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**Method for impeding transverse relative displacements of a pipe and at least one cable**

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**ABSTRACT**

A method for impeding transverse relative displacements of a pipe (2) and at least one cable (3) which extends in this pipe (2), and doing so with a certain transverse play (4),

this method being characterized in that it comprises the following steps:

- selecting at least one portion (8), of a predetermined longitudinal dimension (L8), of pipe (2),

- then, with the cable (3) inserted in the pipe (2), locally constructing between the cable (3) and said pipe (2) at least one wedging element (9) of a nature so as to suppress the transverse play (4) existing between the cable (3) and the pipe (2) in said at least one selected pipe portion (8).

(Figure 7)

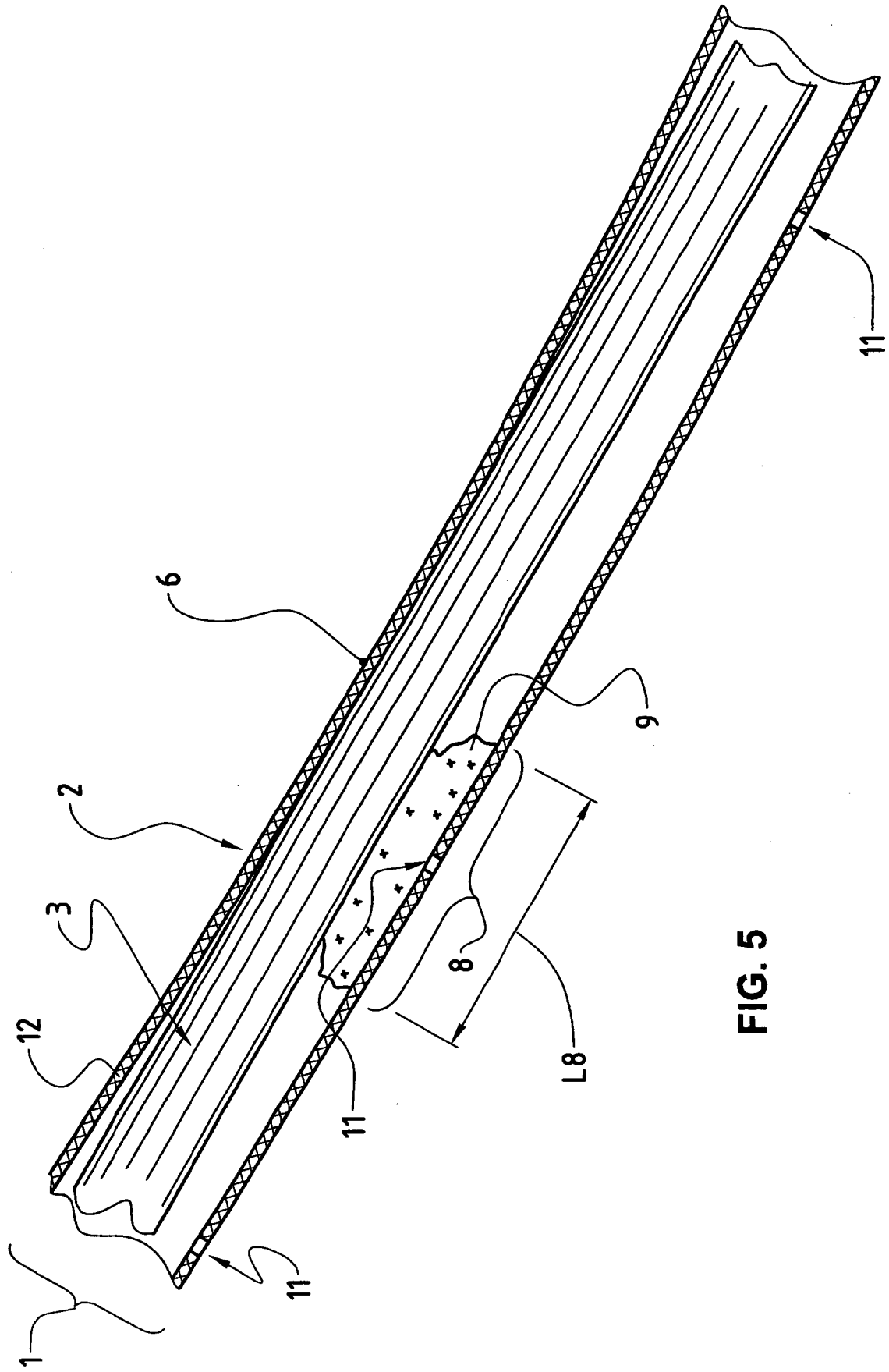


FIG. 5

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**COMPLETE SPECIFICATION**

**STANDARD PATENT**

**Applicant(s):**

VSL INTERNATIONAL AG

**Invention Title:**

METHOD FOR IMPEDING TRANSVERSE RELATIVE DISPLACEMENTS OF A PIPE AND AT LEAST ONE CABLE

The following statement is a full description of this invention, including the best method of performing it known to me/us:

**Method for impeding transverse relative displacements of a pipe and at least one cable**

The invention relates to a method for impeding transverse relative displacements of a pipe and at least one cable which extends into this pipe, and this with a certain transverse play. The invention also relates to assemblies each made up of a cable and a pipe which are immobilized with respect to one another according to the aforementioned method. The invention also relates to stayed structures which include at least one assembly of the aforementioned type.

