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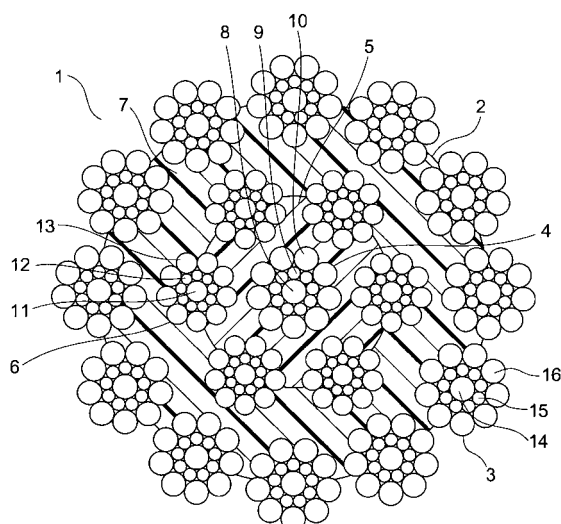
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(54) **ELEVATOR ROPE**

(57) An elevator rope has a core rope, and twelve outer layer strands that are arranged on an outer peripheral portion of the core rope at intervals from one another. The core rope has a core strand, an inner layer covering member with which an outer periphery of the core strand is covered, six inner layer strands which are arranged on an outer peripheral portion of the inner layer covering

member at intervals from one another, and an outer layer covering member with which the core strand, the inner layer covering member and the individual inner layer strands are collectively covered. The core strand, the individual inner layer strands and the individual outer layer strands are respectively composed of a plurality of elemental wires twisted together.

FIG. 1



Description

[TECHNICAL FIELD]

5 **[0001]** The present invention relates to a rope for an elevator used as a rope or the like for hanging an elevator car for example.

[TECHNICAL FIELD]

10 **[0002]** In the past, there has been proposed a wire rope in which elastomer is filled in between a rope core and six side strands which are twisted around the rope core so as to improve the tensile strength thereof. The rope core and each of the side strands are respectively composed of a plurality of elemental wires twisted together. The cross sectional area of each of elemental wires of the side strands is made to be larger than the cross sectional area of each of elemental wires of the rope core. Elastomer is filled into the interior of the rope core (see a first patent document).

15 **[0003]**

[First Patent Document] Japanese patent No. 2,992,783

[DISCLOSURE OF THE INVENTION]

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[PROBLEMS TO BE SOLVED BY THE INVENTION]

[0004] When such a conventional wire rope is used for an elevator apparatus as a rope for hanging a car for example, a plurality of ropes are wrapped around a sheave. In this case, the number of side strands for each rope is six and hence
25 small, so the area of that portion of each rope which is in contact with the sheave becomes small, and the contact surface pressure of each rope becomes large. Accordingly, the ropes are worn out at an early time, and the service life of the ropes is shortened.

[0005] In addition, when the diameter of the sheave is made large so as to increase the life span of the ropes, the elevator apparatus as a whole is accordingly increased in size.

30 **[0006]** Further, if the strength of the ropes is enhanced so as to increase the life span of the ropes, the hardness of the elemental wires becomes larger, so the sheave will be worn at an early time.

[0007] The present invention is intended to obviate the problems as referred to above, and has for its object to obtain a rope for an elevator which can has an increased life span, and which can prevent an increase in size of an elevator apparatus as a whole.

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[MEANS FOR SOLVING THE PROBLEMS]

[0008] A rope for an elevator according to the present invention includes: a core rope that has a core strand which is formed of a plurality of elemental wires twisted together, an inner layer covering member with which an outer periphery
40 of the core strand is covered, six inner layer strands which are arranged on an outer peripheral portion of the inner layer covering member at intervals from one another and are formed of a plurality of elemental wires twisted together, and an outer layer covering member with which the core strand, the inner layer covering member and the individual inner layer strands are covered in a collective manner; and twelve outer layer strands that are arranged on an outer peripheral portion of the outer layer covering member at intervals from each other and are formed of a plurality of elemental wires
45 twisted together.

[EFFECT OF THE INVENTION]

[0009] In the rope for an elevator according to the present invention, the six inner layer strands are arranged on the
50 outer peripheral portion of the inner layer covering member with which the core strands are covered, and twelve outer layer strands are arranged on the outer peripheral portion of the outer layer covering member with which the core strand, the inner layer covering member, and the individual inner layer strands are covered in a collective manner. As a result, the individual outer diameters of the core strand, the inner layer strands and the outer layer strands can be made close to uniform, and the diameters of the individual elemental wires can also be made close to uniform. Accordingly, it is
55 possible to prevent a bending stress of the elevator rope from becoming too large due to extremely thick elemental wires, or to prevent extremely thin elemental wires from being worn out at an early time. With this, the diameter of a sheave, around which the elevator rope is adapted to be wrapped, can be made smaller, thus making it possible to reduce the entire size of the elevator apparatus. In addition, it is also possible to increase the life span of the elevator rope.

[BRIEF DESCRIPTION OF THE DRAWINGS]

[0010]

5 Fig. 1 is a cross sectional view showing a rope for an elevator according to a first embodiment of the present invention.
 Fig. 2 is a schematic side elevational view showing the elevator rope of Fig. 1 with a part thereof being broken away.
 Fig. 3 is a cross sectional view showing a state of the elevator rope of Fig. 1 being wrapped around a sheave.
 Fig. 4 is a cross sectional view showing a rope for an elevator according to a second embodiment of the present invention.
 10 Fig. 5 is a cross sectional view showing a rope for an elevator according to a third embodiment of the present invention.

[THE BEST MODE FOR CARRYING OUT THE INVENTION]

15 [0011] Hereinafter, preferred embodiments of the present invention will be described while referring to the accompanying drawings.

Embodiment 1.

20 [0012] Fig. 1 is a cross sectional view that shows a rope for an elevator according to a first embodiment of the present invention. Fig. 2 is a schematic side elevational view that shows the elevator rope of Fig. 1 with a part thereof being broken away. In these figures, an elevator rope 1 has a core rope 2, and twelve outer layer strands 3 that are arranged on an outer peripheral portion of the core rope 2.

25 [0013] The core rope 2 includes a core strand 4, an inner layer covering member 5 made of resin with which an outer periphery of the core strand 4 is covered, six inner layer strands 6 that are arranged on an outer peripheral portion of the inner layer covering member 5, and an outer layer covering member 7 with which the core strand 4, the inner layer covering member 5, and the individual inner layer strands 6 are covered in a collective manner.

