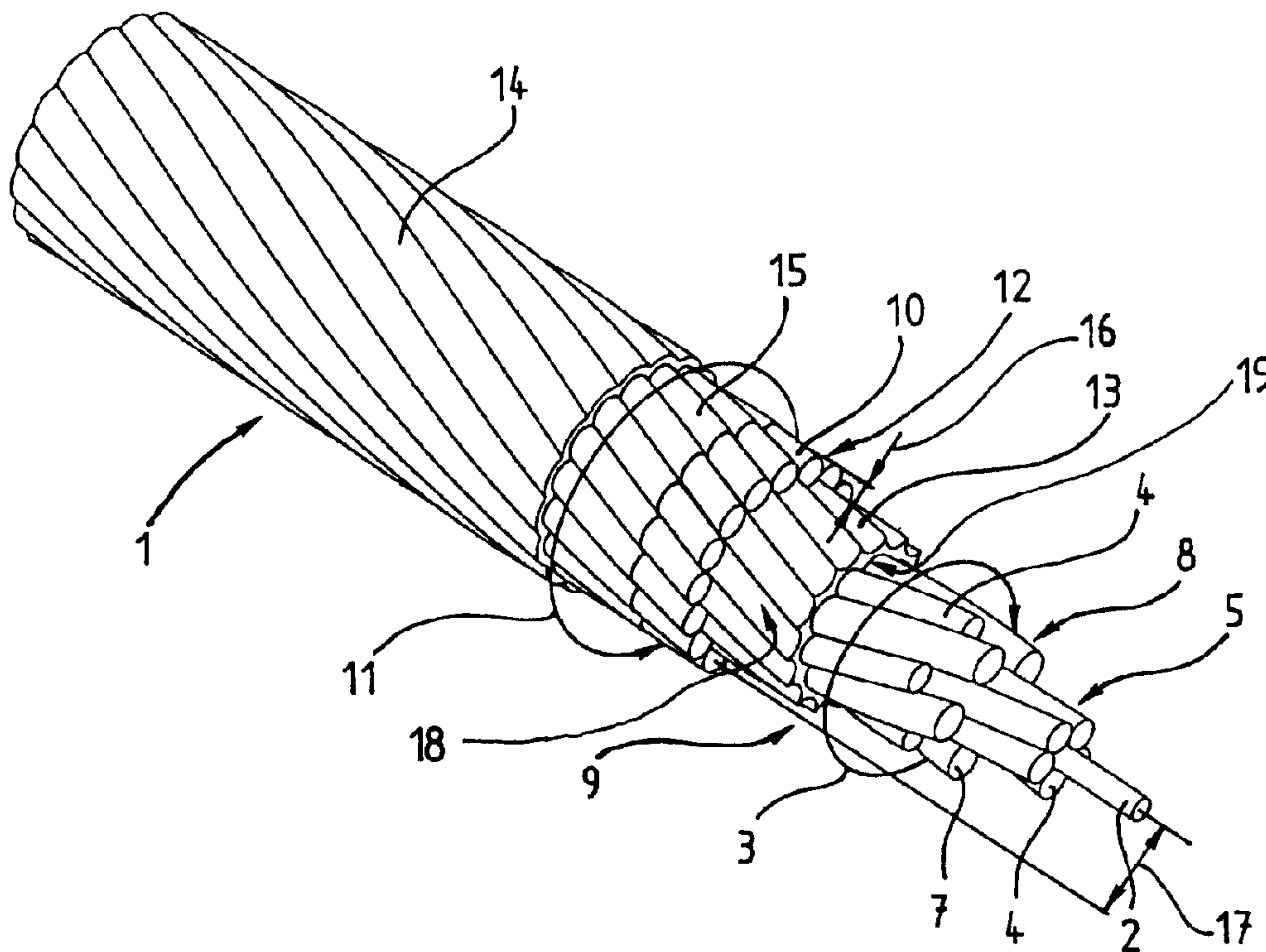




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(54) Title: SYNTHETIC FIBER ROPE