Designated by cable is particularly, but not exclusively, a cable used for the construction of stayed structures, such as suspension bridges, cable-stayed bridges, stadium roofs, buildings, telecommunications towers, etc.

Such a cable comprises at least one strand embedded in a protective piping, but, generally, such a cable is constituted of a bundle of strands.

For example, each strand is made up of a plurality of monostrands which are themselves made up of metallic wires.

Each strand can either be made up of a bare metallic strand or an individually greased and sheathed monostrand.

Designated by pipe is particularly a robust outer stay pipe which achieves a full encapsulation of the cable in order to ensure durability of said cable.

During construction of a system of stays, a pipe -- also referred to as a stay pipe -- is generally placed between two points of anchorage provided for the cable -- also referred

to as a stay cable. Then the cable is constructed in the pipe in particular through successive introduction of cable strands.

This method of construction implies the use of a pipe whose inner diameter is noticeably greater than the outer diameter of the cable.

Thus when a stay has been constructed, there exists a noticeable play between the pipe and the cable, and this transverse play is sufficient to allow a transverse displacement relative to the two elements (the said pipe and the said cable) under the effect of a moving force applied on the outer surface of the pipe, such as the action of the wind.

When the intensity of the moving force fluctuates (varies), it can bring about a rattling of the cable which causes noise and mechanical actions that can be detrimental for the life of the assembly.

It would be an advantage if the present invention would provide a method that makes it possible to prevent in a simple and economical way the relative displacement of a pipe, such as a stay pipe, and a cable, such as a stay cable, these elements being assembled, one in the other, with a certain transverse play.

It would be an advantage if the present invention would provide a method that can be adapted to different configurations of pipe and cable.

The present invention provides in one aspect a method for impeding transverse relative displacements of a pipe and at least one cable which extends in this pipe, and doing so with a certain transverse play,

this method being characterized in that it comprises the following steps:

- selecting at least one portion, of a predetermined longitudinal dimension, of pipe,

- then, with the cable inserted in the pipe, locally constructing between the cable and said pipe at least one wedging element of a nature so as to suppress the transverse play existing between the cable and the pipe in said at least one selected pipe portion.

Aspects of the present invention also relate to

- assemblies each made up of a cable and a pipe which are treated according to the method of the invention, i.e. immobilized with respect to one another according to the aforementioned method, and

- structures which include at least one assembly of the aforementioned type.

The present invention also provides an assembly made up of a pipe and a cable treated according to the above-defined method characterized in that it comprises at least one wedging element located between the cable and said pipe in at least one portion, of predetermined longitudinal dimension, of pipe, said wedging element being constructed by injecting locally into the pipe a substance able to solidify.

The present invention further provides a method for impeding transverse relative displacements of a pipe and at least one cable which extends in this pipe, and doing so with a certain transverse play, wherein the at least one cable is first engaged into the pipe,

the method comprising the following steps:

- selecting at least one portion, of a predetermined longitudinal dimension, of pipe, the at least one portion being selected from a plurality of portions,

- then, with the at least one cable engaged into the pipe, locally constructing at least one wedging element between the cable and said pipe in said at least one selected pipe portion.

The invention will be better understood from reading the following description, given by way of non-limiting example, with reference to the attached drawings:

Figure 1 is a lateral view of a structure having two assemblies each made up of a cable and a pipe,

Figure 2 is a cross-sectional view along 2-2, on a larger scale, of a cable and a pipe making up one of the assemblies of Figure 1,

Figure 3 is a cross-sectional view of a cable and a pipe subjected to the action of the wind,

Figure 4 is a cross-sectional view of a cable and a pipe immobilized with respect to one another according to the method of the invention,

Figures 5 and 6 are two partial views and a longitudinal section of a pipe and a cable during the immobilization according to two variants of the method of the invention,

Figure 7 is a diagrammatic longitudinal section of a pipe and a cable during immobilization according to the method of the invention.

Referring to the drawings, one sees an assembly 1 including at least one pipe 2 and one cable 3 engaged in this pipe 2 with a transverse play sufficient to allow a transverse displacement relative to the two elements, i.e. the said pipe 2 and the said cable 3, for example under the effect of a moving force 5 applied on the outer surface 6 of the pipe 2.

In Figure 3, the moving force 5 has been indicated by a large broken arrow and the displacement of the pipe 2 which results has been indicated by fine lines of dots and dashes.

The pipe 2 and the cable 3 each have a predetermined longitudinal dimension L2, L3 and the cable 3 is engaged in the pipe 2, at least partially, but generally over the entire longitudinal dimension L2 of this pipe 2.

A transverse displacement relative to the pipe 2 and the cable 3 can be expected when the flexibility of the cable 3 and/or of the pipe 2 is sufficient to allow such a displacement as is frequent in the case of stayed structures 7 such as bridges 7.

In Figure 1, such a structure 7 has been shown with noticeable simplifications and with details greatly enlarged over reality in order to facilitate better understanding of the invention.

The cable 3 has each of its ends 30, 31 firmly anchored to an anchoring device 70, 71 itself connected to the structure 7.

Likewise, the pipe 2 also has each of its ends 20, 21 firmly anchored to the device 70, 71 for anchoring the ends of the cable 3.

