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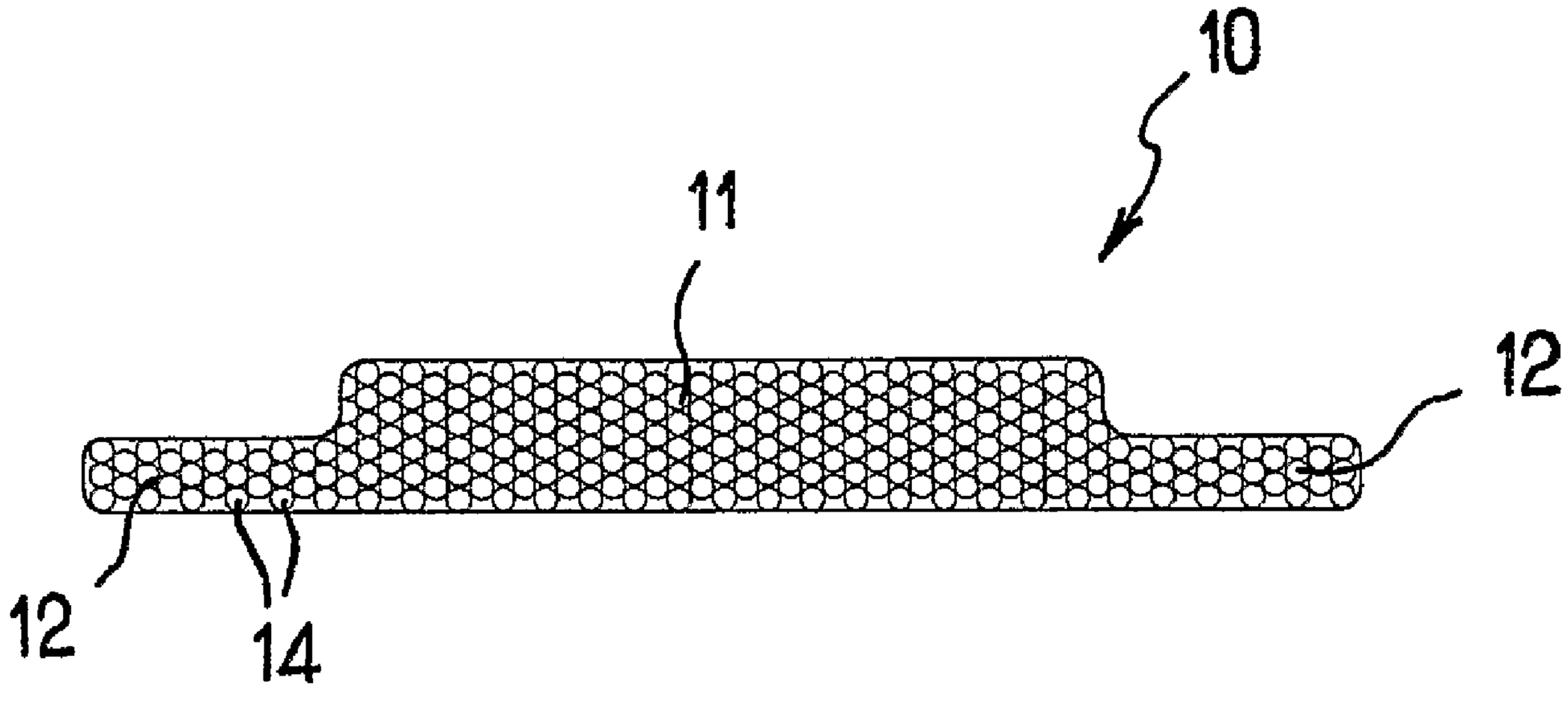
(54) Titre : RUBAN DE RENFORT A STRUCTURE TEXTILE PLATE POUR TUYAU ET TUYAU AINSI RENFORCE
(54) Title: FLAT TEXTILE REINFORCING TAPE FOR A PIPE AND A PIPE THUS REINFORCED



(57) Abrégé/Abstract:
The invention relates to a flat textile strip which is made from, for example, a reinforced thermoplastic material. The inventive strip is wound around a tube in order to act as armour for a duct through which a pressurised fluid flows. The invention is characterised in that said strip (10) comprises a central piece (11) having a more or less rectangular section and two longitudinal edges (12) which are thinner than the central piece.

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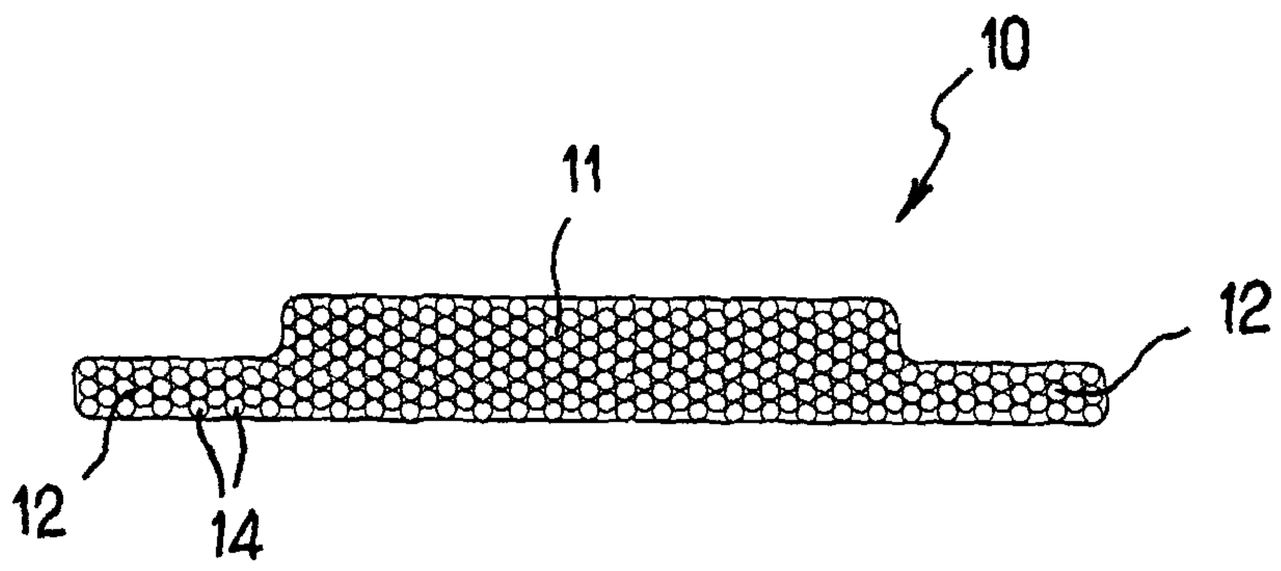
(54) **Title:** FLAT TEXTILE REINFORCING STRIP FOR DUCTS AND THE DUCT THUS REINFORCED