(57) Abrégé/Abstract:

With reference to a synthetic fiber rope consisting of load-bearing aramide fiber strands (9, 10, 11) laid together in parallel in concentric layers of strands (14, 16) it is proposed to have an intersheath (13) with sheath surfaces adapted to the external contours of the adjacent layers of strands. According to the invention, by positively bonding the inner and outer layers of strands a higher torsional rigidity is achieved as well as a rope structure of the stranded rope which is less susceptible to twisting. Furthermore, the elastic intersheath (13) between the layers of strands (16, 21) serves to protect the strands (10, 11, 12) against abrasion and assists in transmitting torque within the rope (1) over a large area.

## ABSTRACT

With reference to a synthetic fiber rope consisting of load-bearing aramide fiber strands (9, 10, 11) laid together in parallel in concentric layers of strands (14, 16) it is proposed to have an intersheath (13) with sheath surfaces adapted to the external contours of the adjacent layers of strands. According to the invention, by positively bonding the inner and outer layers of strands a higher torsional rigidity is achieved as well as a rope structure of the stranded rope which is less susceptible to twisting. Furthermore, the elastic intersheath (13) between the layers of strands (16, 21) serves to protect the strands (10, 11, 12) against abrasion and assists in transmitting torque within the rope (1) over a large area.

## SYNTHETIC FIBER ROPE

The invention relates to a synthetic fiber rope, preferably of aromatic polyamide, and which includes at least an inner and an outer concentric layer of load-bearing synthetic fiber strands laid together, and between the inner layer of strands and the outer layer of strands a tubular shaped intersheath which surrounds the inner layer of strands.

Especially in materials handling technology, for example on elevators, in crane construction, and in open-pit mining, etc. ropes are an important element of machinery and subject to heavy use. An especially complex aspect is the loading of driven ropes, for example as they are used in elevator construction.

Specifically, on elevator installations the lengths of rope needed are large, and considerations of energy lead to the demand for smallest possible masses. High-tensile synthetic fiber ropes, for example of aromatic polyamides or aramides with highly oriented molecule chains, fulfil these requirements better than conventional steel ropes.

Specifically, ropes constructed of aramide fibers have a substantially higher lifting capacity than conventional steel ropes of the same cross section, and only between one fifth and one sixth of their specific gravity. However, the atomic structure of aramide fiber causes it to have a comparatively low ultimate elongation and a low shear strength.

Such an aramide fiber rope with parallel lay is known, for example, from EP 0 672 781 A1. There, between the outermost and inner layers of strands there is an intersheath which prevents contact between the strands of different layers and thereby reduces the wear due to their rubbing against each other. The aramide rope described so far has satisfactory values of service life, resistance to abrasion, and fatigue strength under reversed bending stresses; however, when loaded under tension the twisted

stranded synthetic fiber rope has a tendency to rotate about its longitudinal axis and/or to untwine. The undesirable untwining of the stranded rope can lead to an unevenly distributed loading of the strands of different strand length over the cross section of the rope and thereby to a reduction in the breaking load of the rope or even to failure of the rope.

The objective of the invention is to avoid the disadvantages of the known synthetic fiber rope and to specify a permanently dependable twisted synthetic fiber rope.

According to the invention this objective is fulfilled by means of a synthetic fiber rope. The synthetic fiber rope consisting of at least an inner and an outer concentric layer of load-bearing synthetic fiber strands (2,4,7,10) laid together, and between the inner layer of strands (5,8) and the outer layer of strands (12) a tubular shaped intersheath (13) which surrounds the inner layer of strands (5,8), wherein the intersheath (13) has sheath surfaces which are adapted to the external contours of the adjacent layers of strands (8,12).

