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(54) **Static rope and mast or boom construction including a static rope**

Statisches Seil, Verwendung eines statischen Seiles sowie ein statisches Seil aufweisende Konstruktion eines Mastes oder eines Baumes

Corde statique, utilisation d'une corde statique et construction d'un mât ou d'un mât de charge comportant une corde statique

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Description**TECHNICAL FIELD**

5 **[0001]** The present invention relates to a static rope according to the precharacterizing clause of Patent Claim 1. The invention also relates to use of a static rope having a covering surrounding a seam fastening together a shorter and a longer rope portion to form a loop, where the covering surrounds the end of the shorter rope portion to form a rigid end stop. The invention relates furthermore to a mast construction comprising a static rope where a loop has been formed by the rope having been bent at one end to form a loop and where the loop is held together by a seam which interconnects
10 a shorter portion of the rope and a longer portion of the rope.

BACKGROUND ART

15 **[0002]** In sailing, static ropes are used to rig sail to masting. In order to maximize the sailing qualities of a boat, the sail is to be fixed well in an optimum position. In the event that the rope used is elastic, the position of the sail will vary greatly depending on the load on the sail. This results in the sailing qualities of the boat being impaired. In order to fix the sail well in a correct position, static ropes are used in sailing. A static rope means a rope where constituent fibres have an elasticity of less than 20%. The rope is also designed to have an elasticity of less than 20%. Suitable materials for static ropes are HMPE fibres (made of polyethylene), Kevlar fibres, Vectran, Zylon fibres and polyester fibres. For
20 particularly exacting purposes, it is desirable for the elasticity of the rope to be less than 6%.

[0003] When the rope is to be used for attaching sail to the rope, the end of the rope has to be provided with a loop. Conventionally, this loop is formed by tying a knot in the rope. However, a knot reduces the tensile strength of the rope by up to 50% on account of the rope being bent in a disadvantageous way. In order to form a loop on a rope in a controlled way without appreciably reducing the tensile strength, the loop can be formed by splicing the rope. For conventional
25 three-stranded rope, a tensile strength amounting to 90% of the tensile strength of the unspliced rope can be achieved. However, a spliced end has a slightly conical piece which extends with increasing diameter towards the start of the loop. This results in the rope not having a distinct stop but being able to become stuck in lead-throughs or pulleys at the conical part. Furthermore, a splice has to be made relatively long in order to have sufficient strength. This means that the sails cannot be pulled sufficiently close to the top of the mast if the risk of pulling the splice firmly into a lead-through or pulley
30 is to be avoided. There is moreover a risk of the line being pulled so far into the lead-through that the thickened portion becomes stuck. However, modern ropes are not designed as a single three-stranded portion but usually consist of a three-stranded or multi-stranded core with a braided covering.

[0004] In recent times, increasingly close coverings have been produced in order to make thin ropes with high tensile strength possible. Examples of such ropes are a rope with a mantle with an outside diameter of 10 mm and an inside
35 diameter of 7.5 mm where the mantle comprises 24 fibre bundles and a rope with a mantle with an outside diameter of 10 mm and an inside diameter of 8.5 mm where the mantle comprises 32 fibre bundles. Such ropes are usually referred to as eggshell ropes on account of the relative thinness of the mantle. With the mantle being made increasingly thin and at the same time braided harder, it is no longer possible to splice the rope while maintaining a high tensile strength of the rope. This is due to the procedure for splicing which requires the core of the rope to be guided out through the mantle
40 before the end of the rope and then reintroduced in order to lie double for a little way after formation of the loop. With thin hard braided mantles, there is simply no room for the splice, which means that the rope is very stiff at the splice, which itself contributes to reduced tensile strength. Furthermore, damage may be caused to the mantle, and material may have to be removed in order to form the splice, both of which contribute to impairing the tensile strength of the rope. For modern spliced ropes, it is difficult to guarantee that the tensile strength will exceed 70% of the tensile strength of
45 the unspliced rope. It is furthermore a very time-consuming procedure to prepare a splice on a modern hard-braided rope, which makes splices an unattractive solution.

DISCLOSURE OF THE INVENTION

50 **[0005]** The object of the invention is to provide a static rope with a mantle and core with a loop where the loop has been produced in a different way than by a knot or a spliced end. Another object of the invention is to provide a static rope with mantle and core where the tensile strength of the rope with loop applied is high and predictable in the sense that the variation between different ropes produced according to the same method is small. A further object is to provide a rope with a loop where the loop is produced according to an efficient method suitable for industrial mass production.
55 It is furthermore an object to produce a rope where, in tensile tests, breaking of the rope will take place outside the loop at the same time as the ultimate tensile strength of the rope will remain as high as possible.

[0006] These objects are achieved by a rope according to the characterizing part of Patent Claim 1.

[0007] In order that the rope will be as good as static, which is necessary in order for it to be possible to fix the sail in

a correct way, it is necessary for the core to have a pitch number which exceeds 5, as short-stranded or braided cores have an inherent elasticity. It is also necessary for the core to be stranded or braided in order for the seam to be capable of engaging in as many of the fibre bundles which make up the strands as possible.

[0008] In order to provide as strong a seam as possible without it having to be made unnecessarily long, the seam comprises at least a lower longitudinal seam with a first, narrower width of stitch and an upper longitudinal seam positioned above the said lower longitudinal seam, where the upper longitudinal seam has wider stitches and is positioned in such a way that the two edges of the upper longitudinal seam lie outside the two edges of the lower longitudinal seam. By designing the seam as an upper and an underlying seam where the stitches of the overlying seam do not penetrate the lower seam, it is ensured that the lower seam retains its strength and is not weakened by perforations.

[0009] In order for it to be possible to make maximum use of the rope and in order for it to be possible to position a sail as close to the top of a mast as possible, it is advantageous if the seam can be made as short as possible. For this purpose, the core is preferably long-stranded or braided with a pitch number of between 5 and 15, preferably between 7 and 11. Suitable lengths of seam are, if the seam is formed by two overlaid longitudinal seams, a length which is greater than half the pitch number and smaller than 3/4 of the pitch number multiplied by the diameter of the rope, or, if the seam is formed by three overlaid longitudinal seams, a length which is greater than a third of the pitch number and smaller than 3/4 of the pitch number multiplied by the diameter of the rope.

[0010] According to the invention, the seam is to be made with a number of stitches which results in an overall breaking strength of the seam which lies between 70 and 90% of the breaking strength of a corresponding rope without loop. Tests have shown that when a loop is formed by attaching two portions to one another with the aid of a seam, the tensile strength of the rope is reduced. The more stitches applied, the more the tensile strength of the rope is reduced. It is also of interest that the seam is stronger than the remaining tensile strength of the rope in order for the tensile strength of the rope to be utilized optimally. The remaining tensile strength of the rope means the strength the rope has at its weakest point, which of course occurs in the region of the loop and where the seam runs through the rope. In these regions, the strength of the rope is reduced in accordance with what was stated above.

[0011] In establishing a balance between ensuring that the seam is stronger than the tensile strength of other parts of the rope and ensuring that the tensile strength of the rope is not reduced to an unnecessarily great extent, it has been found that the seam is to be made with a number of stitches which results in an overall breaking strength of the seam which lies between 70 and 90% of the breaking strength of a corresponding rope without loop. The optimum value of the overall breaking strength of the seam amounts to roughly 80%, the risk of the seam breaking increasing when the value approaches 70% and the overall breaking strength decreasing when the value approaches 90%. For this purpose, the seam is preferably made with an overall breaking strength which lies between 75 and 85%, preferably between 78 and 82%, of the breaking strength of a corresponding rope without loop. If the same material is used in the mantle and core of the rope as in the seam, the seam is to be made with an overall cross-sectional area of the seam which corresponds to 70-90%, preferably 75-85%, and still more preferably 78-82% of the overall cross-sectional area of the fibre bundles making up the strands.