(54) **Titre :** RUBAN TEXTILE PLAT DE RENFORT POUR CONDUITE ET CONDUITE AINSI RENFORCEE



(57) Abstract: The invention relates to a flat textile strip which is made from, for example, a reinforced thermoplastic material. The inventive strip is wound around a tube in order to act as armour for a duct through which a pressurised fluid flows. The invention is characterised in that said strip (10) comprises a central piece (11) having a more or less rectangular section and two longitudinal edges (12) which are thinner than the central piece.

(57) Abrégé : Ce ruban textile plat, par exemple en matière thermoplastique renforcée, destiné à réaliser, par enroulement autour d'un tube, l'armure d'une conduite servant à véhiculer un fluide sous pression, est caractérisé en ce que le ruban (10) est constitué d'une section centrale (11) à section sensiblement rectangulaire et de deux bords longitudinaux (12) plus minces que la section centrale.

WO 03/016769 A1

Flat textile reinforcing tape for a pipe and a pipe thus reinforced

The present invention relates to a flat tape intended to reinforce a pipe for transporting a pressurized fluid, especially a flexible pipe for transporting hydrocarbons and gases.

Documents FR 2 739 673 and EP 0 853 547 in the name of the Applicant disclose a flat tape of this type serving as armor for a pipe consisting of an impermeable internal tube, one or more windings (preferably crossed windings) of a flat textile tape and, where appropriate, an outer sheath. The flat textile tape is produced, using the technique for reinforced thermoplastic products, as an assembly of filament rovings (or yarns) held together by binding means and a bonding material. The filament rovings are advantageously made of aramid (Kevlar®). The preferred weave density of the rovings for the tapes is advantageously greater than 60% and the overall weave density of the tapes is greater than 39%.

In practice, such tapes are wound around the internal tube using an armoring machine with a lay angle of about 55°. The armoring machine simultaneously deposits a large number (about fifty or so) of relatively narrow flat tapes carried by spools mounted on a rotating cage. Such a technique is expensive. Firstly, an armoring machine is itself an expensive precision machine. Secondly, textile reinforcing tapes manufactured with a small width cost more than if they were manufactured with a large width. However, this technique is adopted because it allows the overall gap to be distributed over a large number of tapes around the perimeter of the tube; this is because, owing to the manufacturing tolerances of the pipe on the one hand and the deformations of the pipe when in service

(expansion owing to the effect of the internal pressure) on the other hand, gaps necessarily appear, the sum of which gaps gives an overall gap which must be distributed between the tapes; if there is a relatively large number of tapes, for example fifty or so, it is easier to control this overall gap since it is distributed over all the tapes, which gives an acceptable mean relative gap per tape, but which would not be acceptable with a much smaller number of tapes.

A person skilled in the art is tempted to use wide tapes in order to reduce costs, wide tapes being less expensive per se and being able to be deposited around the internal tube using a simple winder, which is less sophisticated and less expensive than an armoring machine. However, if it is desired to use wide textile tapes to produce the pipe reinforcements, there will be less tape around the perimeter of the tube and the overall gap will therefore be distributed over a considerably smaller number of tapes, correspondingly increasing the nominal value of the relative gap (or inter-turn gap) between the tapes. Such gaps are problematic as they result in creep of the internal tube and therefore local stressing of the second armor ply when the pipe is in service. In addition, the way the tapes are positioned amongst themselves during the taping operations is less precise than when an armoring machine is used. There is therefore poor control of the gaps and the positioning of the tapes. In addition, when the external diameter of the internal tube varies because of the manufacturing tolerances, it is impossible to compensate for this variation when an already dimensioned wide tape is used, whereas with a narrower tape it is sufficient to modify the number of tapes loaded into the armoring machine.

To solve this problem, a person skilled in the art might be tempted to wind the tapes with overlapping edges, but this would result in drawbacks, and

especially in wear and fatigue problems. Furthermore, this would create irregularities liable to cause defects in the successive upper layers that have to be added. If the tape is loosely woven, at least along its edges, so that the filament rovings of the overlapping edges mutually interleave and create neither a discontinuity nor an additional thickness, there would then not be the high compactness required according to the teaching of the abovementioned patents of the Applicant, this being necessary in order to obtain the desired reinforcement characteristics.

A person skilled in the art is therefore still faced with an unsolved problem in being able to produce a winding of textile tape armors that are less expensive than in the conventional technique but without correspondingly abandoning the good mechanical characteristics. The objective of the invention is to solve such a problem.

