WEBBING AND BELTING MEANS FOR USE IN SEAT BELTS

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ABSTRACT

Weight belt restraining structure having a webbing with a multiple-step give. The webbing belts and the like having a multiple-step give. The webbing has a first warp of yarn of medium strength high tensility and has a second and third warp of yarn of low strength low tensility, medium strength medium tensility, on high strength low tensility as compared with the strength and tensility of the first warp. The weft is yarn of medium strength and high tensility. All of the warp yarns are sufficiently strong so they are not broken until the initial load applied to the webbing reaches a predetermined value between 200–1,000 kg, and the warp yarns also have sufficient strength not to elongate in proportion to an increase in load. Above the predetermined load value, the second and third warp yarns are gradually and repeatedly broken while the shape of the web is maintained by the first warp yarn and the weft until the tensility reaches a predetermined value after the initial load reaches such a value, after which the webbing elongates without an increase in the load applied thereto. The webbing does not return to its initial state with a violent recoil after removal of the load, due to the action of the first and second warps, thereby giving the webbing a multiple-step give with a load-deflection curve substantially in the form of a parallelogram.

8 Claims, 15 Drawing Figures
WEBBING AND BELTING MEANS FOR USE IN SEAT BELTS

This application is a division of U.S. Pat. Ser. No. 236,749, filed Mar. 21, 1972 now U.S. Pat. No. 3,756,288.

This invention relates to webbing and belting means for use in seat belts for easing mechanical shocks applicable to drivers of automobiles and crew of airplanes and the like in the case of collisions of such vehicles and preventing said drivers and crew from secondary collisions against structures inside the vehicles, and also for use in parachute belts, life belts for workers at high altitudes, and the like.

Hereinbefore, safety belts of this kind were constructed of webbing comprising two kinds of warp each having different elasticity as disclosed, for example, in the specification of U.S. Pat. No. 3,464,459. However, the belt webbing of said U.S. Patent is not so constructed as will induce a correlative function between the two kinds of warp, i.e., the core warp and the other warp which function independently of each other. When the correlative function is lacking between the two kinds of warp, there is no multiplicative energy absorption between said two kinds of warp, and the functions of safety belt as described hereinbefore can scarcely be expected from such webbing.

Furthermore, the specification of U.S. Pat. No. 3,148,710 discloses a device wherein a binding medium for binding two kinds of warp is interposed therebetween enabling to obtain a correlative function between the two kinds of warp each having different elasticity when an instantaneous impact is applied thereto. However, such construction will increase the thickness of the belt involving the defects of necessitating a large-sized retractor particularly in the case of a type wherein the belt when not used is retracted into a retractor, and depriving the belt of flexibility when said belt is fitted.

A first object of this invention is to obtain webbing having the multiple-step give wherein the warp resists a predetermined initial load, a subsequent increase in load being disposed of by elongation and intermittent repetition of breakup of particular warp thereby preventing an increase in load applicable to the belt, violent recoil after removal of the load being prevented by the resistance of the broken warp, and also to obtain belting means making use of said webbing.

A second object of this invention is to provide webbing having a characteristic of absorbing a predetermined increase in load under spontaneous impact elongation and intermittent repetition of breakup of said particular warp comprising more than two kinds of yarn each having different elasticity and strength, said intermittent repetition of breakup of the particular warp, being accomplished by a correlative function between a first texture comprising main warp and weft and a second texture comprising other warp and said weft without the help of the binding medium.

A third object of this invention is to reduce the production cost by simplifying the texture and to obtain belt webbing easily retractable into a small-sized retractor by reducing the thickness of said webbing.

These and other objects are accomplished by proper combinations of warp yarns to be used and the texture comprising warp and weft, preferred embodiments of which are shown by way of example in the accompanying drawing and herein described in detail.

