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(54) **CONNECTOR FOR A HOISTING ROPE OF A HOISTING APPARATUS**

(57) The invention relates to a connector (15) for a hoisting rope (1), (19) of a hoisting apparatus, preferably of an elevator for transporting passengers and/or goods. The connector (15) for a hoisting rope (1), (22) of a hoisting apparatus according to the present invention, in which the hoisting rope (1), (22) comprises a plurality of adjacent conductive load bearing members (3-6) for bearing the load exerted on the hoisting rope (1), (22) in longitudinal direction, wherein the connector (15) comprises a connector plate part (18), a top clamp part (16) and a bottom clamp part (17) for clamping said connector plate part (18) to an end (7), (8), (21) of said hoisting rope (1), (19); wherein said hoisting rope (1), (19) has a notch opening (20) ground to said end (7), (8), (21) of said hoisting rope (1), (19), so that said notch opening (20) exposes said conductive load bearing members (3-6), wherein said connector plate part (18) has a bended portion (22) matching with said notch opening (20), and wherein one of said top clamp part (16) and said bottom clamp part (17) has a tooth part (23) matching with said bended portion (22) of said connector plate part (18) and with said notch opening (20); so that upon clamping said top clamp part (16) and said bottom clamp part (17) together, said bended portion (22) of said connector plate part (18) presses onto said exposed conductive load bearing members (3-6) in said ground a notch opening (20) and forms an electrical connection between said load bearing members (3-6) and said connector plate part (18).

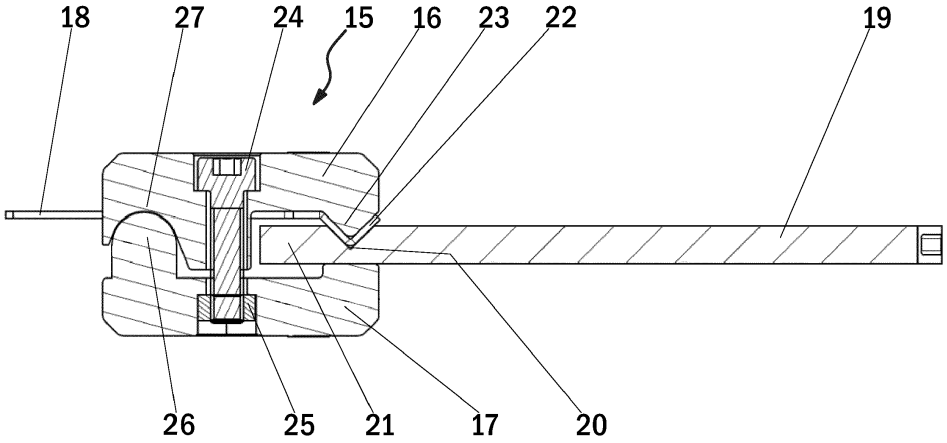

Fig. 6

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Description

FIELD OF THE INVENTION

[0001] The invention relates to a connector for a hoisting rope of a hoisting apparatus. Said hoisting rope is preferably a hoisting rope which has electrically conductive properties. Said hoisting apparatus is preferably an elevator for transporting passengers and/or goods.

BACKGROUND OF THE INVENTION

[0002] Hoisting ropes typically include one or several load bearing members that are elongated in the longitudinal direction of the rope, each load bearing member forming a structure that continues unbroken throughout the length of the rope. Load bearing members are the members of the rope which are able to bear together the load exerted on the rope in its longitudinal direction. The load, such as a weight suspended by the rope, causes tension on the load bearing member in the longitudinal direction of the rope, which tension can be transmitted by the load bearing member in question all the way from one end of the rope to the other end of the rope. Ropes may further comprise non-bearing components, such as an elastic coating, which cannot transmit tension in the above described way.

[0003] In prior art, such hoisting ropes exist where the load bearing members are embedded in non-conducting coating, such as polymer coating, forming the surface of the hoisting rope and extending between adjacent load bearing members thereby isolating them from each other both mechanically and electrically.

[0004] For facilitating awareness of condition of the ropes, and thereby for improving safety of the hoisting apparatus, monitoring of the condition of the load bearing members has been proposed. The visual inspection of the internal tensile elements is generally not possible and hence the need arises for non-visual inspection. The condition monitoring has been proposed to be arranged by monitoring electrical parameters of the load bearing members.

[0005] One known method for checking the condition of the tensile elements is the resistance-based inspection, which is based on a measure of the electrical resistance of the tensile elements. A change in the electrical resistance or a deviation from an expected value is interpreted as a damage of the tensile elements.

[0006] In the prior art there is not known any proper solutions for a connector for connecting a hoisting rope of a hoisting apparatus to a condition monitoring device. One prior art solution for a connector is to use several fixing screws for fixing a connecting element to the tensile elements and for providing an electrical connection between said tensile elements and a condition monitoring apparatus.

[0007] There are some drawbacks to this prior art connector solution. It has been found, that the thermal expansion affects the movement to the fixing screw connection and causes variation and uncertainness to the electrical connection. Consequently, the reliability of the connection is not satisfactory.

[0008] Another drawback of the prior art connector solution is that the on-site installation of the prior art electrical connection is troublesome and time-consuming. In the installation process of the prior art electrical connection there is also a risk of tightening the fixing screw connection too tight and causing uncorking.

BRIEF DESCRIPTION OF THE INVENTION

[0009] The object of the invention is to introduce a connector for a hoisting rope of a hoisting apparatus, which provides reliable electrical connection to a hoisting rope of a hoisting apparatus. Advantageous embodiments are furthermore presented, inter alia, wherein qualitative information about the damage magnitude is provided.

[0010] It is brought forward a new connector for a hoisting rope of a hoisting apparatus, which hoisting rope comprises a non-conductive coating, and a plurality of adjacent conductive load bearing members for bearing the load exerted on the hoisting rope in longitudinal direction thereof embedded in the coating and extending parallel to each other and to the longitudinal direction of the hoisting rope, the coating forming the surface of the hoisting rope and extending between adjacent load bearing members thereby isolating them from each other, in which connector comprises: a connector plate part, a top clamp part and a bottom clamp part for clamping said connector plate part to an end of said hoisting rope; wherein said hoisting rope has a notch opening ground to said end of said hoisting rope, so that said notch opening exposes said conductive load bearing members, wherein said connector plate part has a bended portion matching with said notch opening, and wherein one of said top clamp part and said bottom clamp part has a tooth part matching with said bended portion of said connector plate part and with said notch opening; so that upon clamping said top clamp part and said bottom clamp part together, said bended portion of said connector plate part presses onto said exposed conductive load bearing members in said ground a notch opening and forms an electrical connection between said load bearing members and said connector plate part. Hereby, one or more of the above mentioned advantages and/or objectives are achieved. These advantages and/or objectives are further facilitated with the additional preferred features and/or steps described in the following.

[0011] In a preferred embodiment of said method, said conductive load bearing members are made of non-metal material.

[0012] In a preferred embodiment of said method, said conductive load bearing members are made of composite material comprising electrically conducting reinforcing fibers in polymer matrix, said reinforcing fibers preferably being carbon fibers.

[0013] In a preferred embodiment, said hoisting rope is belt-shaped, i.e. larger in width direction than thickness direction.

[0014] In a preferred embodiment, said connector comprises a fixing bolt and a nut, said fixing bolt and said nut arranged to hold said top clamp part and said bottom clamp part together.