In one aspect, there is provided a textile tape having a substantially flat cross section for forming armor for a pipe for transporting a pressurized fluid, comprising: a central section having a first thickness and an approximately rectangular cross section; and two separate and separated lateral longitudinal edge regions at respective opposite sides of the central section, each of the lateral longitudinal edge regions having a thickness that is less than the first thickness of the central section, wherein the central section and the two separate and separated lateral longitudinal edge regions have the same textile structure.

In another aspect, there is provided a textile tape having a substantially flat cross section for forming armor for a pipe for transporting a pressurized fluid, comprising: a central section having a first thickness and an approximately rectangular cross section; and two separate and separated lateral longitudinal edge regions at respective opposite sides of the central section, each of the lateral longitudinal edge regions having a thickness that is less than the first thickness of the central section, wherein the central section and the two lateral longitudinal edge regions include a plurality of parallel filament rovings, at least two of which are held together by at least one binding device and wherein the central section and the two separate and separated lateral longitudinal edge regions have the same textile structure.

In another aspect, there is provided a textile tape having a substantially flat cross section for forming armor for a pipe for transporting a pressurized fluid, comprising: a central section having a first thickness and an approximately rectangular cross section; and two lateral longitudinal edge regions at respective opposite sides of the central section, each of the lateral longitudinal edge regions having a thickness that is less than the first thickness of the central section, wherein the central section and the two lateral longitudinal edge regions have a textile structure including substantially parallel filament rovings arranged in the longitudinal direction of the textile tape and held in place by binding means.

Advantageously, the thickness of the edges is uniform and approximately equal to one half of the thickness of the central section; their width is advantageously between 5% and 15%, preferably in the region of 10%, of the width of the central section.

The thinning of the overlapping edges is known per se, in fields very remote from the invention, for example in assemblies of clinkered boards or from document JP 59035924 which discloses a multilayer resin tape for forming a transparent tube that will then be sectioned to form containers. The tape is produced with thinning of the lateral edges and it is wound without any clearance on itself with welding of the edges. This is the constituent tape of the tube itself, but in no way a reinforcing tape of a pipe. In addition, the tape is made of a uniform resin and is not a textile tape, the method of manufacture of which is completely different.

In another aspect, there is provided a pipe for transporting a pressurized fluid, consisting of an internal tube coated with at least one ply of flat textile tapes wound helically on the tube, characterized in that each tape has a uniform textile structure and includes a central section with an approximately rectangular cross section and two lateral longitudinal edge regions that are thinner than the central section, the textile tapes being wound with at least partial overlapping of the lateral longitudinal edge regions.

Other features and advantages of the invention will become apparent upon reading the following description of several illustrative examples, with reference to the

appended drawings in which: figure 1 is a perspective view of a pipe that includes reinforcing layers produced by winding a tape according to the invention;

- figure 2 is a perspective view of a first embodiment of a flat tape according to the invention;

- figures 3 and 4 are sectional views of a second and third embodiment of a flat tape according to the invention;

- figure 5 is a sectional view of a winding of the tape of the second embodiment, showing the overlapping of the edges; and

- figure 6 is a sectional view of a fourth embodiment of the invention.

Figure 1 shows a pipe 1 for transporting pressurized fluids, consisting of an internal tube 2, for example an extruded tube, covered with a first ply 3 and with a second ply 4 of reinforcing tapes, and with an external sealing sheath 5, which is also extruded. The

reinforcement plies 3 and 4 are produced by cross-winding of a flat tape 10 according to the invention, with a lay angle of approximately 55° (between 52° and 58°) with respect to the longitudinal axis of the pipe. As may be seen in the figure, the adjacent edges of the tapes 10 overlap. The total number n of tapes 10 around the periphery is relatively small; this is preferably chosen to be less than ten, which, for a given diameter and a given lay angle, makes it possible to determine a preferred minimum average width of the tapes equal to $\pi D\cos\alpha/10$ (the exposed mean width of the tape, defined as the width of the central section increased by the width of a single edge in order to take account of the overlaps, is taken to be equal to $\pi D\cos\alpha/n$, where D is the outside diameter of the tube 2, n is the number of tapes and α is the lay angle of the tape ply).

Figures 2 to 4 show three tape embodiments that differ by the arrangement of the thin edges. For the sake of clarity of the drawings, the width of the edges relative to that of the central section of the tape has been exaggerated in the drawings.

The tape 10 of the invention, having a mean width $L+\ell$, consists of a central section 11 with a rectangular cross section, of width L and thickness E, flanked laterally by two longitudinal edges or flanges 12, with a width ℓ and thickness e. It is preferable that: $e = E/2$ and $L/20 < \ell < 3L/20$.

The flanges 12 may be placed at mid-height of the edges of the central section 11 (figure 2), either so as to alternate at the top and bottom of the two edges of the central section 11 (figures 3 and 5) or exclusively at the bottom (or at the top) of the two edges of the central section 11, or in any other arrangement. Although the arrangement shown in figures 3 and 5 is that which lends itself most naturally to the overlapping of the edges 12, the other arrangements are

suitable in practice, owing to the flexibility of the tape and to its deformation during winding.

As shown in figure 2, and, more schematically, in figures 3 to 5, the tape of the invention is a textile tape formed from layers of filament rovings 14 held in place by binding means 15. It is formed, for example, in accordance with the teaching of document EP 0 853 547, from layers of filament rovings 14 joined together and held in place by binding means 15 and a bonding material so as to maintain a high overall weave density, for example at least 39%. The bonding material, for example a thermoplastic, coating the filament rovings has not been shown. However, the tape may also be formed only by the weaving of filament rovings with a weft yarn, but with no bonding material. In the case of a woven tape with no bonding material, the weave density is advantageously kept high, for example at least 39%. The filament rovings 14 used as warp yarn may be of any type, such as those made of aramid (Kevlar®, Twaron® or Technora®) or made of carbon, for example. The edges 12 are made of the same material as the central section, simply with a smaller thickness, and therefore for example with a fewer number of layers of filament rovings. According to the invention, it is advantageous for the binding means (weft yarns) to be spaced out so as, when the pipe bends, to allow the wound tapes to untwist and their longitudinal fibers to be reorganized.

