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(54) **Webbing for occupant restraint belt, seat belt, and seat belt apparatus**

(57) In order to provide a technology which is effective both for applying stiffness and for reducing the weight of an occupant restraint belt to be installed in a vehicle, in a seat belt apparatus which is installed in a vehicle, webbing composing a seat belt which is a long belt for restraining a vehicle occupant is woven in such a manner that warp yarns and weft yarns made of synthetic filaments extend perpendicular to each other. At least either of the warp yarns and the weft yarns are made of synthetic filaments having thermal adhesiveness which are made

by bundling a plurality of filament bodies each of which comprises a first filament and a second filament which is attached to the outer surface of the first filament and has melting point lower than that of the first filament. The second filaments are melted when heated under a condition of a temperature of 150 °C or more and a process time of 180 seconds or more so that the filament bodies are welded. The webbing has weight of 60 g/m or less, tensile strength of 25 kN or more, and retention rate after hexagonal bar abrasion of 70% or more.

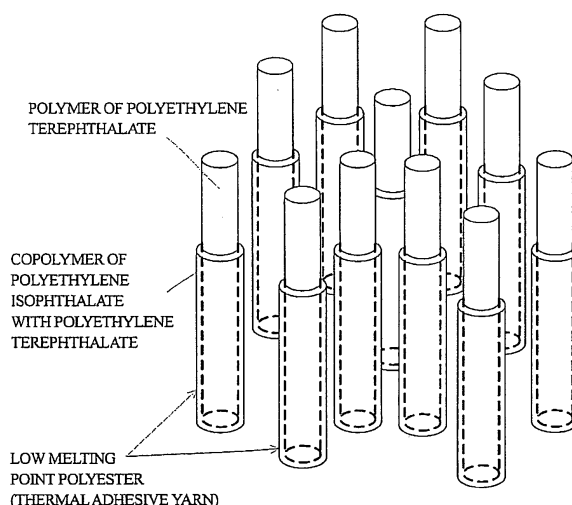


FIG. 3

Description

[0001] The present invention relates to a technology for developing an occupant restraint belt used for restraining an occupant in a vehicle in the event of a collision.

Background of the Invention

[0002] For example, Japanese Unexamined Patent Publication No. 2004-315984 discloses a conventional technology for developing such an occupant restraint belt. Proposed in this Patent Document is a technology which relates to a seat belt as an occupant restraint belt which is a long belt for restraining an occupant and can develop a seat belt having excellent retractility and comfortability by improving filament bundle and weaving arrangement thereof to be used in the seat belt and such.

Problems to be solved by the Invention

[0003] By the way, in designing the seat belt of this kind, it is required to apply stiffness to the seat belt for achieving its fundamental performance of restraining the occupant in the event of a vehicle collision. In addition, taking into consideration the comfortability for occupant wearing the seat belt and the ease of withdrawing the seat belt from a retractor, it is also required to reduce the weight of the seat belt which is a long belt. To achieve the reduction in weight of the seat belt, there may be a technique of reducing the number of filaments in the filament yarns of the seat belt. Though the technique of simply reducing the number of filaments achieves the reduction in weight, the technique has a risk of causing the reduction in stiffness according to the reduction in the number of filaments. In this case, it is difficult to achieve the fundamental performance of restraining the occupant.

[0004] The present invention has been made in order to solve the aforementioned problems and the object of the present invention is provide a technology which is effective both for applying stiffness and for reducing the weight of an occupant restraint belt to be installed in a vehicle.

Means to solve the Problems

[0005] According to the invention, this object is achieved by a webbing for an occupant restraint belt as defined in claim 1, a seat belt as defined in claim 6, and a seat belt apparatus as defined in claim 7. The dependent claims define preferred and advantageous embodiments of the invention.

[0006] For achieving the object, the present invention is made. The present invention can be typically adapted to a seat belt or a safety belt as a means for restraining an occupant in a vehicle such as an automobile.

[0007] A webbing for occupant restraint belt of this in-

vention is used for an occupant restraint belt such as a seat belt which is a long belt to be wound and unwound by a seat belt retractor and a safety belt for an aircraft. The webbing for occupant restraint belt is webbing which is woven from warp yarns and weft yarns made of synthetic filaments such that the warp yarns and the weft yarns extend perpendicular to each other.

[0008] In the webbing for occupant restraint belt of this invention, at least either of the warp yarns and the weft yarns are made of synthetic filaments having thermal adhesiveness which are made by bundling a plurality of filament bodies each of which comprises a first filament and a second filament which is attached to the outer surface of the first filament and has a melting point lower than that of the first filament. The second filaments are melted when heated under a condition of a temperature of 150 °C or more and a process time of 180 seconds or more so that the filament bodies are welded. The configuration of the filament bodies used here includes an embodiment in which the second filament is attached partially to the outer surface of the first filament and an embodiment in which the entire outer surface of the first filament is enclosed by a layer of the second filament, that is, a double layer structure. The synthetic filaments having thermal adhesiveness can be called as "thermal welding type synthetic filaments" or "thermal adhesion yarns". The present invention contains an embodiment in which either of the warp yarns and the weft yarns are made of synthetic filaments having thermal adhesiveness and an embodiment in which both the warp yarns and the weft yarns are made of synthetic filaments having thermal adhesiveness. In this case, parts or all of the warp yarns and the weft yarns may be made of synthetic filaments having thermal adhesiveness. As a specific example of the synthetic filament having thermal adhesiveness, polyester filament may be employed.