30 [0014] The core strand 4 is arranged in the center of core rope 2. In addition, the core strand 4 has a strand central portion, a first elemental wire layer that surrounds an outer periphery of the strand central portion, and a second elemental wire layer that surrounds an outer periphery of the first elemental wire layer. In the strand central portion, an elemental wire or filament made of steel is arranged as a center elemental wire 8. In the first elemental wire layer, a plurality of elemental wires or filaments made of steel, which are twisted around the center elemental wire 8, are arranged as first elemental wires 9. In the second elemental wire layer, a plurality of elemental wires made of steel, which are twisted around the outer peripheries of the first elemental wires 9, are arranged as second elemental wires 10. That is, the core strand 4 is composed of a plurality of steel elemental wires 8 through 10 twisted with one another.

35 [0015] The individual second elemental wires 10 are twisted in parallel to the individual first elemental wires 9 in such a manner as to be in contact with the neighboring first elemental wires 9. That is, the manner of twisting the second elemental wires 10 with respect to the first elemental wires 9 is made to be a parallel twist in which the twist lengths of the elemental wires 9, 10 become equal to each other.

40 [0016] The inner layer covering member 5 is composed of, for example, polyethylene resin, polypropylene resin, or the like. In addition, the inner layer covering member 5 may be formed, after covering the outer periphery of the core strand 4 with resin, by twisting the individual inner layer strands 6 around an outer peripheral portion of the resin, or it may be formed by filling resin in between the core strand 4 and the individual inner layer strands 6.

45 [0017] The individual inner layer strands 6 are arranged at intervals along the outer peripheral portion of the inner layer covering member 5. In addition, the individual inner layer strands 6 are twisted around the outer periphery of the inner layer covering member 5 so as to surround the core strand 4. Further, a part of the inner layer strands 6 is embedded in the outer peripheral portion of the inner layer covering member 5.

50 [0018] Similar to the core strand 4, each of the inner layer strands 6 has a strand central portion, a first elemental wire layer that surrounds an outer periphery of the strand central portion, and a second elemental wire layer that surrounds an outer periphery of the first elemental wire layer. In the strand central portion, an elemental wire or filament made of steel is arranged as a center elemental wire 11. In the first elemental wire layer, a plurality of elemental wires or filaments made of steel, which are twisted with the center elemental wire 11, are arranged as first elemental wires 12. In the second elemental wire layer, a plurality of elemental wires made of steel, which are twisted around the outer peripheries of the first elemental wires 12, are arranged as second elemental wires 13. That is, the inner layer strands 6 are each composed of a plurality of steel elemental wires 11 through 13 twisted with one another.

55 [0019] The individual second elemental wires 13 are twisted in parallel to the individual first elemental wires 12 in such a manner as to be in contact with the neighboring first elemental wires 12. That is, the manner of twisting the second elemental wires 13 with respect to the first elemental wires 12 is made to be a parallel twist in which the twist lengths of the elemental wires 12, 13 become equal to each other.

[0020] The outer layer covering member 7 is composed of, for example, polyethylene resin, polypropylene resin, or the like. A part of the inner layer strands 6 is embedded in an inner peripheral portion of the outer layer covering member 7. As a result, the inner layer covering member 5 and the outer layer covering member 7 are respectively interposed between adjacent ones of the individual inner layer strands 6. In addition, the outer layer covering member 7 may be formed, after covering the core strand 4, the inner layer covering member 5 and the individual inner layer strands 6 with resin, by twisting the individual outer layer strands 3 around an outer peripheral portion of the resin, or it may be formed by filling resin in between the individual inner layer strands 6 and the individual outer layer strands 3.

[0021] The individual outer layer strands 3 are arranged at intervals along the outer peripheral portion of the outer layer covering member 7. In addition, the individual outer layer strands 3 are twisted on an outer periphery of the core rope 2 in a direction opposite to the twisting direction of the individual inner layer strands 6 (Fig. 2). Further, a part of the outer layer strands 3 is embedded in the outer peripheral portion of the outer layer covering member 7. Accordingly, the outer layer covering member 7 is interposed between adjacent ones of the outer layer strands 3.

[0022] Similar to the core strand 4, each of the outer layer strands 3 has a strand central portion, a first elemental wire layer that surrounds an outer periphery of the strand central portion, and a second elemental wire layer that surrounds an outer periphery of the first elemental wire layer. In the strand central portion, an elemental wire or filament made of steel is arranged as a center elemental wire 14. In the first elemental wire layer, a plurality of elemental wires or filaments made of steel, which are twisted with the center elemental wire 14, are arranged as first elemental wires 15. In the second elemental wire layer, a plurality of elemental wires made of steel, which are twisted around the outer peripheries of the first elemental wires 15, are arranged as second elemental wires 16. That is, the outer layer strands 3 are each composed of a plurality of steel elemental wires 14 through 16 twisted with one another.

[0023] The individual second elemental wires 16 are twisted in parallel to the individual first elemental wires 15 in such a manner as to be in contact with the neighboring first elemental wires 15. That is, the manner of twisting the second elemental wires 16 with respect to the first elemental wires 15 is made to be a parallel twist in which the twist lengths of the elemental wires 15, 16 become equal to each other.

[0024] A lubricant (e.g., lubricating oil or the like) is impregnated into the core rope 2 and the individual outer layer strands 3. That is, the lubricant is filled into minute gaps in the core rope 2 and in each of the outer layer strands 3. In addition, the cross sectional structure of each of the core strand 4, the inner layer strands 6 and the outer layer strands 3 is made to be of a Seale type.

[0025] Here, the number of the outer layer strands 3 can be increased to more than twelve in order to further suppress the wear of the outer layer strands 3, but if the number of the outer layer strands 3 is increased to more than twelve, the outer layer strands 3 will be made smaller in diameter. As a result, the area occupied by the outer layer strands 3 with respect to the core rope 2 becomes smaller. As a result, the ratio of the strength bearing capacity of the individual outer layer strands 3 with respect to the elevator rope 1 (the strength bearing ratio of the outer layer strands 3) becomes less than the ratio of the strength bearing capacity of the core rope 2 with respect to the elevator rope 1 (the strength bearing ratio of the core rope 2).

[0026] On the other hand, when the elevator rope 1 is used for an elevator apparatus, a determination as to whether the elevator rope 1 needs to be replaced is made by regular check so as to avoid trouble due to the aging degradation or deterioration of the elevator rope 1. Such a determination of the need for replacing the elevator rope 1 is carried out by checking (observing) the state of the outer layer strands 3 (e.g., break, the degree of wear, or the like of the elemental wires 14 through 16). That is, whether the elevator rope 1 needs to be replaced is determined not by the state of the core rope 2 but rather by the state of the outer layer strands 3.

