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(54) **Metal rope with fibres of liquid-crystal polymer**

(57) The present invention refers to a metal rope with improved features, in particular having high ultimate tensile strength and a high number of sustainable fatigue cycles. The metal rope (10) according to the present in-

vention consists of a plurality of strands (12) wound around a central core (14) and is **characterised in that** the central core (14) is made of a fibre spun from a liquid-crystal polymer. Preferably, this fibre spun from a liquid-crystal polymer is VectranTM.

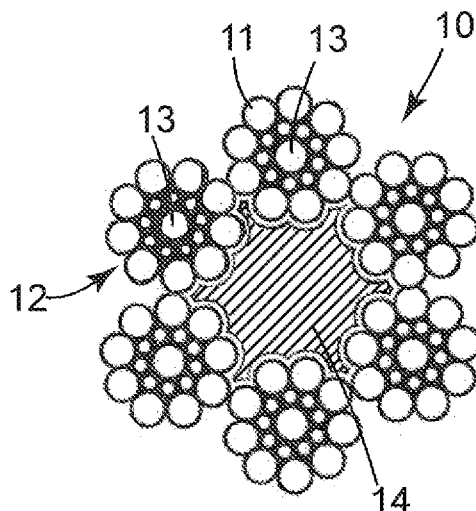


Fig. 2a

Description

[0001] The present invention refers to a metal rope with improved features, in particular having high ultimate tensile strength and a high number of sustainable fatigue cycles.

[0002] The metal ropes that are known today consist of a plurality of strands wound around a central core.

[0003] The strands in turn consist of a set of metal wires arranged in a helix around a core consisting of a metal wire or a thread of natural or synthetic fibre.

[0004] The metal wires are obtained by drawing the rod and, depending on applications, the metal wires are subsequently coated, for example via a galvanising operation.

[0005] In general, these wires are of the galvanised twice drawn class "B" type according to the standard ISO 2232.

[0006] In order to obtain a rope, the strands are initially subjected to a so-called preforming operation during which they take on a helical shape that they maintain in the final formation of the rope and subsequently they are subjected to the stranding operation that consists of winding the metal wires around the core.

[0007] Owing to the preforming, it is obtained that in the event of cutting and/or breaking, the strands and the single wires forming the strands stay in position and do not unwind.

[0008] Subsequently, stranding takes place, which involves winding the strands around the core of the rope.

[0009] Until today, depending on the special application for which the rope is intended, various types of metal ropes are made, which differ, for example, through composition, the direction of winding of the external metal wires with respect to the strands and of the strands themselves with respect to the overall rope, and differ through the possible coating of the metal wires and/or the plasticisation of the rope.

[0010] The composition of a rope is distinguished by the number of strands constituting the rope, the number of wires forming each strand and the type of metal core, for example made of steel, or textile core, made of natural or synthetic fibres.

[0011] The metal wires can be protected by appropriate lubrication or be coated by galvanising, depending on the aggressiveness/corrosiveness of the environment in which the respective ropes are to be used.

[0012] Lastly, inserting a filler made of plastics between the core and the strands reduces the possibility of corresponding sliding of the various components whilst permitting the necessary freedom of movement of the various components. In this manner there is, moreover, reduced wear and internal corrosion of the rope.

[0013] Today, on the market there exist different types of ropes with a steel core that have high ultimate tensile strength, which ropes with a steel core, nevertheless, owing to the great metal section, do not always provide sufficient performance in terms of the number of fatigue

cycles, difficulties being further found in combining the rope and the plant according to the features of the plant or the operating conditions.

[0014] Ropes with a steel core also have the drawback of being subject to the phenomenon of pitting, due to the contact of the external strands with the metal core, which produces internal damage that is difficult to assess during the step of periodical checking and which determines an average life of the rope that is significantly lower than that of ropes with a textile core.

[0015] On the other hand, the ropes with a core of textile fibre have always been known for the flexibility that they provide, for capacity to absorb stress transmitted by the system (angle of deflection and shock) and for the great number of fatigue cycles that they are able to bear.

[0016] Nevertheless, ropes with a textile core have a decidedly lower ultimate tensile strength value compared with that of a rope with a metal core.

[0017] Owing to the reduced ultimate tensile strength value that they are able to provide, such ropes are not always usable inasmuch as they are not always able to meet the safety requirements required by standards.

[0018] Further, using ropes with a textile core has always been a drawback in environments with high humidity owing to the possible rotting thereof, such as to cause the deterioration thereof and the consequent loss of geometry of the rope.

[0019] This deterioration can also affect ropes with a metal core not only in the presence of humidity but also in applications in aggressive/corrosive environments (acids), which inhibit internal lubrication, giving rise to corrosion, the effects of which affect the ultimate tensile strength of the rope.