[0009] In the webbing for occupant restraint belt of this invention, at least either of the warp yarns and the weft yarns are made of synthetic filaments having thermal adhesiveness which are made by bundling a plurality of filament bodies in which the second filaments are melted when heated under a condition of a temperature of 150 °C or more and a process time of 180 seconds or more so that the filament bodies are welded to each other, whereby the second filaments (low melting point filaments) having lower melting point in the synthetic filaments having thermal adhesiveness are preferentially melted when heated under the aforementioned condition so that the adjacent filament bodies, i.e. the first filaments which are high melting point filaments, are welded to each other. That is, the second filaments having low melting point in the synthetic filaments having thermal adhesiveness exhibits works and effect as a binder for connecting the first filaments. Therefore, since the filament bodies are welded to each other, the overall stiffness of the webbing is enhanced. Thus, since the stiffness of the webbing is enhanced because of the yarns including the synthetic filaments having thermal adhesiveness, it allows reduc-

tion in number of filaments of warp yarns and weft yarns so as to achieve the weight saving. Accordingly, webbing for occupant restraint belt having weight of 60 g/m or less, tensile strength of 25 kN or more, and retention rate after hexagonal bar abrasion of 70% or more is obtained, thereby providing a seat belt having both stiffness and light weight properties. The measurement of tensile strength (force) of webbing was carried out by a method according to JIS L1096 8.12.1 A and the measurement of retention rate after hexagonal bar abrasion of webbing was carried out by a method according to JIS D4604.

[0010] The webbing for occupant restraint belt of this invention may be adapted such that the weft density is 20 picks per inch or less.

[0011] As for the sectional configuration of webbing of this kind, the warp yarns are curved so as to form "crimps (ruffling)", while weft yarns extend linearly. This is a phenomenon unique to a weaving method (weaving structure) of woven fabric in which weft yarns are inserted into portions formed by spacing warp yarns alternately. In such an arrangement, the wavy profile of the crimps as curves of warp yarns can be smoothened by reducing weft density to 20 picks per inch or less, preferably 17 or less, thereby reducing stress concentration on the curves. Therefore, with regard to satisfaction of both stiffness and weight saving of webbing, further improvement of performance can be obtained.

[0012] The webbing for occupant restraint belt of this invention may be adapted such that at least either of the warp yarns and the weft yarns are made of filament yarn material of twist yarns or filament yarn material made of entangled non-twist yarn. The present invention contains an embodiment in which the warp yarns or the weft yarns are made of filament yarn material of twist yarns or filament yarn material made of entangled non-twist yarn and an embodiment in which both the warp yarns and the weft yarns are made of filament yarns material of twist yarns or filament yarn material made of entangled non-twist yarn. This increases the tangles of filaments so as to improve the cohesion thereof, thereby enhancing the stiffness of the webbing. Especially, using the filament yarn material made of entangled non-twist yarn contributes lower material cost than a case using the filament yarn material of twist yarns, thereby reducing the manufacturing cost of the webbing for occupant restraint belt.

[0013] A seat belt of this invention is an occupant restraint belt which comprises the webbing for occupant restraint belt as mentioned above. This arrangement allows satisfaction of both stiffness and weight saving of the seat belt.

[0014] A seat belt apparatus of this invention comprises: at least a seat belt as described above; a seat belt retractor; a buckle, and a tongue. The seat belt retractor has a function of winding and unwinding the seat belt and has a retractor housing and a spool which is accommodated in the retractor housing. The seat belt retractor may be provided with a driving mechanism for driving the spool and a control mechanism for controlling the driving.

The tongue which is attached to the seat belt is latched to the buckle fixed to the vehicle when the seat belt is worn. According to this arrangement, there can be provided a seat belt apparatus in which stiffness and weight saving of the seat belt are both satisfied.

Effects of the Invention

[0015] As mentioned above, the present invention relates to webbing for occupant restraint belt which is woven from warp yarns and weft yarns made of synthetic filaments such that the warp yarns and the weft yarns extend perpendicular to each other and provides a technology which is effective both for applying stiffness and for reducing the weight of an occupant restraint belt by such an arrangement that at least either of the warp yarns and the weft yarns are made of synthetic filaments having thermal adhesiveness.

Brief Explanation of the drawings

[0016] Fig. 1 is an illustration schematically showing the structure of a seat belt apparatus 100 according to an embodiment.

[0017] Fig. 2 is a table indicating weaving conditions and webbing properties of seat belt webbing composing a seat belt 110 shown in Fig. 1 with regard to examples (Example 1 through Example 4) and a comparative example.

