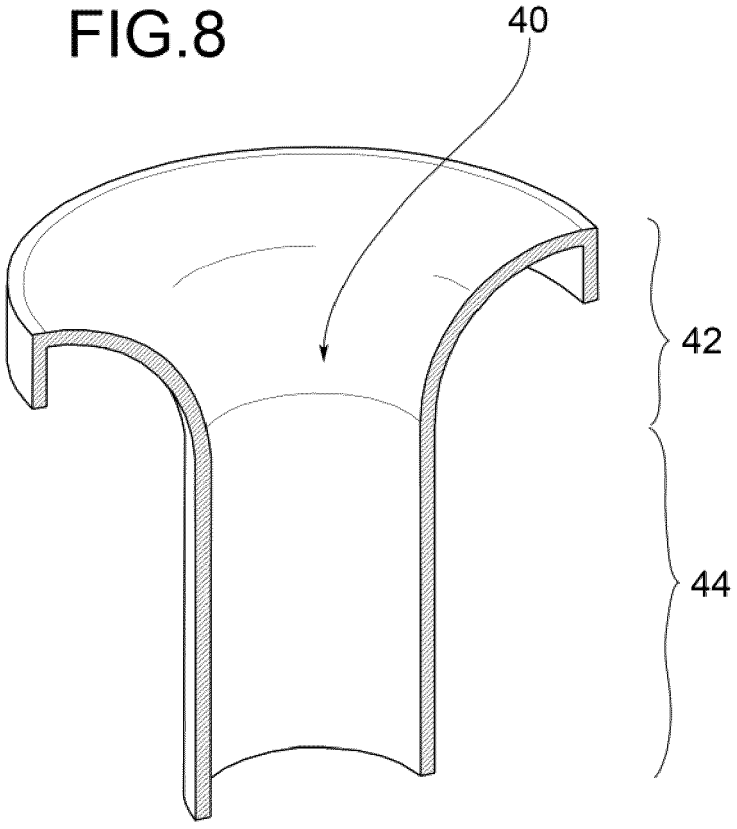

FIG.9