[0020] The object of the present invention is to remedy the aforesaid drawbacks and in particular that of creating a metal rope that has great high ultimate tensile strength and is able to withstand a great number of fatigue cycles.

[0021] Another object of the present invention is to provide a metal rope that is not substantially subject to damage even when used in humid or aggressive/corrosive environments.

[0022] Not the last object of the present invention is to devise a metal rope that is not substantially subject to pitting, providing a long average life.

[0023] These and other objects according to the present invention are achieved by making a metal rope like the one disclosed in claim 1.

[0024] Further features of the device are the object of the appended claims.

[0025] The features and the advantages of a metal rope according to the present invention will become clearer from the following description given by way of nonlimiting example, referring to the attached schematic drawings in which:

- figure 1 is a perspective view of a metal rope according to the present invention;
- figure 2a is a section view of a metal rope according

to the present invention;

- figure 2b is a section view of a metal rope with a steel core known today.

[0026] With reference to the figures, a metal rope is shown, which is overall indicated by 10.

[0027] This metal rope 10 consists of a plurality of strands 12 wound around a central core 14, in turn consisting of a set of metal wires 11 arranged as a helix around a core 13 constituted by a metal wire or a natural or synthetic textile fibre.

[0028] According to the present invention the central core 14 of the rope 10 is made of textile fibre spun from a liquid-crystal polymer.

[0029] This fibre is characterised by orientation of the molecules thereof along the axis of the fibre, the final structure of which, because it is highly orientated, has high resistance properties and a high elasticity module.

[0030] In a preferential embodiment, the fibre spun from a liquid-crystal polymer is Vectran™.

[0031] The most striking features of this fibre can be summarised as toughness and great modulus, low humidity absorption, high resistance to a plurality of chemical agents, low thermal expansion coefficient, high dielectric resistance, high resistance to creep, high resistance to abrasion, high maintenance of mechanical properties, also following exposure to repeated temperature cycles, and excellent vibration-damping features.

[0032] In an advantageous embodiment that is not shown also the core 13 of the strands is made of textile fibre spun from a liquid-crystal polymer and is preferably made of Vectran™.

[0033] The Applicant has found that in the construction of the metal rope 10 with a central core 14 made of fibre spun from a liquid-crystal polymer, with the adoption of stranding ratios of the rope and of preferential stranding and of a particular structure of the yarn with which the central core 14 is made, ultimate tensile strength values are reached that are comparable to a rope with a steel core 17, without penalising the advantages provided by the textile cores.

[0034] In particular, the stranding ratios that provide excellent results in terms of ultimate tensile strength are comprised between 6.5 and 7.2 times the diameter of the rope, whilst the closing/stranding ratios of the steel wires are comprised between 6.9 and 7.3 times diameter of the strand. Further, the fibre spun from a liquid-crystal polymer preferably consists of a number of parallel strands comprised between 5 and 18.

[0035] The Applicant has further conducted various tests run on ropes with a nominal diameter of 4.9 mm, a first rope of which is of the type with a steel core and a second rope of which is of the type according to the present invention.

[0036] A first test, called the rotating fatigue test, was conducted by means of a machine consisting of two spindles on which the rope was anchored, the first of which was an idling spindle and a second spindle of which was

suitable for rotating the rope.

[0037] The two spindles of this machine are arranged parallel alongside one another so that the rope being tested, being anchored by the first on the second, is arranged in a "U".

[0038] The driven spindle is mounted on a rail and is piloted to approach and move away.

[0039] By decreasing the distance between the two spindles a folding is simulated that is generally equal to the winding ratio between the rope and the pulley.

[0040] The test consists of twisting the rope and letting the rope rotate until a first breakage of the wire occurs, detected by the sensor located near the zone where the folding of the rope occurs.

[0041] This test has shown that the metal rope according to the present invention is able to support a number of fatigue cycles (more than 10,000) that is 20% greater than the metal rope with a steel core (approximately 8000) and comparable with the metal ropes with a textile core.

[0042] A second test has enabled the ultimate tensile strength of the two ropes disclosed above to be measured, from which a value that is similar and equal to 20.8 kN emerged.

[0043] This test was conducted with a machine of vertical type and consisted of tightening the two ends of the rope in the clamps of this machine and applying an increasing load until the rope breaks, which may also affect a single strand thereof.

[0044] The methods with which this test was conducted, i.e. the length of the sample and the speed of application of the load, conform to the standards UNI 3171-85 and ISO 7500.

[0045] The metal rope 10 according to the present invention thus has great ultimate tensile strength, high resistance to fatigue, being in addition to that able to provide good support to the geometry of the rope even after several work cycles.

[0046] In addition, the rope 10 according to the present invention, with respect to the rope with a steel core 17, is not substantially subject to the phenomenon of pitting inasmuch as the external strands 12 do not undergo rubbing against a very stiff material such as steel but against a central core 14 made of a fibre spun from a liquid-crystal polymer.

