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(54) **FIREPROOF FABRIC AND PROTECTIVE SUIT MADE OF SAID FABRIC**

(57) Fireproof fabric in particular for applications in the field of motor sports, wherein: the warp threads are arranged to form a plurality of levels; the weft comprises at least one thread arranged as a binding thread for all the levels so as to prevent relative slipping of said levels;

the warp threads used for all the levels have the same composition; the weft is elasticized; said at least one binding thread of the weft forms a square quilted stitch obtained directly in the loom.

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Description

Field of the invention

[0001] The invention relates to a fireproof fabric and a suit made of said fabric, in particular for motor sports.

Prior art

[0002] Professional drivers, as is known, wear a fireproof suit which must have given flame-proof and heat resistance characteristics. The requirements for homologation of the fabric are generally prescribed by a regulating body, for example the FIA - *Fédération Internationale de l'Automobile*. For example, the current FIA standard applicable to fireproof protective garments is the standard 8856-2000.

[0003] Many suits for drivers at present are made of a fabric comprising several layers (i.e. a sandwich structure), in which each layer is made of fireproof material and the layers are joined together by means of a series of stitches performed using an additional thread so as to form a quilted stitch as stipulated by the aforementioned standard FIA 8856-2000.

[0004] For example a known fireproof fabric structure comprises: an outer layer consisting of meta-aramid fabric; an intermediate layer formed by a felt or mesh interlining; an inner layer, with the function of a lining, formed by an aramid (meta-aramid and/or para-aramid) mesh.

[0005] This multi-layer fabric has the drawback that it is heavy, stiff to handle, with no elasticity very poor breathability. In particular, the lack of elasticity reduces the comfort and freedom of movement of the driver. Said lack of elasticity is due to the fact that the heat-resistant fibers are not elastic and moreover the quilted stitch represents a further impediment to movements. The quilted stitch is necessary in order to keep the compound of three layers together, but stiffens the overall structure. The suit, as a result, is tiring for the driver and increases the stress levels. Owing to the stress the driver does not always manage to deliver the best performance.

[0006] Another drawback is that the intermediate lining may shift relative to the inner layer and outer layer, especially because of wear, losing effectiveness.

[0007] Another drawback is the need for a separate machining step for the quilted stitch, which is made off-loom in a special quilting machine. The purpose of the quilted stitch is essentially to keep the compound of various layers joined together. Another drawback is the use of different materials for the three layers which makes the joining difficult.

[0008] Moreover, the felt and mesh, which are used as interlining and lining, have disadvantageous hydrophilic characteristics.

[0009] In some fabrics of the prior art, the heat or fire resistance is obtained by means of a coating, for example a fireproof material which is spread over the fabric. This, however, represents a drawback because this fireproof

coating makes the fabric heavier and stiffer.

[0010] EP 3 231 908 discloses an improved fireproof fabric in which: the warp threads are arranged on a plurality of warp levels; the warp levels are bound together by means of at least one weft thread operating as a binding thread, arranged to prevent relative slipping of said levels, and at least one of the set of weft threads and the set of warp threads consists of elasticized threads.

Summary of the invention

[0011] The object of the present invention is to improve further the technology of fireproof fabrics intended for suits for motor sports. In particular, the object of the invention is to provide a fireproof fabric which can be homologated for motor sports and which may replace the known triple-layer compounds, but at the same time is elasticized and is significantly lighter, so as not to obstruct the movements of the driver.

[0012] The objects are achieved with a fireproof fabric comprising:

warp threads arranged to form a plurality of levels,

a weft which comprises at least one thread arranged as a binding thread for all the levels, preventing relative slipping between said levels,

wherein the warp threads used for all the levels have the same composition,

wherein the weft is elasticized,

said at least one binding thread belonging to the weft forms a square quilted stitch of the fabric.

[0013] Preferably, a fabric according to the invention is a triple ply, in which the overall number of levels formed by the warp threads is equal to three.