Of the drawings:

FIG. 1 is a longitudinally sectional side view on a magnified scale in part showing the webbing of this invention;

FIG. 2 is a perspective on a magnified scale and broken off in part showing the texture of webbing of this invention;

FIG. 3 is a descriptive plan on a magnified scale showing the texture of the webbing of this invention;

FIG. 4 is a graph showing curves indicating the relation between the load and tensility of a seat belt in which the webbing of this invention is used;

FIG. 5 is a graph showing curves indicating the relation between the strength and tensility of the yarn for use in the webbing of this invention;

FIG. 6 is a graph showing curves indicating the relation between the load and tensility of a seat belt in which is used webbing of another embodiment of this invention;

FIG. 7(a) is a graph showing curves indicating the relation between the load and tensility when the webbing of this invention is used for a waist belt;

FIG. 7(b) is a graph showing curves indicating the relation between the load and tensility when the webbing of this invention is used for a shoulder belt;

FIG. 8(a) is a graph showing curves indicating the relation between the load and tensility of the known webbing for a waist belt;

FIG. 8(b) is a graph showing curves indicating the load and tensility of the known webbing for a shoulder belt;

FIG. 9 is an elevation of a triple seat belt so called three-points seat belt comprising in combination the waist belt webbing having the load-tensility property shown in FIG. 7(a) and the shoulder belt webbing having the load-tensility property shown in FIG. 7(b);

FIG. 10 is an elevation of a triple seat belt comprising in combination the known waist belt webbing having the load-tensility property shown in FIG. 8(a) and the known shoulder belt webbing having the load-tensility property shown in FIG. 8(b);

FIG. 11 is a graph showing curves indicating the relation between gravity and time duration arising on the floor of a vehicle in an impact test;

FIG. 12 is a graph showing curves indicating the relation between forward and backward gravity and time duration in connection with the head of a dummy in an impact test;

FIG. 13 is a graph showing curves indicating the relation between the load arising at the anchorage 7 the shoulder belt and the time duration in an impact test;

FIGS. 14 and 15 are elevations showing still another embodiment of the invention.

Referring now to FIGS. 1 to 3, the numerals 11, 12, 13 and 14 designate warp respectively, 15 designating weft, each comprising yarn as described hereinunder.

Warp 11: Medium strength high tensility type
Warp 12: Low strength low tensility type
Warp 13: High strength low tensility type
Warp 14: Medium strength medium tensility type
Weft 15: Medium strength high tensility type

Referring to FIGS. 1 and 2, warp 11 runs over two threads of weft 15 and then runs under the adjacent
two threads of weft 15, thereby constituting a first texture consisting of so-called 2 up – 2 down twill.

Furthermore, warp 12, 13, each comprising a plurality of threads arranged in parallel, run across weft 15 up and down alternately, thereby constituting a second texture which is a plain web. Moreover, warp 14 runs across weft 15 up and down alternately between each adjacent warp 11, thereby constituting part of the second texture which is a plain web.

FIG. 3 shows the construction of the texture described hereinbefore. In this construction chart warp runs longitudinally, weft running transversely, white squares showing where warp runs over weft, black squares showing where warp runs under weft.

In the texture above mentioned, suitable yarn for warp 12 is polyamide fiber yarn of which tensility has been increased by a boiling process in hot water at temperatures 95° – 100° C for 25–30 minutes, the tensility being increased by approximately 10 percent by the said boiling process. The same yarn as said processed warp 11 may be used for the second texture in addition to warp 12, 13 and 14, if necessary.

With regard to warp 12, two, three, four or five threads instead of a single thread may be passed in combination in some section of the web.

Each embodiment of webbing shown in FIGS. 1 to 3 is described hereinafter.

EMBODIMENT NO. 1

An automobile seat belt webbing having a breadth of 50mm was woven into texture as shown in FIG. 3 making use of warp 11, 12, 13, 14 and weft 15 of the description as set forth hereinafter.

