ENHANCED KNIT FABRIC FIRE BARRIER FOR MATTRESSES

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Appl. No.: 13/440,775

Filed: Apr. 5, 2012

Related U.S. Application Data

Provisional application No. 61/473,140, filed on Apr. 7, 2011.

Publication Classification

Int. Cl.
A47C 17/00 (2006.01)
D04B 13/00 (2006.01)
D04B 9/00 (2006.01)

ABSTRACT

An enhanced knit fabric fire barrier for mattresses and method for making same, the fabric barrier including a looped terry knitted fabric with a jersey side and a looped terry side; the jersey side including a fire retardant yarn and a melting yarn; the looped terry side including a fire retardant yarn; the loops in the jersey side are very high loops between about 4 mm and about 8 mm which char to provide a fire barrier for latex and highly volatile foams in mattresses. Also a double knit construction and method for making same, the fabric providing improved performance with the addition of a fire retardant yarn on the outside of the loops. Also, an enhanced fire-resistant full-foam mattress.
Figure 5 - Enhanced Knit Fabric Fire Barrier

High loop
FR fiber & Cotton yarn

Jersey stitch using FR fiber wrapped around Fiberglass knit with polyester
Figure 6 - Enhanced Knit Fabric Fire Barrier after Burning

Figure 6
Figure 10

Fire Retardant and Fire Resistant yarn knitting on the Cylinder side of the fabric

Feed 1

Polyester melting yarn knit with the FR Yarn

Feed 2

Fire Retardant and Fire Resistant yarn knitting on the Dial side of the fabric

Feed 3

Middle yarn creates the space between inside and outside fabrics, uses FR yarn blends
This side of fabric faces outside Ticking

Fire Retardant and Fire Resistant yarn knitting on the Dial side of the fabric

Middle yarn creates the space between inside and outside fabrics, uses FR yarn blends

Polyester melting yarn knits with the FR Yarn

Fire Retardant and Fire Resistant yarn knitting on the Cylinder side of the fabric

This side of fabric faces Mattress Core
ENHANCED KNIT FABRIC FIRE BARRIER FOR MATTRESSES

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This non-provisional utility patent application claims the benefit of prior filed U.S. provisional application Ser. No. 61/473,140 filed Apr. 7, 2011, which is incorporated herein by reference in its entirety.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention relates to knitted fabric and more specifically to a fire barrier fabric used specifically for covering mattresses or furniture.

[0004] 2. Description of the Prior Art

[0005] Current residential mattresses use products like polyurethane foam and latex on the sleep surfaces to improve the comfort of the mattresses. Current studies show that consistent support of the body from head to toe provides a better sleep condition. Therefore it is important that mattress shapes to the body. As an example to this, most new comfort beds that are foam, latex or a combination of these products including traditional springs, use a knitted fabric as the mattress ticking in place of the older style woven ticking fabric. The knitted ticking fabric has 4-way stretch and allows the mattress to shape to the body providing continuous support. Therefore it is most important to allow all the fabrics that are covering the foam, latex, etc., to have stretch and continuously move without deterioration in the ability to shape to the users in order to provide the best sleeping surface.

[0006] The U.S. Consumer Product Safety Commission approved a federal mattress flammability standard to take effect Jul. 1, 2007. This is referred to as 16 CFR 1633 requirement for all mattresses. Compliance to this requirement was the criteria that through the test procedure a mattresses maintain a heat release rate of less than 200 kW during the first 30 minutes of the test and also that the Total Heat Release be less than 15MJ in the first 10 minutes of the test.

[0007] With the newer foam and latex mattresses, the challenge of meeting these requirements becomes tougher. Polyurethane foam, latex and other products are more flammable than the conventional spring mattresses. This provides a challenge to the manufacturer as many of these more flammable sleep surfaces also contain air pockets and produces very challenging opportunities.