[0018] Fig. 3 is an illustration showing a brief overview of the low melting point polyester filaments (thermal adhesion yarns).

Best Modes for carrying out the Invention

[0019] Hereinafter, an embodiment of the present invention will be described in detail with reference to drawings. The embodiment relates to a seat belt apparatus to be installed in an automobile and proposes a seat belt which is suitable for composing the seat belt apparatus and a method for manufacturing the same.

[0020] First, description will be made as regard to a seat belt apparatus 100 as an embodiment of "seat belt apparatus" of the present invention with reference to Fig. 1. Fig. 1 is an illustration schematically showing the structure of the seat belt apparatus 100 of this embodiment according to the present invention.

[0021] As shown in Fig. 1, the seat belt apparatus 100 of this embodiment is a seat belt apparatus which is installed in a vehicle and mainly comprises a seat belt retractor 101, a seat belt 110, a tongue 104, and a buckle 106 and such.

[0022] The seat belt retractor 101 of this embodiment comprises a retractor housing 101a in which at least a cylindrical spool 102 is accommodated and is capable of winding and unwinding the seat belt 110 by the spool 102. The spool 102 is driven by a driving means composed of a spring or a motor. In the example illustrated

in Fig. 1, the seat belt retractor 101 is attached in an accommodating space in a B-pillar 10 of a vehicle. The seat belt retractor 101 corresponds to the "seat belt retractor" of the present invention.

[0023] The seat belt 110 of this embodiment is a long belt which is used for restraining a vehicle occupant C and is made by forming webbing made of synthetic filaments into a long strip. The seat belt 110 corresponds to the "occupant restraint belt" and the "seat belt" of the present invention. The seat belt 110 is withdrawn from the seat belt retractor 101 fixed relative to the vehicle and extends through a shoulder guide anchor 103 provided around an area about the shoulder of the vehicle occupant C and is connected to an outer anchor 105 through the tongue 104. By inserting (engaging) the tongue 104 to the buckle 106 fixed to the vehicle, the seat belt 110 becomes into the state worn by the vehicle occupant C. The tongue 104 corresponds to the "tongue" of the present invention and the buckle 106 corresponds to the "buckle" of the present invention.

[0024] Inventors of the present invention manufactured seat belt webbing according to the predetermined weaving conditions as will be described later for the purpose of developing a seat belt which is excellent in practical use and carried out estimation of the seat belt webbing about the properties. The seat belt webbing corresponds to the "webbing for occupant restraint belt" of the present invention.

[0025] Fig. 2 is a table indicating weaving conditions and webbing properties of seat belt webbing composing the seat belt 110 shown in Fig. 1 with regard to examples (Example 1 through Example 4) and a comparative example. The seat belt webbing of any of the examples and the comparative example is a woven fabric which is woven from warp yarns and weft yarns made of synthetic filaments filament such that the warp yarns and the weft yarns extend perpendicular to each other. Especially, thermal adhesion yarns having thermal adhesiveness are used as the weft yarns in the examples (Example 1 through Example 4), while the weft yarns are not thermal adhesion yarns in the comparative example.

[0026] As shown in Fig. 2, in Example 1, a filament bundle of warp yarns of 1670 dtex and 144 filaments, which was a weight-reduced filament yarn bundle obtained by reducing 34 warp yarns from a normal product (in which the number of warp yarns was 280), was used as a first filament yarn bundle. By this reduction, the number of the warp yarns was decreased to 246. As the first filament bundle, filament yarn material in which non-twist yarns were interlaced was used. In addition, used as a second filament bundle was weft yarns composed of high melting point polyester filaments of 560 dtex and 96 filaments and low melting point polyester filaments of 280 dtex and 16 filaments, specifically thermal adhesion yarns of which heat shrinkage factor was 30% when heated under a condition of a temperature of 210°C and a process time of 180 seconds (filaments corresponding to "synthetic filaments having thermal adhesiveness").

As for the mixture between the high melting point polyester filaments and the low melting point polyester filaments of the weft yarn, for example, one low melting point polyester filament (highly shrinkable yarn) of 280 dtex and 16 filaments is mixed per one high melting point polyester filament of 560 dtex and 96 filaments. In this case, the mixing ratio of the high melting point polyester filament relative to the low melting point polyester filament (highly shrinkable yarn) is set to 2:1.

[0027] The heat shrinkage factor of filaments is the degree of shrinkage in the longitudinal direction of filaments. As the thermal adhesion yarn, one of which heat shrinkage factor ranges of from 20% to 60% when heated under a condition of a temperature of 150 °C or more and a process time of 180 seconds or more is selected. The heat shrinkage factor of filaments, i.e. the degree of shrinkage in the longitudinal direction of filaments, is obtained from the lengths before and after the process under the aforementioned condition. That is, the heat shrinkage factor is indicated by $((\text{length after process} - \text{length before process}) / \text{length after process}) \times 100$. The lengths are obtained by process method or measuring method based on, for example, JIS L 1909.