Warp 11: 188 threads of Type 6 nylon (Teijin Nylon T500, brand of polyamide synthetic fiber of Teijin K.K., Japan) of medium strength high tensility (relation between both properties as per FIG. 5) of 840/96 – 1/2S – 140 T/m

Warp 12: 100 threads of Teijin Tetoron R120 (brand of polyester synthetic fiber of Teijin K.K., Japan) of low strength low tensility (relation between both properties as per FIG. 5) of 250/24 – 1/2S – 75 T/m

Warp 13: 10 threads of Teijin Tetoron P500 (brand of polyester synthetic fiber of Teijin K.K., Japan) of high strength low tensility of 1000/250 – 1/1S – 100 T/m

Warp 14: 10 threads of Teijin Tetoron R620 (brand of polyester synthetic fiber of Teijin K.K., Japan) of medium strength medium tensility (relation between both properties as per FIG. 5) of 1000/250 – 1/1S – 100 T/m

Weft 15: 18 pick/inch of Type 6 nylon (Teijin Nylon T500, brand of polyamide synthetic fiber of Teijin K.K., Japan) of medium strength high tensility (relation between both properties as per FIG. 5) of 840/96 – 1/2S – 100 T/m

By giving tensile stress to the webbing above mentioned, the relation between the load applied to said webbing and the tensility thereof and the resilience after removal of said load were tested, and the result was as per the graph shown in FIG. 4, of which the vertical axis indicates an increase in load upwardly, the transverse axis indicating elongation of the belt in the right direction.

As is clear from this graph, the belt, under load not greater than 400 kg, was rectilinearly elongated by 7–8 percent, the load being absorbed by the belt from Point A onward, the elongation reaching approximately 25 percent at Point B. The principle of the function of warp 11, 12, 13, 14 and weft 15 between Points A and B is presumably as described hereinafter.

At Point A warp 12 of low strength low tensility is first broken, thereafter warp 13, 14 except weft 15 are broken according as the load exceeds the strength and tensility of said warp. After the load reaches Point A primary breakage arises on warp 12, 13, 14 simultaneously and/or successively. If the load is further increased, the first texture including warp 11 which was in loose correlation with the second texture including warp 12, 13, 14 is brought into closer correlation with the latter.

In other words, weft 15 of the first texture which was hitherto in loose engagement with warp of the second texture gives strong pressure support to warp already broken or not yet broken as a result of elongation of warp 11 which has absorbed the load and/or tension of said warp 11 due to direct application of the load thereto through temporary breakage of said other warp, stronger correlation being thus brought between the first texture and the second texture. Consequently, the load is again applied to the warp which were already subjected to the primary breakage through the medium of the first texture, thereby causing a secondary and a tertiary breakage of warp, one after another, with the result that an increase in load applicable to the entire webbing is absorbed effectively.

Though warp 12, 13, 14 are gradually and repeatedly broken, warp 11 of the first texture is free from breakage, the webbing as a whole being subjected to plastic deformation as shown by the curve A – B in FIG. 4 thereby absorbing energy.

The value of the initial load at Point A can be determined by selecting the strength, tensility and number of the component threads of warp 12, 13, 14 and particularly 12.

If tensility exceeds 25 percent, the load increases, the belt being elongated. At Point C where the load reaches 1,130 kg, the tensility exceeds 40 percent, the belt slightly shrinking to Point D with removal of the load. However, since a considerable number of warp have already been broken, the shrinkage is minimized by the resistance between threads of warp thereby preventing the risk of the human body being harmed by a violent resilient force.

Moreover, by adjusting the number of warp per unit length and the number of weft per unit length, the substantially horizontal portion between A and B of the curve in FIG. 4, that is, the length of the plateau portion, can be adjusted. Furthermore, it is also practicable to produce a belt wherein the portion between B and C where said plateau terminates and the curve rises upwardly again is maintained horizontally just as the portion between B and E, said B – C portion being adapted to be restored to the E – D portion after removal of the load.