[0027] Accordingly, even if the core rope 2 has been damaged to a remarkable extent, a determination that the replacement of the elevator rope 1 is not necessary is made when the state of the outer layer strands 3 has not been deteriorated. In this case, when the strength bearing ratio of the core rope 2 becomes larger than the strength bearing ratio of the outer layer strands 3, the remarkable damage of the core rope 2 leads directly to a remarkable reduction in the strength of the entire elevator rope 1. As a consequence, the determination that the rope replacement is not necessary might be an incorrect determination.

[0028] To eliminate such an incorrect determination, in the elevator rope 1, it is set such that the strength bearing ratio of the outer layer strands 3 becomes larger than the strength bearing ratio of the core rope 2, by making the number of the outer layer strands 3 to be 12. Specifically, the total value of the breaking forces or loads of the individual elemental wires 8 through 13, which constitute the core strand 4 and the individual inner layer strands 6, (the collective breaking load of the core rope 2), is set to be equal to or less than 0.6 times the total value of the breaking forces or loads of all the elemental wires 14 through 16, which constitute the individual outer layer strands 3, (the collective breaking load of all the outer layer strands 3).

[0029] It has been found, as a result of inventor's experiments, that the breaking load of the elevator rope 1 is lowered by about 25 % with respect to the total value of the breaking loads of all the elemental wires 8 through 16 that constitute the elevator rope 1 (the collective breaking load of the elevator rope 1), by twisting the individual elemental wires 8 through 16 with one another. That is, it has been found, as a result of inventor's experiments, that the breaking load of

the elevator rope 1 is subjected to an efficiency reduction of about 25 % (twisting reduction rate) with respect to the collective breaking load of the elevator rope 1, by the twisting of the individual elemental wires 8 through 16.

[0030] Accordingly, in case where the collective breaking load of the core rope 2 is set to be 0.6 times the collective breaking load of all the outer layer strands 3, assuming that the collective breaking load of all the outer layer strands 3 is A, the collective breaking load of the core rope 2 is 0.6 x A, and an (initial) breaking load P1 of the elevator rope 1 immediately after the production thereof is represented by expression (1) below.

[0031]

$$P1 = (A + 0.6 \times A) \times (1 - 0.25) = 1.2 \times A \cdots (1)$$

[0032] In contrast to this, it is found that as the elevator rope 1 is subjected to secular or successive use (bending), the load bearing ratios of the individual elemental wires 8 through 16 are made equal to one another, and the twisting reduction rate can be improved by at least 5 % or more. Accordingly, when a certain plurality of inner layer strands 6 are completely broken during an extended use of the elevator rope 1 to reduce the collective breaking load of the core rope 2 up to 50 % of the initial value, and when 10 % of all the elemental wires, which constitute the individual outer layer strands 3, are cut or broken, a breaking load P2 of the elevator rope 1 during use is represented by expression (2) below.

[0033]

$$P2 = (A \times 0.9 + 0.6 \times A \times 0.5) \times (1 - 0.2) = 0.96 \times A \cdots (2)$$

[0034] If the state that the ratio of the broken ones in all the elemental wires 14 through 16, which constitute the individual outer layer strands 3, (elemental wire breakage rate of the outer layer strands 3), reaches a predetermined reference value equal to or less than 10 % is set as a criterion for rope replacement, a determination that rope replacement is necessary can be made before the breaking load P2 of the elevator rope 1 falls below 80 % of the initial breaking load P1 of the elevator rope 1. That is, by setting the strength bearing ratio of the outer layer strands 3, for which the determination of a need for rope replacement is to be made, to a value equal to or more than a predetermined value, it becomes possible to prevent an incorrect determination as to whether the rope replacement is necessary.

[0035] In such an elevator rope 1, the six inner layer strands 6 are arranged on the outer peripheral portion of the inner layer covering member 5 with which the core strand 4 is covered, and the twelve outer layer strands 3 are arranged on the outer peripheral portion of the outer layer covering member 7 with which the core strand 4, the inner layer covering member 5, and the individual inner layer strands 6 are covered in a collective manner. As a result, the individual outer diameters of the core strand 4, the inner layer strands 6 and the outer layer strands 3 can be made close to uniform, and the diameters of the individual elemental wires 8 through 16 can also be made close to uniform. Accordingly, it is possible to prevent the bending stress of the elevator rope 1 from becoming too large due to extremely thick elemental wires, or to prevent extremely thin elemental wires from being worn out at an early time. With this, the diameter of the sheave, around which the elevator rope 1 is adapted to be wrapped, can be made smaller, thus making it possible to reduce the size of the elevator apparatus as a whole. In addition, it is also possible to increase the life span of the elevator rope 1.

[0036] In addition, since the number of the outer layer strands 3 is more than that in conventional cases, the area of that portion of the elevator rope 1 which is in contact with the sheave can be made large. That is, Fig. 3 is a cross sectional view that shows a state of the elevator rope 1 of Fig. 1 being wrapped around a sheave. As shown in this figure, a sheave 21 has a groove 22 formed on an outer peripheral portion thereof. In this example, the cross sectional shape of the groove 22 is made semicircular. The elevator rope 1 is wrapped around the sheave 21 while being inserted into the groove 22.

[0037] When the elevator rope 1 is wrapped around the sheave 21, the outer layer strands 3 are placed in contact with the inner surface of the groove 22. Since the number of the outer layer strands 3 is made to be twelve which is more than that, i.e., six, in the conventional cases, the number of those outer layer strands 3 which are in contact with the inner surface of the groove 22 becomes more, so the area of the portion of the elevator rope 1 being in contact with the sheave 21 can be increased. As a result, the contact pressure of the elevator rope 1 on the sheave 21 can be reduced, thus making it possible to suppress the wear of the elevator rope 1. Accordingly, it is also possible to further increase the life span of the elevator rope 1.

[0038] In actuality, it is general that an undercut groove is formed on a bottom portion of the groove 22, but even in such a case, good contact between the outer layer strands 3 and the inner surface of the groove 22 can be ensured

unless the size of the undercut groove is extremely large, so the contact area of the elevator rope 1 with respect to the sheave 21 can be made larger than that in the conventional cases.