[0028] The aforementioned high melting point polyester filaments composing the weft yarn are typically made of a polymer of polyethylene terephthalate which is manufactured by esterification of terephthalic acid and ethylene glycol. On the other hand, the aforementioned low melting point polyester filaments (thermal adhesion yarns) composing the weft yarn are typically made of a polymer of polyethylene terephthalate and a copolymer of polyethylene isophthalate with the aforementioned polyethylene terephthalate, which is manufactured by esterification of terephthalic acid, isophthalic acid and ethylene glycol.

[0029] The schematic illustration of the low melting point polyester filaments (thermal adhesion yarns) is shown in Fig. 3. As shown in Fig. 3, the low melting point polyester filaments are composed of filament bodies each of which comprises a polymer of polyethylene terephthalate and a copolymer of polyethylene isophthalate with polyethylene terephthalate coating the entire outer surface of the polymer of polyethylene terephthalate. That is, the low melting point polyester filaments are structured as double-layered copolymer in which the high melting point polymer of polyethylene terephthalate as a core is enclosed by the copolymer of polyethylene isophthalate with polyethylene terephthalate as a sheath. The low melting point polyester filaments correspond to the "filament bodies each of which comprises a first filament and a second filament which is attached to the outer surface of the first filament and has a lower melting point than that of the first filament" of the present invention. In this embodiment, multi-filaments made by bundling a plurality of low melting point polyester filaments (monofilaments) are used as some of the weft yarns. When the webbing using the weft yarns is heated, the copolymer of polyethylene isophthalate with polyethylene tereph-

thalate (low melting point filaments) having a lower melting point than that of the polymer of polyethylene terephthalate is preferentially melted so that the polyethylene terephthalate as the high melting point filaments are welded and the adjacent monofilaments and multi-filaments are thus welded to each other. That is, the low melting point copolymer of polyethylene isophthalate with polyethylene terephthalate in the low melting polyester filaments exhibits works and effects as a binder for connecting filaments. Therefore, since the adjacent monofilaments and multi-filaments are welded to each other, the overall stiffness of the webbing is enhanced. The polymer of polyethylene terephthalate corresponds to the "first filaments" of the present invention and the copolymer of polyethylene isophthalate with polyethylene terephthalate corresponds to the "second filaments having a melting point lower than that of the first filaments" of the present invention.

[0030] As the copolymerization rate, i.e. the used amount, of polyethylene isophthalate (isophthalic acid) is increased in the low melting point polyester filaments, the melting point of the original yarns is lowered. For instance, when the copolymerization rate of polyethylene isophthalate is 10% (the rate of polyethylene terephthalate is 90%), the melting point of the low melting point polyester filaments is 230 °C. When the copolymerization rate of polyethylene isophthalate is 30% (the rate of polyethylene terephthalate is 70%), the melting point of the low melting point polyester filaments is 160 °C. In this embodiment, the low melting point polyester filaments in which the copolymerization ratio of polyethylene isophthalate is 30% and the melting point is thus 160 °C are used as the thermal adhesion yarns.

[0031] The first filament bundle and the second filament bundle of the aforementioned Example 1 were processed by a needle-type weaving machine based on the weaving conditions shown in Fig. 2 so as to make a seat belt webbing (evaluation webbing). In the weaving process, the weft density was 19 picks per inch. After that, the evaluation webbing was processed by dyeing and predrying, if necessary, and was then processed by heat stabilization. The heat stabilization was conducted by passing the evaluation webbing in a heating furnace, which was controlled to have a temperature in the vicinity of 210 °C, taking about 180 seconds. The process condition for the heat stabilization may be suitably set by selecting a temperature from a range equal to and higher than 150 °C and selecting a process time from a range equal to and greater than 180 seconds. For example, a process condition that the temperature is 150 °C and the process time is 300 seconds may be selected. Further, for measuring the properties of webbing shown in Fig. 2, the evaluation webbing was cut to be a test piece of given dimensions and the test piece was dried naturally and was exposed to a predetermined condition with constant temperature and humidity (20°C, 65%RH).

[0032] In Example 1, the weight per unit length of the entire seat belt webbing was 52.80 g/m because of the

reduction of warp yarns in the first filament bundle and such. In this case, the weight saving ratio was 14.29%.

[0033] In Example 2, a filament bundle of warp yarns of 1670 dtex and 144 filaments, which was a weight-reduced filament yarn bundle obtained by reducing 34 warp yarns from a normal product (in which the number of warp yarns was 280); was used as the first filament yarn bundle. By this reduction in number of the warp yarns, the number of the warp yarns was set to 246. As this first filament yarn bundle, a yarn material made of entangled non-twist yarns was used. In addition, as the second filament yarn bundle, the same filament yarn bundle as that in example-1 was used, and the weft density was set to 20 picks per inch. The other conditions were the same as those of Example 1.