The technical particularities of the anchoring devices 70, 71 are not shown in further detail or have not been represented because they are not directly related to the invention.

As has been indicated further above, particularly when the intensity of the moving force 5 fluctuates (varies), this moving force 5 can bring about a rattling of the pipe 2 on the cable 3 which causes noise and mechanical actions that can be detrimental for the life of the assembly of pipe 2 and cable 3.

Although not exclusive to stayed structures 7, such as bridges 7, these rattling phenomena are typical for such stayed structures 7.

This is why the term cable 3 particularly -- but not exclusively -- designates a cable 3 used for the construction of stayed structures 7, such as suspension bridges, cable-stayed bridges, stadium roofs, buildings, telecommunications towers, etc.

As shown, the pipe 2 is a pipe intended to protect a cable 3 consisting of a stay cable, such as a stay cable of a suspended bridge 7, and in this case the mentioned moving force 5 results in particular from the action of the wind.

An embodiment of the invention relates to a method for impeding transverse relative displacements of a pipe 2 and at least one cable 3 which extends in this pipe 2, and doing so with a certain transverse play.

According to and embodiment of the invention, this method comprises the following steps

- selecting at least one portion 8, of a predetermined longitudinal dimension L8, of pipe 2,

- then, with the cable 3 inserted in the pipe 2, locally constructing between the cable 3 and said pipe 2 at least one wedging element 9 of a nature so as to suppress the transverse play 4 existing between the cable 3 and the pipe 2 in said at least one selected pipe portion 8.

According to an embodiment of the invention, the said wedging element 9 is constructed by injecting locally into the pipe 2 a substance 10 able to solidify.

In a noteworthy way, polyurethane foam is used in making each wedging element 9.

According to a further preferred embodiment of the method of the invention, in injecting said substance 10 locally into the pipe 2, at least one orifice 11 is traversed that has been provided beforehand in the pipe wall 12 at a predetermined place on the selected pipe portion 8.

One skilled in the art will know how to determine the position and the length L8 of each portion of pipe 2 in which a wedging element 9 must be formed.

When the injection of the substance 10 into the pipe 2 must be carried out through an orifice 11 made beforehand in a portion 8, selected beforehand, of the wall of this pipe 2, one skilled in the art will know how to choose the means best suited for an operation of piercing an orifice 11 in the wall 12 of the pipe for an operation of injection of the substance 10 into this pipe 2.

The piercing means has not been shown.

The injection means has been symbolized simply by the encircled 90 marking (Figure 7).

As has been explained, the cable 3 is made up of a plurality of strands 13 which are disposed successively in the pipe 2 so as to constitute a bundle 14 of a predetermined number of strands 13.

This technique of constructing cable 3 in the pipe 2 is not described in further detail because it does not form part of the invention as such.

Moreover, one skilled in the art knows different techniques for constructing a cable 3 in a pipe 2, and the method according to the invention is independent of these techniques.

According to another preferred embodiment of the method of the invention, the substance 10 is injected locally in said pipe 2 by means of the following steps:

- disposing at least one duct 15 in said pipe in such as way that this duct 15 has one end 16, referred to as the near end 16, which is situated outside the pipe 2, and the other end 17, referred to as the remote end 17, which is situated inside said pipe 2, and at least after having disposed all said strands 13 in the pipe 2,

- adjusting the position of said remote end 17 of the duct 15 in the pipe 2, through action upon said duct 15 so as to place said remote end 17 in a selected pipe portion 8 to constitute a wedging element 9,

- injecting said substance 10 into the duct 15 from the near end 16, and doing so in such a way as to make this substance 10 come out again through the remote end 17 situated in the selected pipe portion 8 until the wedging element 9 is formed.

According to an embodiment of the invention, each duct 15 is disposed in the pipe at least after the cable has been formed in the pipe 2, but preferably before the said cable 3 is formed in the said pipe 2.

According to an embodiment of the invention, when it is necessary to form a plurality of wedging elements 9 in the pipe 2, the method comprises the following steps:

moving the remote end 17 of the duct 15, through action on the duct 15, into another selected pipe portion 8 in which a wedging element 9 is to be formed,

then forming said wedging element, and continuing this procedure until all wedging elements 9 have been formed.

In a noteworthy way, the position of said remote end 17 of said duct 15 in said pipe 2 is adjusted by acting upon said duct 15 through traction, in particular from its near end 16.

According to an embodiment of the invention,

- to adjust the position of the remote end 17 in the pipe 2, one proceeds with controlled traction on the said duct 15 by acting upon the near end 16 of this duct 15 which is situated outside the pipe 2,

- in order to allow this adjustment to be made of the position of the remote end 17 of the duct 15 in the pipe 2 by exerting traction on its near end 16 upon disposing the duct 15

in the pipe, one places this duct 15 in such a way that its remote end 17 can be pulled in any way whatsoever toward a first portion 8 of the duct 2 selected for formation of a wedging element 9.

For example, the near end 16 of the duct 15 passes beyond the pipe at the level of one of its opposite end regions 20, 21 and the adjustment of the position of the remote end 17 in the pipe 2 is carried out by exerting traction on the said duct 15, then on the near end 16.

This near end 16 of the duct 15 can also pass beyond the pipe through a specially made cut-out in the wall 12 of the pipe 2.