[0008] Mattress manufacturers have begun to use different products to meet the 16 CFR 1633 standard. Some of these products include knitted socks or fabric covers using inherently fire retardant yarns made of fibers used but not limited to, include fibers of Modacrylic, flame resistant rayon, flame retardant viscose, meta-aramid, para-aramid, fiberglass, melamine, poly-benzimidazole, oxidized polycrylonitrile, novoloid, pre-oxidized and carbon fibers, wool, and flame retardant treated cotton and fibers yet to be developed. Also used are knitted socks with topically treated fabric like but not limited to flame retardant treated cotton fabrics. Other solutions include non-woven fabrics with inherently fire retardant fibers, used but not limited to, include fibers of Modacrylic, flame resistant rayon, flame retardant viscose, meta-aramid, para-aramid, fiberglass, melamine, poly-benzimidazole, oxidized polycrylonitrile, novoloid, pre-oxidized and carbon fibers, wool, and flame retardant treated cotton and fibers yet to be developed. Also used are topically treated non-woven fabrics. Topical treatment of fibers for yarn and fabric and topical treatment of fabrics may include but not limited to treatments both durable and non-durable like ammonium bromide, ammonium chloride, boric acid, borax, phosphate, sulfamate, esters, halogenated organic compounds, antimony oxides and many more topical treatments to make fibers, yarns, fabrics, knit, woven or non-woven to have fire retardant properties.

[0009] The non-woven products are less expensive to manufacture than the knitted fabrics. Because of manufacturing cost it is much less expensive to produce a non-woven fabric, and therefore this solution has been the preferred solution for spring coil type mattresses. The preferred solution for polyurethane foam mattresses has been the knitted fabric solution. The knitted fabric solution provides a FR fabric that has 4-way stretch and allows the mattress to perfectly shape to the body of the user. Some manufacturers have used the non-woven solution on their least expensive mattresses. This solution loses the opportunity to shape to the body. The non-woven fabric is rigid and does not have stretch. If it does get stretched, there is no recovery of the fabric and the stretch area is now deformed.

[0010] The benefit of using the non-woven as the FR barrier is that you can make the weight of the non-woven much greater with a small increase in cost. This increase in weight provides better FR protection yet also reduces the comfort and feel of the bed. Every increase in weight and thickness of the non-woven FR barrier significantly reduces the feel of the mattresses.

[0011] The current use of highly volatile sleep surfaces like latex produces more challenges to provide FR protection to meet the 16 CFR 1633 standard. Latex mattresses are particularly hard to pass due to the holes and pockets that are made in the latex to provide better shaping of the bed to the user. These holes and pockets provide more oxygen to fuel the fire. Also, a drafting effect of the air through the holes creates a torch effect when on fire. This torch effect has a control and increases the amount of heat released during the 16 CFR 1633 test.

[0012] Latex and other volatile foams on all or part of a mattress create a difficult obstacle to pass the 16 CFR 1633 test.

[0013] Mattress manufacturers have been using non-woven FR barriers to achieve a positive pass of the 16 CFR 1633 test. The non-woven FR barrier works because the fibers within the non-woven product are extremely intertwined and create a blanket effect during the burn test. This blanket effect blocks the flow of the air out of the latex holes. Yet because of the intertwining of the fibers, the non-woven fabric has no stretch and recovery.

[0014] Another embodiment of the non-woven fabric is to make it thicker and have the fibers less intertwined. The problem with this embodiment is that the non-woven fabric may stretch some but it will not recover. Therefore if the non-woven fabric is stretched, it stays stretched and creates a puckered area. To make this product more usable, some solutions are to sandwich the non-woven between two stretchable knit fabrics during a quilting process. The quilting process limits the area of the puckered area and assists in the shape back closer to the original, but never exactly to the original shape.

[0015] Some mattresses manufacturers have used multiple layers of the knitted sock fabrics, mostly with limited success.
The knitted sock fabrics open during the burn test and expose an underlying layer. Most of the time the underlying layer is the latex and therefore these embodiments do not pass the 16 CFR 1633 test. Due to the inconsistency in results, most manufacturers have decided not to use this solution.

[0016] Prior art patents and patent applications include:


[0018] United States Patent Application 20100088818 filed by Rock; Moshe; et al. Apr. 15, 2010 for Coverings For Viscoelastic Foam Mattresses teaches covers for mattresses having a reclining surface of viscoelastic foam have a fabric body with a first surface disposed in engagement with the reclining surface; an opposite, second surface disposed for engagement by a person reclining upon the cover; and at least one air flow region defined by the fabric body for enhanced circulation of air between the reclining surface of viscoelastic foam and an opposed skin surface of the person reclining upon the cover. The circular knit fabric body comprises a flame retardant material.