[0034] In Example 2, the weight per unit length of the entire seat belt webbing was 53.73 g/m because of the reduction of the first filament bundle. In this case, the weight saving ratio was 12.78%.

[0035] In Example 3, a filament bundle of warp yarns of 1670 dtex and 144 filaments, which was a weight-reduced filament yarn bundle obtained by reducing 26 warp yarns from a normal product (in which the number of warp yarns was 280), was used as the first filament yarn bundle. By this reduction in number of the warp yarns, the number of the warp yarns was set to 254. As this first filament yarn bundle, a yarn material made of entangled non-twist yarns was used. In addition, as the second filament yarn bundle, the same filament yarn bundle as that in example-1 was used, and the weft density was set to 17 picks per inch. The other conditions were the same as those of Example 1.

[0036] In Example 3, the weight per unit length of the entire seat belt webbing was 54.02 g/m because of the reduction of warp yarns in the first filament bundle and reduction in weft density in the second bundle. In this case, the weight saving ratio was 12.31 %.

[0037] In Example 4, a filament bundle of warp yarns of 1670 dtex and 144 filaments, which was a weight-reduced filament yarn bundle obtained by reducing 26 warp yarns from a normal product (in which the number of warp yarns was 280), was used as the first filament yarn bundle. By this reduction in number of the warp yarns, the number of the warp yarns was set to 254. As this first filament yarn bundle, a yarn material made of entangled non-twist yarns was used. In addition, as the second filament yarn bundle, the same filament yarn bundle as that in example-1 was used, and the weft density was set to 18 picks per inch. The other conditions were the same as those of Example 1.

[0038] In Example 4, the weight per unit length of the entire seat belt webbing was 54.59 g/m because of the reduction of warp yarns in the first filament bundle and reduction in weft density in the second bundle. In this case, the weight saving ratio was 11.38%.

[0039] In Comparative Example, used as a first filament bundle was a filament bundle of warp yarns of 1670 dtex and 144 filaments, in which the number of warp

yarns was the same of the number (280) of warp yarns of a normal product. As this first filament yarn bundle, a yarn material made of entangled non-twist yarns was used. In addition, used as a second filament bundle was a filament bundle of weft yarns of 830 dtex and 96 filaments, not including any thermal adhesion yarn as used in Example 1 through Example 4. The weft density in the second filament bundle was 19 picks per inch.

[0040] In Comparative Example, the weight per unit length of the entire seat belt webbing was 61.60 g/m. This weight was defined as the reference value for weight saving.

[0041] With regard to the respective seat belt webbings of Example 1 through Example 4 and Comparative Example which were woven based on the aforementioned weaving condition, inventors of the present invention carried out the measurements of the following items for the purpose of evaluating the webbing properties. Since the inventors carried out each measurement using at least five test pieces for each webbing, it was confirmed that the results of measurements had reproducibility.

(Measurement Items)

[0042] In this embodiment, as the measurement items for evaluating the webbing properties of seat belt webbing, "tensile strength (sometimes referred to "force" or "strength")" and "retention rate after hexagonal bar abrasion" were used.

(Measurement of Force)

[0043] In this embodiment, the measurement of tensile strength (force) of webbing was carried out by a method according to JIS L1096 8.12.1A. By designing seat belt webbing to have tensile strength exceeding, for example, 25 kN, it is ensured to provide a desired load capacity required for seat belt.

(Measurement of Retention Rate after Hexagonal Bar Abrasion)

[0044] In this embodiment, the measurement of retention rate after hexagonal bar abrasion of webbing was carried out by a method according to JIS D4604. By designing seat belt webbing to have retention rate after hexagonal bar abrasion exceeding, for example, 70%, it is ensured to provide a desired abrasion resistance required for seat belt.

(Evaluation Items)

[0045] Then, the inventors evaluated the respective seat belt webbings of Example 1 through Example 4 and Comparative Example based on the results of the aforementioned measurements. As the evaluation items, "lightweight properties", "strength", and "abrasion resistance" of webbing were used.

[0046] Since, as shown in Fig. 2, the webbing of Example 1 had a weight saving ratio of 14.29% relative to Comparative Example because of the thinning of the first filament bundle by reducing 34 warp yarns, it was confirmed that the webbing was superior especially in lightweight properties. Though the webbing of Example 1 was slightly inferior to Comparative Example with regard to the tensile strength and the retention rate after hexagonal bar abrasion, the webbing satisfied the required levels, i.e. tensile strength greater than 25 kN and retention rate after hexagonal bar abrasion greater than 70%. That is, it was confirmed that the webbing of Example 1 was also excellent in strength and abrasion resistance.

[0047] Since the webbing of Example 2 had a weight saving ratio of 12.78% relative to Comparative Example because of the thinning of the first filament bundle by reducing 34 warp yarns, it was confirmed that the webbing was superior in light weight properties. Though the webbing of Example 2 was slightly inferior to Comparative Example with regard to the tensile strength, the webbing satisfied the required level, i.e. tensile strength greater than 25 kN. That is, it was confirmed that the webbing of Example 2 was also excellent in strength. Further, since the retention rate after hexagonal bar abrasion of the webbing was 83.43% which was larger than that of Comparative Example, it is also confirmed that the webbing was excellent in abrasion resistance.