[0012] By virtue of what has been proposed, a rope with a loop is therefore obtained where the seam comprises a number of stitches which results in an overall breaking strength of the seam which exceeds the breaking strength of the other parts of the rope when the loop of the rope has been completed at the same time as the breaking strength of the rope is not reduced to an unnecessarily great extent.

[0013] In order to provide good breaking strength of the rope, it is necessary for the seam to run through as many of the fibre bundles making up the strands as possible. For this purpose, the seam is to be made with such a length that the thread which forms the seam runs through at least 90%, preferably 95%, of all the fibre bundles making up the said three or more strands. Optimally, the thread passes through all the fibre bundles.

[0014] This is brought about in preferred embodiments by a selection or a combination of the following measures:

- the difference in width between a lower and a following overlaid seam amounts to at least twice the diameter of the fibre bundles which form the said strands, two stitches lying one on top of another each then engaging in its own fibre bundle;
- the step length of a stitch is such that between one stitch and the next the seam engages in a first fibre bundle and a following adjacent fibre;
- the step length of the stitches amounts to the diameter of a fibre bundle multiplied by the cotangent of the pitch angle;
- if the seam is formed by two overlaid longitudinal seams, the length of the seam exceeds half the pitch number multiplied by the diameter of the rope, and/or
- if the seam is formed by three overlaid longitudinal seams, the length of the seam exceeds a third of the pitch number multiplied by the diameter of the rope.

[0015] According to a preferred embodiment of the invention, a covering surrounds the rope along a piece of the rope which extends in such a way that the covering covers the entire seam, surrounds the end of the short portion and extends

a little way onto the long portion after the said end of the short portion. By virtue of this construction, the seam can be made wear-resistant at the same time as the end of the shorter portion of that part of the rope which forms the loop can be used as a rigid end stop.

5 **[0016]** The invention also relates to use of a rope as above having a covering where the end of the shorter portion of that part of the rope which forms the loop can be used as a rigid end stop. The invention also relates to a mast construction which comprises a rope according to the invention, in particular a mast construction which comprises a rope according to the description above where the rope extends partly inside a cavity which extends through the length of the mast, out through a lead-through arranged at the top of the mast with the said loop positioned outside the mast, which loop is arranged to be attached to a sail, where a covering is applied to the rope along a piece of the rope which extends in
10 such a way that the covering covers the entire seam, surrounds the end of the short portion and extends a little way onto the long portion after the said end of the short portion, the end of the short portion being used as a rigid end stop.

DESCRIPTION OF FIGURES

15 **[0017]** The invention will be described in greater detail below with reference to accompanying drawing figures, in which:

Fig. 1 shows a graph of the tensile strength of a seam as a function of the number of stitches making up the seam, and the tensile strength of a rope as a function of the number of stitches sewn into the rope;

20 Fig. 2 shows diagrammatically a three-stranded core;

Fig. 3 shows diagrammatically a three-stranded core with a braided mantle;

25 Fig. 4 shows diagrammatically the definition of pitch number for a core;

Fig. 5 shows diagrammatically a rope according to the present invention;

Fig. 6 shows diagrammatically the definition of the length of a stitch;

30 Fig. 7 shows diagrammatically a rope according to the present invention where the seam is enclosed in a covering, and

Fig. 8 shows a mast construction according to the present invention.

PREFERRED EMBODIMENT(S)

35 **[0018]** Figure 1 shows diagrammatically a graph of the tensile strength of a seam as a function of the number of stitches making up the seam, and the tensile strength of a rope as a function of the number of stitches sewn into the rope. The tensile strength of the seam is in principle directly proportional to the number of stitches making up the seam. With an increased number of stitches, the tensile strength of the seam increases. In order to obtain a strong seam, the
40 number of stitches is therefore to be large. The tensile strength of an adapted rope with a loop at its end is also shown in comparison with the tensile strength of the same rope in the unadapted state, that is when the rope does not have a loop or anything which is added.

[0019] In Figure 1 and the associated piece of text, it emerges that the strength of the seam is directly proportional to the number of stitches. It also emerges that the strength of the adapted rope decreases with the number of stitches due
45 to the fact that the stitches weaken the rope. It is also stated that as soon as the rope is bent in order to form a loop, the rope is weakened in comparison with a rope in the unadapted state, that is before a loop or a seam has been added.

[0020] In the figure and the rest of the application, the breaking strength of the seam is indicated as a percentage of the unadapted rope, that is the rope before it has been bent and the seam has been applied. The unadapted rope therefore has the breaking strength 100%.

50 **[0021]** As emerges from Figure 1, the strength of the seam increases proportionally to the number of stitches, at the same time as the breaking strength of the adapted rope falls. When the breaking strength of the seam is greater than the breaking strength of the rope, the rope breaks instead of the seam. This break will of course take place in the region where the seam has affected the rope, but it is the rope which breaks and not the seam which breaks. In order to ensure that the seam does not break, it is not necessary for the breaking strength of the seam to exceed the breaking strength
55 of the unaffected rope, but it is sufficient if the strength of the seam amounts to between 70 and 90% of the breaking strength of the unaffected rope.

[0022] By selecting this range, a rope is obtained of which the seam is stronger than the rope with the seam. The tensile strength of an unaffected rope can be determined very accurately. The tensile strength of the seam is determined

wholly by the number of stitches involved and the quality of the thread. This means that the expert can easily implement the invention with the aid of stated data about the tensile strength of the unaffected rope and the tensile strength of the thread used for the seam. Simple division gives the number of stitches necessary to arrive within the stated range.

[0023] Merely by bending the rope, the load on the individual fibres is changed and the rope loses strength. This means that a loop without a seam has a lower tensile strength than a completely straight rope. The tensile strength depends on the constitution of the loop and on individual variation between ropes which are otherwise the same. By bending the rope so that it ends in a loop, a tensile strength amounting to 85-90% of the strength of the unaffected rope (without loop and seam) is obtained. Once the seam is added, the rope is weakened for every needle prick added. With a few needle pricks, the rope is weakened moderately, that is the derivative of the tensile strength of the rope is slightly negative. With an increased number of needle pricks, the magnitude of the negative derivative increases owing to the fact that a perforation effect occurs where a number of needle pricks interact to produce greater overall damage to the rope. This gives rise to the curve for the tensile strength of the rope as a function of the number of needle pricks being slightly curved. The tensile strength of the seam as a function of the number of needle pricks shows barely any statistical variation between different seams but is wholly dependent on the number of needle pricks and the quality of the thread. With a stated tensile strength for a thread, a suitable number of stitches can be determined. The tensile strength of the rope as a function of the number of needle pricks does have a statistical variation, however, which depends on how the needle pricks have perforated the rope. With every needle prick, there is a risk of the prick breaking fibres making up fibre bundles instead of sliding between the individual fibres. The figure shows two curves for the tensile strength of the rope. The upper curve shows the 99th percentile of the ropes, that is the ropes where few breaks happened on the individual fibres and where the rope has thus obtained a high tensile strength. 99% of the ropes have a strength which falls below this tensile strength. The lower curve shows the 1st percentile of the ropes, that is the ropes where many breaks happened on the individual fibres and where the rope has thus obtained a low tensile strength. 1% of the ropes have a strength which falls below this tensile strength.