[0039] Further, because of the increased number of the outer layer strands 3 being more than that in the conventional cases, the outer layer strands 3 can be composed of the elemental wires 14 through 16 which are thinner than those used in the conventional cases, whereby the fatigue resistance of the elevator rope 1 can be improved. As a result, it is possible to further reduce the diameter of the sheave 21, thereby making it possible to achieve a further reduction in size of the elevator apparatus as a whole. In this example, the diameter of the sheave, which should be conventionally 40 times or more the diameter of the elevator rope, can be decreased up to about 30 times the diameter of the elevator rope 1.

[0040] In addition, since the elemental wires 14 through 16 of the outer layer strands 3 become thinner than conventional ones, it is possible to improve the mounting or packing density of the elemental wires 8 through 16 that occupy the elevator rope 1. As a result, it is also possible to increase the strength of the elevator rope 1.

[0041] In addition, the individual inner layer strands 6 are arranged along the outer peripheral portion of the inner layer covering member 5 at intervals from one another, and the individual outer layer strands 3 are arranged along the outer peripheral portion of the outer layer covering member 7 at intervals from one another. As a result, it is possible to prevent the core strand 4, the individual inner layer strands 6 and the individual outer layer strands 3 from being in contact with one another. Accordingly, the respective wear of the core strand 4, the individual inner layer strands 6 and the individual outer layer strands 3 can be suppressed, thus making it possible to further increase the life span of the elevator rope 1. Also, the bending stress of the entire elevator rope 1 can be alleviated by the cushioning action of the inner layer covering member 5 and the outer layer covering member 7.

[0042] In addition, each of the core strand 4, the inner layer strands 6 and the outer layer strands 3 is formed by twisting a plurality of elemental wires with one another in a parallel twist. Accordingly, the state of contact of the individual elemental wires can be made into a line to line contact. As a result, the contact pressure of each elemental wire can be reduced, and the wear of each elemental wire can be suppressed. Thus, it is also possible to further increase the life span of the elevator rope 1. In addition, gaps between adjacent ones of the individual elemental wires can also be decreased in size, so the mounting or packing density (effective cross sectional area or stress area) of the individual elemental wires can be further improved.

[0043] Moreover, the lubricant is impregnated into the core rope 2 and the individual outer layer strands 3, so friction between the individual elemental wires 8 through 16 of the elevator rope 1 can be reduced, and the wear of the individual elemental wires 8 through 16 can be suppressed. Accordingly, it is possible to further increase the life span of the elevator rope 1.

[0044] Further, the collective breaking load of the core rope 2 is set to be equal to or less than 0.6 times the collective breaking load of all the outer layer strands 3. As a result, the strength bearing ratio of the outer layer strands 3, for which a determination as to whether rope replacement is necessary is made, can be made large. Accordingly, it is possible to make such a determination as to whether the replacement of the elevator rope 1 is necessary in a more accurate manner only by observing the state of the individual outer layer strands 3, whereby the occurrence of an incorrect determination as to whether the replacement of the elevator rope 1 is necessary can be prevented.

[0045] In addition, the individual outer layer strands 3 are twisted in a direction opposite to the twisting direction of the individual inner layer strands 6, so the untwisting torque of the elevator rope 1 can be reduced.

[0046] Although in the above-mentioned example, the collective breaking load of the core rope 2 is set to be equal to or less than 0.6 times the collective breaking load of all the outer layer strands 3, it is preferable that such a setting be in a range of from 0.4 times to 0.6 times.

Embodiment 2.

[0047] Fig. 4 is a cross sectional view that shows a rope for an elevator according to a second embodiment of the present invention. In this figure, the cross sections of elemental wires 8 through 10 of a core strand 4 are made to deform by compressing the core strand 4 from its outer periphery. In addition, the cross sections of elemental wires 11 through 13 of each inner layer strand 6 are also made to deform by compressing the inner layer strand 6 from its outer periphery. Further, the cross sections of elemental wires 14 through 16 of each outer layer strand 3 are also made to deform by compressing the outer layer strand 3 from its outer periphery. That is, the cross sections of the individual elemental wires of the core strand 4, the inner layer strands 6 and the outer layer strands 3 are deformed to take irregular shapes by individually compressing the core strand 4, the inner layer strands 6 and the outer layer strands 3 from their outer peripheries. The construction of this embodiment other than the above is similar to that of the first embodiment.

[0048] In such an elevator rope 1, the cross sections of the elemental wires of each of the core strand 4, the inner layer strands 6 and the outer layer strands 3 are deformed to take irregular shapes by individually compressing the core strand 4, the inner layer strands 6 and the outer layer strands 3 from their outer peripheries. Accordingly, gaps between individual elemental wires in each of the individual strands 4, 6, 3 can be further decreased in size, whereby the mounting

or packing densities (effective cross sectional areas or stress areas) of the individual elemental wires 8 through 16 can be improved. In addition, the outer peripheral portions of the individual strands 4, 6, 3 are smoothed by making the individual elemental wires to be deformed, so even when the individual strands 4, 6, 3 are in contact with one another for example due to aging deterioration, production errors, etc., it is possible to further decrease the contact pressure between adjacent ones of the individual strands, thereby making it possible to extend the life span of the elevator rope 1.

Embodiment 3.

[0049] Fig. 5 is a cross sectional view that shows a rope for an elevator according to a third embodiment of the present invention. In this figure, the cross sections of elemental wires 8 through 10 of a core strand 4 are made to deform by compressing the core strand 4 from its outer periphery. In addition, the cross sections of elemental wires 11 through 13 of each inner layer strand 6 are also made to deform by compressing the inner layer strand 6 from its outer periphery.

[0050] The cross sections of elemental wires 14 through 16 of each outer layer strand 3 is not made to deform, but take shapes (i.e., substantially circular shapes) similar to the cross sections of the elemental wires 14 through 16 of the first embodiment. Thus, gaps between adjacent ones of the elemental wires 14 through 16 of each outer layer strand 3 become larger in size than gaps between adjacent ones of the elemental wires 8 through 10 of the core strand 4 and gaps between adjacent ones of the elemental wires 11 through 13 of each inner layer strand 6.