[0019] U.S. Pat. No. 7,743,476 issued to Rock, et al. Jun. 29, 2010 and United States Patent Application 20100242148 and 20080198924 for Engineered fabric articles teaches methods for forming unitary fabric elements for use in engineered thermal fabric articles, including thermal fabric garments, thermal fabric home textiles, and thermal fabric upholstery covers, and for forming these articles, having predetermined discrete regions of contrasting insulative capacity positioned about the thermal fabric article in correlation to insulative requirements of a user’s body. In one implementation, loop yarn in first regions is formed to a first pile height, and loop yarn in other regions is formed to another, different, relatively greater pile height. In another implementation, loop yarn having a first shrinkage performance is formed in first regions to a predetermined loop height, and loop yarn having another, different shrinkage performance is formed in other regions; the loops are cut and finished to a common pile height and the web is exposed to heat to cause loop yarn to shrink to one or more different pile heights.

[0020] United States Patent Application 2005007652 filed by Rock, Moshe; et al. May 12, 2005 for Multi-layer flame retardant fabric teaches a composite velour fabric garment includes a laminate consisting of an outer woven shell layer, an inner thermal layer of knit construction, and an intermediate layer disposed between and laminated to each of the shell layer and the thermal layer. The outer woven shell layer contains spandex in at least a welf direction for stretch and recovery in a width direction. The knit construction of the inner thermal layer provides stretch in at least a width direction, in harmony with the shell layer, and the inner thermal layer has a raised surface facing inwardly, away from the shell layer. The intermediate layer has controlled air permeability, including zero air permeability.

[0021] United States Patent Application 20050115001 Horst, Gerd-Hermann Jun, 2, 2005 for Protective cover for bedding or bedding equipped with protective cover, teaches a bedding article which includes a core and a flame-resistant protective cover surrounding and enclosing the core.

[0022] United States Patent Application 20040060120 Murphy, Harrison Robert; et al. Apr. 1, 2004 for Composite fire barrier and thermal insulation fabric for mattresses and mattress foundations teaches an open flame resistant article composed of filling materials and a fire barrier fabric including a fire barrier layer and a thermally insulating layer at least partially enclosing the filling materials.

[0023] U.S. Pat. No. 6,823,548 issued to Murphy, et al. Nov. 30, 2004 and United States Patent Applications 2004060120 and 20040060119 for Composite fire barrier and thermal insulation fabric for mattresses and mattress foundations teaches a composite fire barrier fabric including a fire barrier layer and a thermally insulating layer at least partially enclosing the core of an open flame resistant mattress. The fire barrier layer and thermally insulating layer are composed of at least one flame-retardant fiber, and not necessarily the same flame retardant fiber.

[0024] United States Patent Application 20070004302 filed by McKinnon; et al. Jan. 4, 2007 for Flame resistant matelasse fabrics utilizing spun and filament flame resistant yarns teaches the use of a flame resistant (FR) three-layer double-knit fabric, also known as a matelasse fabric. The top layer is of standard non-FR face yarn, the middle layer is of a FR filler spun yarn and the bottom layer is of a FR spun yarn or FR filament yarn. This FR matelasse fabric can be used to protect a mattress, foundation, upholstery cushion, pillow, office panel, transportation seat or any other article requiring FR protection. In this invention, a matelasse fabric is formed by circular double knitting a FR spun or FR filament yarn into the bottom portion of the fabric, utilizing a heavy cotton count FR filler spun yarn for the middle layer and using conventional non-FR yarns for the top layer.

[0025] U.S. Pat. Nos. 6,782,590, 6,828,003, RE40,314, and RE41,574 and related United States Patent Applications 2003003264 and 20040083768 by Rock, et al. Aug. 31, 2004 for Velour fabric articles having flame retardance and improved dynamic insulation performance teach a velour fabric article consisting of a fabric body having a technical face formed by a filament stitch yarn and a technical back formed by a loop yarn. The filament stitch yarn includes a heat sensitive material, e.g. a hot melt material or a heat shrinkable material, and/or an elastomeric material, such as spandex. The loop yarn includes flame retardant material, such as M-Aramid fiber. The fabric body has a velour surface formed at one or both of the technical back and the technical face. Raised fibers of at least one of the technical face and the technical back may be entangled, including in and/or through interstices of the fabric body, toward the other of the technical face and the technical back, e.g., by a hydroentanglement process applied after finishing. The fabric body has permeability of about 90 ft.sup.3/ft.sup.2/min. or less, under a pressure difference of \( \frac{1}{2} \) inch of water across the fabric body.

BRIEF DESCRIPTION OF THE DRAWINGS

[0026] FIG. 1 is a photograph of a sinker according to the present invention.