In the embodiment described hereinbefore warp 11 and weft 15 of the first texture were woven into twilled web. However, the same characteristics can be expected from webbing of plain weave instead of twill and also from webbing wherein the second texture comprising warp 12, 13, 14 is woven into twill web same as the first texture.
5 Furthermore, webbing for use in safety belts and particularly for shoulder belts can be obtained by selecting the predetermined value of the initial breakage of warp within the scope of 200 – 800 kg, webbing being adapted to have greater tensility as compared with the increase in load until the tensility reaches 20 – 30 percent after said predetermined value.

As shown in FIG. 6, peak load can be determined prior to the determined value of the initial load and higher than said load by increasing the component number of warp 12, 13, 14 constituting the second texture than in the case of Embodiment No. 1 as seen in Embodiment No. 2 which is described hereinafter, and by giving comparatively great tendency to warp 11 of the first texture. Such peak load serves to ease gravity applied to the human head by impact.

As described hereinbefore, if the warp 11 is woven at higher tension, the broken warp shall be pressedly suspended by the first texture simultaneously with the initial breakage, thereby said warp shall not slip in the first and second texture and shall serve its function. In other words, since the broken warp is pressure supported by the first texture said warp is capable of working in resistance to the subsequent load promptly after the breakage.

EMBODIMENT NO. 2

Webbing having the identical breadth with Embodiment No. 1 was produced in the identical texture with said embodiment making use of warp 11, 12, 13, 14 and weft 15 which are identical with said embodiment only excepting the number of threads. However, the webbing was produced by applying greater tensile strength (300 – 350 g/thread) to warp 11 than that of Embodiment No. 1 (150 – 200 g/thread).

Warp 11: 188 threads
Warp 12: 180 threads
Warp 13: 18 threads
Warp 14: 18 threads
Weft 15: 18 pick/inch

By applying tensile strength to the above-mentioned webbing, the relation between the load and tensility as well as the resilience as the time of removal of said load was tested, the result of which was as shown in FIG. 6. The webbing has proved to have excellent properties for seat belts and particularly for shoulder belts as described hereinbefore.

Furthermore, though warp 11 and weft 15 constituting the first texture was woven into twilled web in the embodiment above mentioned, the identical properties with those of Embodiment No. 1 are obtainable even if the webbing is woven into plain web instead of twill, and even if the second texture comprising warp 12, 13, 14 is woven into twill web same as Embodiment No. 1.

In addition thereto, the webbing of this embodiment can be used for seat belts and particularly for shoulder belts by setting the predetermined value of the initial load within the scope of 200 – 800 kg, the warp being adapted to have greater tensility as compared with an increase in load until the tensility reaches 20 – 30 percent after said predetermined value.

The seat belt in which the webbing of this invention is used in the shoulder and/or waist belt thereof has a distinguished energy absorbing effect.

Hereinunder is described still another embodiment of a triple seat belt wherein webbing of Embodiment No.

1 is used in the shoulder belt and webbing of another kind of this invention is used in the waist belt.

EMBODIMENT NO. 3

Webbing for seat belts having the identical breadth with Embodiment No. 1 was woven in the identical composition with Embodiment No. 1.

The load-tensility property of the webbing obtained was as shown in FIG. 7(a).

| Warp 11: | Teijin Tetoron R 120 | 160 threads |
| Warp 12: | Teijin Tetoron P500 | 40 do. |
| Weft 15: | Teijin Tetoron R120 | 18 pick/inch |

A triple seat belt A as shown in FIG. 9 was constructed with webbing of Embodiment No. 3 used as webbing for the waist belt 21 and with webbing having the load-tensility property as shown in FIG. 7(b) used as webbing for the shoulder belt 22. Referring to FIG. 9, the numeral 23 designates a buckle, AnA, AnA' and AnA'' designating anchorages.

On the other hand, a triple seat belt B as shown in FIG. 10 was constructed making use of known webbing as waist belt webbing 24 having the properties shown in FIG. 8(b) and shoulder belt webbing 25 (having the properties as shown in FIG. 8(b)). In said figure, the numeral 26 designates buckles, AnB, AnB' and AnB'' designating anchorages.