[0024] The object of the invention is to produce a reliable seam which will not break before the rope does at the same time as the rope is not weakened to an unnecessarily great extent by an excessive number of stitches. Tests have shown that the optimum value of the strength of the seam in relation to the strength of the unaffected rope amounts to 80%. There is individual variation around the optimum value. In a first preferred embodiment, very good results are obtained in the respect that extremely few seams break at the same time as the tensile strength of the rope has not been reduced to an unnecessarily great extent if the seam is given a tensile strength amounting to between 78 and 82% of the tensile strength of the unaffected rope. In this case, it was found that less than 2% of the ropes break before the seam at the same time as the ropes have a high tensile strength in the finished state. In a second, less preferred embodiment where good results are still achieved, the seam is given a tensile strength amounting to between 75 and 85% of the tensile strength of the unaffected rope. For the ropes located within the range between 75 and 78%, it was found that less than 5% of the ropes break before the seam at the same time as the ropes have a high tensile strength in the finished state. For the ropes which have a seam with 85% of the tensile strength of the unaffected rope, it was found that the strength of the ropes decreased by roughly 1 % but that this is necessary in order to prevent the seam breaking before the rope. In a third, less preferred embodiment where good results are still obtained, the seam is given a tensile strength amounting to between 70 and 90% of the tensile strength of the unaffected rope. For the ropes which have a seam with a tensile strength amounting to 70%, it was found that 10% of the ropes break before the seam at the same time as the ropes have a high tensile strength in the finished state. For the ropes which have a seam with 90% of the tensile strength of the unaffected rope, it was found that the strength of the ropes decreased by roughly 4% but that this is necessary in order to prevent the seam breaking before the rope.

[0025] Tests have been carried out which show that the tensile strength measured in per cent of the rope is greater for more compact lines and that the tensile strength measured in per cent of the rope is greater for stronger lines.

[0026] The experiments indicated below show how the tensile strength of ropes varies depending on whether the rope has a compact core or the rope has a porous core.

Diameter mm	Nominal strength N	Number of stitches	Strength after seam	% of nominal strength	Length of seam mm
Poly-Braid-32 rope, compact 3-stranded core (difficult to splice)					
8	1800	80	1350	75	35
10	2500	121	1950	78	40
12	3300	169	2700	82	55

(continued)

Poly-Braid-16 rope, loose construction					
8	1500	80	1050	70	35
10	2100	121	1550	73.8	40
12	2700	169	2030	75.2	55

[0027] The test shows that a higher tensile strength measured in % of the original strength of the rope is obtained for compact cores than for corresponding ropes with porous cores when a seam with the same number of stitches is used.

[0028] In order to provide the desired tensile strength of the seam, the number of stitches necessary can be calculated from a stated tensile strength of the thread.

[0029] The seam preferably comprises a number of stitches which results in an overall breaking strength of the seam which exceeds the breaking strength of the other parts of the rope when the loop of the rope has been completed.

[0030] Figure 2 shows a core 1 for a rope. The core comprises three or more strands 2 which are each formed from a number of fibre bundles 3. Figure 2 shows the core 1 surrounded by a braided mantle 4. The function of the mantle is to protect the core from wear, and the function of the core is statically to support the loading of the rope. For this purpose, the core is to be designed with low elasticity. In its finished form, the rope has an elasticity of less than 20%. For this purpose, the core has a high pitch number in excess of 5. The pitch number preferably lies between 5 and 15, suitably between 7 and 11. A high pitch number reduces the elasticity because the fibre lies in the main in the direction of the rope. For the invention, however, it is necessary that the core is not completely straight because it is necessary for the seam to engage in the majority of the fibre bundles which form the strands making up the core. The desire to use short seams and for most of the fibre bundles to be caught and the requirement for low elasticity have resulted in the pitch number indicated above being found to be suitable.

[0031] Figure 4 shows diagrammatically how the concept of pitch number is to be understood. The figure shows a stranded core with a diameter D. The figure shows a strand K, which runs around the centre of the core. The strand K₁ regains the same original position after the distance H. The pitch number is defined as the quotient H/D. The invention can be used for both stranded and braided cores, so long as the core has a pitch number in excess of 5. The pitch number is preferably between 5 and 15. In a still more preferred embodiment, the pitch number lies between 7 and 11.

[0032] Figure 5 shows a rope 5 according to the present invention. The rope is provided with a loop 6 formed at one end of the rope. The loop 6 is formed by the rope being bent at the said end and forming a long portion 7 and a short portion 8, which portions have been positioned next to and in contact with one another and are joined together by a seam 9 which runs along the portions and engages in both portions. The seam 9 comprises at least a lower longitudinal seam 10 with a first, narrower width of stitch B₁ and an upper longitudinal seam 11 positioned above the said lower longitudinal seam 10, the upper longitudinal seam having wider stitches, with a width B₂, and being positioned in such a way that the two edges 12a, 12b of the upper longitudinal seam 11 lie outside the two edges 13a, 13b of the lower longitudinal seam 10.

[0033] As shown diagrammatically in Figure 5a, the seam preferably comprises three overlaid seams, a lower longitudinal seam 10, an intermediate longitudinal seam 14 and an upper longitudinal seam 11. The intermediate longitudinal seam 14 is to be made with wider stitches, with a width B₃, than the lower longitudinal seam 10, which has a width of stitch B₁. Furthermore, the intermediate longitudinal seam 14 is positioned in such a way that the two edges 15a, 15b of the intermediate longitudinal seam lie outside the two edges 13a, 13b of the lower longitudinal seam 10. The upper longitudinal seam 11 has wider stitches than the intermediate longitudinal seam 14 and is positioned in such a way that the two edges 12a, 12b of the upper longitudinal seam lie outside the two edges 15a, 15b of the intermediate longitudinal seam. For the sake of clarity, only part of the overlying seam has been shown in Figure 5. The overlying seam has a length L_o which is preferably the same as the length L_u of the underlying seam. For the sake of clarity, only part of the intermediate and the overlying seam is shown in Figure 5a. The overlying seam has a length L_o and the intermediate seam has a length L_m which are preferably the same as the length L_u of the underlying seam.

[0034] In order to obtain great tensile strength of the finished rope, it is important that the seam engages in as many fibre bundles as possible. For this purpose, the seam is to be made with such a length that the thread which forms the seam runs through at least 90%, preferably at least 95%, of all the fibre bundles making up the said three or more strands. In a still more preferred embodiment, the seam is made with such a length that the thread engages in all the fibre bundles in the core. As the core comprises the strand with a pitch number, the seam will, statistically, catch all the constituent fibre bundles if the seam is made sufficiently long. For this purpose, a suitable dimension of the length of the seam, if the seam is formed by two overlaid longitudinal seams, is for the length of the seam to exceed half the pitch number multiplied by the diameter of the rope. If the seam is formed by three overlaid longitudinal seams, the length of the seam suitably exceeds a third of the pitch number multiplied by the diameter of the rope.