In a noteworthy manner, in determining the value for the longitudinal dimension L8 of the selected pipe portion 8 that receives the wedging element 9 intended to be interposed between the cable 3 and said pipe 2, the capability of the substance 10, of which said wedging element 9 is made, to impede the displacement of the pipe 2 and/or the cable 3 is taken into account.

In a manner which is noteworthy, in the selected pipe portion 8, having a transversal lower part 18 and a transversal upper part 19, the wedging element 9 is made in the transversal lower part 18 of the selected pipe portion 8 in such a way as to bring the cable 3 into contact with the pipe 2 in the transversal upper part 19 of the selected pipe portion 8.

In another noteworthy manner, in the selected pipe portion 8, having a transversal lower part 18 and a transversal upper part 19, the wedging element 9 is made in the transversal upper part 19 of the selected pipe portion 8 in such a way as to keep the cable 3 in contact with the pipe 2 in the transversal lower part 18 of the selected pipe portion 8.

As has been specified, the invention also relates to assemblies 1 made up of a pipe 2 and a cable 3 which have been treated according to the method, i.e. are immobilized with respect to one another according to the method described above.

An assembly 1 made up of a pipe 2 and cable treated according to the method of the invention is noteworthy in that it comprises at least one portion 8, of predetermined longitudinal dimension L8, of pipe 2, in which portion at least one wedging element 9 is located constructed locally between the cable 3 and said pipe 2, this at least one wedging element 9 being of a nature so as to suppress the transverse play 4 existing between the cable 3 and the pipe 2 in said at least one selected pipe portion 8.

Likewise, an assembly 1 made up of a pipe 2 and a cable 3 treated according to the method of the invention is noteworthy in that at least one wedging element 9 is located disposed between the cable 3 and said pipe 2 in at least one portion 8, of predetermined longitudinal dimension L8, of pipe 2, said wedging element 9 being constructed by injecting locally into the pipe 2 a substance 10 able to solidify.

As has been specified, the invention also relates to structures 7 comprising at least one assembly 1 made up of a pipe 2 and a cable 3 of the aforementioned type.

2003203770 24 Aug 2009



**THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:**

1. The present invention provides a method for impeding transverse relative displacements of a pipe and at least one cable which extends in this pipe, and doing so with a transverse play, wherein the at least one cable is first engaged into the pipe,

the method comprising the following steps:

- selecting at least one portion, of a predetermined longitudinal dimension, of pipe, the at least one portion being selected from a plurality of portions,

- then, with the at least one cable engaged into the pipe, locally constructing at least one wedging element between the cable and said pipe in said pipe at least one selected pipe portion.

2. The method of claim 1, characterized in that said wedging element is constructed by injecting locally into the pipe a substance able to solidify.

3. The method according to claim 2, characterized in that in injecting said substance locally into the pipe, at least one orifice is traversed that has been provided beforehand in the pipe wall at a predetermined place on the selected pipe portion.

4. The method according to claim 2, used for impeding transverse relative displacements of a pipe and at least one cable which extends into this pipe, the cable being made up of a plurality of strands which are disposed successively in the pipe so as to constitute a bundle of a predetermined number of

strands, characterized in that said substance is injecting locally in said pipe by means of the following steps:

- disposing at least one duct in said pipe in such a way that this duct has one end, referred to as the near end, which is situated outside the pipe, and the other end, referred to as the remote end, which is situated inside said pipe, and at least after having disposed all of said cable in the pipe,

- adjusting the position of said remote end of the duct in the pipe, through action upon said duct so as to place said remote end in a selected pipe portion to constitute a wedging element,

- injecting said substance into the duct from the near end, and doing so in such a way as to make this substance come out again through the remote end situated in the selected pipe portion until the wedging element is formed.

5. The method according to the claim 4, characterized in that when it is necessary to form a plurality of wedging elements in the pipe, the method comprises the following steps:

- moving the remote end of the duct, through action on the duct, into another selected pipe portion in which a wedging element is to be formed,

- then forming said wedging element, and continuing this procedure until all wedging elements have been formed.

6. The method according to the claim 5, characterized in that the position of said remote end of said duct in said pipe is adjusted by acting upon said duct through traction, in particular from its near end.

7. The method according to the claim 6, characterized in that

- to adjust the position of the remote end in the pipe, controlled traction is applied on the said duct by acting upon the near end of this duct which is situated outside the pipe,

- in order to allow this adjustment to be made of the position of the remote end of the duct in the pipe by exerting traction on its near end upon disposing the duct in the pipe, one places this duct in such a way that its remote end can be pulled in any way whatsoever toward a first portion of the duct selected for formation of a wedging element.

8. The method according to one of the claims 1 to 7, characterized in that in determining the value for the longitudinal dimension of the selected pipe portion that receives the wedging element intended to be interposed between the cable and said pipe, the capability of the substance, of which said wedging element is made, to impede the displacement of the pipe and/or the cable is taken into account.

9. The method according to the claim 8, characterized in that, in the selected pipe portion, having a transversal lower part and a transversal upper part, the wedging element is made in the transversal lower part of the selected pipe portion in such a way as to bring the cable into contact with the pipe in the transversal upper part of the selected pipe portion.