[0015] In a preferred embodiment, one of the said top clamp part and said bottom clamp part comprise a hexagonal pocket arranged for one of the said fixing bolt and said nut.

[0016] In a preferred embodiment, wherein one of said top clamp part and said bottom clamp part comprise a pivot shape and the another one of said the said top clamp part and said bottom clamp part comprise a chuck shape.

[0017] In a preferred embodiment, said top clamp part and said bottom clamp part comprise hinge joint counterparts.

[0018] In a preferred embodiment, said connector plate part is attached to said top clamp part.

[0019] In a preferred embodiment, said notch opening is a V-shape notch opening, a U-shape notch opening or a semicircular shape notch opening.

[0020] In a preferred embodiment, said bended portion of said connector plate part includes abrasive jaws.

[0021] In a preferred embodiment, said connector plate part is cut to form two separate blade connectors of said connector.

[0022] In a preferred embodiment, said connector is connected to a condition monitoring device.

[0023] It is also brought forward a new use of a connector in an arrangement for condition monitoring of a hoisting rope of a hoisting apparatus, which hoisting rope comprises a non-conductive coating, and a plurality of adjacent conductive load bearing members for bearing the load exerted on the hoisting rope in longitudinal direction thereof embedded in the coating and extending parallel to each other and to the longitudinal direction of the hoisting rope, the coating forming the surface of the hoisting rope and extending between adjacent load bearing members thereby isolating them from each other, in which connector comprises: a connector plate part, a top clamp part and a bottom clamp part for clamping said connector plate part to an end of said hoisting rope; wherein said hoisting rope has a notch opening ground to said end of said hoisting rope, so that said notch opening exposes said conductive load bearing members, wherein said connector plate part has a bended portion matching with said notch opening, and wherein one of said top clamp part and said bottom clamp part has a tooth part matching with said bended portion of said connector plate part and with said notch opening; so that upon clamping said top clamp part and said bottom clamp part together, said bended portion of said connector plate part presses onto said exposed conductive load bearing members in said ground a notch opening and forms an electrical connection between said load bearing members and said connector plate part.

BRIEF DESCRIPTION OF THE DRAWINGS

[0024] In the following, the present invention will be described in more detail by way of example and with reference to the attached drawings, in which:

Figure 1 illustrates an arrangement for condition monitoring of a hoisting rope of a hoisting apparatus according to one embodiment of the present invention.

Figure 2 illustrates a preferred inner structure of the load bearing member according to the present invention.

Figure 3 illustrates a three dimensional view of a section of the load bearing member according to the present invention.

Figure 4 illustrates an arrangement for condition monitoring of a hoisting rope of a hoisting apparatus according to another embodiment of the present invention having a defect in the hoisting rope.

Figure 5 illustrates a side view of a connector for a hoisting rope of a hoisting apparatus according to one embodiment of the present invention.

Figure 6 illustrates a cross-sectional view of a connector for a hoisting rope of a hoisting apparatus according to one embodiment of the present invention.

Figure 7 illustrates a perspective view of a connector for a hoisting rope of a hoisting apparatus according to one embodiment of the present invention.

[0025] The foregoing aspects, features and advantages of the invention will be apparent from the drawings and the detailed description related thereto.

DETAILED DESCRIPTION

[0026] Figure 1 illustrates an arrangement for condition monitoring of a hoisting rope of a hoisting apparatus according to one embodiment of the present invention. The hoisting rope 1 is belt-shaped, i.e. larger in width direction than thickness direction and has a first end 7 and other end 8. The hoisting rope 1 comprises a non-conductive coating 2, and a plurality of conductive load bearing members 3-6 for bearing the load exerted on the hoisting rope 1 in longitudinal direction thereof, which are adjacent in width direction of the hoisting rope 1. The load bearing members 3-6 are embedded in the non-conductive coating 2 and extend parallel to each other as well as to the longitudinal direction of the hoisting rope 1 unbroken throughout the length of the hoisting rope 1. The coating 2 forms the surface of the hoisting rope 1 and extends between adjacent load bearing members 3-6, thereby isolating them from each other both mechanically and electrically. The said conductive load bearing members 3-6 may be made of non-metal material. The said conductive load bearing members 3-6 may be made of composite material comprising electrically conducting rein-

forcing fibers in polymer matrix, said reinforcing fibers preferably being carbon fibers.

[0027] In a preferred embodiment, the hoisting rope according to the present invention comprises protrusions and/or grooves for guiding the rope. Furthermore, in a preferred embodiment, the hoisting rope is provided with a cogged surface in order to produce a positive contact with a drive sheave. Furthermore, in a preferred embodiment, the hoisting rope is symmetrical in its thickness direction.

[0028] The arrangement for condition monitoring of a hoisting rope of a hoisting apparatus according to the present invention comprises an at least one condition monitoring device 9 for monitoring the condition of the hoisting rope 1. The arrangement for condition monitoring of a hoisting rope of a hoisting apparatus according to the present invention also comprises an at least one connection interface 10-13. The arrangement for condition monitoring of a hoisting rope of a hoisting apparatus according to the embodiment of the present invention presented in Figure 1 comprises a condition monitoring device 9 of said at least one condition monitoring device 9 and a first connection interface 10, a second connection interface 11, a third connection interface 12 and a fourth connection interface 13 of said at least one connection interface 10-13.

[0029] In the arrangement for condition monitoring of a hoisting rope of a hoisting apparatus according to the presented embodiment two individual conductive load bearing members 3, 4 are coupled together in the first connection interface 10 at the first end 7 of the hoisting rope 1. Similarly, two individual conductive load bearing members 5, 6 are coupled together in the second connection interface 10 at the first end 7 of the hoisting rope 1. Likewise, at the second end 8 of the hoisting rope 1, two individual conductive load bearing members 3, 4 are coupled together in the third connection interface 12 and two individual conductive load bearing members 5, 6 are coupled together in the fourth connection interface 13. At the first end 7 of the hoisting rope 1, the first connection interface 10 and the second connection interface 11 are coupled to the condition monitoring device 9.

[0030] In Figure 1 the further coupling of the third connection interface 12 and the fourth connection interface 13 at the second end 8 of the hoisting rope 1 are not shown. Said third connection interface 12 and said fourth connection interface 13 at the second end 8 of the hoisting rope 1 may be coupled to the same condition monitoring device 9 as said first connection interface 10 and said second connection interface 11 at the first end 7 of the hoisting rope 1. Alternatively, said third connection interface 12 and said fourth connection interface 13 at the second end 8 of the hoisting rope 1 may be coupled to another condition monitoring device or to another device, e.g. to a signal generator or an analyzer device. Further alternatively, said third connection interface 12 and said fourth connection interface 13 at the second end 8 of the hoisting rope 1 may simply be terminated or left uncoupled.

[0031] In the arrangement for condition monitoring of a hoisting rope of a hoisting apparatus according to the embodiment of the present invention an electrical pulse or an electromagnetic signal is inserted into said conductive load bearing members 3-6 to propagate from the first end 7 to the second end 8 of the hoisting rope 1 or from the second end 8 to the first end 7 of the hoisting rope 1. Thereafter, in the arrangement for condition monitoring of a hoisting rope of a hoisting apparatus according to the embodiment of the present invention the condition monitoring device 9 receives an electrical pulse or an electromagnetic signal propagating in said conductive load bearing members 3-6 through said first connection interface 10 and said second connection interface 11. By analyzing and monitoring said received electrical pulse or said received electromagnetic signal said condition monitoring device 9 may determine the condition of the hoisting rope 1.