[0048] Since the webbing of Example 3 had a weight saving ratio of 12.31 % relative to Comparative Example because of the thinning of the first filament bundle by reducing 26 warp yarns and the reduction in weft density per inch of the second filament bundle (17 picks per inch), it was confirmed that the webbing was superior in light weight properties. Though the webbing of Example 3 was slightly inferior to Comparative Example with regard to the tensile strength and the retention rate after hexagonal bar abrasion, the webbing satisfied the required levels, i.e. tensile strength greater than 25 kN and retention rate after hexagonal bar abrasion greater than 70%. That is, it was confirmed that the webbing of Example 3 was also excellent in strength and abrasion resistance.

[0049] Since the webbing of Example 4 had a weight saving ratio of 11.38% relative to Comparative Example because of the thinning of the first filament bundle by reducing 26 warp yarns and the reduction in weft density per inch of the second filament bundle (18 picks per inch), it was confirmed that the webbing was superior in light weight properties. Though the webbing of Example 2 was slightly inferior to Comparative Example with regard to the tensile strength, the webbing satisfied the required level, i.e. tensile strength greater than 25 kN. That is, it was confirmed that the webbing of Example 4 was also excellent in strength. Further, since the retention rate after hexagonal bar abrasion of the webbing was 83.48% which was larger than that of Comparative Example, it is also confirmed that the webbing was excellent in abrasion resistance.

(Comprehensive Evaluation)

[0050] Based on the aforementioned results of evaluation, in Fig. 2, the comprehensive evaluation of each seat belt webbing of Example 1 through Example 4 was "◎" because each of them was excellent in all of light weight properties, strength, and abrasion resistance, while the comprehensive evaluation of the seat belt webbing of Comparative Example was "×" because it did not satisfy the desired level as the comprehensive level relating to the light weight properties, the strength, and the abrasion resistance. Especially, since the weight of the seat belt webbing of Comparative Example exceeds 60 g/m, it had trouble with light weight properties.

[0051] As mentioned above, the embodiment provides a seat belt (webbing) which is excellent in practicality such as light weight properties, strength, and abrasion resistance, and provides a seat belt apparatus using the seat belt.

[0052] That is, the seat belt webbings of Example 1 through Example 4 which were woven according to the embodiment are excellent overall such as weight, tensile strength, retention rate after hexagonal bar abrasion as compared to Comparative Example and thus are effective in weight saving while preventing the reduction in seat belt strength.

[0053] Especially, the webbing of each of Example 1 through Example 4 uses the weft yarns in which the low melting point polyester filaments (thermal adhesion yarns) having thermal adhesiveness which are melt when heated under a condition of a temperature of 210°C or more and a process time of 180 seconds or more so as to contribute filament welding are mixed with the high melting point polyester filaments. Therefore, when the webbing is heated under the aforementioned condition, the polyethylene isophthalate having a lower melting point than the other synthetic filaments having thermal adhesiveness is preferentially melted so that the adjacent filaments are welded to each other by the effect as a binder. Therefore, the high melting point polyester filaments are welded to each other, thereby enhancing the overall stiffness of the webbing. Thus, since the stiffness of the webbing is enhanced because of the yarns including the synthetic filaments having thermal adhesiveness, it allows reduction in number of filaments of warp yarns and weft yarns so as to achieve the weight saving. Accordingly, seat belt webbing having weight of 60 g/m or less, tensile strength of 25 kN or more, and retention rate after hexagonal bar abrasion of 70% or more is obtained, thereby providing a seat belt having both stiffness and light weight properties.

[0054] What the present invention requires is to obtain seat belt webbing having weight of 60 g/m or less, tensile strength of 25 kN or more, and retention rate after hexagonal bar abrasion of 70% or more by suitably employing synthetic filaments having thermal adhesiveness in which low melting point filaments are melted to weld high melting point filaments when heated under a condition

of a temperature of 150 °C or more and a process time of 180 seconds or more. In the present invention, the kinds of filaments to be used in warp yarns and weft yarns and the process condition may be suitably changed, if necessary. Though the weft yarns are made by mixing the low melting point polyester filaments (thermal adhesion yarns) with the high melting point polyester filaments in the aforementioned embodiment, the kinds of high melting point filaments and low melting point filaments, the combination and the mixing ratio of the high melting point filaments and the low melting point filaments may be suitably changed, if necessary.

[0055] In the seat belt webbings of Example 1 through Example 4 which are woven according to this embodiment, the warp yarns may be made of filament yarn material of twist yarns or material made of entangled non-twist yarn. This increases the tangles of filaments so as to improve the cohesion thereof, thereby enhancing the stiffness of the webbing. Especially, using the material made of entangled non-twist yarn contributes lower material cost than a case using the filament yarn material of twist yarns, thereby reducing the manufacturing cost of the webbing.