[0051] That is, only the core strand 4 and the inner layer strands 6 among the core strand 4, the inner layer strands 6 and the outer layer strands 3 are individually compressed from their outer peripheries to deform only the cross sections of the individual elemental wires 8 through 13 of the core strand 4 and the inner layer strands 6, whereas the deformation of the cross sections of the elemental wires 14 through 16 of the outer layer strands 3 is blocked or inhibited. In other words, in the core strand 4, the cross sectional shapes of the elemental wires 8 through 10 when twisted with one another are deformed by the compression to the core strand 4 from its outer periphery, and in the inner layer strands 6, the cross sectional shapes of the elemental wires 11 through 13 when twisted with one another are deformed by the compression to the inner layer strands 6 from their outer peripheries. In contrast to this, in the outer layer strands 3, the cross sectional shapes of the elemental wires 14 through 16 when twisted with one another are left as they are. The construction of this embodiment other than the above is similar to that of the first embodiment.

[0052] In such an elevator rope 1, only the core strand 4 and the inner layer strands 6 among the core strand 4, the inner layer strands 6 and the outer layer strands 3 are individually compressed from their outer peripheries to deform only the cross sections of the individual elemental wires 8 through 13 of the core strand 4 and the inner layer strands 6. As a result, the mounting or packing densities (effective cross sectional areas or stress areas) of the individual elemental wires 8 through 16 can be improved, thus making it possible to increase the strength of the elevator rope 1.

[0053] Here, the core strand 4 and the inner layer strands 6 are covered at least with the outer layer covering member 7, so the lubricant in the interior thereof is less liable to flow out to the outside. Accordingly, the lubrication condition in the interior of each of the core strand 4 and the inner layer strands 6 is also less liable to deteriorate even if the elevator rope 1 is used over the years. In contrast to this, the outer layer strands 3 are adapted to be in direct contact with the sheave 21, so the lubricant in the interior thereof is liable to flow out to the outside due to, for example, the migration of the lubricant to the sheave 21 or the like. Accordingly, if the elevator rope 1 is used over the years, the lubrication condition in the interior of the outer layer strands 3 becomes liable to deteriorate.

[0054] In addition, when the cross sections of the elemental wires 14 through 16 of the outer layer strands 3 are made to deform, the lubricant in the interior of the outer layer strands 3 becomes liable to be squeezed out due to deformation processing, in addition to which gaps between adjacent ones of the elemental wires 14 through 16 for holding the lubricant are also decreased. Accordingly, the lubrication condition in the interior of the outer layer strands 3 becomes more liable to be deteriorated.

[0055] In the elevator rope 1, the deformation of the cross sections of the elemental wires 14 through 16 of the outer layer strands 3 is blocked or inhibited, so an amount of lubricant, being more than the amounts of lubricant impregnated into the core strand 4 and the inner layer strands 6, can be impregnated into the outer layer strands 3, whereby the deterioration of the lubricated condition in the interior of the outer layer strands 3 can be suppressed. Accordingly, it is possible to further increase the life span of the elevator rope 1.

[0056] Here, note that in the above-mentioned respective embodiments, the cross-sectional structure of each of the core strand 4, the inner layer strands 6 and the outer layer strands 3 is of Seale type, but it may be of other cross sectional structures such as Warrington type, Warrington Seale type, filler type, etc.

[0057] In addition, in the above-mentioned respective embodiments, each of the core strand 4, the inner layer strands 6 and the outer layer strands 3 has a strand central portion, a first elemental wire layer that surrounds an outer periphery of the strand central portion, and a second elemental wire layer that surrounds an outer periphery of the first elemental wire layer, but each of the core strand 4, the inner layer strands 6 and the outer layer strands 3 may further has a third elemental wire layer that surrounds an outer periphery of the second elemental wire layer. In this case, in the third elemental wire layer, a plurality of elemental wires made of steel, which are twisted in parallel to the second elemental

wires so as to be in contact with the adjacent second elemental wires, are arranged as third elemental wires.

[0058] Moreover, in recent years, the higher strengthening of elemental wires is becoming possible due to the advancement of the wire drawing technique of steel materials. Accordingly, in the above-mentioned respective embodiments, for example, an elemental wire having a strength of 2,050 N/mm² or more may be applied to the core strand 4 and the inner layer strands 6, and an elemental wire having a strength of 1,770 N/mm² or less may be applied to the outer layer strands 3. By doing so, it is possible to suppress the wear of the sheave 21 due to the contact thereof with the outer layer strands 3, and it is possible to further increase the strength of the elevator rope 1.

Claims

1. A rope for an elevator **characterized by** comprising:

a core rope that has a core strand which is formed of a plurality of elemental wires twisted together, an inner layer covering member with which an outer periphery of the core strand is covered, six inner layer strands which are arranged on an outer peripheral portion of the inner layer covering member at intervals from one another and are formed of a plurality of elemental wires twisted together, and an outer layer covering member with which the core strand, the inner layer covering member and the individual inner layer strands are covered in a collective manner; and

twelve outer layer strands that are arranged on an outer peripheral portion of the outer layer covering member at intervals from each other and are formed of a plurality of elemental wires twisted together.

2. The rope for an elevator as set forth in claim 1, **characterized in that**

each of the core strand, the inner layer strands and the outer layer strands has a strand central portion, a first elemental wire layer that surrounds an outer periphery of the strand central portion, and a second elemental wire layer that surrounds an outer periphery of the first elemental wire layer;

in the strand central portion, the elemental wire is arranged as a center elemental wire;

in the first elemental wire layer, the elemental wires, which are twisted with the center elemental wire, are arranged as first elemental wires; and

in the second elemental wire layer, the elemental wires, which are twisted in parallel to the first elemental wires so as to be in contact with the adjacent first elemental wires, are arranged as second elemental wires.

3. The rope for an elevator as set forth in claim 1, **characterized in that**

lubricant is impregnated into the core rope and the outer layer strands.

4. The rope for an elevator as set forth in claim 1, **characterized in that**

the cross sections of the individual elemental wires of the core strand, the inner layer strands and the outer layer strands are deformed to take irregular shapes by individually compressing the core strand, the inner layer strands and the outer layer strands from their outer peripheries.

5. The rope for an elevator as set forth in claim 1, **characterized in that**

only the core strand and the inner layer strands among the core strand, the inner layer strands and the outer layer strands are individually compressed from their outer peripheries to deform only the cross sections of the individual elemental wires of the core strand and the inner layer strands.

6. The rope for an elevator as set forth in claim 1, **characterized in that**

a collective breaking load of the core rope is set to be equal to or less than 0.6 times a collective breaking load of all the outer layer strands.

7. The rope for an elevator as set forth in claim 1, **characterized in that**

the individual outer layer strands are twisted in a direction opposite to a twisting direction of the individual inner layer strands.