As illustrated in figure 5, the tape 10 of the invention makes it possible to accommodate the overall clearance during taping, by at least partially overlapping the edges 12 of the adjacent tapes. This at least partial overlapping of the edges 12 prevents the formation of through-gaps (over the entire thickness of the reinforcing layer) between two tapes. At the very most, a gap 13 smaller than the width ℓ of the edge is formed, which gap is not a through-gap. The outer gap

13 may result in a slight set-back of the outer sheath, but this is, however, blocked by the lower edge 12 partially overlapped by the upper edge 12 of the adjacent tape. Moreover, if the mechanical properties of the edges 12 are identical to those of the central section 11, the presence of a gap results in a slight degradation in the mechanical properties of the armor ply at this point, which may in principle lead to a lower burst pressure than that which would be obtained with an arrangement of conventional narrow tapes with no gap. This drawback may be alleviated by providing different mechanical properties, these being higher at the edges, for example by modifying the nature or the degree of twisting of the filament rovings used, or by a different weave density. In particular, along the edges it may be beneficial to use fibers that have a higher elongation at break than the fibers used in the central part.

The embodiment of the tape 10 of figure 6 differs from that of figure 2 in that, instead of being produced by several thicknesses of filament rovings, it is produced only by weaving in two dimensions (warp yarns and weft yarns), with a single thickness of filament rovings 14, 14'. The rovings 14 of the central part 11 are of larger size than the rovings 14' of the thin edge parts 12.

It is also advantageous to provide a tracer on the tape 10, for example a colored yarn 16, which allows the position of the tape during winding to be displayed. This yarn 16 is advantageously placed between the edge 12 and the central part 11 of the tape 10 (this yarn has been illustrated only in figure 6, but it may apply to all the embodiments) in order to define the interface. Thus, it is possible to visually check that no tape edge 12 overlaps a central tape part 11 (there must always be two tracers 16 side by side; no tracer

16 must be covered if the winding has been carried out correctly).

CLAIMS

1. A textile tape having a substantially flat cross section for forming armor for a pipe for transporting a pressurized fluid, comprising:

a central section having a first thickness and an approximately rectangular cross section; and

two separate and separated lateral longitudinal edge regions at respective opposite sides of the central section, each of the lateral longitudinal edge regions having a thickness that is less than the first thickness of the central section, wherein

the central section and the two separate and separated lateral longitudinal edge regions have the same textile structure.

2. The textile tape of claim 1, wherein each of the thicknesses of the lateral longitudinal edge regions is approximately equal to one half of the thickness of the central section.

3. The textile tape of claim 1 or 2, wherein each of the central section and the lateral longitudinal edge regions has a respective width, the width of each lateral longitudinal edge region is between 5% and 15% of the width of the central section.

4. The textile tape of any one of claims 1 to 3, wherein the flat textile tape has a compactness at least equal to 39%.

5. The textile tape of any one of claims 1 to 4, wherein the central section and the lateral longitudinal edge regions are formed from filament rovings held

together by a binding agent and a thermoplastic bonding material.

6. The textile tape of claim 1, wherein the central section and the lateral longitudinal edge regions are formed from a single layer of filament rovings having respective thicknesses, the first thickness is the thickness of the filament rovings of the central section and the thicknesses of the lateral longitudinal edge regions are the thicknesses of the filament rovings forming the lateral longitudinal edge regions, the thickness of the central section is greater than the thicknesses of the filament rovings forming the lateral longitudinal edge regions.

7. The textile tape of any one of claims 1 to 6, further comprising visible tracers respectively arranged at boundary regions between the central section and the lateral longitudinal edge regions.

8. The textile tape of claim 1 or 2, wherein each of the central section and the lateral longitudinal edge regions has a respective width, the width of each lateral longitudinal edge region is narrower than the width of the central section.

9. A textile tape having a substantially flat cross section for forming armor for a pipe for transporting a pressurized fluid, comprising:

a central section having a first thickness and an approximately rectangular cross-section; and

two separate and separated lateral longitudinal edge regions at respective opposite sides of the central section, each of the lateral longitudinal edge regions

having a thickness that is less than the first thickness of the central section,

wherein the central section and the two lateral longitudinal edge regions include a plurality of parallel filament rovings, at least two of which are held together by at least one binding device and wherein the central section and the two separate and separated lateral longitudinal edge regions have the same textile structure.

10. The textile tape of claim 9 wherein the binding device weaves the parallel filament rovings with weft yarns in order to hold at least two parallel filament rovings together.

11. The textile tape of claim 9 or 10, wherein the parallel filament rovings are made of aramid.

12. The textile tape of claim 9 or 10, wherein the parallel filament rovings are made of carbon.

13. The textile tape of claim 9, wherein the parallel filament rovings are woven with weft yarns in a single layer.

14. The textile tape of claim 9, wherein parallel filament rovings of the central section are larger than parallel filament rovings of the lateral longitudinal edge regions.

15. A textile tape having a substantially flat cross section for forming armor for a pipe for transporting a pressurized fluid, comprising:

a central section having a first thickness and an approximately rectangular cross section; and

two lateral longitudinal edge regions at respective opposite sides of the central section, each of the lateral longitudinal edge regions having a thickness that is less than the first thickness of the central section, wherein

the central section and the two lateral longitudinal edge regions have a textile structure including substantially parallel filament rovings arranged in the longitudinal direction of the textile tape and held in place by binding means.