[0032] Figure 2 illustrates a preferred inner structure of the load bearing member according to the present invention. In Figure 2 the width direction w and the thickness direction t of a load bearing member 3 is shown. In Figure 2 the cross section of the load bearing member 3 as viewed in the longitudinal direction l of the load bearing member 3 is shown in particular. The rope could alternatively have some other number of load bearing members 3, either more or less than what is disclosed in the Figures.

[0033] The load bearing members 3-6 are made of composite material comprising reinforcing fibers F embedded in polymer matrix m. The reinforcing fibers F are more specifically distributed in polymer matrix m and bound together by the polymer matrix, particularly such that an elongated rod-like piece is formed. Thus, each load bearing member 3-6 is one solid elongated rod-like piece. The reinforcing fibers F are distributed preferably substantially evenly in the polymer matrix m. Thereby a load bearing member with homogeneous properties and structure is achieved throughout its cross section. In this way, it can be also ensured that each of the fibers can be in contact and bonded with the matrix m. Said reinforcing fibers F are most preferably carbon fibers as they are electrically conducting and have excellent properties in terms of load bearing capacity, weight and tensile stiffness, which makes them particularly well suitable for use in elevator hoisting ropes. Alternatively, said reinforcing fibers F can be of any other fiber material which is electrically conducting. The matrix m comprises preferably of epoxy, but alternative materials could be used depending on the preferred properties. Preferably, substantially all the reinforcing fibers F of each load bearing member 3-6 are parallel with the longitudinal direction of the load bearing member 3-6. Thereby the fibers are also parallel with the longitudinal direction of the hoisting rope 1 as each load bearing member is oriented parallel with the longitudinal direction of the hoisting rope 1. Thereby, the fibers in the final hoisting rope 1 will be aligned with the

force when the hoisting rope 1 is pulled, which ensures that the structure provides high tensile stiffness. This is also advantageous for achieving unproblematic behavior of the internal structure, particularly internal movement, when the hoisting rope 1 is bent.

[0034] The fibers F used in the preferred embodiments are substantially untwisted in relation to each other, which provides them said orientation parallel with the longitudinal direction of the hoisting rope 1. This is in contrast to the conventionally twisted elevator ropes, where the wires or fibers are strongly twisted and have normally a twisting angle from 15 up to 30 degrees, the fiber/wire bundles of these conventionally twisted elevator ropes thereby having the potential for transforming towards a straighter configuration under tension, which provides these ropes a high elongation under tension as well as leads to an unintegral structure.

[0035] The reinforcing fibers F are preferably long continuous fibers in the longitudinal direction of the load bearing member, the fibers F preferably continuing for the whole length of the load bearing member 3-6 as well as the hoisting rope 1. Thus, the load bearing ability, good conductivity as well as manufacturing of the load bearing member 3-6 are facilitated. The fibers F being oriented parallel with longitudinal direction of the hoisting rope 1, as far as possible, the cross section of the load bearing member 3-6 can be made to continue substantially the same in terms of its cross-section for the whole length of the hoisting rope 1. Thus, no substantial relative movement can occur inside the load bearing member 3-6 when it is bent.

[0036] As mentioned, the reinforcing fibers F are preferably distributed in the aforementioned load bearing member 3-6 substantially evenly, in particular as evenly as possible, so that the load bearing member 3-6 would be as homogeneous as possible in the transverse direction thereof. An advantage of the structure presented is that the matrix m surrounding the reinforcing fibers F keeps the interpositioning of the reinforcing fibers F substantially unchanged. It equalizes with its slight elasticity the distribution of a force exerted on the fibers, reduces fiber-fiber contacts and internal wear of the hoisting rope, thus improving the service life of the hoisting rope 1. The composite matrix m, into which the individual fibers F are distributed as evenly as possible, is most preferably made of epoxy, which has good adhesion to the reinforcement fibers F and which is known to behave advantageously with carbon fiber. Alternatively, e.g. polyester or vinyl ester can be used, but alternatively any other suitable alternative materials can be used. Figure 2 presents inside the circle a partial cross-section of the load bearing member 3-6 close to the surface thereof as viewed in the longitudinal direction of the hoisting rope 1. The reinforcing fibers F of the load bearing member 3-6 are preferably organized in the polymer matrix m according to this cross-section. The rest (parts not showed) of the load bearing member 3-6 have a similar structure.

[0037] Figure 3 illustrates a three dimensional view of a section of the load bearing member according to the present invention. From the presented Figure 2 and Figure 3 it can also be seen how the individual reinforcing fibers F of a load bearing member 3 are substantially evenly distributed in the polymer matrix m, which surrounds the reinforcing fibers F. The polymer matrix m fills the areas between individual reinforcing fibers F and binds substantially all the reinforcing fibers F that are inside the matrix m to each other as a uniform solid substance. A chemical bond exists between, the individual reinforcing fibers F (preferably each of them) and the matrix m, one advantage of which is uniformity of the structure. To improve the chemical adhesion of the reinforcing fiber to the matrix m, in particular to strengthen the chemical bond between the reinforcing fiber F and the matrix m, each fiber can have a thin coating, e.g. a primer (not presented) on the actual fiber structure between the reinforcing fiber structure and the polymer matrix m. However, this kind of thin coating is not necessary. The properties of the polymer matrix m can also be optimized as it is common in polymer technology. For example, the matrix m can comprise a base polymer material (e.g. epoxy) as well as additives, which fine-tune the properties of the base polymer such that the properties of the matrix are optimized. The polymer matrix m is preferably of a hard non-elastomer as in this case a risk of buckling can be reduced for instance. However, the polymer matrix need not be non-elastomer necessarily, e.g. if the downsides of this kind of material are deemed acceptable or irrelevant for the intended use. In that case, the polymer matrix m can be made of elastomer material such as polyurethane or rubber for instance. The reinforcing fibers F being in the polymer matrix means here that the individual reinforcing fibers F are bound to each other with a polymer matrix m, e.g. in the manufacturing phase by immersing them together in the fluid material of the polymer matrix which is thereafter solidified. In this case the gaps of individual reinforcing fibers bound to each other with the polymer matrix comprise the polymer of the matrix. In this way a great number of reinforcing fibers bound to each other in the longitudinal direction of the hoisting rope are distributed in the polymer matrix. As mentioned, the reinforcing fibers are preferably distributed substantially evenly in the polymer matrix m, whereby the load bearing member is as homogeneous as possible when viewed in the direction of the cross-section of the hoisting rope. In other words, the fiber density in the cross-section of the load bearing member 3-6 does not therefore vary substantially. The individual reinforcing fibers of the load bearing member 3-6 are mainly surrounded with polymer matrix m, but random fiber-fiber contacts can occur because controlling the position of the fibers in relation to each other in their simultaneous impregnation with polymer is difficult, and on the other hand, perfect elimination of random fiber-fiber contacts is not necessary from the viewpoint of the functioning of the solution. If, however, it is desired to reduce their random occurrence, the individual reinforcing fibers F can

be pre-coated with material of the matrix m such that a coating of polymer material of said matrix is around each of them already before they are brought and bound together with the matrix material, e.g. before they are immersed in the fluid matrix material.