An impact test was conducted by causing an automobile (Carora 1970 model of Toyota Automobile Manufacturing Co., Ltd., Japan) equipped with said triple seat belts A and B respectively to collide against a stationary barrier with an initial colliding speed of 47 km/h. The gravity which acted on the floor of the automobile was as shown in FIG. 11.

The gravity which acted in the forward and backward direction on the head of the dummy restrained by the belt A was as indicated by the curve shown in solid line in FIG. 12, the gravity which acted in the forward and backward direction on the head of the dummy restrained by the belt B being as indicated by the curve shown in the dotted line in said figure.

Moreover, the load curves indicating the load applied to anchorages AnA and AnB (see FIGS. 9 and 10) of the belts A and B were as shown by the solid line and the broken line respectively in FIG. 13. The maximum loads appeared at said anchorages AnA and AnB of the belts A and B were 678 kg and 868 kg respectively, the loads applied to the anchorage AnA' on the side of the center of the car of the shoulder belt of the belt A, the anchorage AnA'' on the opposite side, the anchorage AnB' on the side of the center of the car of the belt B, and the anchorage AnB'' on the opposite side were as designated in the table shown hereunder.

| AnA' | AnA'' |
| 981 kg | 664 kg |
| AnB' | AnB'' |
| 882 kg | 534 kg |

The test described hereinbefore disclosed that the webbing of this invention had a distinguished effect in energy absorption.
The webbing for the shoulder belt of the said triple seat belt is preferably adapted to have greater tensility as compared with an increase in load until said tensility reaches 20 – 30 percent after a predetermined value of the initial load, said predetermined value being restricted within the scope of 200 – 800 kg as in the case of Embodiments No. 1 and No. 2.

The webbing for the waist belt to be combined with the shoulder belt of such triple seat belt is preferably adapted to have greater tensility as compared with an increase in load until the tensility reaches 10 – 20 percent after a predetermined value of the initial load, said predetermined value being set within the scope of 500 – 1,100 kg.

Furthermore, the webbing of Embodiment No. 2 was trially used for the shoulder belt of the triple seat belt with as satisfactory results as those of the above-mentioned test.

The seat belt shown in FIG. 9 is an embodiment of the triple seat belt. It goes without mentioning, however, that the use of this embodiment enables one to obtain the same satisfactory results if applied to the full-harness type belt and the inverted Y type belt as shown in FIGS. 14 and 15.

In FIGS. 14 and 15, the waist belt webbing 27, 29 is the webbing shown in Embodiment No. 3, the shoulder belt webbing 28, 30 being the webbing shown in Embodiment No. 1 or No. 2, thereby constituting a seat belt C, D. In FIGS. 14 and 15, AnC, AnC’, AnC’’, AnD, AnD’ and AnD’’ being anchoring respectively.

As described hereinbefore, this invention enables to obtain webbing having the multiple-step give from woven textures, such as plain web, twill web and the like, said textures though simple in construction being adapted to comprise more than two kinds of warp of each different tensility and thickness which are brought into correlation when violent tension is applied thereto, thereby enabling to obtain satisfactory results.

What we claim is:

1. A seat belt comprising a shoulder belt and a waist belt, said shoulder belt comprising at least in part first warp consisting of yarn of medium strength high tensility and webbing including at least second and third warp, said second and third warp being selected from yarn of low strength low tensility, medium strength medium tensility, high strength low tensility as compared with the strength and tensility of said first warp, said first warp constituting a first texture together with web consisting of yarn of medium strength and high tensility, said second and third warp constituting a second texture together with said web, all said warp being adapted not to break until the initial load applied to the webbing reaches a predetermined value between 200 – 800 kg, said warp also having comparatively great strength not to elongate in proportion to an increase in load, second and third warp being gradually and repeatedly broken sustained by the first texture until the tensility attains 20 – 30 percent after the initial load reached the predetermined value thereby enabling the webbing to elongate without increasing the load applied thereto, said webbing being a multiple-step give member having a load-flection curve which is substantially a parallelogram wherein restoration with violent resilience is prevented thereby.