16. A pipe for transporting a pressurized fluid, consisting of an internal tube coated with at least one ply of flat textile tapes wound helically on the tube, characterized in that each tape has a uniform textile structure and includes a central section with an approximately rectangular cross section and two lateral longitudinal edge regions that are thinner than the central section, the textile tapes being wound with at least partial overlapping of the lateral longitudinal edge regions.

17. The pipe as claimed in claim 16, characterized in that the tapes have a lay angle relative to a longitudinal axis of the pipe is between 52° and 58°.

18. The pipe as claimed in claim 17, characterized in that the lay angle is 55°.

19. The pipe as claimed in any one of claims 16 to 18, characterized in that the tapes are less than ten in number.

20. The pipe as claimed in any one of claims 16 to 19, characterized in that each tape has a mean width that is equal to or greater than $\pi D\cos\alpha/10$, where D is an outside diameter of the tube and α is the lay angle of the tape.

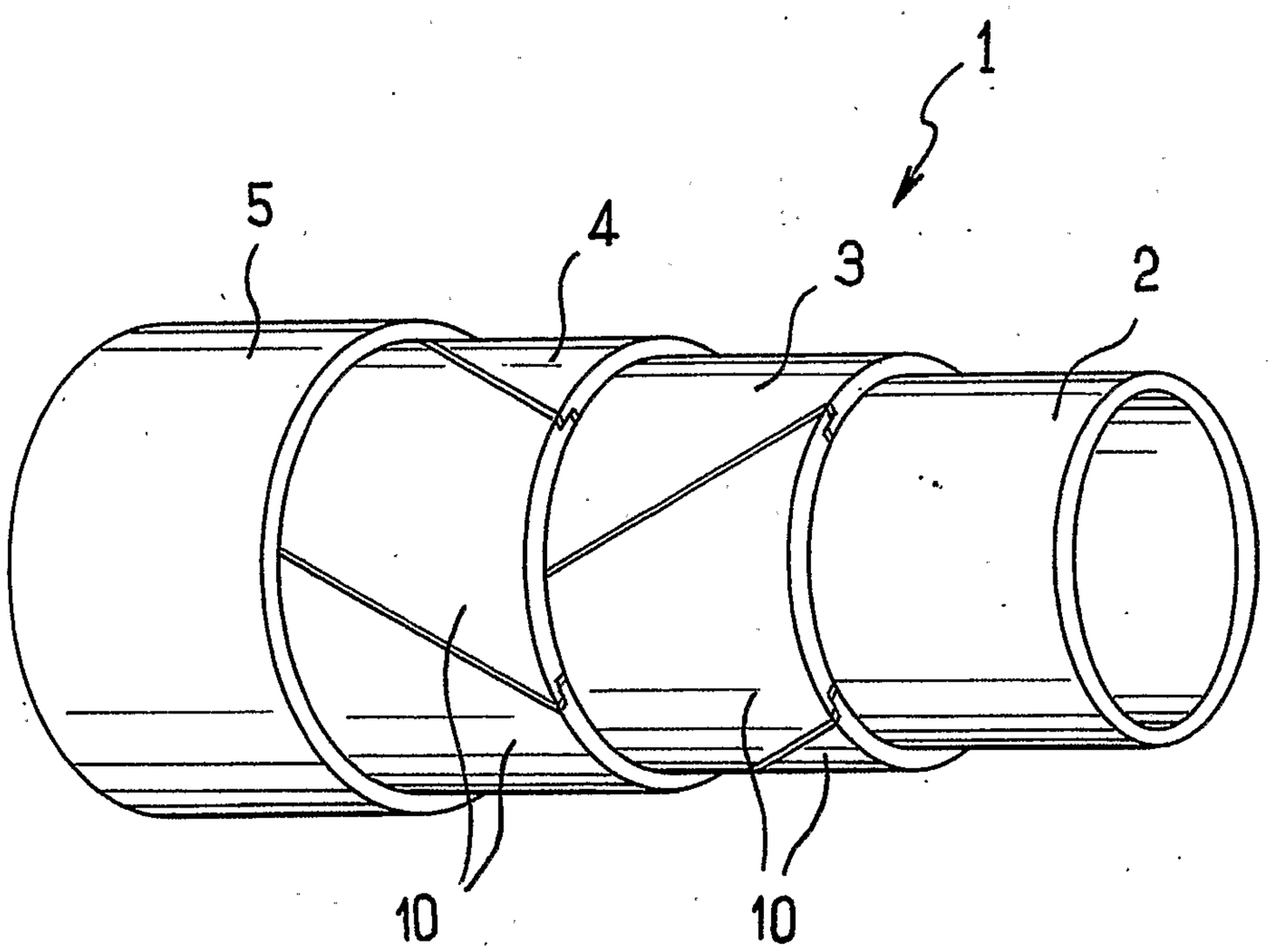