[0038] As above mentioned, the matrix m of the load bearing member 3-6 is most preferably hard in its material properties. A hard matrix m helps to support the reinforcing fibers F, especially when the hoisting rope bends, preventing buckling of the reinforcing fibers F of the bent rope, because the hard material supports the fibers F efficiently. To reduce the buckling and to facilitate a small bending radius of the load bearing member 3-6, among other things, it is therefore preferred that the polymer matrix m is hard, and in particular non-elastomeric. The most preferred materials for the matrix are epoxy resin, polyester, phenolic plastic or vinyl ester. The polymer matrix m is preferably so hard that its module of elasticity E is over 2 GPa, most preferably over 2.5 GPa. In this case the module of elasticity E is preferably in the range 2.5-10 GPa, most preferably in the range 2.5-3.5 GPa. There are commercially available various material alternatives for the matrix m which can provide these material properties.

[0039] Preferably over 50% of the surface area of the cross-section of the load bearing member 3-6 is of the aforementioned electrically conducting reinforcing fiber. Thereby, good conductivity can be ensured. Fibers F will be in contact with each other randomly along their length whereby electromagnetic wave signal inserted into the load bearing member will propagate within substantially the whole cross section of the load bearing member. To be more precise preferably 50%-80% of the surface area of the cross-section of the load bearing member 3-6 is of the aforementioned reinforcing fiber, most preferably such that 55%-70% is of the aforementioned reinforcing fiber, and substantially all the remaining surface area is of polymer matrix. In this way conductivity and longitudinal stiffness of the load bearing member 3-6 are facilitated yet there is enough matrix material to bind the fibers F effectively to each other. Most preferably, this is carried out such that approx. 60% of the surface area is of reinforcing fiber and approx. 40% is of matrix material.

[0040] Figure 4 illustrates an arrangement for condition monitoring of a hoisting rope of a hoisting apparatus according to another embodiment of the present invention having a defect in the hoisting rope. The arrangement for condition monitoring of a hoisting rope of a hoisting apparatus presented in Figure 4 is similar to that of presented in Figure 1 with the exception of that there is a defect 14 in the first parallel conductor transmission line 14 of the defected hoisting rope 1 of Figure 4. The defected hoisting rope 1 is partially broken from a defect 14 in the middle part of the defected hoisting rope 1.

[0041] In the arrangement for condition monitoring of a hoisting rope of a hoisting apparatus according to the presented another embodiment of the present invention having defect 14 in the hoisting rope an electrical pulse or an electromagnetic signal is inserted into said conductive load bearing members 3-6 to propagate from the first end 7 to the second end 8 of the hoisting rope 1 or from the second end 8 to the first end 7 of the hoisting rope 1. Thereafter, in the arrangement for condition monitoring of a hoisting rope of a hoisting apparatus according to the presented another embodiment of the present invention having defect 14 in the hoisting rope the condition monitoring device 9 receives an electrical pulse or an electromagnetic signal propagating in said conductive load bearing members 3-6 through said first connection interface 10 and said second connection interface 11. By analyzing and monitoring said received electrical pulse or said received electromagnetic signal said condition monitoring device 9 may substantiate the defect 14 and type of the damage and determine the condition of the hoisting rope 1.

[0042] Figure 5 illustrates a side view of a connector for a hoisting rope of a hoisting apparatus according to one embodiment of the present invention. The connector 15 for a hoisting rope of a hoisting apparatus according to the presented embodiment comprises a top clamp part 16, a bottom clamp part 17 and a connector plate part 18. A hoisting rope 19 of a hoisting apparatus according to the presented embodiment has a notch opening 20 ground to the end part 21 of the hoisting rope 19. Said connector plate part 18 of said connector 15 for a hoisting rope has a bended portion 22 matching with said notch opening 20 in the end part 21 of said hoisting rope 19. Furthermore, said top clamp part 16 of said connector 15 for a hoisting rope has a tooth part 23 matching with said bended portion 22 of said connector plate part 18 and with said notch opening 20 in the end part 21 of said hoisting rope 19.

[0043] Figure 6 illustrates a cross-sectional view of a connector for a hoisting rope of a hoisting apparatus according to one embodiment of the present invention. The connector 15 for a hoisting rope of a hoisting apparatus according to the presented embodiment comprises a top clamp part 16, a bottom clamp part 17 and a connector plate part 18. Said connector plate part 18 may be directly attached to said top clamp part 16. A hoisting rope 19 of a hoisting apparatus according to the presented embodiment has a notch opening 20 ground to the end part 21 of the hoisting rope 19 so that said notch opening (20) exposes the conductive load bearing members of the hoisting rope. Said connector plate part 18 of said connector 15 for a hoisting rope has a bended portion 22 matching with said notch opening 20 in the end part 21 of said hoisting rope 19. Furthermore, said top clamp part 16 of said connector 15 for a hoisting rope has a tooth part 23 matching with said bended portion 22 of said connector plate part 18 and with said notch opening 20 in the end part 21 of said hoisting rope 19.

[0044] The connector 15 for a hoisting rope of a hoisting apparatus according to the presented embodiment also comprises a fixing bolt 24 and a nut 25, said fixing bolt 24 and said nut 25 arranged to hold said top clamp

part 16 and said bottom clamp part 17 of the connector 15 for a hoisting rope together. One of the said fixing bolt 24 and said nut 25 may be arranged to lie in a hexagonal pocket arranged in one of the said top clamp part 16 and said bottom clamp part 17.

[0045] The connector 15 for a hoisting rope of a hoisting apparatus according to the presented embodiment has a pivot shape 26 arranged in one of the said top clamp part 16 and said bottom clamp part 17 of said connector 15 and respectively a chuck shape 27 arranged in another one of the said top clamp part 16 and said bottom clamp part 17 and matching said pivot shape. In Figure 6 the pivot shape 26 of the bottom clamp part 17 and the matching chuck shape 27 of the top clamp part 16 allow the said top clamp part 16 and said bottom clamp part 17 to pivot as the said fixing bolt 24 and said nut 25 of said connector 15 are tightened. As the end part 21 of said hoisting rope 19 is placed between said top clamp part 16 and said bottom clamp part 17 and said fixing bolt 24 and said nut 25 of said connector 15 are tightened said tooth part 23 of said top clamp part 16 presses said bended portion 22 of said connector plate part 18 onto said notch opening 20 ground to the end part 21 of the hoisting rope 19. Alternatively, said top clamp part 16 and said bottom clamp part 17 of said connector 15 may comprise hinge joint counterparts.

[0046] In the installation of the connector for a hoisting rope of a hoisting apparatus according the present invention there is first a notch opening 20 ground to the end part 21 of the hoisting rope 19. The ground notch opening 20 may have a V-shape, a U-shape or a semicircular shape for self-locking said top clamp part 16 at direction of the said hoisting rope 19. A V-shape, a U-shape or a semicircular shape of said ground notch opening 20 also open a wide area of the ground surfaces of said reinforcing fibers F heads. The ground notch opening 20 may have another shape than V-shape, a U-shape or a semicircular shape. Also the said bended portion 22 of said connector plate part 18 may include abrasive jaws to increase the attachment surface said reinforcing fibers F of the load bearing members 3-6 of the hoisting rope 19.