[0035] In order to ensure that the seam catches as large a proportion of the fibre bundles as is desirable, a model of the core of the rope can be studied where the width and position of the strands are clear. Each strand is formed by a bunch of fibre bundles which each have a certain diameter. By studying the model, it can be established that a stitch will, depending on where on the rope the stitch is made, catch a certain number of fibre bundles. If the seam is made entirely straight along the rope, it is possible with a good confidence interval to determine how large a proportion of the fibre bundles have been caught by a seam which has a certain length, although it is not entirely possible to determine exactly how many threads have been caught by each stitch owing to inter alia the fact that it is not possible to state which rotational position strands and fibre bundles making up the strands were in at a specific stitch. By locating a number of seams along the rope, the desired percentage of fibre bundles caught can be achieved.

[0036] Whether the seam is formed by two or three overlaid seams, it is suitable for the length of the seam to be less than three quarters of the pitch number multiplied by the diameter of the rope.

[0037] In order to ensure that the seam does not have to be made excessively long, the step length of the stitches and the widths of the seams in preferred embodiments should be designed according to a selection or a combination of the following measures:

- the difference in width between a lower and a following overlaid seam amounts to at least twice the diameter of the fibre bundles which form the said strands, two stitches lying one on top of another each then engaging in its own fibre bundle;
- the step length of a stitch is such that between one stitch and the next the seam engages in a first fibre bundle and a following adjacent fibre;
- the step length of the stitches amounts to the diameter of a fibre bundle multiplied by the cotangent of the pitch angle;
- if the seam is formed by two overlaid longitudinal seams, the length of the seam exceeds half the pitch number multiplied by the diameter of the rope, and/or
- if the seam is formed by three overlaid longitudinal seams, the length of the seam exceeds a third of the pitch number multiplied by the diameter of the rope.

[0038] A definition of the step length of a stitch is shown diagrammatically in Figure 6, where a stitch 16 with the width B and the step length S is shown.

[0039] Figure 7 shows a rope according to the present invention where a covering 17 surrounds the rope along a piece of the rope which extends in such a way that the covering covers the entire seam 9, surrounds the end 18 of the short portion and extends a little way 19 onto the long portion after the said end 18 of the short portion. In this way, the rope is provided with a rigid end stop in the form of the enclosed end 18 of the shorter portion. In order that the end stop will be as rigid as possible, the end 20 of the seam lies close to the end 18 of the portion. The end of the seam preferably lies at a distance from the end of the portion which is smaller than the diameter than the rope. The covering is preferably made of plastic and has been glued and shrunk onto the rope.

[0040] Figure 8 shows an upper part of a mast construction where a rope 5 according to the present invention extends partly inside a cavity 21 which extends inside a mast 22, out through a lead-through 22a arranged at the top 23 of the mast with the said loop 6 positioned outside the mast, which loop is arranged to be attached to a sail, where a covering 17 is applied to the rope along a piece of the rope which extends in such a way that the covering covers the entire seam, surrounds the end of the short portion and extends a little way onto the long portion after the said end of the short portion, the end of the short portion being used as a rigid end stop.

[0041] Generally, the invention relates to a static rope having an outer braided mantle and an inner core formed by three or more strands which each comprise a set of fibre bundles, where the core and the mantle are each made from synthetic fibres with an elasticity of less than 20%, where the rope is provided with a loop fashioned at one end of the rope which is formed by the rope being bent at the said end and forming, to create the said loop, two portions starting from the loop, a long and a short portion, which portions are positioned next to and in contact with one another and are joined together by a seam which runs along the portions and engages in both portions, and where the said seam is made so that the seam is stronger than the rope affected by the seam and the loop, the rope breaking before the seam under great loading at the same time as the seam is weaker than the unaffected rope, that is to say the rope without loop and seam.

[0042] According to the description above, an advantageous embodiment also consists of a static rope having an outer braided mantle and an inner core formed by three or more strands which each comprise a set of fibre bundles, where the core and the mantle are each made from synthetic fibres with an elasticity of less than 20%, where the rope is provided with a loop fashioned at one end of the rope which is formed by the rope being bent at the said end and forming, to create the said loop, two portions starting from the loop, a long and a short portion, which portions are positioned next to and in contact with one another and are joined together by a seam which runs along the portions and engages in both portions, and where the said seam is made so that the seam is stronger than the rope affected by the seam and the loop and where a covering is arranged to surround the rope along a piece of the rope which extends in

Claims

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1. A static rope (5) having an outer braided mantle (4) and an inner stranded or braided core (1) formed by three or more strands (2) which each comprise a set of fibre bundles (3), where the core (1) and the mantle (4) are each made from synthetic fibres with an elasticity of less than 20%, where the rope (5) is provided with a loop (6) fashioned at one end of the rope (5) which is formed by the rope (5) being bent at the said end and forming, to create the said loop (6), two portions starting from the loop, a long and a short portion (7,8), which portions are positioned next to and in contact with one another and are joined together by a seam (9) which runs along the portions (7,8) and engages in both portions, **characterized in that** the core (1) of the rope (5) has a pitch number which amounts to at least 5, and **in that** the seam (9) comprises a number of stitches which results in an overall breaking strength of the seam (9) which lies between 70 and 90% of the breaking strength of a corresponding rope (5) without a loop (6), and **in that** the said seam comprises at least a lower longitudinal seam (10) with a first, narrower width of stitch and an upper longitudinal seam (11) positioned above the said lower longitudinal seam (10), where the upper longitudinal seam (11) has wider stitches and is positioned in such a way that the two edges (12a, 12b) of the upper longitudinal seam (11) lie outside the two edges (13a, 13b) of the lower longitudinal seam (10).
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2. Rope according to Claim 1, **characterized in that** the seam (9) comprises a number of stitches which results in an overall breaking strength of the seam which lies between 75 and 85% of the breaking strength of a corresponding rope (5) without loop (6).
- 25
3. Rope according to Claim 1, **characterized in that** the seam (9) comprises a number of stitches which results in an overall breaking strength of the seam (9) which lies between 78 and 82% of the breaking strength of a corresponding rope (5) without loop (6).
- 30
4. Rope according to any one of the preceding claims, **characterized in that** the seam (9) is made from a thread of the same material as the core (1) of the rope and **in that** the overall cross-sectional area of the seam (9), which corresponds to the cross-sectional area of the thread which forms the seam multiplied by the number of stitches, corresponds to 70-90%, preferably 75-85%, and still more preferably 78-82% of the overall cross-sectional area of the fibre bundles making up the strands.
- 35
5. Rope according to any one of the preceding claims, **characterized in that** the seam (9) comprises a number of stitches which results in an overall breaking strength of the seam (9) which exceeds the breaking strength of the other parts of the rope (5) when the loop (6) of the rope (5) has been completed.
- 40
6. Rope according to any one of the preceding claims, **characterized in that** the seam (9) has such a length (L) that the thread which forms the seam (9) runs through at least 90% of all the fibre bundles making up the said three or more strands (2).
7. Rope according to Claim 6, **characterized in that** the seam (9) has such a length (L) that the thread which forms the seam (9) runs through at least 95% of all the fibre bundles making up the said three or more strands (2).
- 45
8. Rope according to Claim 6, **characterized in that** the seam (9) has such a length (L) that the thread which forms the seam (9) runs through all the fibre bundles making up the said three or more strands (2).
- 50
9. Rope according to any of the previous claims, **characterized in that** the seam comprises three overlaid seams (10, 11, 14), a lower longitudinal seam (10), an intermediate longitudinal seam (14) and an upper longitudinal seam (11), where the intermediate longitudinal seam (14) has wider stitches than the lower longitudinal seam (10) and is positioned in such a way that the two edges (15a, 15b) of the intermediate longitudinal seam (14) lie outside the two edges (13a, 13b) of the lower longitudinal seam (10) and the upper longitudinal seam (11) has wider stitches than the intermediate longitudinal seam (14) and is positioned in such a way that the two edges (12a, 12b) of the upper longitudinal seam (11) lie outside the two edges (15a, 15b) of the intermediate longitudinal seam (14).
- 55
10. Rope according to claim 1 or 9, **characterized in that** the difference in width between a lower and a following overlaid seam (9,10) amounts to at least twice the diameter of the fibre bundles which form parts of said strands (2), two stitches lying one on top of another each then engaging in its own fibre bundle.
11. Rope according to any one of the preceding claims, **characterized in that** the step length (S) of a stitch is such that between one stitch and the next the seam engages in a first fibre bundle and a following adjacent fibre bundle.