The advantages resulting from the invention relate to the fact that the intersheath, by having sheath surfaces adapted to the contours of adjacent layers of strands, provides a larger area of contact with the strands and thereby also completely bridges the interstices between the strands of the layers of strands adjacent to it. The tight bond between inner and outer layers of strands results in a higher torsional rigidity of the stranded rope. This prevents a loaded rope with contoured intersheath according to the invention from twisting irrespective of the type of torque acting on it. With the invention there is therefore a greater supporting and/or load-bearing area of sheath available even when the rope is in the loaded state. This in turn results in a homogenized transfer of torque over the entire circumferential area of the sheath to the interior of the rope. As a result, the constrictive force of the covering layer of strands no longer acts mainly as a transverse force on the highest points of individual

strands but is spread widely, i.e. with reduced pressure, over the entire circumferential surface of the sheath of the adjacent layers of strands.

5 With appropriately selected elasticity, the intersheath can absorb differing longitudinal movements of adjacent strands without the strands moving relative to the intersheath, from which advantages are derived in relation to the flexibility of the rope and its behavior under reversed  
10 bending.

#### BRIEF DESCRIPTION OF THE DRAWINGS

Further advantageous details are described below by reference to an embodiment of the intersheath according to the invention illustrated in the drawing. The drawings  
15 show:

Figure 1 A perspective drawing of an elevator rope with an intersheath according to the invention;

Figure 2 A view of a cross-section of the elevator rope of  
20 Figure 1.

Figure 1 shows a rope 1 such as is used in elevator installations as a means of suspension and hoisting, for example by being driven via a rope sheave or rope drum. In  
25 such installations the car sling of a car, which is moved in an elevator hoistway, and a counterweight are connected together by a rope. To raise and lower the car and the counterweight, the rope runs over a traction sheave which is driven by a drive motor. The drive torque is transferred  
30 by friction to the section of rope which at any moment is lying in the angle of wrap. At this point the rope is subjected to high transverse forces.

The rope 1 is constructed of a core strand 2 around which  
35 in a first direction of lay 3 five identical strands 4 of a first layer of strands 5 are laid helically, and on them ten strands 4, 7 of a second layer of strands 8 laid in

parallel lay are laid with a balanced ratio between the direction of twist of the strands and the rope lay.

The second layer of strands 8 comprises an alternating arrangement of two types of five identical strands 4, 7 each. The cross-section through a rope illustrated in Figure 2 shows five further strands 7 with large diameter which lie helically in the hollows of the first layer of strands 5 which supports them, while five strands 4 with the diameter of the strands 4 of the first layer of strands 5 lie on the highest points of the first layer of strands 5 that supports them and thereby fill the gaps between two adjacent strands 7 having a greater diameter. In this way, the doubly parallel laid rope core 9 receives a second layer of strands 8 with an almost circular external profile, which in combination with the intersheath 13 affords advantages which are subsequently described below. When the rope 1 is loaded longitudinally, the parallel lay of the rope core 9 creates a torque in the opposite direction to the direction of lay 3. On the rope core 9, seventeen strands 10 are laid in hawser manner in a second direction of lay 11 opposite to the first direction of lay 3 to form a covering layer of strands 12. In the illustrated embodiment, the ratio of the length of lay of the strands lying on the outside 10 to the strands 4, 7 of the inner layers of strands 5, 8 is 1.6. Under load, the lay of the covering layer of strands 12 develops a torque in the opposite direction to the second direction of lay 11.

Between the covering layer of strands 12 laid in the second direction of lay 11 and the strands 4, 7 of the second layer of strands 8 is an intersheath 13. The intersheath 13 consists of an elastically deformable material such as polyurethane or polyester elastomers and is molded or extruded onto the stranded rope core 9. During this process the freshly applied intersheath 13 is plastically deformed,

lying tight against contours of the circumferential sheath of the layers of strands 8 and 12 , filling all the interstices, and retaining the grooves 18, 19 impressed on it by the adjacent layers of strands 8, 12.