[0047] After grinding of said notch opening 20 the next step in the installation of the connector for a hoisting rope of a hoisting apparatus according the present invention is to slide the end part 21 of the hoisting rope 19 between the top clamp part 16 and the bottom clamp part 17, said top clamp part 16 having said connector plate part 18 attached to it. Said end part 21 of the hoisting rope is slid so that said notch opening 20 in the end part 21 of said hoisting rope 19 is in position with said tooth part 23 of said top clamp part 16 and with said bended portion 22 of said connector plate part 18. After the sliding of said hoisting rope 19 said fixing bolt 24 and said nut 25 of said connector 15 are tightened and said tooth part 23 of said top clamp part 16 presses said bended portion 22 of said connector plate part 18 onto said notch opening 20 ground to the end part 21 of the hoisting rope 19. Tightening fixing bolt 24 and said nut 25 causes said tooth part 23 to press said bended portion 22 of said connector plate part 18 onto the ground surfaces of said reinforcing fibers F heads of the load bearing members 3-6 thereby forming an electrical connection between the load bearing members 3-6 and said connector plate part 18. Thereafter, a possible small piece of sheet metal of said connector plate part 18 may be cut away for forming separate blade connectors of said connector 15.

[0048] Figure 7 illustrates a perspective view of a connector for a hoisting rope of a hoisting apparatus according to one embodiment of the present invention. The connector 15 for a hoisting rope of a hoisting apparatus according to the presented embodiment comprises a top clamp part 16, a bottom clamp part 17 and a connector plate part 18. A hoisting rope 19 is placed between said top clamp part 16 and said bottom clamp part 17 so that a notch opening 20 in the end part of said hoisting rope 19 is in position with a tooth part of said top clamp part 16 and with a bended portion of said connector plate part 18. A fixing bolt 24 and a respective nut 25 are for tightening and consequently clamping said top clamp part 16 and said bottom clamp part 17 of said connector 15 onto said hoisting rope 19. Said tightening and clamping cause said tooth part 23 to press said bended portion 22 of said connector plate part 18 onto the ground surfaces of said reinforcing fibers F heads of the load bearing members 3-6 thereby forming an electrical connection between the load bearing members 3-6 and said connector plate part 18. Figure 7 also illustrates a small piece 28 of sheet metal of said connector plate part 18 may be cut away to form two separate blade connectors 29, 30 of said connector 15.

[0049] The connector 15 for a hoisting rope can now connected to a condition monitoring device 9. The connector 15 for a hoisting rope may forward information for quantifying the severity of the defect 14 such as e.g. fiber damage to said condition monitoring device 9. In this kind of system, the connector 15 for a hoisting rope could be assumed as one obstacle for the user.

[0050] In the illustrated embodiments, the load bearing members 3-6 are substantially rectangular. However, this is not necessary as alternative shapes could be used. Said composite members 3-6 can be manufactured for example in any known way, such as in the manner presented in WO2009090299A1.

[0051] In the illustrated embodiments, the rope 1 comprises four load bearing members 3-6. Of course, alternative configurations are possible, where the arrangement is implemented with a rope provided with some other number of load bearing members 3-6.

[0052] When referring to conductivity, in this application it is meant electrical conductivity.

[0053] With the help of the connector for a hoisting rope according to the present invention a connection of good quality between load bearing members 3-6 of the hoisting rope and the condition monitoring device 9 can be secured. With the help of the good quality connection the condition monitoring device 9 can monitor the condition

of the hoisting rope and notice if there is an indication of damage or an indication that the rope is going to brake.

[0054] With the help of the connector solution according to the present invention the on-site installation of the electrical connection is easier and faster than with the prior art solutions. Furthermore, the connector solution according to the present invention is reliable and withstands temperature changes considerably better than the prior art solutions.

[0055] It is to be understood that the above description and the accompanying Figures are only intended to teach the best way known to the inventors to make and use the invention. It will be apparent to a person skilled in the art that the inventive concept can be implemented in various ways. The above-described embodiments of the invention may thus be modified or varied, without departing from the invention, as appreciated by those skilled in the art in light of the above teachings. It is therefore to be understood that the invention and its embodiments are not limited to the examples described above but may vary within the scope of the claims and their equivalents.

Claims

1. A connector (15) for a hoisting rope (1), (19) of a hoisting apparatus, which hoisting rope (1), (19) comprises a non-conductive coating (2), and a plurality of adjacent conductive load bearing members (3-6) for bearing the load exerted on the hoisting rope (1), (22) in longitudinal direction thereof embedded in the coating (2) and extending parallel to each other and to the longitudinal direction of the hoisting rope (1), (22), the coating (2) forming the surface of the hoisting rope (1), (22) and extending between adjacent load bearing members (3-6) thereby isolating them from each other, which connector (15) comprises:

- a connector plate part (18),
- a top clamp part (16) and a bottom clamp part (17) for clamping said connector plate part (18) to an end (7), (8), (21) of said hoisting rope (1), (19);
- wherein said hoisting rope (1), (19) has a notch opening (20) ground to said end (7), (8), (21) of said hoisting rope (1), (19), so that said notch opening (20) exposes said conductive load bearing members (3-6),
- wherein said connector plate part (18) has a bended portion (22) matching with said notch opening (20), and
- wherein one of said top clamp part (16) and said bottom clamp part (17) has a tooth part (23) matching with said bended portion (22) of said connector plate part (18) and with said notch opening (20); so that:
- upon clamping said top clamp part (16) and said bottom clamp part (17) together, said bended portion (22) of said connector plate part (18) presses onto said exposed conductive load bearing members (3-6) in said ground a notch opening (20) and forms an electrical connection between said load bearing members (3-6) and said connector plate part (18).

2. A connector (15) according to claim 1, wherein said conductive load bearing members (3-6) are made of non-metal material.

3. A connector (15) according to claim 1, wherein said conductive load bearing members (3-6) are made of composite material comprising electrically conducting reinforcing fibers (F) in polymer matrix (m), said reinforcing fibers (F) preferably being carbon fibers.

4. A connector (15) according to any of the preceding claims 1-3, wherein said hoisting rope (1), (19) is belt-shaped, i.e. larger in width direction than thickness direction.

5. A connector (15) according to any of the preceding claims 1-4, wherein said connector (15) comprises a fixing bolt (24) and a nut (25), said fixing bolt (24) and said nut (25) arranged to hold said top clamp part (16) and said bottom clamp part (17) together.

6. A connector (15) according to claim 5, wherein one of the said top clamp part (16) and said bottom clamp part (17) comprise a hexagonal pocket arranged for one of the said fixing bolt (24) and said nut (25).

7. A connector (15) according to any of the preceding claims 1-6, wherein one of said top clamp part (16) and said bottom clamp part (17) comprise a pivot shape (26) and the another one of said the said top clamp part (16) and said bottom clamp part (17) comprise a chuck shape (27).

8. A connector (15) according to any of the preceding claims 1-6, wherein said top clamp part (16) and said bottom clamp part (17) comprise hinge joint counterparts.

9. A connector (15) according to any of the preceding claims 1-8, wherein said connector plate part (18) is attached to said top clamp part (16).

10. A connector (15) according to any of the preceding claims 1-9, wherein said notch opening (20) is a V-shape notch opening (20), a U-shape notch opening (20) or a semicircular shape notch opening (20).

11. A connector (15) according to any of the preceding claims 1-10, wherein said bended portion (22) of said connector plate part (18) includes abrasive jaws.