[0014] The square quilted stitch formed by the binding thread, or by several binding threads depending on the embodiment, has preferably a square pitch of 10 cm, namely forms 10 x 10 cm squares on the said fabric.

[0015] It should be noted that the term "quilted stitch" indicates a structural feature of the fabric according to the invention which is formed directly in the loom. The invention does not involve a separate quilting step. A fabric according to the invention has a loom design pattern which forms the said quilted stitch, thanks to the arrangement of the weft.

[0016] Preferably, a fabric according to the invention has no external coating. The outer layer of the fabric therefore is formed by one of the fabric levels. Optionally the fabric may be impregnated with a flame-retardant agent. Impregnation with the flame-retardant agent may be performed during a finishing step.

[0017] A fabric according to the invention may comprise a single weft thread or a plurality of weft threads. If

a plurality of weft threads are provided, preferably all the weft threads are arranged as binding threads passing around all the levels formed by the warp threads.

[0018] Said at least one binding thread passes around all the warp threads for each weft pass. In this way the binding thread prevents relative slipping between the fabric levels.

[0019] In a preferred embodiment the warp threads are not elasticized and consequently the fabric is elasticized only along the weft. Such a fabric is also called a "monostretch" fabric since it is elasticized in one direction only, which corresponds to the direction of the weft.

[0020] Conventionally the direction of the warp threads is termed length and the direction of the weft is termed height. This conventional nomenclature is due to the arrangement of the threads on the loom.

[0021] In a particularly preferred embodiment, of the monostretch type, the non-elasticized warp threads are entirely made of aramid fiber, preferably meta-aramid fiber; the weft comprises one or more threads with a core made of elasticized fabric, preferably Elastane, coated by at least one thread of aramid fiber, of preferably meta-aramid fiber. Preferably said core is coated by at least two twisted aramid fiber threads.

[0022] Preferably all the levels have a specific weight (g/m^2) which is identical or substantially identical, apart from the machining tolerances. Preferably the specific weight of the fabric levels differs, between one level and another, by no more than 10%, for example by about 7%.

[0023] In a preferred embodiment of the triple-ply type, (i.e. with number of levels equal to three), the total weight of the fabric is in the range of 300 to 350 g/m^2 , more preferably is equal to 330 g/m^2 .

[0024] The overall composition of the fabric is 96% meta-aramid fiber and 4% Elastane, in a preferred form.

[0025] Another aspect of the invention relates to a method for manufacturing a fireproof fabric which comprises the steps of:

arranging warp threads in a loom, so as to form a plurality of levels, each level comprising respective warp threads,

forming a weft comprising at least one thread passing around all the levels so as to bind together all the levels and prevent relative slipping of said levels, forming with said at least one weft thread a quilted stitch of the fabric directly in the loom,

wherein the warp threads used for all the levels have the same composition, and

wherein the weft is elasticized.

[0026] The method advantageously provides the step of arranging three levels.

[0027] The method advantageously does not provide the application of a coating. Optionally, the method may

comprise a finishing step which comprises impregnating the fabric with a flame-retardant agent.

[0028] Another aspect of the invention relates to a fireproof suit for motor sports made of the fabric described further above.

[0029] In a preferred embodiment the fireproof suit uses a mono-stretch fabric of the type described further above, which is elasticized only in the weft.

[0030] More advantageously, a suit according to the invention comprises at least two panels of fabric which are arranged with a different orientation of the weft direction. This allows the orientation of the direction of mono-elasticity in a desired manner depending on the region of the garment.

[0031] Depending on the number and the arrangement of the panels which form the fabric, different regions of the garment can be made with a mono-elasticity according to desired different directions.

[0032] In some embodiments at least two panels of the garment have directions of mono-elasticity arranged at 90 degrees relative to each other.

[0033] This re-directing of the mono-elasticity (which is determined by the weft) can be obtained by rotating the pattern with respect to the weft. This operation in the textile field is referred to as displacement of the grain. The term "grain" refers to the direction parallel to the selvages; the selvages are the side edges of the fabric.