[0056] As for the sectional configuration of webbing of this kind, warp yarns are curved so as to form "crimps (ruffling)", while weft yarns extend linearly. This is a phenomenon unique to a weaving method (weaving structure) of woven fabric in which weft yarns are inserted into shed of warp yarns alternately. The wavy profile of the crimps as curves of warp yarns can be smoothened by reducing the weft density to 20 picks per inch or less like the seat belt webbings of Example 1 through Example 4, especially by reducing the weft density to 17 or 18 picks per inch as Example 3 or Example 4, thereby reducing stress concentration on the curves. Therefore, with regard to satisfaction of both stiffness and weight saving of webbing, further improvement of performance can be obtained. In the present invention, the weft density per inch may be suitably set within a range equal to and smaller than 20. Further, the weft density may be set to exceed 20 picks per inch when desired webbing properties can be obtained by employing synthetic filaments having thermal adhesiveness.

(Another embodiment)

[0057] The present invention is not limited to the aforementioned embodiment, so various variations and modifications may be made. For example, the following embodiments as variations of the aforementioned examples may be carried out.

[0058] Though the above examples have been described with regard to a case that only weft yarns among warp yarns and weft yarns are structured to include synthetic filaments having thermal adhesiveness, only warp yarns or both warp yarns and weft yarns may be structured to include synthetic filaments having thermal adhesiveness in the present invention.

[0059] Though the above examples have been described with regard to a case that only warp yarns among warp yarns and weft yarns are made of material made of entangled non-twist yarn, only weft yarns or both warp yarns and weft yarns may be made of filament yarn material of twist yarns or material made of entangled non-twist yarn in the present invention. In the present invention, warp yarns and weft yarns may be made without using the filament yarn material of twist yarns or the material made of entangled non-twist yarn when desired webbing properties can be obtained by employing synthetic filaments having thermal adhesiveness.

[0060] Though the above embodiment has been described with regard to the seat belt apparatus 100 to be installed in an automobile, the present invention can be adapted to seat belts for restraining occupants in a driver seat, a front passenger seat, and a rear seat, and seat belts to be installed in vehicles such as aircraft and boat other than the automobile.

any one of claims 1-4, wherein the second filament comprises a copolymer of polyethylene isophthalate with polyethylene terephthalate.

5 6. A seat belt, wherein said seat belt is said occupant restraint belt (110) which comprises the webbing for occupant restraint belt (110) as claimed in any one of claims 1 through 5.

10 7. A seat belt apparatus comprising:

a seat belt (110) as claimed in claim 6;
a seat belt retractor (101) capable of winding and unwinding said seat belt (110);
15 a buckle (106) fixed to a vehicle;
a tongue (104) which is attached to said seat belt (110) and is latched to said seat belt buckle (106) when said seat belt (110) is worn.

20

Claims

1. Webbing for an occupant restraint belt which is a long belt (110) for restraining a vehicle occupant (C),
25 being woven from warp yarns and weft yarns made of synthetic filaments such that the warp yarns and weft yarns extend perpendicular to each other, wherein at least either of said warp yarns and said weft yarns are made of synthetic filaments having thermal adhesiveness which are made by bundling a plurality of filament bodies each of which comprises a first filament and a second filament which is attached to the outer surface of said first filament and has a melting point lower than that of said first filament, and said second filaments are melted when heated under a condition of a temperature of 150 °C or more and a process time of 180 seconds or more so that the filament bodies are welded to each other, and wherein said webbing has weight of 60 g/m or less, tensile strength of 25 kN or more, and retention rate after hexagonal bar abrasion of 70% or more.
30
2. Webbing for an occupant restraint belt as claimed in claim 1, wherein
45 the weft density is 20 picks per inch or less.
3. Webbing for an occupant restraint belt as claimed in claim 1 or 2, wherein
50 at least either of said warp yarns and said weft yarns are made of material of twist yarns or material made of entangled non-twist yarn.
4. Webbing for a occupant restraint belt as claimed in any one of claims 1-3, wherein the first filament comprises polyethylene terephthalate.
55
5. Webbing for a occupant restraint belt as claimed in