FIG. 1

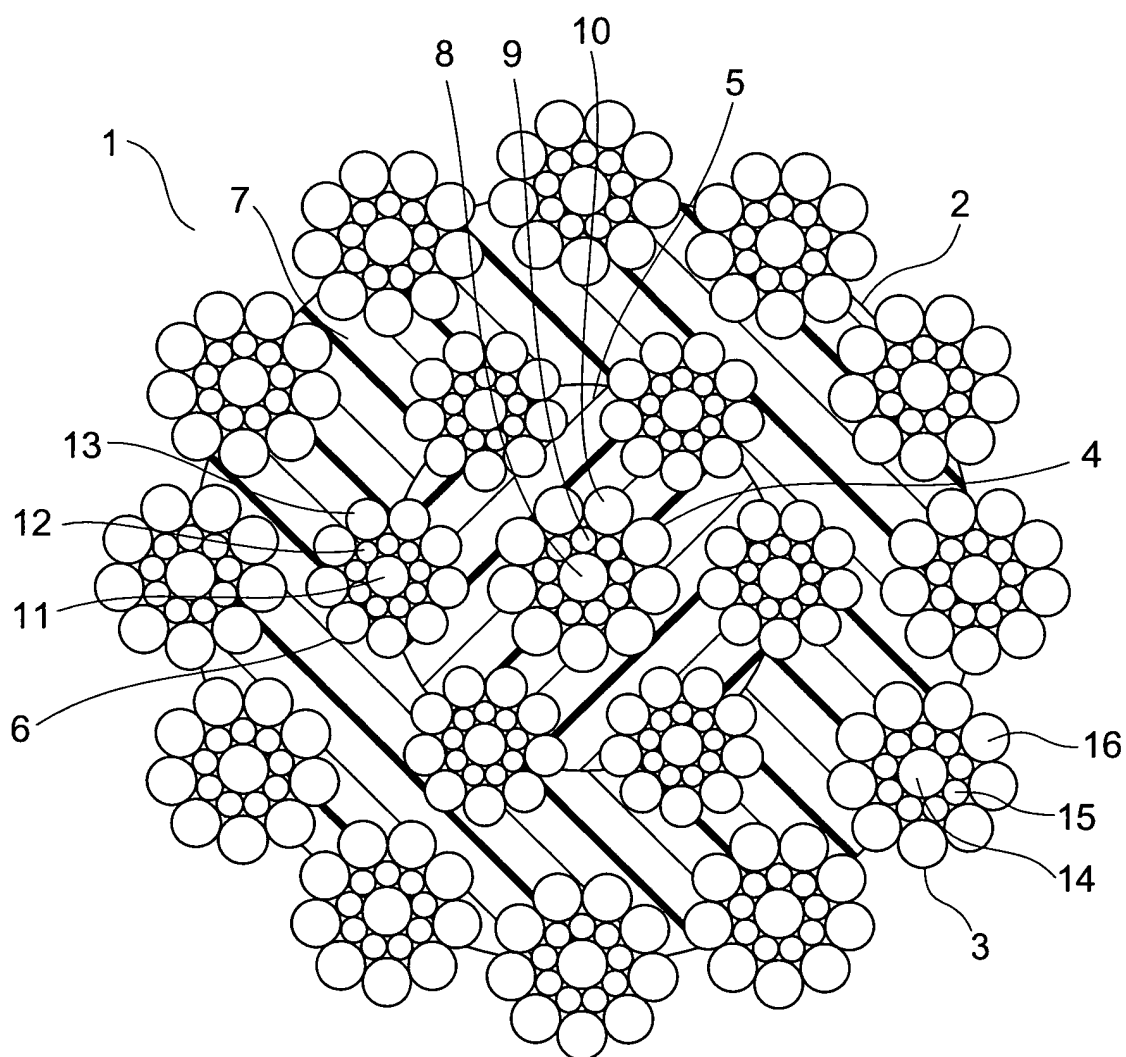


FIG. 2

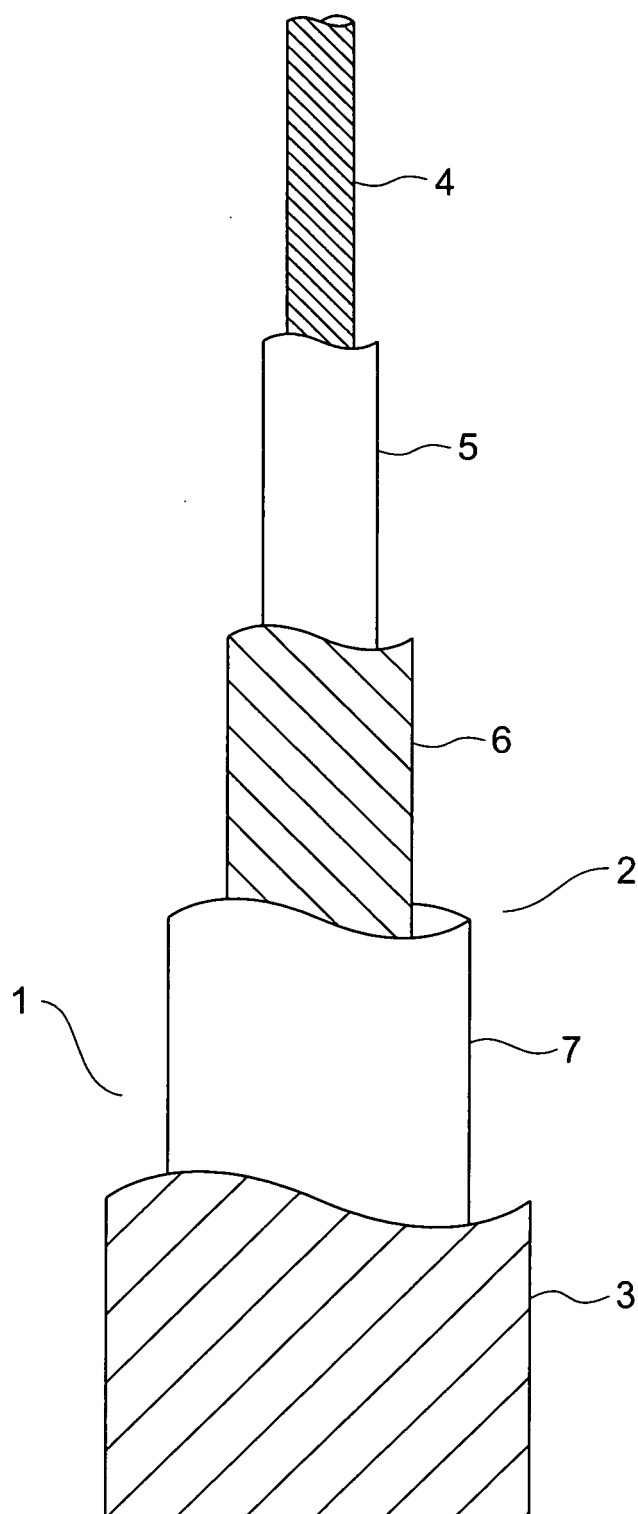


FIG. 3

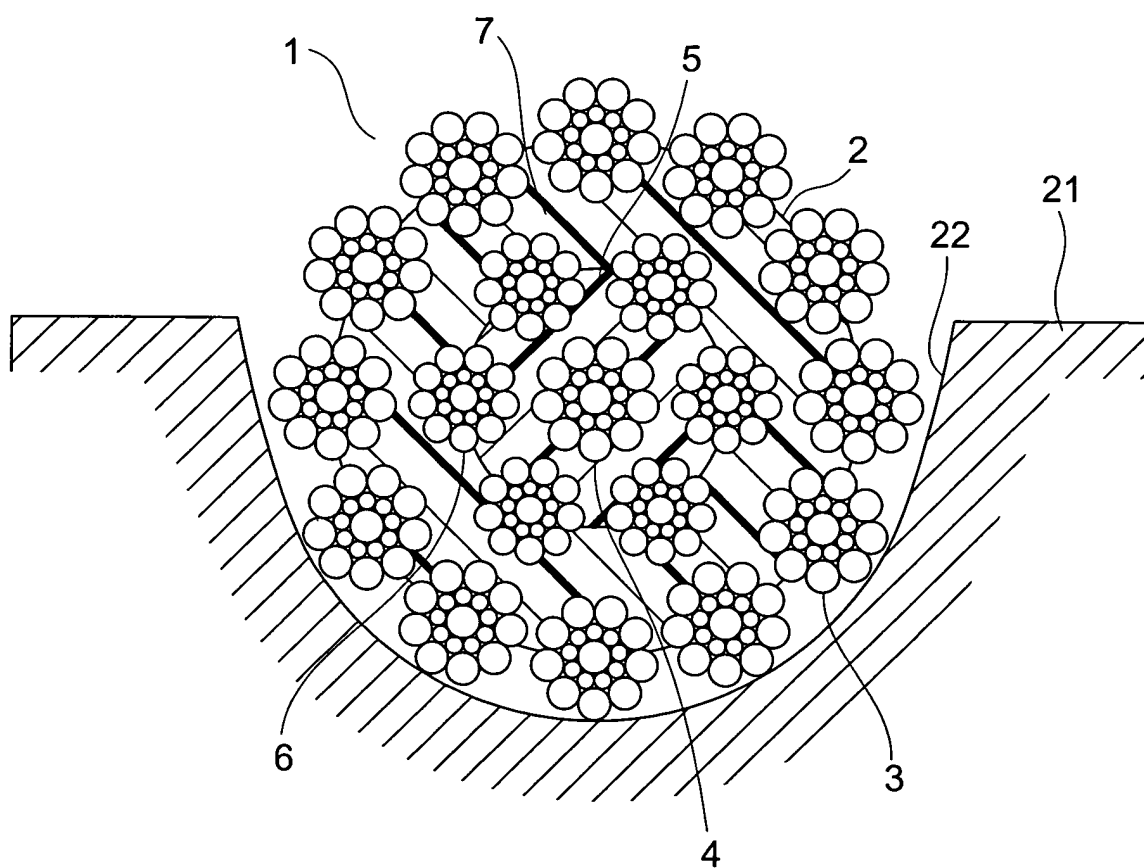


FIG. 4

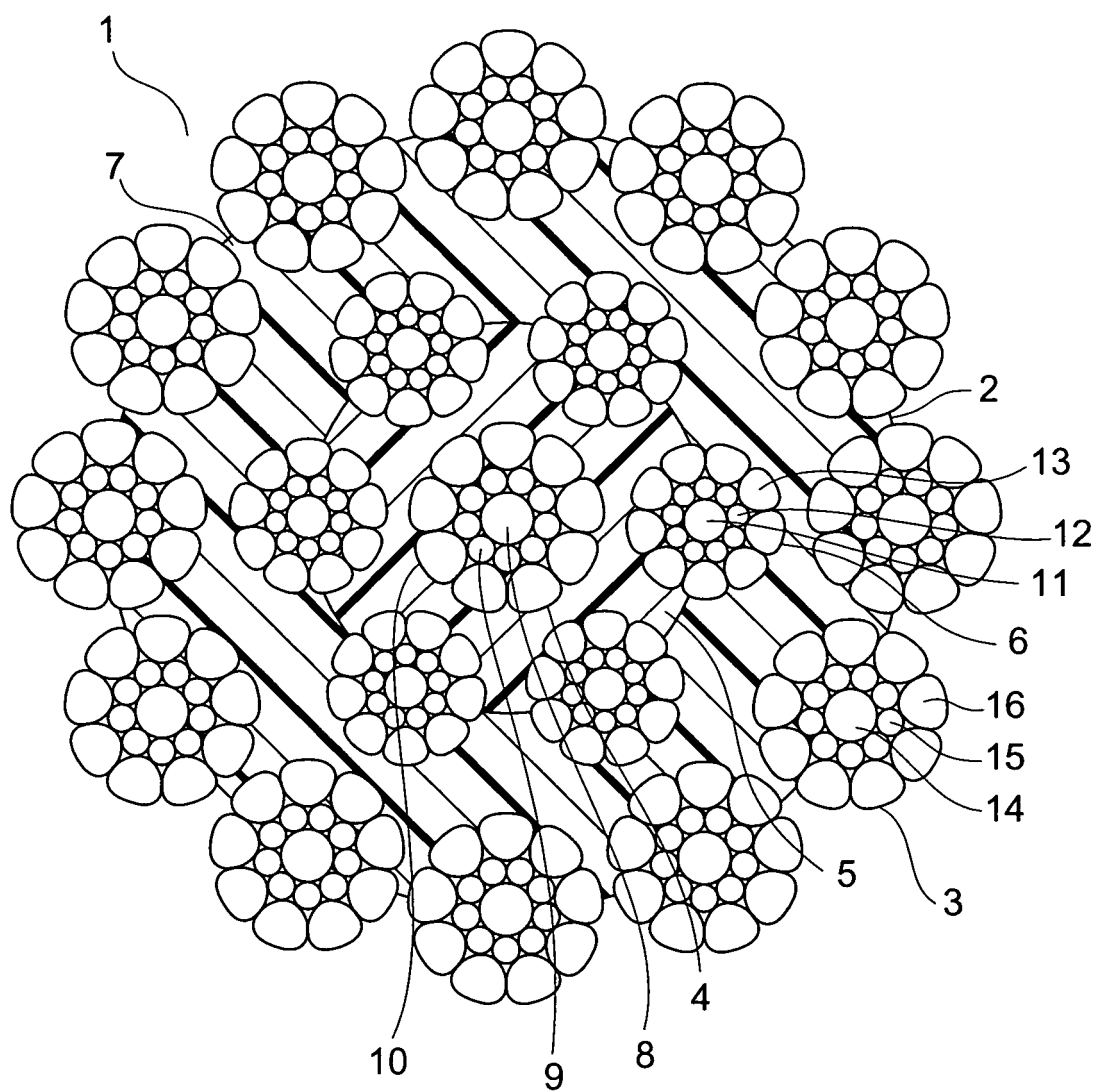
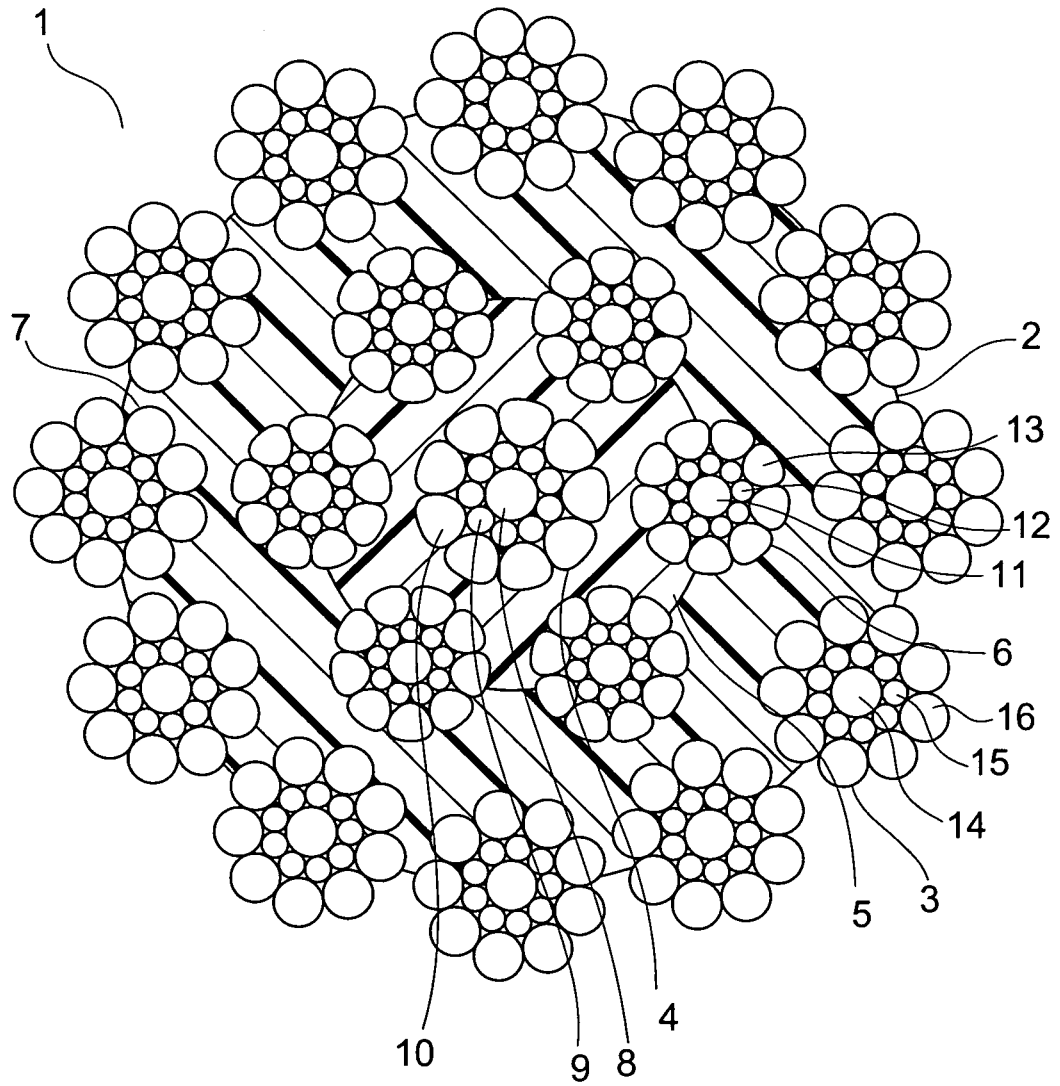


FIG. 5



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2006/316728

A. CLASSIFICATION OF SUBJECT MATTER

D07B1/06(2006.01)i, B66B7/06(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

B66B7/00-B66B7/12

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2007
Kokai Jitsuyo Shinan Koho	1971-2007	Toroku Jitsuyo Shinan Koho	1994-2007