5

The contoured intersheath 13 takes the form of a tube enveloping the second layer of strands 8 and thereby prevents contact of the strands 4, 7 with the strands 10. In this way it prevents wear of the strands 4, 7, 10 being  
10 caused by the strands 4, 7, 10 rubbing against each other as a result of moving relative to each other when the rope 1 runs over the traction sheave , such relative movement taking place to compensate differences in tensile stress which occur, for example, when the direction of the rope is  
15 reversed under load on the traction sheave.

By virtue of friction and its shape, the intersheath 13 also transmits the torque which is developed in the covering layer of strands 12 when the rope 1 is under load  
20 to the second layer of strands 8, and thereby to the rope core 9, whose parallel lay develops a torque in the opposite direction to the direction of lay 3.

25 At the same time, the frictional resistance  $u > 0.15$  between the strands 4, 7, 10 and the intersheath 13 is so chosen that practically no relative movement occurs between the strands and the intersheath 13, but so that the intersheath 13 follows the compensating movements by  
30 deforming elastically. The elasticity of the intersheath 13 is greater than that of the strand impregnation and that of the supporting strand material and thereby prevents their becoming prematurely damaged. On the other hand, the overall extension of the material selected for the  
35 intersheath 13 is in all cases greater than the maximum movement that occurs of the strands 4, 7, 10 relative to each other.

The thickness 20 of the intersheath 13 can be used to set in a controlled manner the radial distance of the covering layer of strands 12 from the center of rotation of the rope 1 and thereby to neutralize the torque ratio between the torque of the covering layer of strands 12 and of the parallel laid rope core 9 which act in opposite directions to each other in the loaded rope 1. The thickness 20 selected for the intersheath 13 must be increased with increasing diameter of the strands 10 and/or the strands 4 and 7. In all cases, the thickness 20 of the intersheath 13 must be given such a dimension as to ensure that under load, when the interstices between the strands 21, 22 are completely filled, there is a remaining sheath thickness of 0.1 mm between strands 4, 7, and 10 of the adjacent layers of strands 8 and 12. The plastically deformed intersheath 13 causes a homogenized transmission of torque over the entire circumferential surface of the sheath. The volume of the interstices between the strands can be minimized by an alternating arrangement of strands of large diameter 7 and strands of smaller diameter 4 in the second layer of strands 8.

As well as being used purely as a suspension rope, the rope can be used in a wide range of equipment for handling materials, examples being elevators, hoisting gear in mines, building cranes, indoor cranes, ship's cranes, aerial cableways, and ski lifts, as well as a means of traction on escalators. The drive can be applied by friction on traction sheaves or Koepe sheaves, or by the rope being wound on rotating rope drums. A hauling rope is to be understood as a moving, driven rope, which is sometimes also referred to as a traction or suspension rope.

We claim:

1. Synthetic fiber rope consisting of at least an inner and an outer concentric layer of load-bearing synthetic fiber strands (2,4,7,10) laid together, and between the inner layer of strands (5,8) and the outer layer of strands (12) a tubular shaped intersheath (13) which surrounds the inner layer of strands (5, 8),  
wherein the intersheath (13) has sheath surfaces which are adapted to the external contours of the adjacent layers of strands (8,12).
2. Synthetic fiber rope according to Claim 1, characterized in that the coefficient of friction  $\mu$  between the strands (4,7,10) and the intersheath (13) is greater than 0.15.
3. Synthetic fiber rope according to Claim 1, characterized in that the overall extension of the intersheath (13) is greater than the maximum movement of the strands (4,7,10) relative to each other.
4. Synthetic fiber rope according to Claim 1, characterized in that the sheath surfaces are fluted.
5. Synthetic fiber rope according to Claim 1, characterized in that outer grooves (18) are helical in shape, the direction of the helix (11) on the outside surface of the sheath being opposite to the direction of the helix (3) of inner grooves (19) on the inner surface of the sheath.

6. Synthetic fiber rope according to Claim 1, characterized in that the thickness (20) of the sheath (13) at its thinnest point is 0.1 mm.

5

7. Elevator installation with a synthetic fiber rope according to any one of the claims 1 to 6 to be driven by a traction sheave or a rope drum.