FIG_1

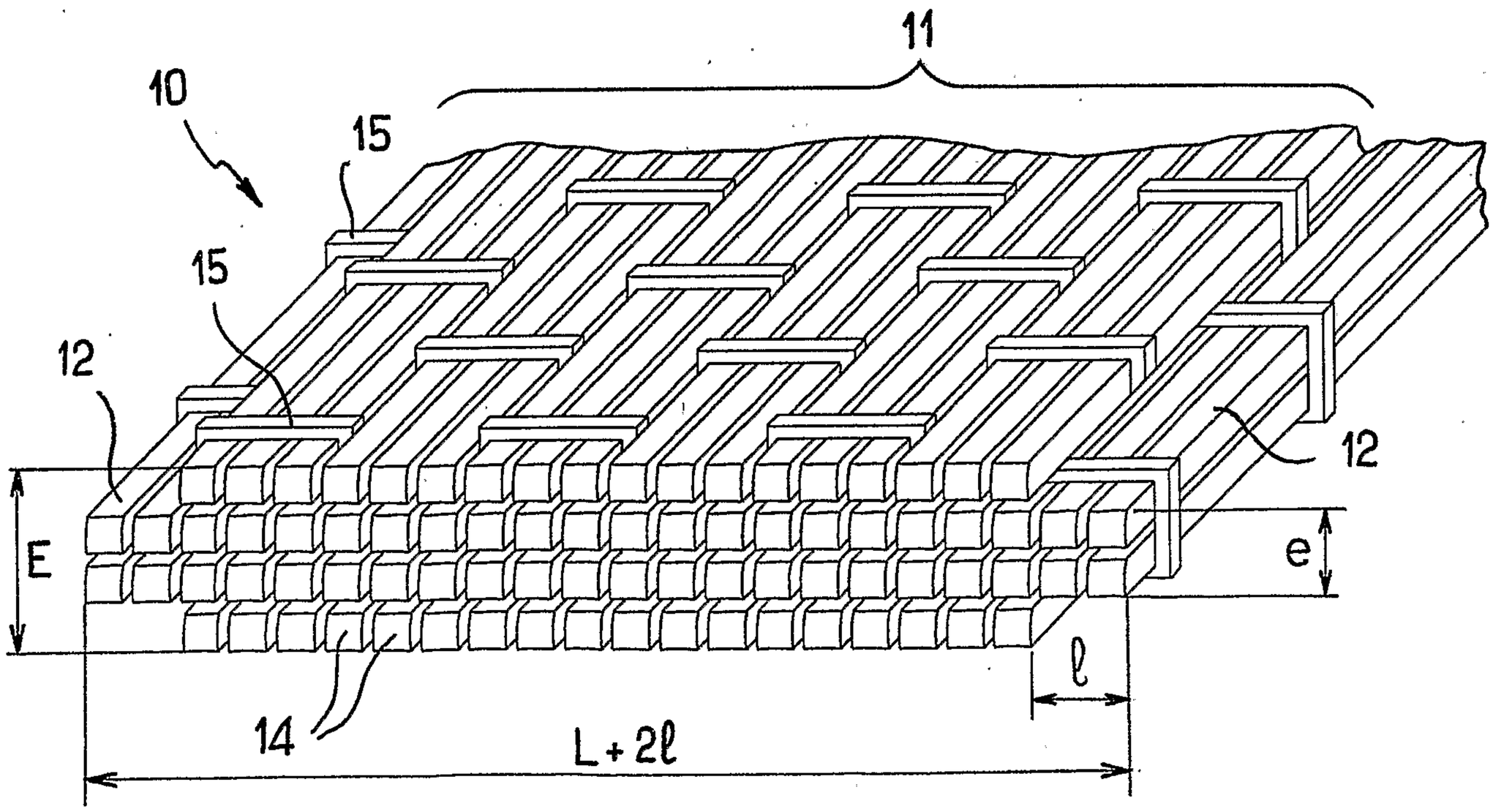


FIG_2

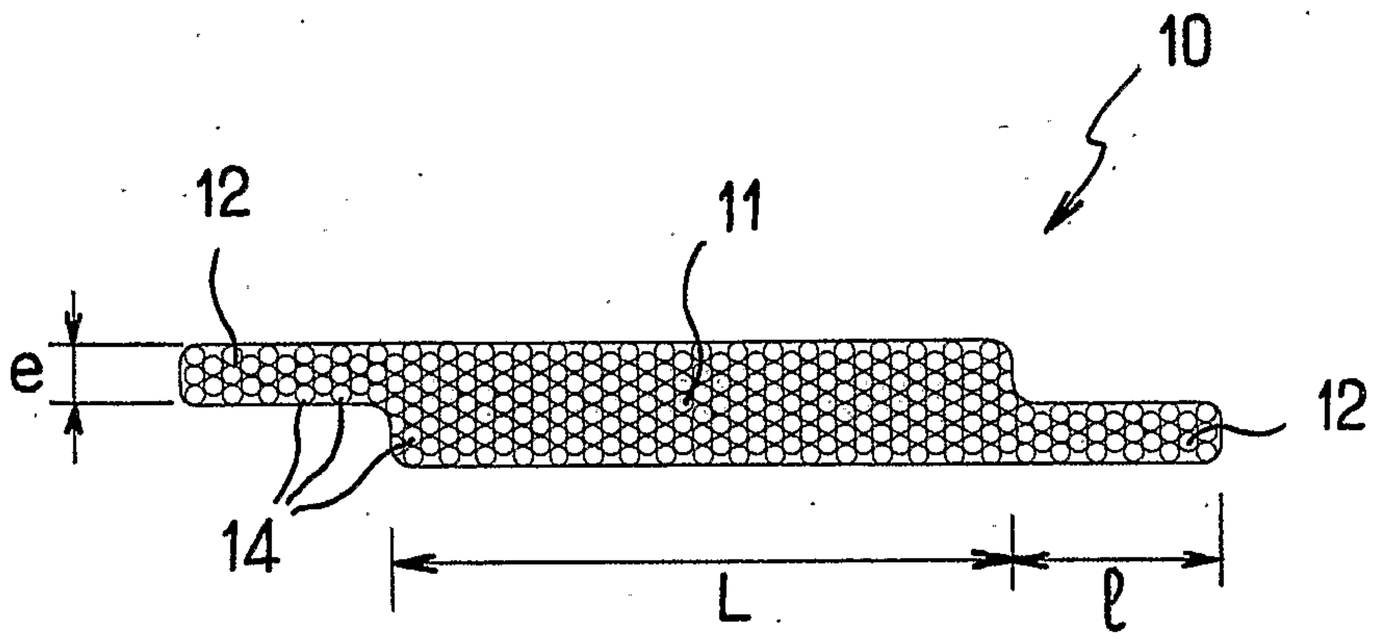


FIG_3

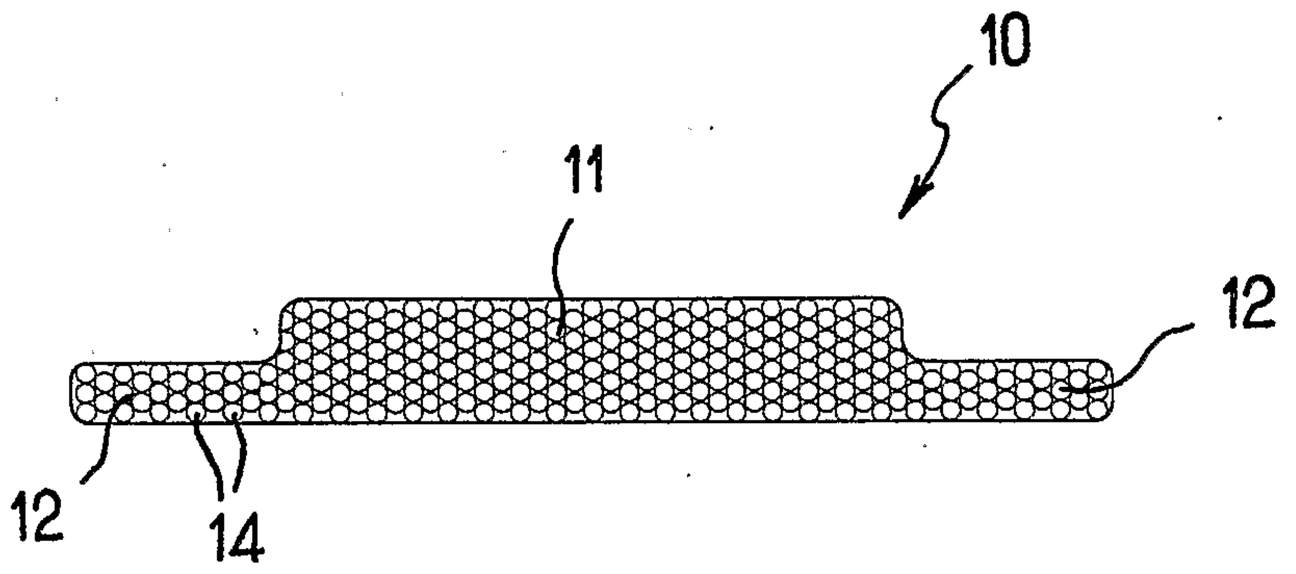


FIG_4

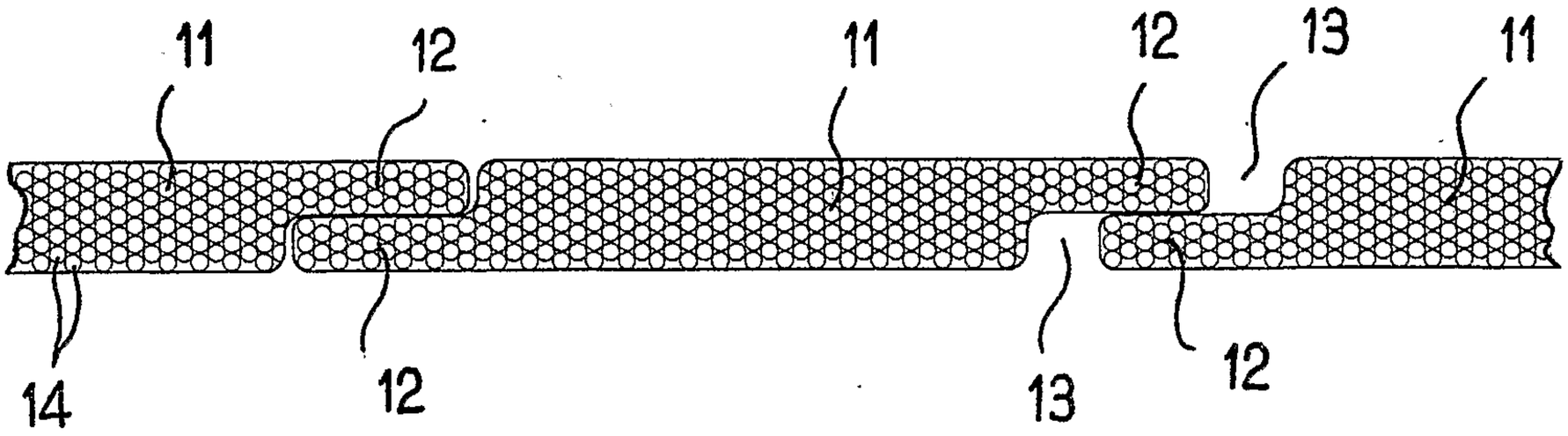


FIG_5

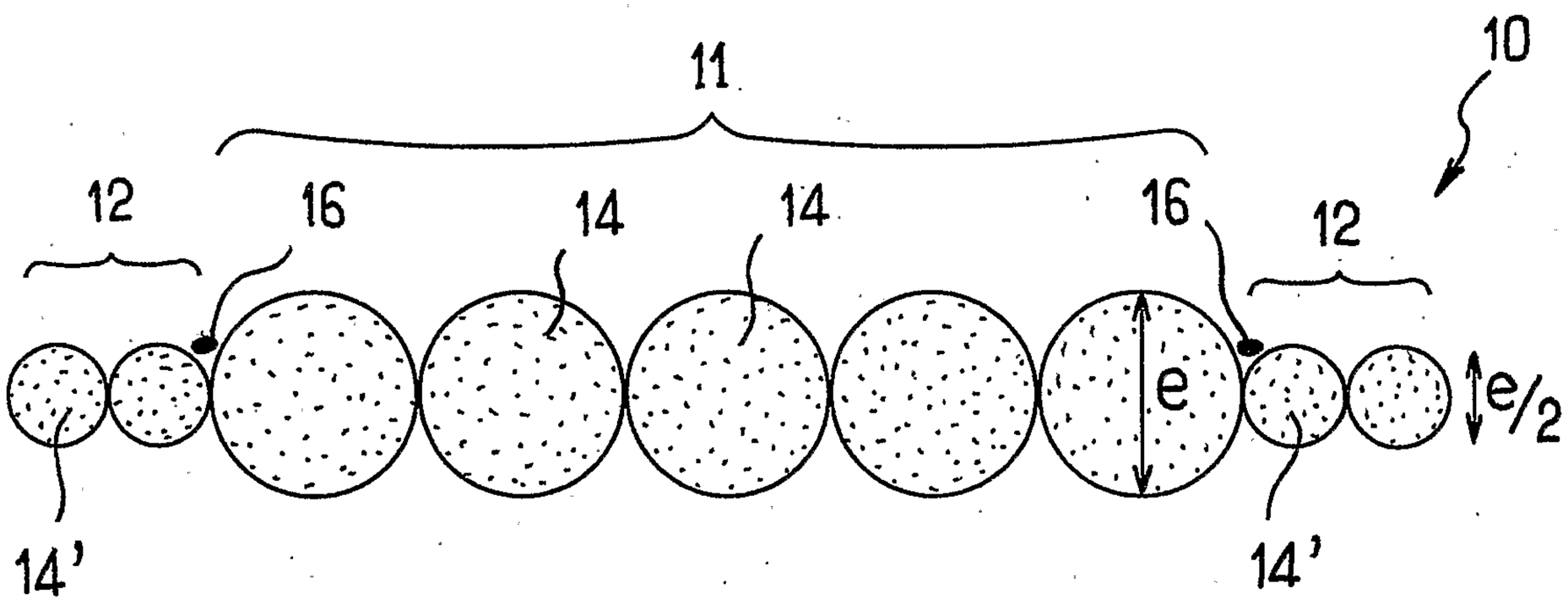
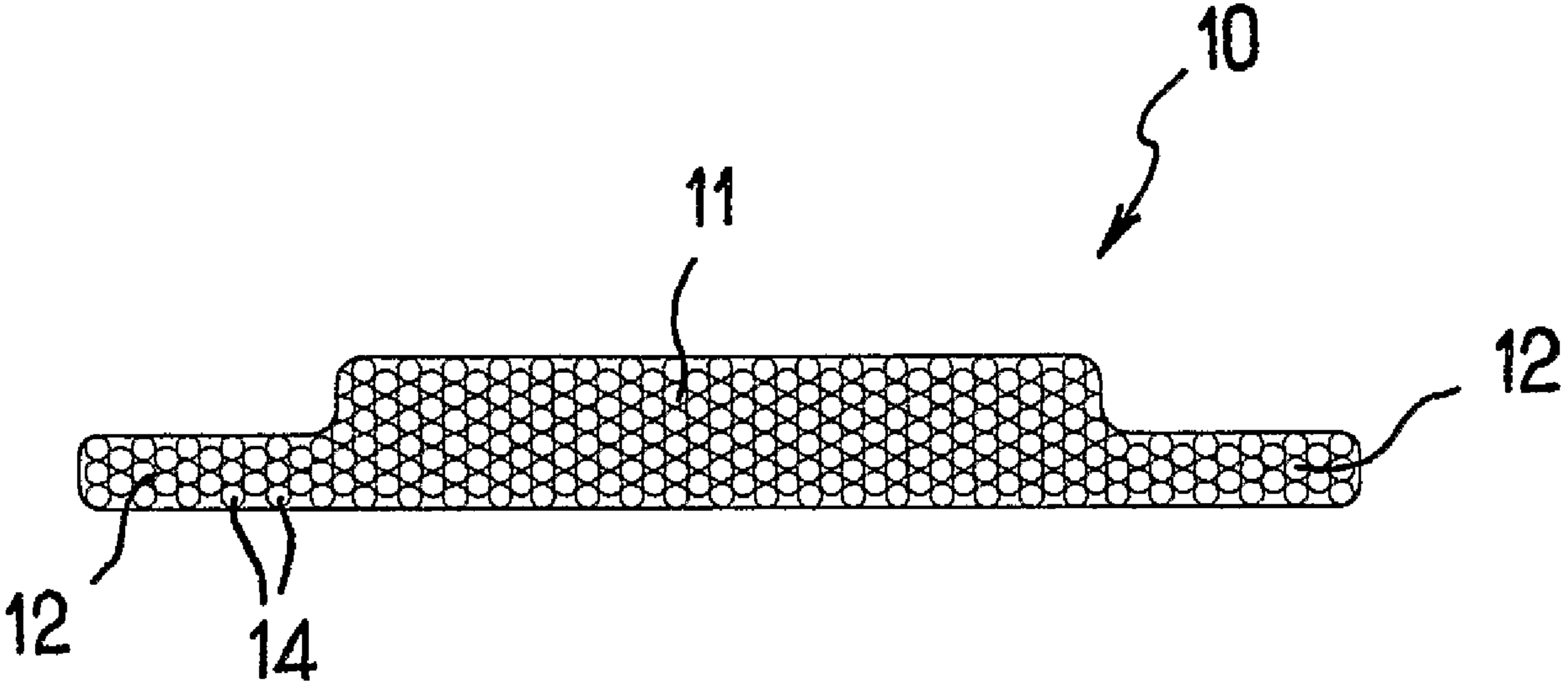


FIG_6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