2. A seat belt as defined in claim 1 wherein the waist belt comprises first warp consisting of yarn of medium strength high tensility and at least second and third warp, said second and third warp being selected from yarn of low strength low tensility, medium strength medium tensility, high strength low tensility respectively as compared with the strength and tensility of said first warp, said first warp constituting a first texture together with said web consisting of yarn of medium strength high tensility, said second and third warp constituting a second texture together with said web, all said warp being adapted not to break until the initial load applied to the webbing reaches a predetermined value set between 500 – 1,100 kg, said warp also having comparatively great strength not to elongate in proportion to an increase in load, second and third warp being broken gradually and repeatedly sustained by the first texture until the tensility attains 10 – 20 percent after the initial load reached the predetermined value, thereby enabling the webbing to elongate without increasing the load applied thereto, said webbing constituting a multiple-step give member wherein the load-flection curve substantially forming a parallelogram and restoration with violent resilience is prevented by a correlative action between the first and second textures after removal of the load.

3. A seat belt comprising a shoulder belt and a waist belt wherein said belt includes at least in part first warp consisting of yarn of medium strength high tensility and at least second and third warp, said second and third warp being selected from yarn of low strength low tensility, medium strength medium tensility, high strength low tensility as compared with the strength and tensility of said first warp, said first warp constituting a first texture together with web consisting of yarn of medium strength high tensility, said second and third warp constituting a second texture together with said web, the volume of third warp and the tension of first warp being comparatively increased, a peak load higher than said predetermined value being adapted to work transitionally upon the webbing prior to the initial load reaching the predetermined value set between 200 – 800 kg thereby causing said warp to break, said warp being not broken until the load applied to the webbing reaches the value of said peak load, said warp also having comparatively great strength not to elongate in proportion to an increase in the load, second and third warp being broken gradually and repeatedly by a load substantially identical with the value of said predetermined load sustained by the first texture until the tensility attains 20 – 30 percent after the initial load reached said predetermined value thereby enabling the webbing to elongate without increasing the load applied thereto, said webbing having a multiple-step give member with the load-flection curve formed substantially in the shape of a parallelogram wherein restoration with violent resilience of said webbing is prevented by a correlative action between the first and second textures after removal of the load therefrom said waist belt comprising webbing of less tensility than that of said shoulder belt.

4. A seat belt as defined in claim 3, said belt comprising first warp consisting of yarn of medium strength high tensility and at least second and third warp, said second and third warp being selected from yarn of low strength low tensility, medium strength medium tensility, high strength low tensility as compared with the
strength and tensility of said first warp, said first warp constituting a first texture together with weft consisting of yarn of medium strength high tensility, said second and third warp constituting a second texture together with said weft, all said warp being not broken until the initial load applied to the webbing reaches a predetermined value set between 500 – 1,100 kg, said warp also having comparatively great strength not to elongate in proportion to an increase in the load, second and third warp being broken gradually and repeatedly sustained by the first texture until the tensility attains 10 – 20 percent after the initial load reached the predetermined value thereby enabling the webbing to elongate without increasing the load applied thereto, said webbing constituting a multiple-step give member wherein the load-flection curve substantially forms a parallelogram and restoration of the webbing with violent resilience after removal of the load is prevented by a correlative action between the first and second textures.

5. A seat belt as defined in claim 1 wherein the shoulder belt comprises at least two straps passing over the right and left shoulders of the human body respectively.

6. A seat belt as defined in claim 2 wherein the shoulder belt comprises at least two straps passing over the right and left shoulders of the human body respectively.

7. A seat belt as defined in claim 3 wherein the shoulder belt comprises at least two straps over the right and left shoulders of the human body respectively.

8. A seat belt as defined in claim 4 wherein the shoulder belt comprises at least two straps passing over the right and left shoulders of the human body respectively.

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