10. The method according to the claim 8, characterized in that, in the selected pipe portion, having a transversal lower part and a transversal upper part, the wedging element is made in the transversal upper part of the selected pipe portion in such a way as to keep the cable in contact with the pipe in the transversal lower part of the selected pipe portion.

11. The method of any one of the preceding claims, characterized in that polyurethane foam is used in making each wedging element.

12. Assembly made up of a pipe and a cable treated according to the method of one of the claims 1 to 11, characterized in that it comprises at least one portion, of predetermined longitudinal dimension, of pipe, in which portion at least one wedging element is located constructed locally between the cable and said pipe, this at least one wedging element being of a nature so as to suppress the transverse play existing between the cable and the pipe in said at least one selected pipe portion.

13. Assembly made up of a pipe and a cable treated according to the method of one of the claims 1 to 11 characterized in that it comprises at least one wedging element located between the cable and said pipe in at least one portion, of predetermined longitudinal dimension, of pipe, said wedging element being constructed by injecting locally into the pipe a substance able to solidify.

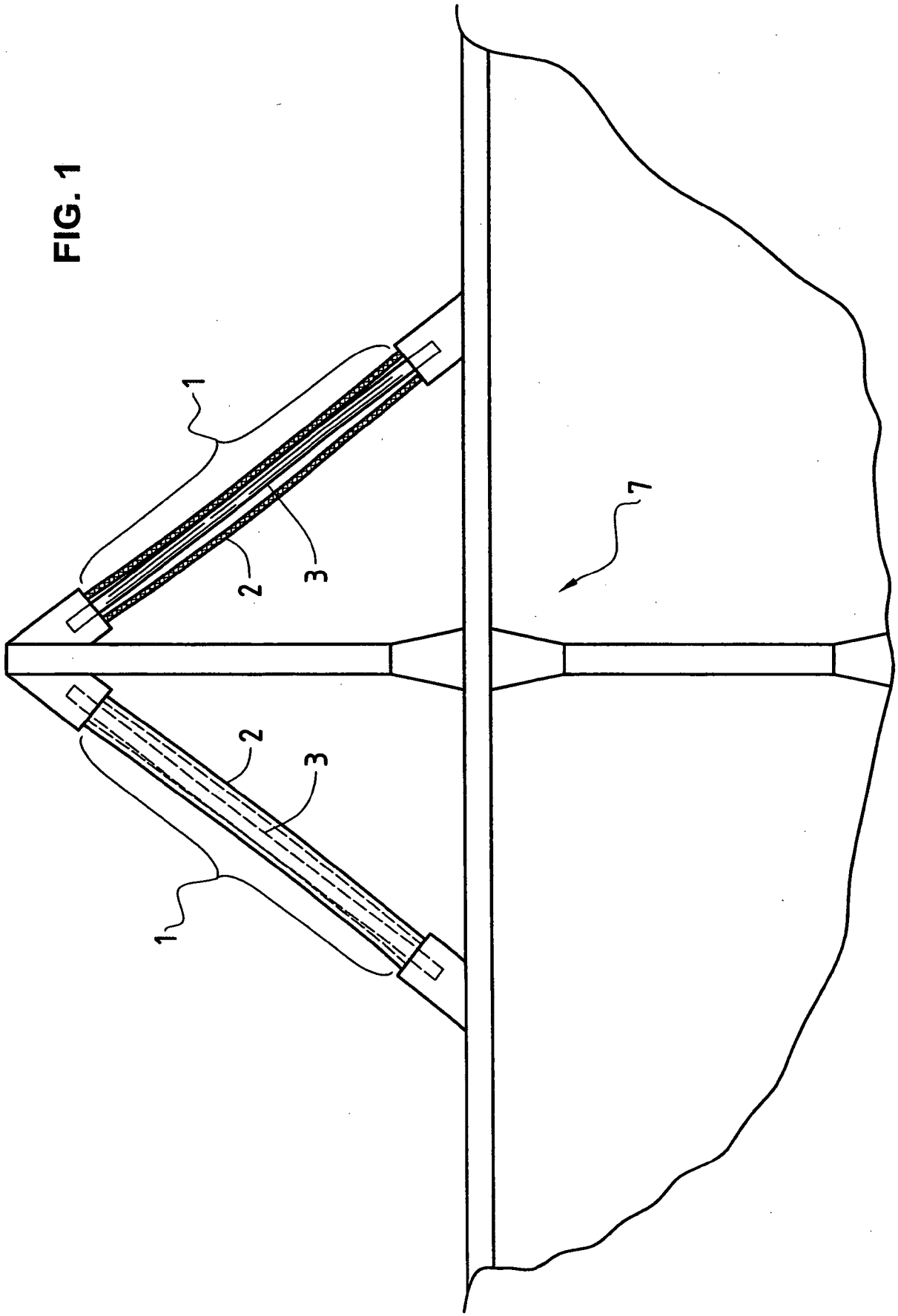
14. Structures including at least one assembly made up of a pipe and a cable treated according to the method of any one of the claims 1 to 11.

15. Stay structures including at least one assembly made up of a pipe and a cable treated according to the method of any one of the claims 1 to 11.

16. A method for impeding transverse relative displacements substantially as herein described with reference to the accompanying drawings.