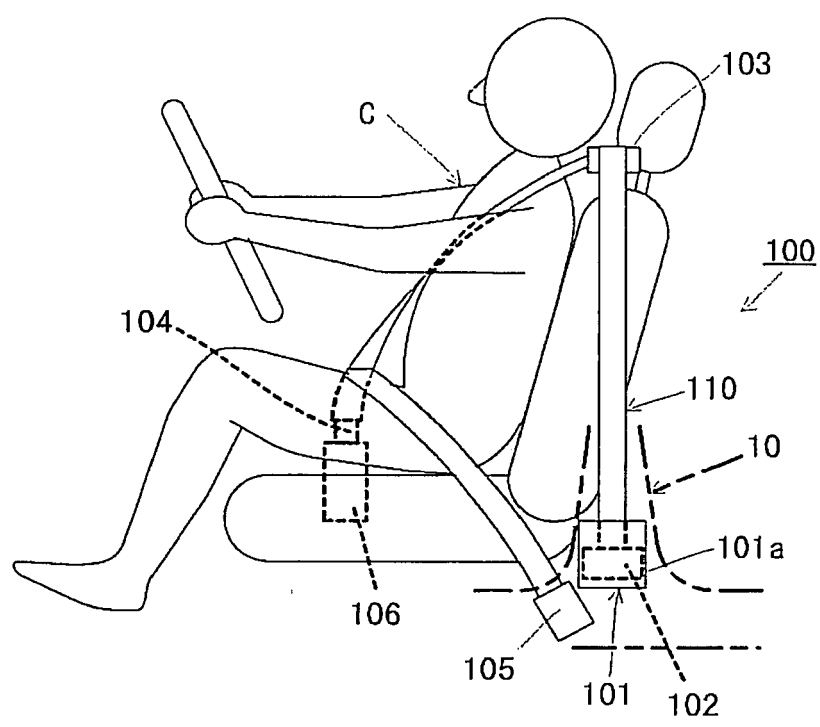


FIG. 1

	WEAVING CONDITION					WEBBING PROPERTIES				COMPREHENSIVE EVALUATION
	WARP		WEFT			WEIGHT SAVING RATIO [%]	TENSILE STRENGTH [RM]	RETENTION RATE AFTER HEXAGONAL BAR ABRASION [%]		
	HIGH MELTING POINT POLYESTER [dtex]f	NUMBER OF WARPS	HIGH MELTING POINT POLYESTER [dtex]f	LOW MELTING POINT POLYESTER (THERMAL ADHESION YARN) [dtex]f	NUMBER OF WOVEN WEFTS (WEFTS PER INCH)					
EXAMPLE 1	1670/144	246	560/96	280/16	19	52.80	14.29	30.07	78.16	⊙
EXAMPLE 2	1670/144	246	560/96	280/16	20	53.73	12.78	29.07	83.43	⊙
EXAMPLE 3	1670/144	254	560/96	280/16	17	54.02	12.31	29.93	80.62	⊙
EXAMPLE 4	1670/144	254	560/96	280/16	18	54.59	11.38	29.47	83.48	⊙
COMPARATIVE EXAMPLE	1670/144	280	830/96	NONE	19	61.60	REFERENCE	32.33	82.30	X

FIG. 2

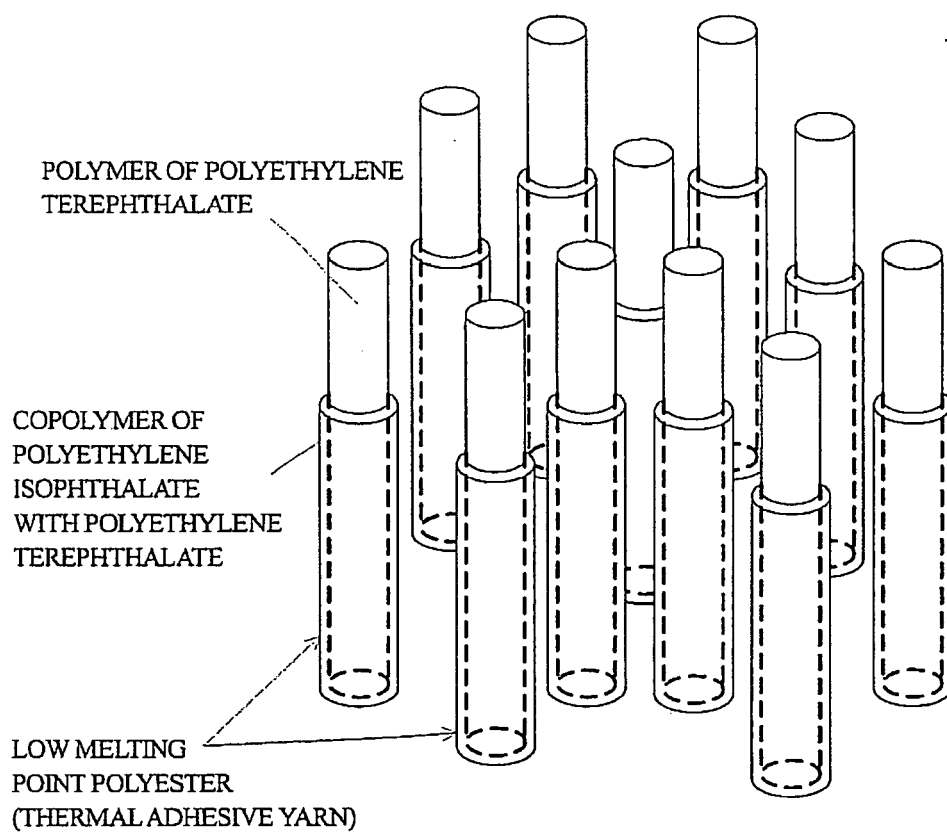


FIG. 3

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2004315984 A [0002]