12. Rope according to Claim 11, **characterized in that** the step length (S) of the stitches amounts to the diameter of a fibre bundle multiplied by the cotangent of the pitch angle.
- 5 13. Rope according to any one of the preceding claims, **characterized in that** the seam is formed by two overlaid longitudinal seams (9,10) and **in that** the length (L) of the seam exceeds half the pitch number multiplied by the diameter of the rope.
- 10 14. Rope according to any one of the preceding claims, **characterized in that** the seam is formed by three overlaid longitudinal seams (9,10,14) and **in that** the length (L) of the seam exceeds a third of the pitch number multiplied by the diameter of the rope.
- 15 15. Rope according to any one of the preceding claims, **characterized in that** the length (L) of the seam is less than three quarters of the pitch number multiplied by the diameter of the rope.
- 16 16. Rope according to any one of the preceding claims, **characterized in that** a covering (17) surrounds the rope (5) along a piece of the rope which extends in such a way that the covering (17) covers the entire seam (9), surrounds the end (18) of the short portion (8) and extends a little way (19) onto the long portion (7) after the said end (18) of the short portion (8).
- 20 17. Rope according to Claim 16, **characterized in that** the covering (17) is made of plastic and has been glued and shrunk onto the rope.
18. Mast construction or boom construction comprising a rope according to any one of the preceding claims.
- 25 19. Mast construction or boom construction according to Claim 18, **characterized in that** the said rope (5) extends partly inside a cavity (21) inside a mast or boom (22), out through a lead-through (22a) arranged in the mast or the boom (22) with the said loop (6) positioned outside the mast or the boom, which loop (6) is arranged to be attached to a sail, where a covering (17) is applied to the rope (5) along a piece of the rope which extends in such a way that the covering (17) covers the entire seam (9), surrounds the end (18) of the short portion (8) and extends a little (19) way onto the long portion (7) after the said end (18) of the short portion (8), the end (18) of the short portion (8) being used as a rigid end stop.
- 30 20. Mast construction or boom construction according to Claim 19, **characterized in that** the covering is made of plastic and has been shrunk and glued onto the rope.
- 35

Patentansprüche

- 40 1. Ein statisches Seil (5), aufweisend einen äußeren geflochtenen Mantel (4) und einen inneren verseilten oder geflochtenen Kern (1), gebildet aus drei oder mehr Litzen (2), die jeweils ein Set von Faserbündeln (3) umfassen, wobei der Kern (1) und der Mantel (4) jeweils aus synthetischen Fasern mit einer Elastizität von weniger als 20% hergestellt sind, wobei das Seil (5) mit einer Schlaufe (6) ausgestattet ist, gestaltet an einem Ende des Seils (5), das durch das Seil (5), an dem Ende gebogen, gebildet ist und ausbildend, zum Erschaffen der Schlaufe (6), zwei an der Schlaufe beginnende Abschnitte, ein langer und ein kurzer Abschnitt (7, 8), die Abschnitte sind nebeneinander und in Kontakt miteinander positioniert und sind miteinander durch eine Naht (9) verbunden, die an den Abschnitten (7, 8) entlang läuft und in beide Abschnitte eingreift, **dadurch gekennzeichnet, dass** der Kern (1) des Seils (5) eine Teilungszahl aufweist, die mindestens 5 beträgt, und dadurch, dass die Naht (9) eine Anzahl von Stichen umfasst, die in einer Gesamtreißfestigkeit der Naht (9) resultiert, die zwischen 70 und 90% der Reißfestigkeit eines entsprechenden Seils (5) ohne Schlaufe (6) liegt, und dass die Naht mindestens eine untere Längsnaht (10) umfasst, mit einer ersten engeren Breite des Stiches und eine obere Längsnaht (11), positioniert über der unteren Längsnaht (10), wobei die obere Längsnaht (11) breitere Stiche aufweist und in so einer Weise positioniert ist, dass die zwei Ränder (12a, 12b) der oberen Längsnaht (11) außerhalb der zwei Ränder (13a, 13b) der unteren Längsnaht (10) liegen.
- 45
- 50 2. Seil gemäß Anspruch 1, **dadurch gekennzeichnet, dass** die Naht (9) eine Anzahl von Stichen umfasst, die in einer Gesamtreißfestigkeit der Naht resultiert, die zwischen 75 und 85% der Reißfestigkeit eines entsprechenden Seils (5) ohne Schlaufe (6) liegt.
- 55