17. An assembly substantially as herein described with reference to the accompanying drawings.

FIG. 1



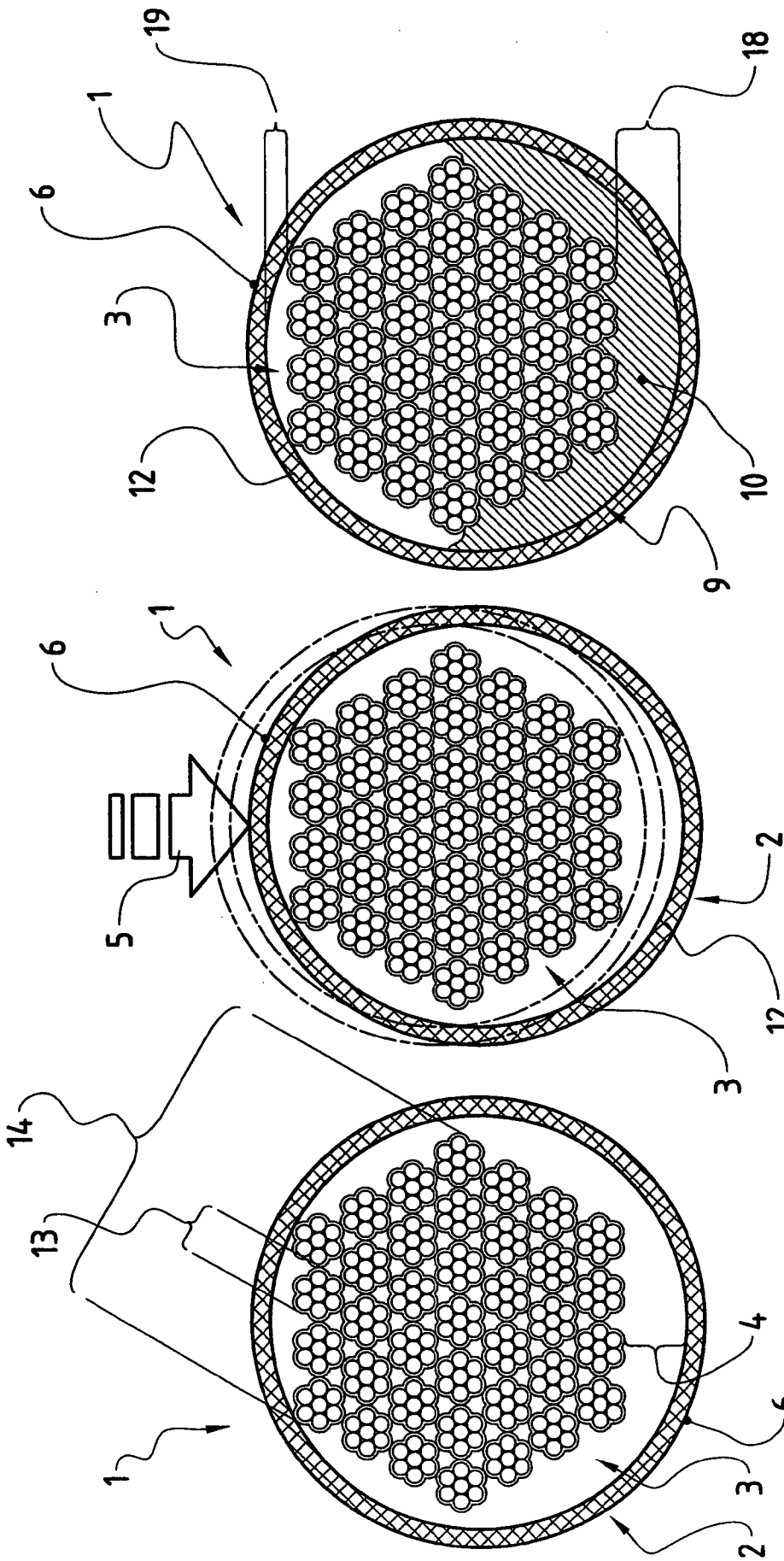



FIG. 4

FIG. 3

FIG. 2

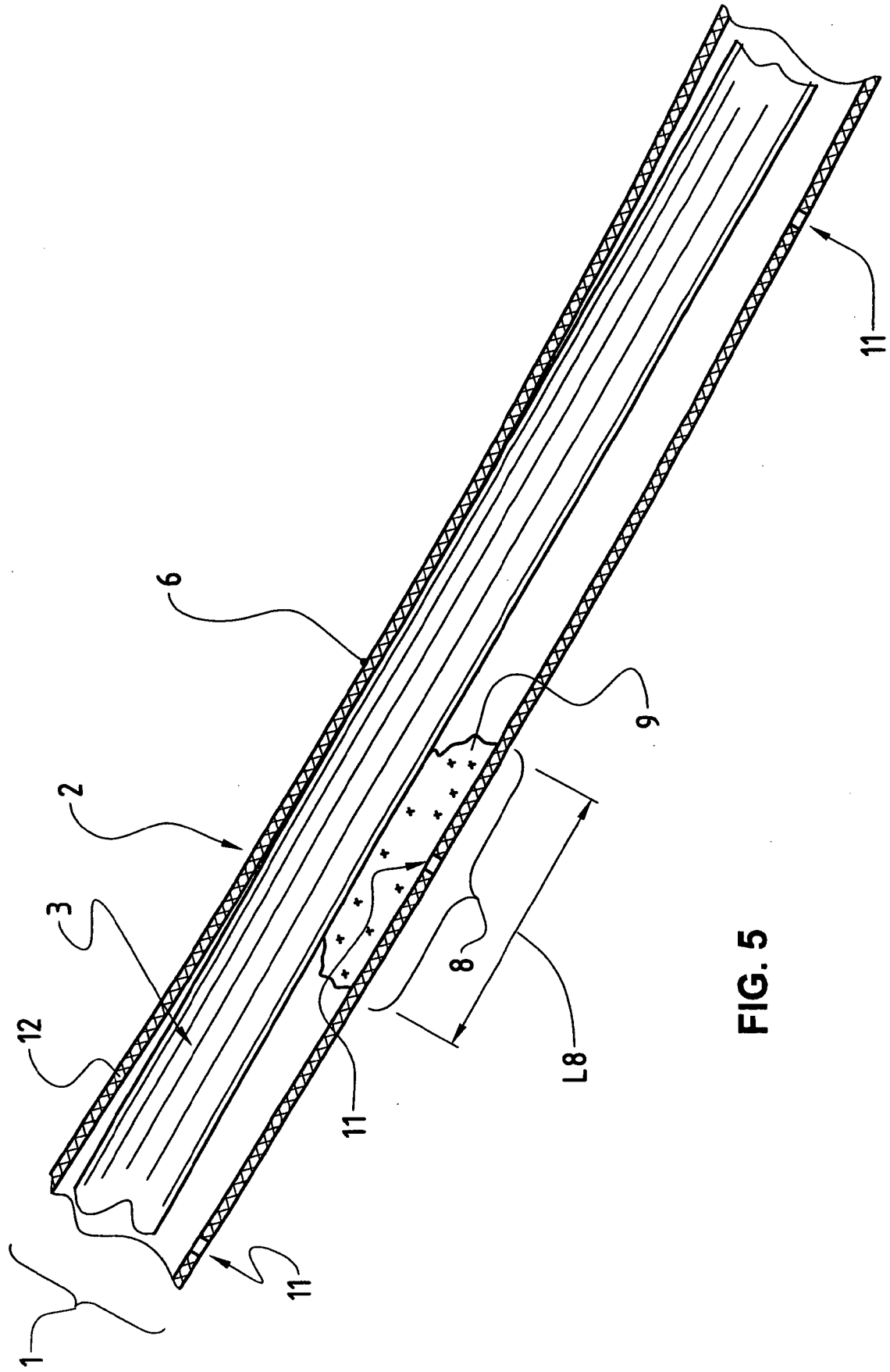