12. A connector (15) according to any of the preceding claims 1-11, wherein said connector plate part (18) is cut to form two separate blade connectors (29), (30) of said connector (15).

13. A connector (15) according to any of the preceding claims 1-12, wherein said connector (15) is connected to a condition monitoring device (9).

14. A connector (15) according to any of the preceding claims 1-13, wherein said connector (15) forwards information for quantifying the severity of the defect (14) such as e.g. fiber damage to a condition monitoring device (9).

15. Use of a connector (15) according to any of the preceding claims 1-14 in an arrangement for condition monitoring of a hoisting rope (1), (19) of a hoisting apparatus.

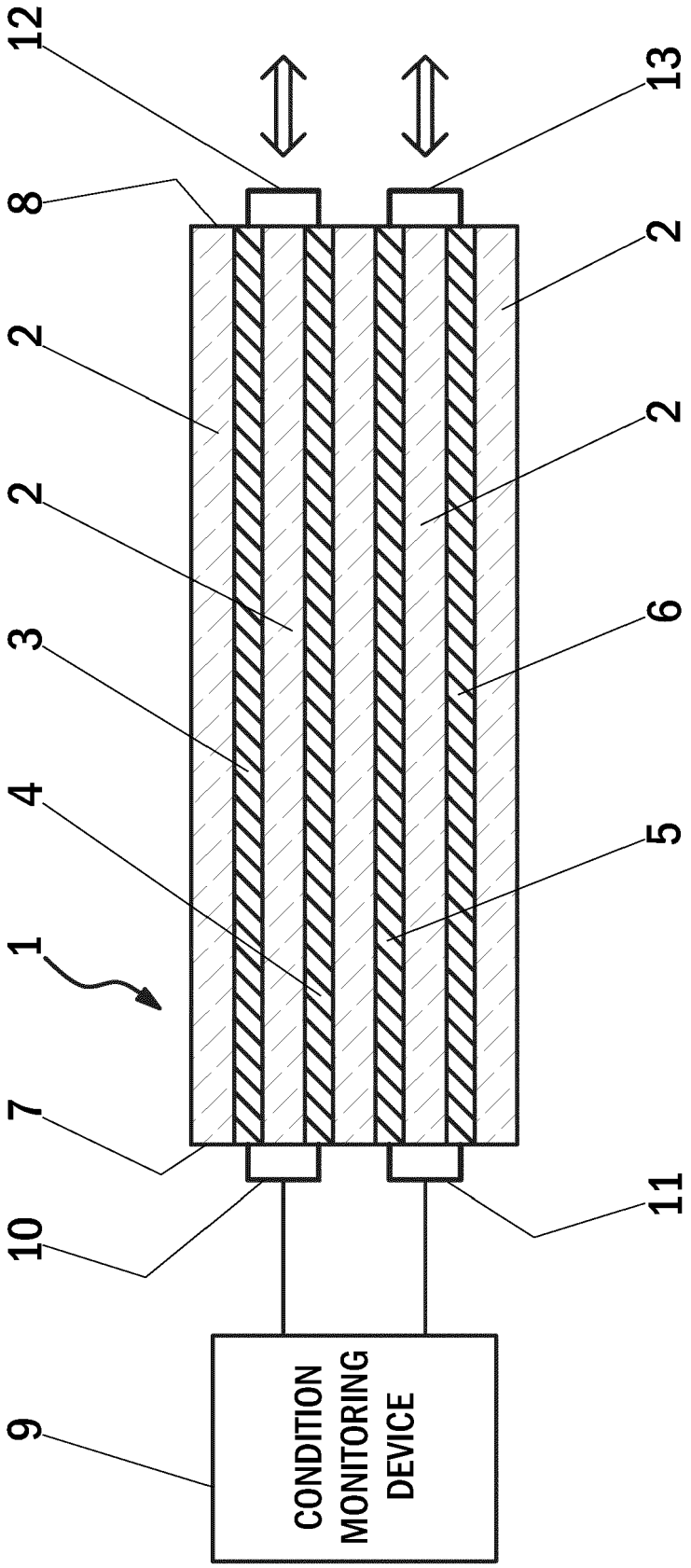

Fig. 1

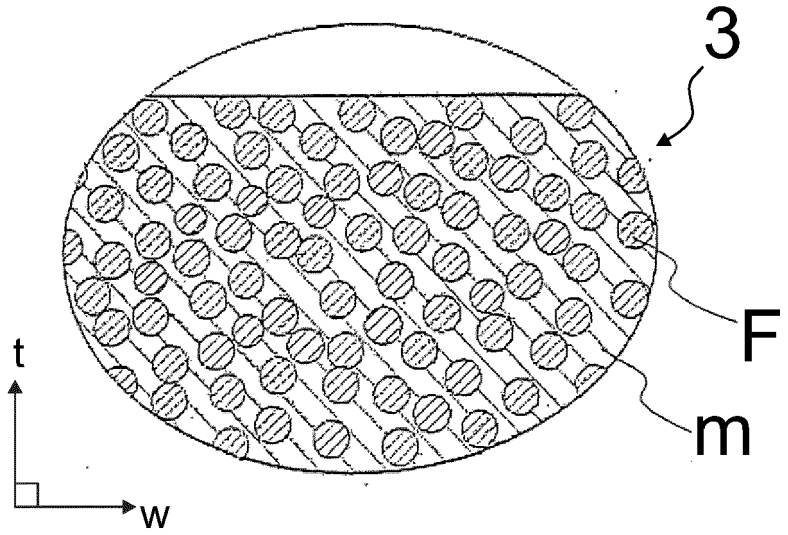

Fig. 2

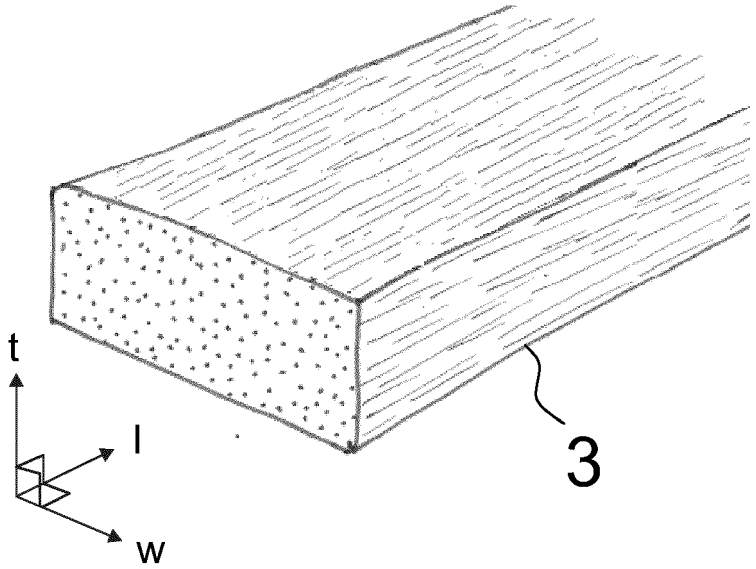

Fig. 3