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3. Seil gemäß Anspruch 1, **dadurch gekennzeichnet, dass** die Naht (9) eine Anzahl von Stichen umfasst, die in einer Gesamtreißfestigkeit der Naht (9) resultiert, die zwischen 78 und 82% der Reißfestigkeit eines entsprechenden Seils (5) ohne Schlaufe (6) liegt.
- 5 4. Seil gemäß einem der vorstehenden Ansprüche, **dadurch gekennzeichnet, dass** die Naht (9) aus einem Faden des gleichen Materials wie der Kern (1) des Seils hergestellt ist und dadurch, dass die Gesamtquerschnittsfläche der Naht (9), die der Querschnittsfläche des Fadens entspricht, der die Naht ausbildet, multipliziert mit der Anzahl der Stiche, zu 70-90%, vorzugsweise 75-85%, und noch bevorzugter 78-82 % der Gesamtquerschnittsfläche der die Litzen ausmachenden Faserbündel entspricht.
- 10 5. Seil gemäß einem der vorstehenden Ansprüche, **dadurch gekennzeichnet, dass** die Naht (9) eine Anzahl von Stichen umfasst, was in einer Gesamtreißfestigkeit der Naht (9) resultiert, die die Reißfestigkeit der anderen Abschnitte des Seils (5) überschreitet, wenn die Schlaufe (6) des Seils (5) vollendet ist.
- 15 6. Seil gemäß einem der vorstehenden Ansprüche, **dadurch gekennzeichnet, dass** die Naht (9) so eine Länge (L) aufweist, dass der Faden, der die Naht (9) bildet, durch mindestens 90% aller die drei oder mehr Litzen (2) ausmachenden Faserbündel läuft.
- 20 7. Seil gemäß Anspruch 6, **dadurch gekennzeichnet, dass** die Naht (9) so eine Länge (L) aufweist, dass der Faden, der die Naht (9) bildet, durch mindestens 95% aller die drei oder mehr Litzen (2) ausmachenden Faserbündel läuft.
- 25 8. Seil gemäß Anspruch 6, **dadurch gekennzeichnet, dass** die Naht (9) so eine Länge (L) aufweist, dass der Faden, der die Naht (9) bildet, durch alle die drei oder mehr Litzen (2) ausmachenden Faserbündel läuft.
- 30 9. Seil gemäß einem der vorstehenden Ansprüche, **dadurch gekennzeichnet, dass** die Naht drei überlagernde Nahten (10, 11, 14) umfasst, eine untere Längsnaht (10), eine Zwischenlängsnaht (14) und eine obere Längsnaht (11), wobei die Zwischenlängsnaht (14) breitere Stiche aufweist als die untere Längsnaht (10) und in so einer Weise positioniert ist, dass die zwei Ränder (15a, 15b) der Zwischenlängsnaht (14) außerhalb der zwei Ränder (13a, 13b) der unteren Längsnaht (10) liegen und die obere Längsnaht (11) breitere Stiche als die Zwischenlängsnaht (14) aufweist und in so einer Weise positioniert ist, dass die zwei Ränder (12a, 12b) der oberen Längsnaht (11) außerhalb der zwei Ränder (15a, 15b) der Zwischenlängsnaht (14) liegen.
- 35 10. Seil gemäß Anspruch 1 oder 9, **dadurch gekennzeichnet, dass** der Unterschied in der Breite zwischen einer unteren und einer darauf folgenden überlagernden Naht (9, 10) sich mindestens zu dem zweifachen Durchmesser der Faserbündel, die Teile der Litzen (2) bilden, ergibt, zwei Stiche übereinander liegend, jeder dann in sein eigenes Faserbündel eingreifend.
- 40 11. Seil gemäß einem der vorstehenden Ansprüche, **dadurch gekennzeichnet, dass** die Schrittlänge (S) eines Stiches so ist, dass zwischen einem Stich und dem nächsten die Naht in ein erstes Faserbündel und ein darauf folgendes angrenzendes Faserbündel eingreift.
- 45 12. Seil gemäß Anspruch 11, **dadurch gekennzeichnet, dass** die Schrittlänge (S) der Stiche sich zu dem Durchmesser eines Faserbündels, multipliziert mit dem Cotangens des Teilungswinkels, ergibt.
- 50 13. Seil gemäß einem der vorstehenden Ansprüche, **dadurch gekennzeichnet, dass** die Naht durch zwei überlagernde Längsnähte (9, 10) gebildet ist und dadurch, dass die Länge (L) der Naht die halbe Teilungszahl, multipliziert mit dem Durchmesser des Seils, übersteigt.
- 55 14. Seil gemäß einem der vorstehenden Ansprüche, **dadurch gekennzeichnet, dass** die Naht durch drei überlagernde Längsnähte (9, 10, 14) gebildet ist und dadurch, dass die Länge (L) der Naht ein Drittel der Teilungszahl, multipliziert mit dem Durchmesser des Seils, überschreitet.
15. Seil gemäß einem der vorstehenden Ansprüche, **dadurch gekennzeichnet, dass** die Länge (L) der Naht weniger als drei Viertel der Teilungszahl, multipliziert mit dem Durchmesser des Seils, ist.
16. Seil gemäß einem der vorstehenden Ansprüche, **dadurch gekennzeichnet, dass** eine Verkleidung (17) das Seil (5) umgibt, entlang eines Teils des Seils, das sich in so einer Weise erstreckt, dass die Verkleidung (17) die gesamte Naht (9) abdeckt, das Ende (18) des kürzeren Abschnitts (8) umgibt und sich einen kleinen Weg (19) auf dem langen

Abschnitt (7) nach dem Ende (18) des kurzen Abschnitts (8) erstreckt.

17. Seil gemäß Anspruch 16, **dadurch gekennzeichnet, dass** die Verkleidung (17) aus Kunststoff hergestellt ist und auf das Seil geklebt und geschrumpft wurde.

18. Mastkonstruktion oder Baumkonstruktion, umfassend ein Seil gemäß einem der vorstehenden Ansprüche.

19. Mastkonstruktion oder Baumkonstruktion gemäß Anspruch 18, **dadurch gekennzeichnet, dass** das Seil (5) sich teilweise in einem Hohlraum (21) innerhalb eines Masts oder Baums (22) erstreckt, nach Außen durch eine Durchführung (22a), angeordnet in dem Mast oder Baum (22), mit der Schlaufe (6) außerhalb des Masts oder Baums positioniert, die Schlaufe (6) ist angeordnet, um an einem Segel angebracht zu werden, wobei eine Verkleidung (17) an dem Seil (5) entlang eines Teils des Seils angebracht ist, das sich in so einer Weise erstreckt, dass die Verkleidung (17) die gesamte Naht (9) abdeckt, das Ende (18) des kurzen Abschnitts (8) umgibt und sich einen kleinen Weg (19) auf dem langen Abschnitt (7) nach dem Ende (18) des kurzen Abschnitts (8) erstreckt, das Ende (18) des kurzen Abschnitts (8) als steifer Endanschlag verwendet.

20. Mastkonstruktion oder Baumkonstruktion gemäß Anspruch 19, **dadurch gekennzeichnet, dass** die Verkleidung aus Kunststoff hergestellt ist und auf das Seil geschrumpft und geklebt wurde.

Revendications

1. Corde statique (5) ayant une enveloppe tressée extérieure (4) et un noyau tressé ou à brins interne (1) formé de trois brins ou plus (2) qui comprennent chacun un ensemble de faisceaux de fibres (3), où le noyau (1) et l'enveloppe (4) sont chacun réalisés en fibres synthétiques avec une élasticité inférieure à 20 %, où la corde (5) est dotée d'une boucle (6) façonnée à une extrémité de ladite corde (5) qui est formée en repliant la corde (5) à ladite extrémité et en formant, afin de créer ladite boucle (6), deux parties partant de la boucle, une partie longue et une partie courte (7,8), lesdites parties étant positionnées l'une près de l'autre et en contact l'une avec l'autre et étant jointes ensemble par une couture (9) qui s'étend le long des parties (7,8) et est en prise avec les deux parties, **caractérisée en ce que** le noyau (1) de la corde (5) a un nombre de pas qui s'élève à au moins 5, et **en ce que** la couture (9) comprend un nombre de points qui donne une résistance à la rupture globale de la couture (9), située entre 70 et 90 % de la résistance à la rupture d'une corde correspondante (5) sans boucle (6), et **en ce que** ladite couture comprend au moins une couture longitudinale inférieure (10), avec une première largeur plus étroite de point et une couture longitudinale supérieure (11) positionnée au-dessus de ladite couture longitudinale inférieure (10), où la couture longitudinale supérieure (11) a des points plus larges et est positionnée de sorte que les deux bords (12a, 12b) de la couture longitudinale supérieure (11) se trouvent hors des deux bords (13a, 13b) de la couture longitudinale inférieure (10).

2. Corde selon la revendication 1, **caractérisée en ce que** la couture (9) comprend un certain nombre de points, qui donnent une résistance à la rupture globale de ladite couture, située entre 75 et 85 % de la résistance à la rupture d'une corde correspondante (5) sans boucle (6).

3. Corde selon la revendication 1, **caractérisée en ce que** la couture (9) comprend un certain nombre de points, qui donnent une résistance à la rupture globale de ladite couture (9), située entre 78 et 82 % de la résistance à la rupture d'une corde correspondante (5) sans boucle (6).

4. Corde selon l'une quelconque des revendications précédentes, **caractérisée en ce que** la couture est constituée d'un fil du même matériau que le noyau (1) de la corde et **en ce que** la superficie transversale globale de la couture (9), qui correspond à la superficie transversale du fil qui forme la couture, multipliée par le nombre de points, correspond à 70-90 %, de préférence 75-85 % et de manière davantage préférée 78-82 % de la superficie transversale globale des faisceaux de fibres qui constituent les brins.