[0027] FIG. 2 is a photograph of a standard sinker overlaying a sinker according to the present invention.
DETAILED DESCRIPTION

Referring now to the drawings in general, the illustrations are for the purpose of describing a preferred embodiment of the invention and are not intended to limit the invention thereto.

The present invention provides knitted fabrics and more specifically a fire barrier fabric used specifically for covering mattresses and/or furniture that require passing a certified burn test related to the product’s use to ensure consumer or user safety based upon regulations in the US. It is known to provide cushioning materials like polyurethane foam and latex to provide a softer feel for products, typically because the use of foam and latex allow products to shape to the user’s body for providing a more comfortable and supportive feel. However, foam and latex are inherently flammable due to their components. Thus, it is important to design a fire barrier product that does not reduce the comfort of the foam and latex, while not compromising on the safety factor ensured by government standards or regulations. It is also important to develop a stretchable product that shapes to the user’s body. Notably, if a non-stretchable product is used as a barrier, then the bed does not shape to the user’s body and only deflects from the heaviest place on the user’s body with respect to the bed, and the balance of the bed is angled from this deflection. So that, it would be beneficial to address shortcomings of the prior art by providing a stretchable knit construction for a fire barrier mattress and/or cover that enhances the shape, support and feel of the bed yet also that passes the US regulation as set forth in 16 CFR 1633 and the test described therein. The 16 CFR 1633 test is difficult to pass when a mattress includes highly volatile latex and foam, as in the prior art. All of the current stretchable knit products do not provide for a positive pass of the 16 CFR 1633 test because of the light weight of the products. Thus, the present invention of a stretchable knit fabric that improves the barrier performance during the 16 CFR 1633 test and allows the comfort of foam and/or latex to be enjoyed by a user is necessary, since it is not provided to date.

The present invention provides for an enhanced knit fabric fire barrier for mattresses, including a looped terry knit fabric with a jersey side and a looped terry side; the jersey side including a fire retardant yarn and a melting yarn, the looped terry side including a fire retardant yarn; the loops in the jersey side are very high loops between about 4 mm and about 8 mm; thereby providing a fire barrier for latex and highly volatile foams in mattresses. In embodiments of the present invention, the very high loops are between about 4 mm and about 8 mm. These very high loops are preferably between about 5 mm and about 6 mm. More preferably, the very high loops are between about 6 mm and about 8 mm.

The melting yarn is preferably nylon, polyester and combinations thereof, although any melting yarn that can be used in comfort fabrics can be used. Preferably, the melting yarn is between about 5% and about 20% of the total fabric compositions. More preferably, the melting yarn is about 10% of the total fabric composition.

Typically, in prior art full Latex beds, there are 10-12 inches of Latex incorporated, which makes them highly flammable. For these types of beds and similar ones, an enhanced barrier according to the present invention is combined with multilayer ticking fabric that is integrally knitted with a fire retardant yarn to provide a fire barrier and fire and/or flame resistance. Thus, the present invention provides a fire barrier for Latex, Visco foam and other highly volatile foams. In embodiments according to the present invention, a fabric cover is provided that is knitted and that provides four-way stretch. It includes very high loops as set forth in the foregoing that provide ventilation during normal use and create fire retardant blanket when they char, similar to non-wovens. The melting yarn plugs char holes when it melts, thus preventing air from feeding flame.

Furthermore, the present invention is directed to and provides a fire barrier solution for Latex and highly volatile foams that have previously not been able to be solved with a knitted fabric cover. Specifically, a knitted fabric cover is provided that has 4-way stretch and allows the mattress to fully shape to the body of an individual in a bed having the knitted fabric cover thereon. The knitted fabric cover of the present invention by knitting a looped terry knit fabric with a specific fire retardant and resistant yarn on the jersey side of the fabric that contains a fire resistant yarn or fiber like fiberglass, aramid, carbon or any other fabric that is resistant to degrading in the presence of fire. The looped terry side of the fabric contains fire retardant fibers such as modacrylic, fire retardant viscose rayon, treated fibers and other fibers that provide a retardant effect in the presence of fire. By way of contrast to the prior art and importantly according to the present invention, the Terry loop side of the fabric must be created with very high loops creating in effect an intertwine of loops and fibers.