Fig. 1

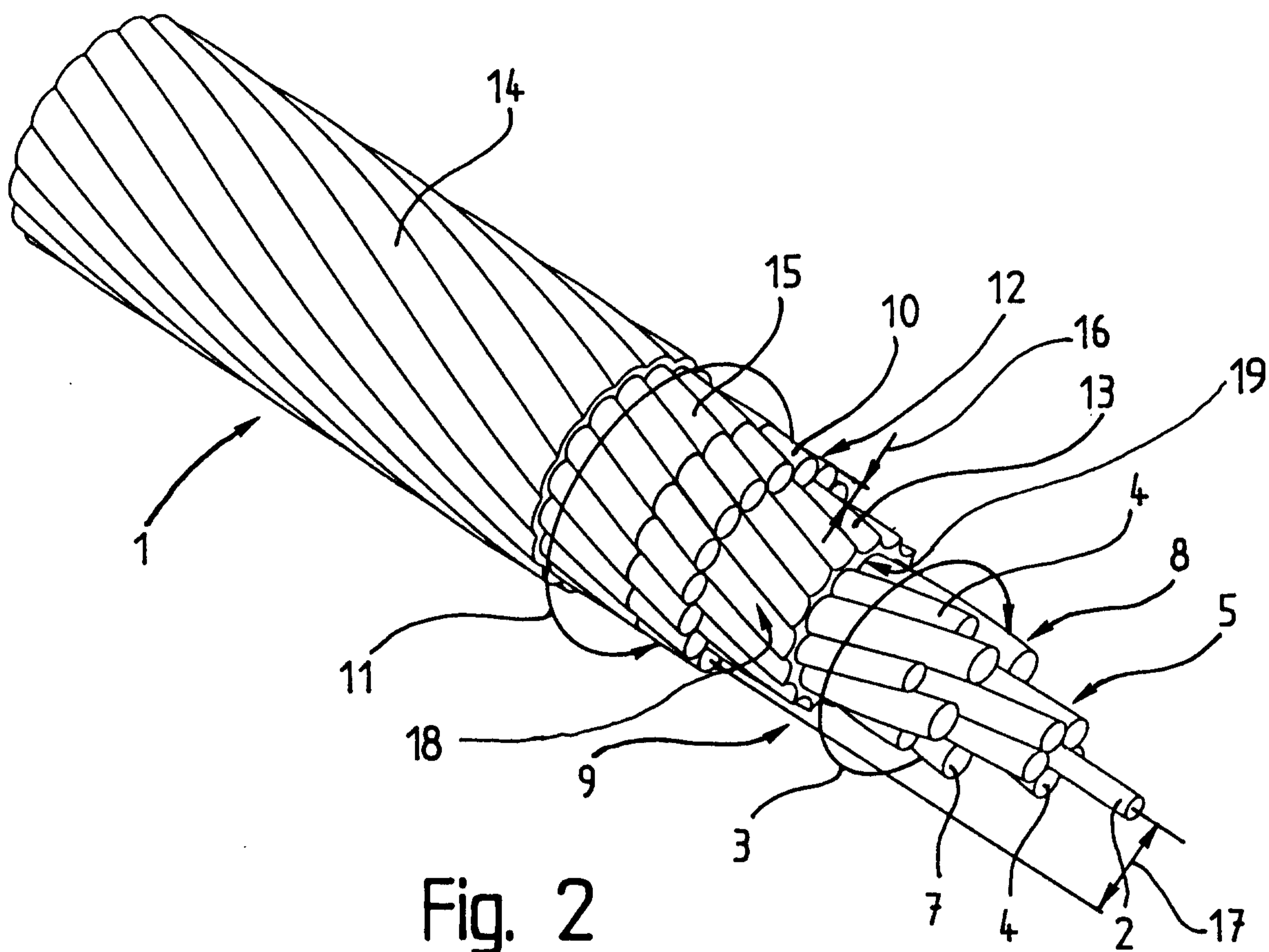


Fig. 2