5. Corde selon l'une quelconque des revendications précédentes, **caractérisée en ce que** la couture (9) comprend un certain nombre de points, qui donnent une résistance à la rupture globale de ladite couture (9) qui dépasse la résistance à la rupture des autres parties de la corde (5) quand la boucle (6) de la corde (5) a été complétée.

6. Corde selon l'une quelconque des revendications précédentes, **caractérisée en ce que** la couture (9) a une longueur (L) telle que le fil qui forme la couture (9) s'étend à travers au moins 90 % de tous les faisceaux de fibres qui

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constituent lesdits trois brins ou plus (2).

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7. Corde selon la revendication 6, **caractérisée en ce que** la couture (9) a une longueur (L) telle que le fil qui forme la couture (9) s'étend à travers au moins 95 % de tous les faisceaux de fibres qui constituent lesdits trois brins ou plus (2).
- 10
8. Corde selon la revendication 6, **caractérisée en ce que** la couture (9) a une longueur (L) telle que le fil qui forme la couture (9) s'étend à travers tous les faisceaux de fibres qui constituent lesdits trois brins ou plus (2).
- 15
9. Corde selon l'une quelconque des revendications précédentes, **caractérisée en ce que** la couture comprend trois coutures superposées (10, 11, 14), une couture longitudinale inférieure (10), une couture longitudinale intermédiaire (14) et une couture longitudinale supérieure (11), où la couture longitudinale intermédiaire (14) a des points plus larges que la couture longitudinale inférieure (10) et est positionnée de sorte que les deux bords (15a, 15b) de la couture longitudinale intermédiaire (14) soient placés hors des deux bords (13a, 13b) de la couture longitudinale inférieure (10) et la couture longitudinale supérieure (11) a des points plus larges que la couture longitudinale intermédiaire (14) et est positionnée de sorte que les deux bords (12a, 12b) de la couture longitudinale supérieure (11) se trouvent hors des deux bords (15a, 15b) de la couture longitudinale intermédiaire (14).
- 20
10. Corde selon la revendication 1 ou 9, **caractérisée en ce que** la différence de largeur entre une couture inférieure et une couture suivante superposée (9, 10) s'élève à au moins deux fois le diamètre des faisceaux de fibres qui font partie desdits brins (2), deux points superposés étant ainsi en prise avec son propre faisceau de fibres.
- 25
11. Corde selon l'une quelconque des revendications précédentes, **caractérisée en ce que** la longueur d'échelon (S) d'un point est telle qu'entre un point et le suivant, la couture se met en prise dans un premier faisceau de fibres et un faisceau de fibres adjacent suivant.
- 30
12. Corde selon la revendication 11, **caractérisée en ce que** la longueur d'échelon (S) des points s'élève au diamètre d'un faisceau de fibres multiplié par la cotangente de l'angle de pas.
- 35
13. Corde selon l'une quelconque des revendications précédentes, **caractérisée en ce que** la couture est formée par deux coutures longitudinales superposées (9, 10) et **en ce que** la longueur (L) de la couture dépasse la moitié du nombre de pas, multipliée par le diamètre de la corde.
- 40
14. Corde selon l'une quelconque des revendications précédentes, **caractérisée en ce que** la couture est formée par trois coutures longitudinales superposées (9, 10, 14) et **en ce que** la longueur (L) de la couture dépasse un tiers du nombre de pas multiplié par le diamètre de la corde.
- 45
15. Corde selon l'une quelconque des revendications précédentes, **caractérisée en ce que** la longueur (L) de la couture est inférieure à trois quarts du nombre de pas, multipliés par le diamètre de la corde.
- 50
16. Corde selon l'une quelconque des revendications précédentes, **caractérisée en ce qu'**un revêtement (17) entoure la corde (5) le long d'un morceau de la corde, qui s'étend de sorte que le revêtement (17) couvre toute la couture (9), entoure l'extrémité (18) de la partie courte (8) et s'étende sur une courte distance (19) sur la partie longue (7) après ladite extrémité (18) de la partie courte (8).
- 55
17. Corde selon la revendication 16, **caractérisée en ce que** le revêtement (17) est constitué de plastique et a été collé et contracté sur la corde.
18. Construction de mât ou construction de bôme comprenant une corde selon l'une quelconque des revendications précédentes.
19. Construction de mât ou construction de bôme selon la revendication 18, **caractérisée en ce que** ladite corde (5) s'étend partiellement à l'intérieur d'une cavité (21) à l'intérieur d'un mât ou d'une flèche (22), à l'extérieur à travers une traversée (22a) disposé dans le mât ou la flèche (22), ladite boucle (6) étant positionnée hors du mât ou de la flèche, ladite boucle (6) étant disposée de façon à être fixée à une voile, où un revêtement (17) est appliqué à la corde (5) le long d'un morceau de la corde qui s'étend de sorte que le revêtement (17) couvre toute la couture (9), entoure l'extrémité (18) de la partie courte (8) et s'étende sur une courte distance (19) sur la partie longue (7) après ladite extrémité (18) de la partie courte (8), l'extrémité (18) de la partie courte (8) étant utilisée comme une butée

d'extrémité rigide.

20. Construction de mât ou construction de bôme selon la revendication 19, **caractérisée en ce que** le revêtement est constitué de plastique et a été contracté et collé sur la corde.

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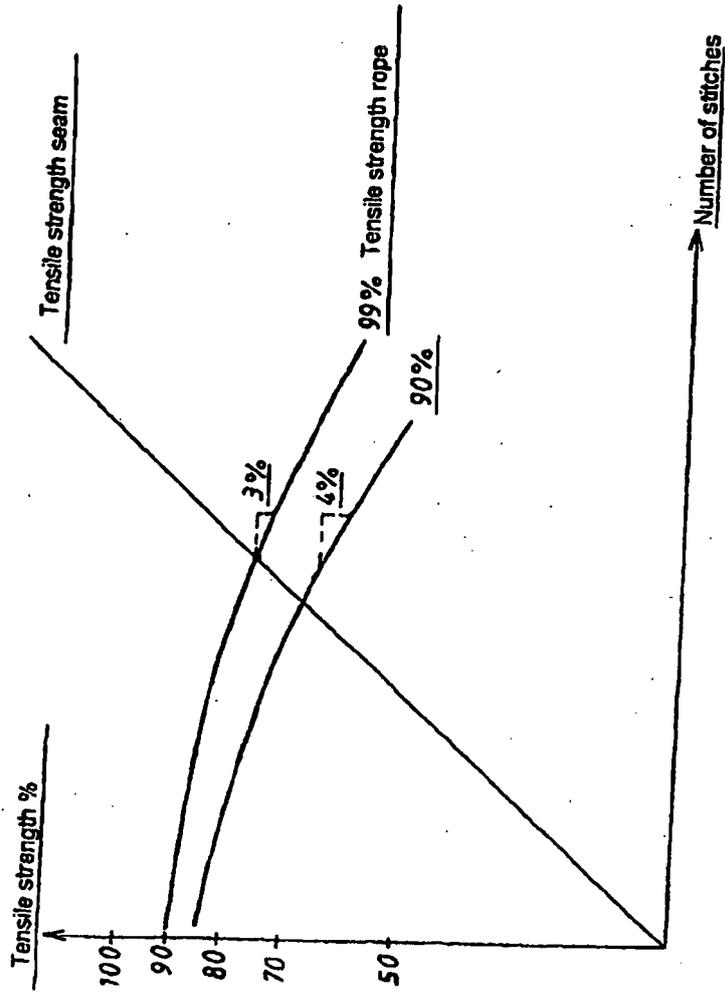