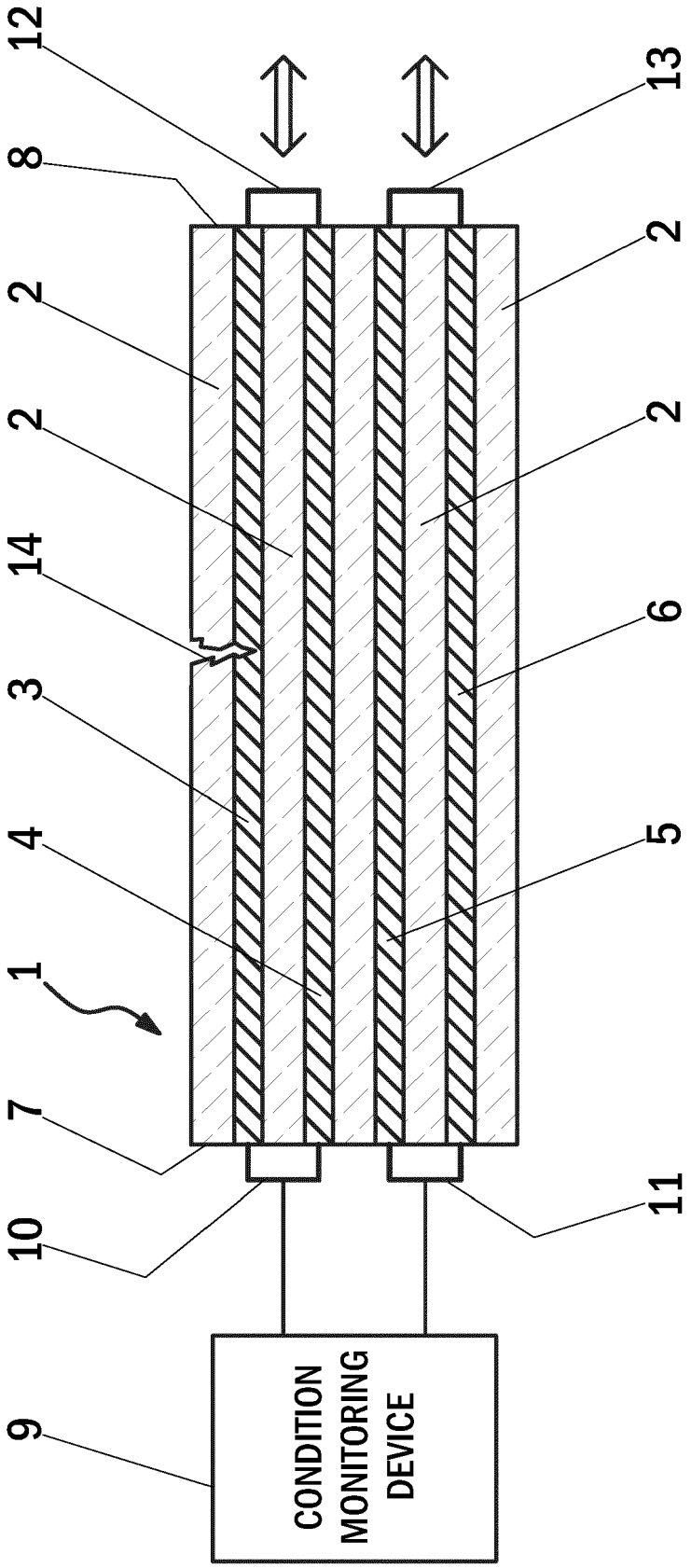

Fig. 4

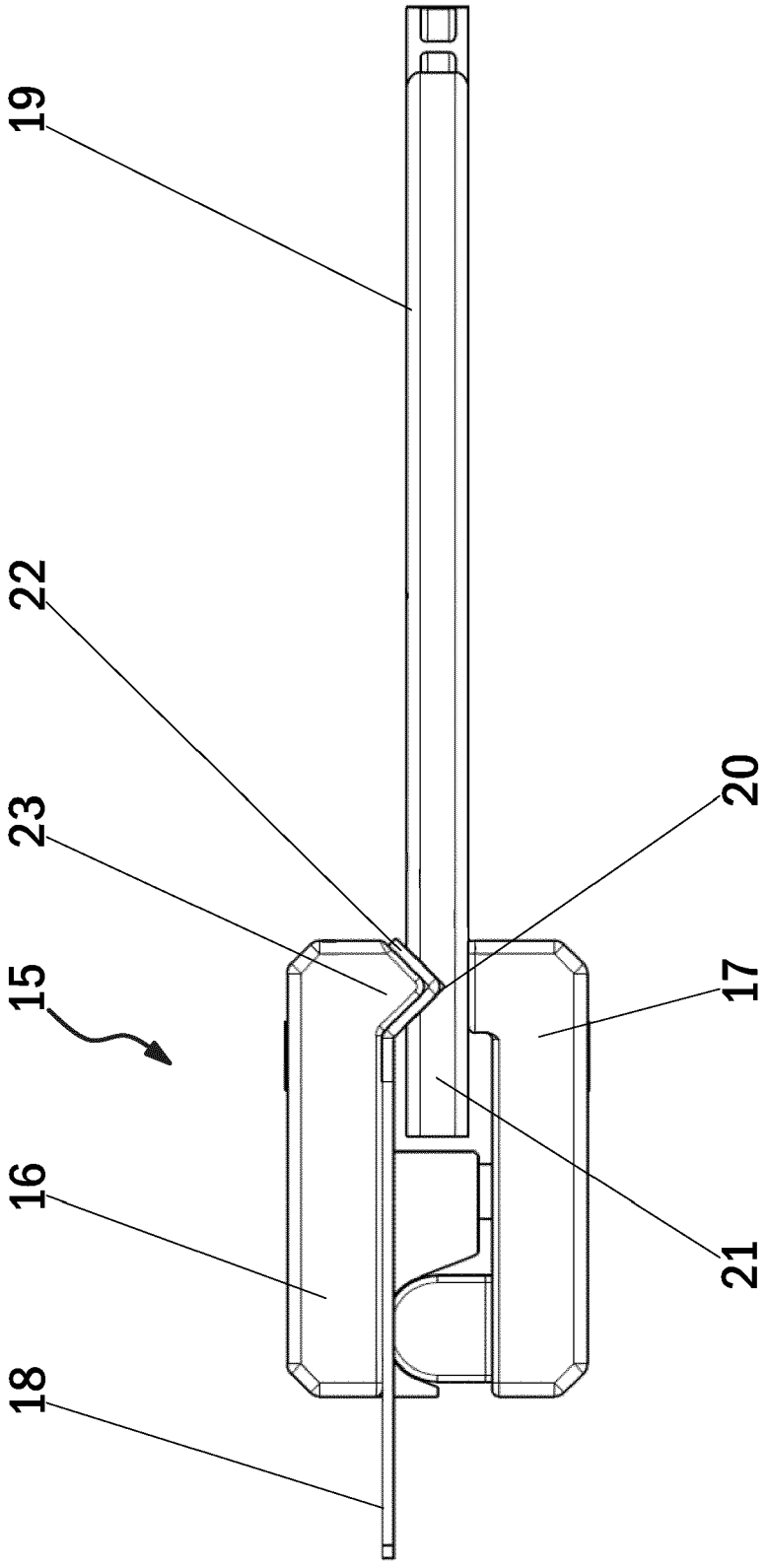

Fig. 5

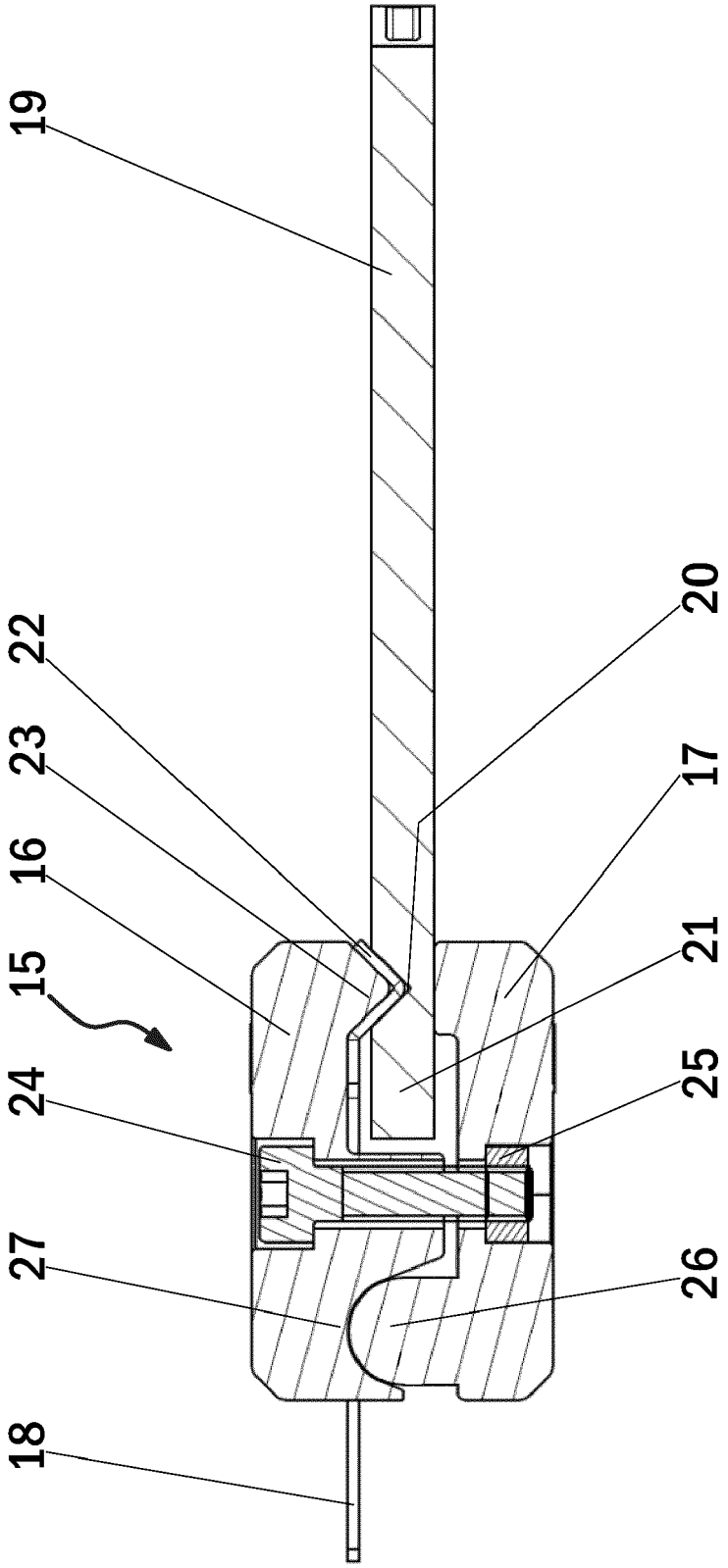

Fig. 6

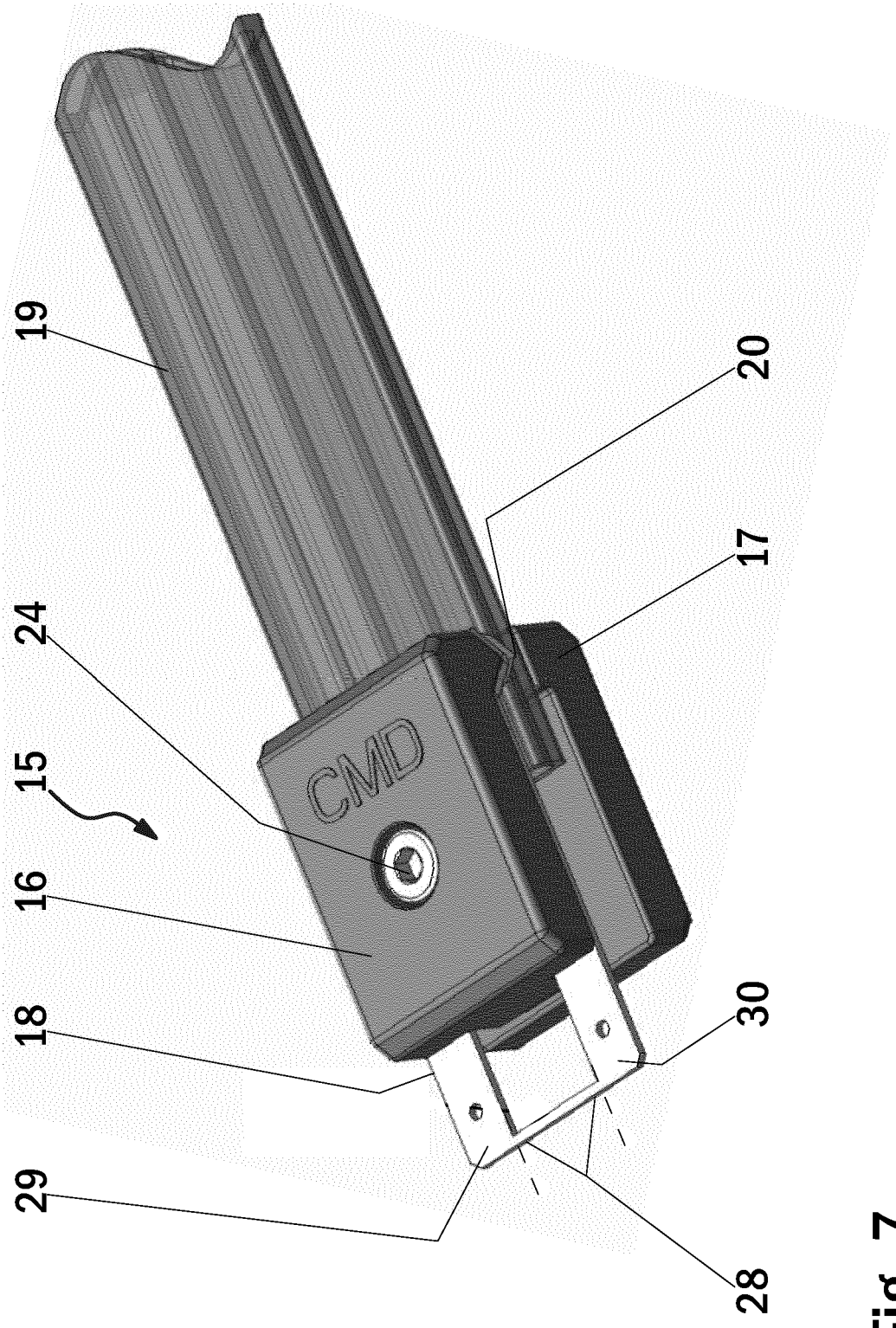

Fig. 7

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EUROPEAN SEARCH REPORT

Application Number
EP 16 20 6745

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	12 June 2017	Janssens, Gerd

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