During a 16 CFR 1633 test, the fire resistant yarns on one side of the fabric maintain the structure of the fabric, thus keeping the fabric from opening up even as the flames have burned into the barrier. Also, the loop side of the fabric has fire retardant fibers; importantly, as these fibers burn during the test, the fibers form a char layer creating a blaneking effect to the barrier and blocking the fire from the highly volatile latex and foam. This char blanket blocks the air from flowing out of the Latex and keeps the intensity of the flames very low. And, surprisingly and importantly, it allows the product to pass the 16 CFR 1633 test. The 16 CFR 1633, and the 16 CFR 1633 test referred to herein are hereby incorporated by reference in their entirety, preferably for the version of the regulation in effect at the time of the present invention filing date.
Notably, most terry loop machines known in the prior art cannot make a loop high enough with sinkers provided by the manufacturer to create a thick loop area that creates the blanket affect when charred. To solve this problem, a special sinker was developed to create a higher than normal loop. Most sinkers provided with terry loop machines provide loops that are measured in mm, with typical loop heights are from 1 mm to 3.5 mm. To create a loop high enough to develop the intertwining of loops and fibers, the sinkers were manufactured to create loops of 4 mm to 8 mm. In the current embodiment, a sinker of 5 mm was specially designed. So the present invention is further embodied as a product by process using this specially designed sinker.

In one embodiment, the present invention is manufactured using a circular single knits terry machine that was retrofitted to allow it to knit a specially designed sinker, as set forth hereinabove, and multiple yarns. The uniqueness of the fabric created by this process with this sinker and multiple yarns on such a machine is to create a loop height long enough to allow two benefits to happen: one benefit of a longer loop means more yarn, more fire retardant fiber in the yarn to be present in the fabric. The competitive product, a non-woven, can lay additional fiber on the non-woven at a lower manufacturing cost to add additional fire retardant fiber, yet this continues to limit any opportunity of the non-woven to stretch. In order for the invention fabric to have the stretch, recovery and benefits of complimenting the flex and shape ability of a latex mattress, a circular single knit terry machine is used. A circular single knit has natural 4-way stretch. For the invention according to the preferred embodiments, the terry loop that is made on the circular single knit terry machine is increased to provide additional fire retardant fiber. The second benefit of the increased loop size is that after the fibers burn and retard the growth of the flame, they create a thicker char layer of fibers. The thicker layer of the charred fibers reduces the amount of air flow allowed through the burned barrier. The reduction of air flow by the charred fibers reduces the quick spreading and increased heat generated from the burning mattress.

The present invention is manufactured using a circular single knit terry machine, as shown in FIG. 4, wherein the standard sinker heights (typical range from 1.2 mm-3.4 mm) are replaced with a specially manufactured 5.0 mm height sinker. Sinkers with heights between about 4 mm and about 8 mm are also provided for in the present invention. FIG. 4 shows the specially-designed sinker next to a standard height sinker. The specially-designed sinker is a 5 mm high sinker. The standard height sinker is a 3.2 mm sinker. The manufacturers of knitting elements do not offer a sinker higher than 4.0 mm because knitting machines are not built to allow sinkers greater than 4.0 mm. The 5.0 mm sinker is used to create the extra length of the loop height. FIG. 2 shows the 3.2 mm sinker overlaying the 5.0 mm sinker. It is important to specially design the sinker so that it would not hit other parts of the knitting elements. Reviewing FIGS. 1 and 2, the areas of the sinker that make the jersey and the area of the sinker that make the loop are illustrated. The area of the sinker to make the jersey part of the fabric is identical between each sinker. In the special designed sinker, it is shown how the height of the sinker was increased to produce the higher loop. It is also important to design the sinker to allow it to move around the machine and not hit the carriers. The back side of the sinker was cut to an angle to allow this.

The carriers, which are guides to thread the yarns into the correct positions, are also adjusted to allow these sinkers to function. Due to the higher profile of the 5.0 mm sinker, the carriers are modified such that they are positioned to guide the yarns into the proper position, while not obstructing the movement of the sinkers around the machine. Importantly, this repositioning keeps the sinkers from hitting the carriers and breaking and damaging the machine.

Once the machine is properly measured, indicated and set, the yarns are threaded into the machine. As shown in FIG. 3, two yarns are used on the jersey side of the fabric. One yarn has a fiber that does not melt or burn, this could be a fiberglass fiber or para-aramid or such. In the embodiment produced the yarn used was a 1/39 fiberglass that was air jet spun with modacrylic FR fibers wrapped around the modacrylic. Plaleted with this yarn into the jersey side of the fabric was a 1/70 polyester yarn. These two yarns make up the flat jersey side of the fabric. The role and function of the 1/70 polyester yarn is to support the fiberglass yarn during the knitting process to reduce the chance of defects like holes to be produced. The most important benefit of the polyester yarn is to melt and mix with the charred modacrylic fibers and caugulate and produce a simulated shield to block the flame from reaching the latex or foam or more importantly reducing the air flow.