FIG.1

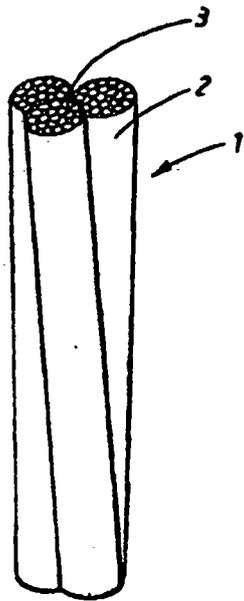


FIG. 2

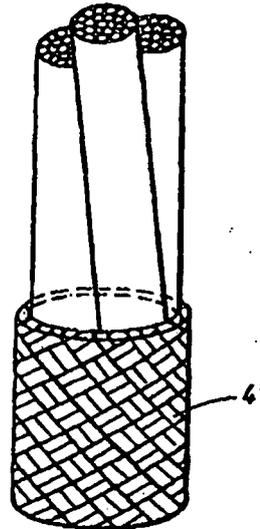


FIG. 3

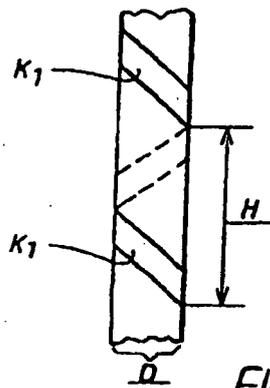


FIG. 4

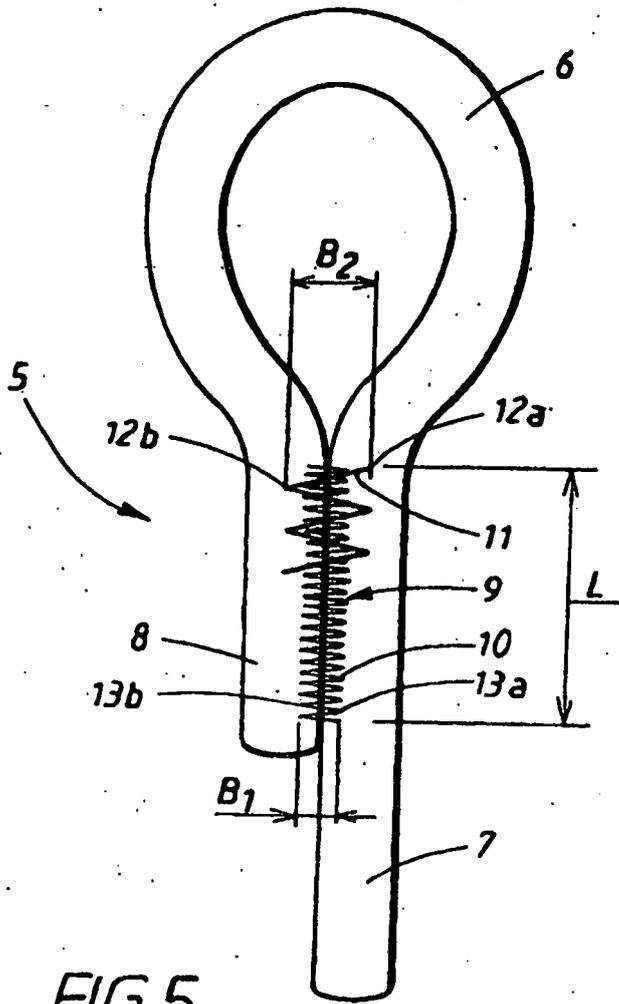


FIG. 5

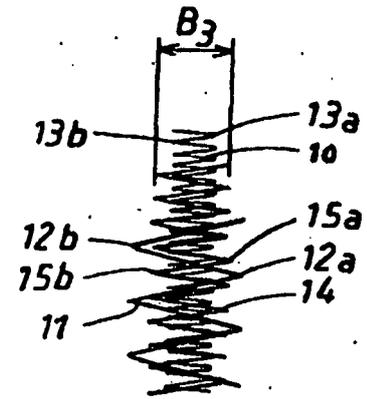


FIG. 5a

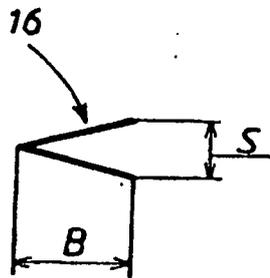


FIG. 6

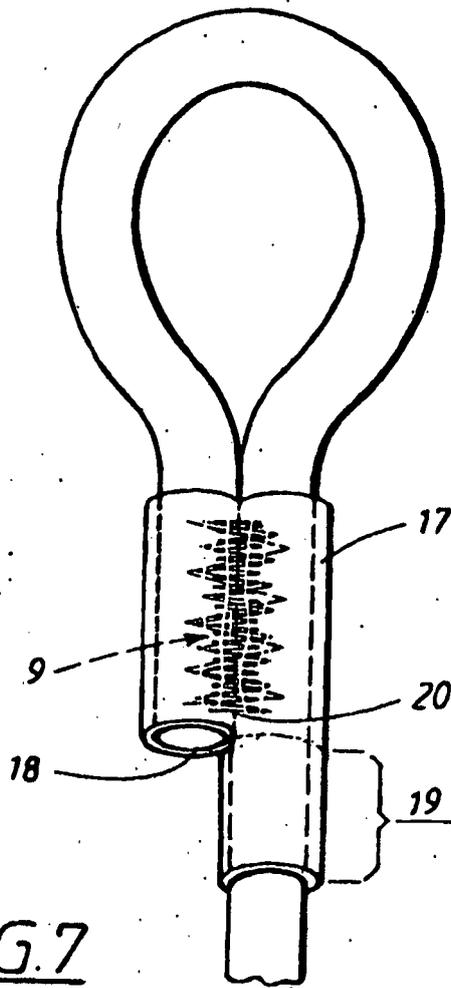


FIG. 7

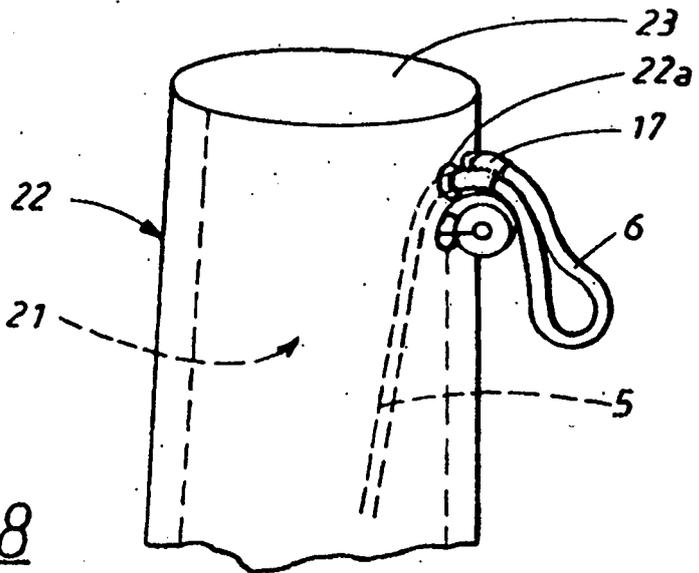


FIG. 8