[0047] Similarly, the metal rope 10 according to the present invention does not require thorough lubrication, it being sufficient to limit lubrication only to the external strands, and it is not subject to problems caused by internal corrosion even if used in aggressive/corrosive environments.

[0048] The particular core 14 further confers on the rope great flexibility and good ease of handling.

[0049] The stabilising effect induced by the core 14 made of liquid-crystal polymer fibre is particularly clear if the rope is subjected to transverse pressure, to twisting due to wide angles of lateral deviation, for example on the pulleys or drums around which they run, to impact

loads or to tearing and pump effects.

[0050] The metal rope according to the present invention is further characterised by modest ultimate elongation equal to a maximum of 3-4 %.

[0051] From the above description the features are clear of the device that is the subject of the present invention, just as the corresponding advantages are clear. 5

[0052] It is lastly clear that the device that is thus conceived is susceptible to numerous modifications and versions, all of which fall within the scope of the invention; the details are further replaceable by technically equivalent elements. In practice, the materials used and the dimensions can be of any type, depending on technical requirements. 10

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Claims

1. Metal rope (10) consisting of a plurality of strands (12) wound around a central core (14) **characterised in that** said central core (14) is made of a fibre spun from a liquid-crystal polymer. 20
2. Metal rope (10) according to claim 1 **characterised in that** said fibre spun from a liquid-crystal polymer is Vectran[™]. 25
3. Metal rope (10) according to any one of claims 1 or 2 **characterised in that** said fibre spun from a liquid-crystal polymer consists of a number of parallel strands comprised between 5 and 18. 30
4. Metal rope (10) according to any preceding claim **characterised in that** it is made with stranding ratios of said strands (12) comprised between 6.5 and 7.2 times the diameter of the rope. 35
5. Metal rope (10) according to any preceding claim **characterised in that** said strands (12) are made with closing/stranding ratios of the metal wires (11) comprised between 6.9 and 7.3 times the diameter of the strand. 40
6. Metal rope (10) according to any preceding claim **characterised in that** said strands (12) consist of a plurality of metal wires (11) made of galvanised steel wound around a corresponding core (13) of the strands. 45
7. Metal rope (10) according to claim 6 **characterised in that** said core (13) of the strands is made of a fibre spun from a liquid-crystal polymer. 50
8. Metal rope (10) according to claim 7 **characterised in that** said core (13) of the strands is made of Vectran[™]. 55

Fig. 1

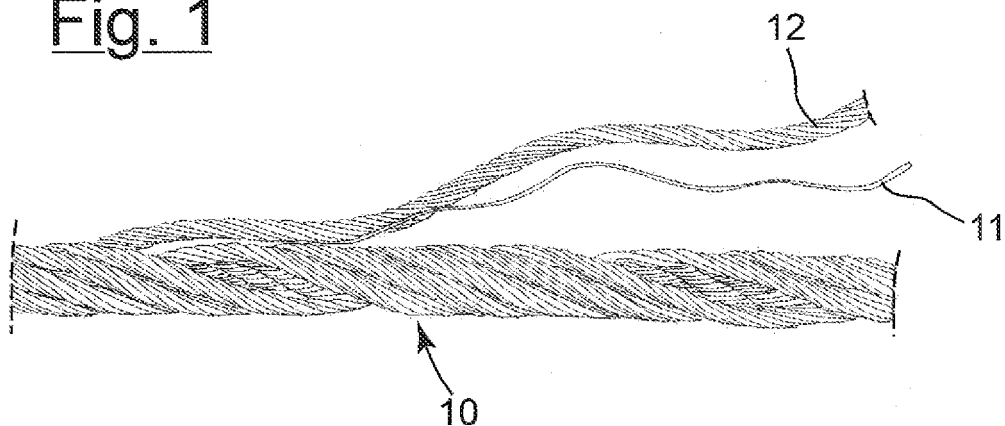


Fig. 2a

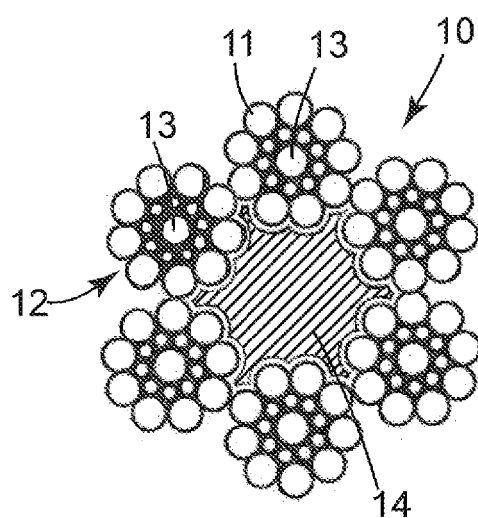


Fig. 2b
Prior Art