The terry loop yarn is knitted into the same feeding positions. In terry loop construction, the loop yarn knits with the jersey stitches, but the terry machine causes the sinker loop of just the terry yarn to be extended much longer than the sinker loop of the jersey yarns. Based on the sinker height used, the terry loop can be changed from very low (almost non-existent) to longer. A sinker made to produce loops longer than 4.0 mm is not normal. Part suppliers do not manufacture and inventory a sinker that produces a very high loop height similar to a 5.0 sinker. Preferably, the loop yarn is made from flame retardant fibers like modacrylic, FR Rayon etc. This can be 100% FR fibers or a blend with other fibers. In the example embodiment a blend of 75% modacrylic and 25% cotton was used. The percent of FR fibers can be increased or decreased based on the amount of fire retardant needed. Also, in another example embodiment includes an additional fiber that will burn and melt into the blend, such as polyester or nylon. The percentage is low, such that the thermoplastic fiber does not drip and add much fuel to the flame. The benefit of the melting fiber would be to mix with the charred fibers and produce a shield barrier.

These large loops intertwining together create an effect similar to non-woven solutions, as shown in FIGS. 5 and 7. The invention specifically was created to simulate a non-wovens effect, yet with a knitted fabric that stretched and recovered. In addition, the fabric must not fall apart when burned; so then fire resistant fibers are used. Also, these intertwined high loops create a blanketing effect that block flames and reduces air flow when the fibers become charred and mix with the melted polyester fiber, as shown in FIGS. 6, 8 and 9.

Another benefit of the enhanced knit fabric barrier is that in addition to stretching and recovering, the fabric allows air to flow through it, having adequate permeability to ensure comfort and breathability of the fabric, as well as insulation. Latex and visco foam beds best provide a cooling or warming sensation when air is allowed to flow through the channels in the Latex or foam and consequently, the barrier and ticking fabric needs to permit air flow. A knit fabric allows air to flow.
through it when it is in its natural unburned state. These factors have provided a longstanding and unmet need in the art for a knitted barrier fabric, as opposed to a non-woven barrier.

[0052] Another aspect of the invention is to include a small amount of a fiber that melts during the testing of the 16 CFR 1633 burn test. This fiber melts during the burning of the bed, and it is then absorbed into the charring fibers, thereby plugging holes in them and creating a more significant barrier between the fire and the volatile latex or visco foam. This barrier reduces the air flow into and out of the latex or foam and significantly reduces the heat release and charring effect of the burning bed. Polyester, nylon, and similar fibers and combinations thereof arc used for this purpose.

[0053] The melting fiber can either be included in the jersey side or the loop side or both. It can be knitted in with the fire resistant yarn, twisted in the fire resistant yarn, and/or blended in the fire retardant yarn. It is important to minimize the amount of this fiber because it is also fuel for the flame. Therefore the amount should be between 5% and 20% of the total fabric compositions, more specifically approximately 10% of the present embodiment.

[0054] The enhanced knit fabric barrier according to the present invention can be used to allow partially Latex and Visco Foam beds to pass the 16 CFR 1633 test. Because there is between 2-4 inches of the Latex or volatile foam on the top of the beds as opposed to 10-12 inches of Latex in a full Latex bed, the Barrier can be used over the core without any other knitted ticking fabric.

[0055] In full-Latex or full-foam beds of 10-12 inches of latex or foam, it becomes necessary to use a multilayer ticking fabric that is integrally knitted with a fire retardant yarn. An example ticking is shown in US Patent Application 20090194101 for Fire barrier fabric for use with articles, which is incorporated herein by reference in its entirety.

[0056] The combination of the Enhanced Barrier and the multilayer ticking fabric that is integrally knitted with a fire retardant yarn provides enough protection to allow the most extreme test of mattresses to pass the 16 CFR 1633 test.

[0057] In evaluating embodiments of the present invention, testing of a bed with 10 inches of Latex and 2 inches of polyurethane mattress core was performed. The testing included a 3-trial test of beds made with the enhanced knit barrier according to the present invention and a TiO® multilayer ticking fabric that is integrally knitted with a fire retardant yarn. The testing outcomes provided that the embodiments of the present invention had passing results three (3) consecutive times.