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	WO 2004/043844 A1 (Mitsubishi Electric Corp.), 27 May, 2004 (27.05.04), Description, page 2, line 21 to page 4, line 9; Figs. 3 to 4 & EP 001582493 A1	1-5, 7 6
Y A	JP 2004-232136 A (Mitsubishi Electric Corp.), 19 August, 2004 (19.08.04), Par. Nos. [0008] to [0010]; Figs. 1, 3 (Family: none)	1-5, 7 6
Y	JP 2003-292270 A (Toshiba Elevator and Building Systems Corp.), 15 October, 2003 (15.10.03), Par. No. [0049]; Fig. 1 (Family: none)	2

☒ Further documents are listed in the continuation of Box C.☐ See patent family annex.

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Date of the actual completion of the international search
10 April, 2007 (10.04.07)Date of mailing of the international search report
17 April, 2007 (17.04.07)Name and mailing address of the ISA/
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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2006/316728

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 2004/065276 A1 (Mitsubishi Electric Corp.), 05 August, 2004 (05.08.04), Description, page 2, line 28 to page 3, line 8; Fig. 1 & EP 001586526 A1	2
Y	WO 2003/050348 A1 (Mitsubishi Electric Corp.), 19 June, 2003 (19.06.03), Description, page 6, line 28 to page 8, line 12 & US 2004-0026178 A1 & GB 002385867 A	3-5

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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