[0034] For example, in a preferred embodiment of a suit according to the invention the weft direction is oriented lengthwise in the top part of the suit, which covers the chest and the arms, and along the legs; the weft direction instead is oriented widthwise in the zone of the pelvis and the crotch of the trousers. The applicant has found that in this zone it is preferable to provide the driver with elasticity widthwise in order to increase the comfort.

[0035] The applicant has found that a fabric according to the invention is able to satisfy the homologation tests and can therefore be used in the sector of motor sports competitions. Compared to the combination of the prior art, the fabric according to the invention is lighter and less thick and also provides elasticity.

[0036] The use of three identical levels of fabric provides a greater breathability and faster drying compared to the compound of the prior art.

[0037] The quilted structure, being obtained directly on the loom, is stable over time and wear-resistant. The lightness is in itself an advantage in the sector of motor sports competitions where, as is known, weight reduction is a primary requirement. Moreover, the lightness combined with elasticity allows the driver to move more freely and consequently helps improve his/her performance. The fatigue of the driver is also reduced, improving the performance during the course of the race.

Claims

1. Fireproof fabric comprising:

- warp threads arranged to form a plurality of levels,
a weft which comprises at least one thread arranged as a binding thread of all the levels preventing relative slipping between said levels,
wherein the warp threads used for all the levels have the same composition,
wherein the weft is elasticized,
wherein said at least one binding thread belonging to the weft forms a square quilted stitch of the fabric.
2. Fabric according to claim 1, wherein the total number of levels formed by the warp threads is equal to three.
3. Fabric according to claim 1 or 2, wherein said quilted stitch has a square pitch of 10 cm.
4. Fabric according to any one of the preceding claims, wherein the fabric has no external coating.
5. Fabric according to any one of the preceding claims, wherein the weft comprises a single thread or a plurality of threads.
6. Fabric according to claim 5, wherein the weft comprises a plurality of threads and all the weft threads are arranged as binding threads of the warp levels.
7. Fabric according to any one of the preceding claims, wherein the warp threads are not elasticized.
8. Fabric according to claim 7, wherein: the non-elasticized warp threads are made entirely of aramid fiber and preferably of meta-aramid fiber; the weft comprises one or more threads having a core made of an elastic fabric coated by at least one thread of aramid fiber, preferably of meta-aramid fiber.
9. Fabric according to any one of the preceding claims, wherein all the levels have identical or substantially identical specific weight (g/m^2).
10. Fabric according to any one of the preceding claims, wherein the total weight of the fabric is 300 to 350 g/m^2 , and is preferably equal to 330 g/m^2 .
11. Fabric according to any one of the preceding claims, wherein the composition of the fabric is 96% meta-aramid fiber and 4% Elastane.
12. Method for manufacturing a fireproof fabric which comprises the steps of:
- arranging warp threads in a loom, to form a plurality of levels, each level comprising respective warp threads,
forming a weft comprising at least one thread passing around all the levels so as to bind together all the levels and prevent relative slipping between said levels, forming with said at least one weft thread a square quilted stitch of the fabric directly in the loom,
wherein the warp threads used for all the levels have the same composition,
wherein the weft is elasticized.
13. Method according to claim 12, wherein the overall number of levels which are provided to form the fabric is equal to three.
14. Method according to claim 12 or 13, wherein the method does not include the application of a coating, and optionally may comprise a step of impregnating the fabric with a flame-retardant agent.
15. Fireproof suit for motor sports made with a fabric according to any one of claims 1 to 11.
16. Fireproof suit according to claim 15, wherein the fabric of the suit is a mono-stretch fabric and the suit comprises two or more panels with a different direction of mono-elasticity.
17. Fireproof suit according to claim 16, wherein the suit portions which cover the top part of the body, the arms and the legs are elasticized lengthwise, while the portion which covers the pelvis and the crotch zone of the trousers is elasticized widthwise.



EUROPEAN SEARCH REPORT

Application Number
EP 18 18 3045

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			TECHNICAL FIELDS SEARCHED (IPC)
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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 18 December 2018	Examiner Louter, Petrus
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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