[0058] For the 16 CFR 1633 as of the date of the present invention, which is incorporated herein by reference in its entirety for the version as of this date of filing, the Heat Release rate must not exceed 200 kW and the Total Heat Release in the first 10 minutes must be less than 15 MJ. Surprisingly, the Heat Release rate results were 81, 64, and 68 kW, well below the allowable maximum of 200 kW. Also surprisingly, the total Heat Release in the First 10 minutes results were 7.2, 6.3, and 3.0 MJ. Again, this is well below the allowable maximum of 15 MJ. These results show the enhanced performance of the present invention.

[0059] Thus, a fire barrier knit fabric with non-woven properties according to the present invention includes a circular single knit fabric having 4-way stretch and recovery; and further including a jersey side and a looped terry side; wherein the jersey side includes a fire retardant yarn and a melting yarn; wherein the looped terry side includes a fire retardant yarn; and wherein the loops in the jersey side are between about 4 mm and about 8 mm, thereby providing a fire barrier fabric that provides 4-way stretch and recovery.

[0060] The loops may be between about 5 mm and about 6 mm or between about 6 mm and about 8 mm. The melting yarn includes nylon, polyester and combinations thereof. The fabric of claim 1, wherein the melting yarn is selected from the group consisting of modacrylic, flame resistant rayon, flame retardant viscose, meta-aramid, para-aramid, fiberglass, melamine, poly-benimidazole, oxidized polyacrylonitrile, novoloid, pre-oxidized and carbon fibers, wool, and combinations thereof.

[0061] A fire-resistant mattress according to the present invention includes a mattress enclosed by a knit fabric fire barrier, the knit fabric fire barrier including a circular single knit fabric having 4-way stretch and recovery, and further including with a jersey side and a looped terry side; wherein the jersey side includes a fire retardant yarn and a melting yarn; wherein the looped terry side includes a fire retardant yarn; and wherein the loops in the jersey side are between about 4 mm and about 8 mm; thereby providing a mattress with a fire-resistant covering that provides 4-way stretch and recovery. The mattress may be full-foam, full-latex and latex-foam mattresses.

[0062] A method for making a knit fabric fire barrier according to the present invention includes the steps of: providing a circular single knit terry machine having a 5.0 mm sinker, constructed and configured for knitting a circular single knit fabric having 4-way stretch and recovery, and further including a jersey side and a looped terry side; providing a fire retardant yarn and a melting yarn for a jersey side; providing a fire retardant yarn for a looped terry side; knitting a circular single knit fabric having 4-way stretch and recovery, and further including with a jersey side and a looped terry side; thereby providing a fire-resistant fabric that provides 4-way stretch and recovery.

[0063] Double-Knit Fabric

[0064] Double-knit fabric structures are also considered within the scope of the present invention and provided as embodiments herein. As illustrated in the figures, specifically FIGS. 10 and 11, for each of the dual side of the 3-dimensional double knit, the same yarn that is used in the ticking with the integrated barrier can be used. Knitting this yarn to the outside of the 3-dimensional double knit creates the same effect of a terry fabric layered with another layer of a fire barrier or also with a ticking with an integrated barrier. The amount of fire retardant materials is equal and an insulating space in the middle of the 3-dimensional double knit is provided that equals the space created with the ticking with integrated fire barrier lays on top of the terry knit.

[0065] Much of the mattress market prefers to develop solutions such that a ticking fabric without an integrated fire barrier can be used, so it was determined that a need to invent a enhanced fire barrier fabric that would have enough protection that the enhanced barrier alone could be used along with a normal ticking fabric that did not have a integrated fire barrier component. Thus, the present invention also provides for an enhanced knit fabric fire barrier for mattresses comprising of a 3-dimensional double knit fabric. During testing of other fire barrier fabrics utilizing a single-knit terry fire barrier fabric, it was determined that along with the terry
fabric, another layer of fire barrier or a ticking fabric with an integrated fire barrier would improve performance in the 16 CFR 1633 test.

[0066] The present invention provides for a fire barrier for latex, visco foam and other highly volatile foams. The present invention provides for one fabric that is a cover for the mattress core that is knitted and provides four-way stretch. The 3-dimensional double knit provides for ventilation of the mattress through the fire barrier into and out of the mattress core. This ventilation provides comfort to the sleeping surface during normal use yet creates a fire retardant blanket when the burned, charred and the melting yarn plugs the holes with the charred fibers and preventing air from feeding the flame.