FIG. 5

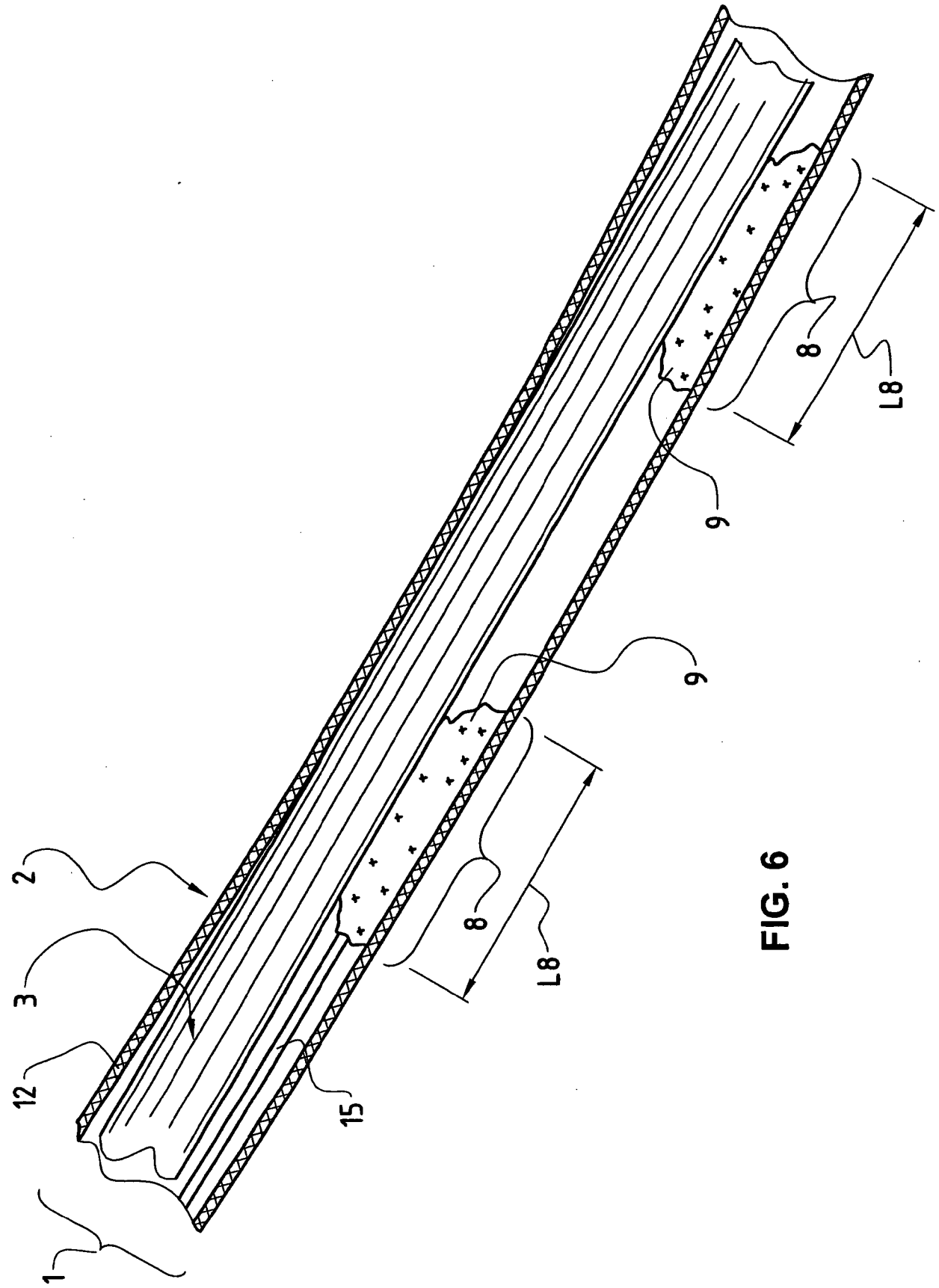



FIG. 6

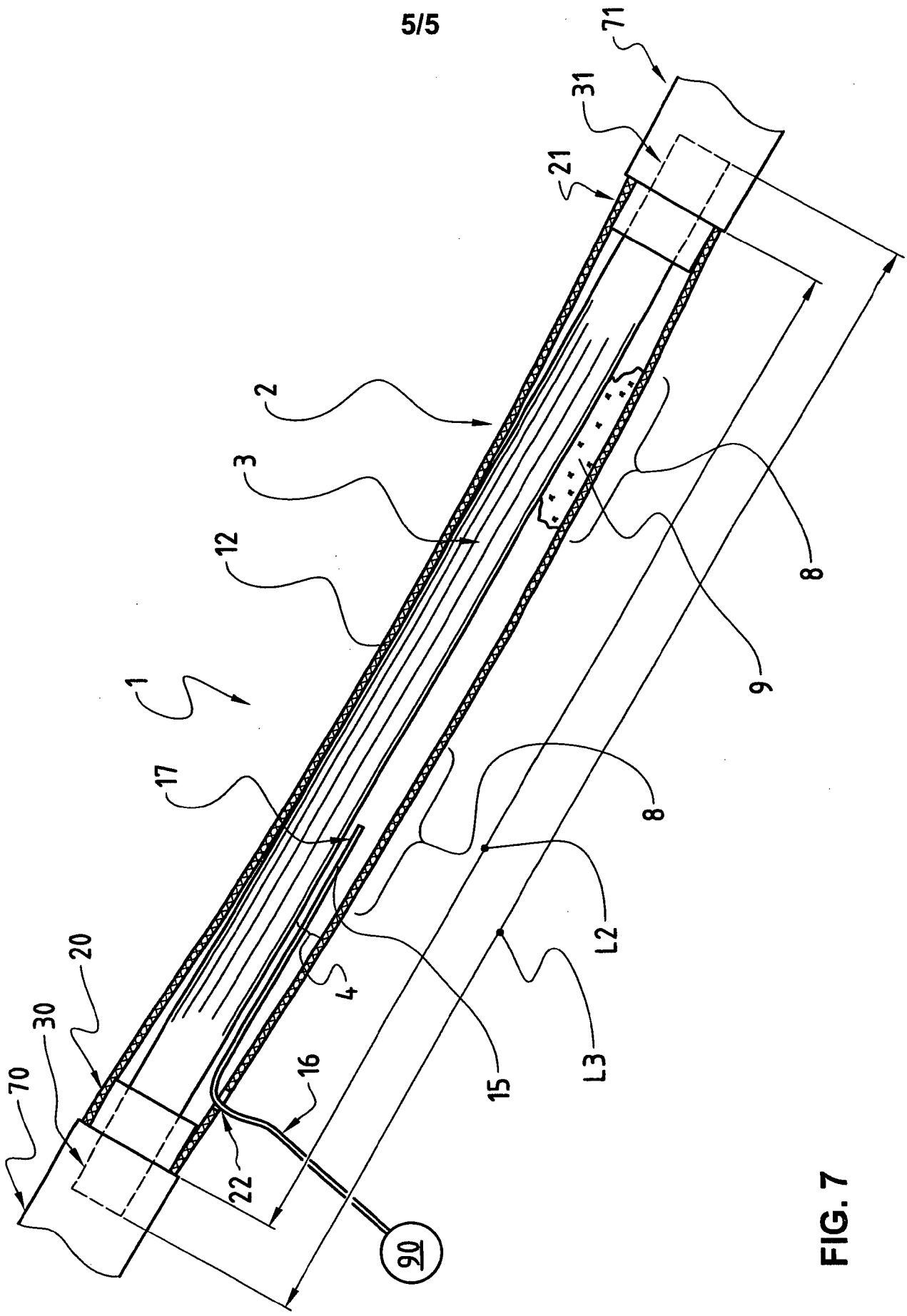



FIG. 7