[0067] The present invention is directed to and provides for an enhanced fire barrier solution for latex and highly volatile foams that have previously not been able to be solved with a knitted fabric cover. Specifically that a knitted fabric cover that has 4-way stretch and allows the mattress to fully shape to the body of the individual in the bed. The invention was developed by knitting a 3-dimensional double knit fabric with a specific fire retardant and resistant yarn on the outsides of the fabric that contains a fire resistant yarn or fiber like fiberglass, aramid, carbon or any other yarn or fiber that is resistant to degrading in the presence of fire. These yarns may also contain fire retardant fibers such as modacrylic, fire retardant viscose rayon, treated fire retardant fibers and other fibers that provide a retardant effect in the presence of fire.

[0068] The middle of the 3-dimensional double knit enhanced barrier can be made of different fibers to provide different levels of protection. In one embodiment yarns blending modacrylic and cotton were used that provided a lower level of performance. In another embodiment yarns blended of modacrylic and fiberglass were used to provide a higher level of performance. Any fibers can be used, both fire retardant and normal cellulose fibers like but not limited to cotton, rayon, hemp, bamboo, that burn and char, or they can be blended with other fibers that provide fire retardant and fire resistant properties and can be used in the middle of the 3-dimensional double knit. This includes and is not limited to modacrylic, fire retardant viscose rayon, fiberglass, aramid, carbon, treated fibers and all other fibers that provide retardant and resistance in the presence of fire.

[0069] In the present invention of the 3-dimensional double knit enhance fire barrier, a terry fabric including the melting yarn is knit and combined with a layer of additional fire retardant yarn that creates the same effect as layering the terry fabric underneath a ticking fabric with an integrated fire barrier component.

[0070] As shown in FIGS. 10 and 11, for Feed 1 on the bottom layer of the 3-dimensional double knit, a fire retardant yarn and a melting yarn are knit on the cylinder side of the double knit machine. The melting yarn is preferably nylon, polyester or combinations thereof, although any melting yarn that can be used in comfort fabrics can be used. Preferably, the melting yarn is between 1% and 15% of the fabric composition. More preferably the melting yarn is about 4% of the total fabric composition. This combination of yarns provides for the melting yarn to mix with the charred fibers of the fire retardant yarn and plug the holes of the knit structure.

[0071] As shown in FIGS. 10 and 11, for Feed 3 in the middle of the 3-dimensional double knit, fire retardant yarns are used to assist in retarding the growth of the fire and create an area of insulation between the outside and the volatile latex or foam core. These yarns are knit in a pattern that creates the same effect of the terry fabric. The yarns are tucked between the cylinder of the machine and the dial and create loops that are tied to both the cylinder side of the fabric and the dial side of the fabric. These tucks/loops hold the dial side of the fabric away from the cylinder side, creating a space between the fabrics. This design simulates the same effect created when the terry fabric was used with the integrated fire barrier ticking fabric. The distance from the cylinder side of the fabric to the dial side of the fabric is the tuck stitch setting, which is adjustable by raising or lowering parts of the knitting machine to create different tuck stitch heights and thus different thicknesses of fabric. The thickness of the fabric is thus determined by the tuck stitch setting, which is the distance from the cylinder side to the dial side of the fabric. The height of the tuck stitch setting, the greater the tuck stitch height and thus the better the fire retardant/resistant protection provided.

[0072] The tuck stitch setting is preferably set such that the tuck stitches are between about 2 and about 8 mm. More preferably, the tuck stitch setting is such that a tuck stitch height of between about 6 mm and about 8 mm is produced. Even more preferably, the tuck stitch setting is such that a tuck stitch height of about 8 mm is produced.

[0073] In addition to the ability to use any ticking fabric the present invention also allow for the ease of installing one fabric that stretches and recovers to benefit the comfort of latex or foam.

[0074] During a 16 CFR 1633 test, the fire resistant yarns on both sides of the 3-dimensional double knit maintained the structure of the fabric keeping the fabric from opening up even as the flames have burned into the bather.

[0075] As the fire retardant fibers burn and char they mix with the melting yarn and create a blanket reducing the exposure to the highly volatile latex or foam core. This char blanket blocks the air from flowing out of the latex and keeps the intensity of the flames very low. This allows the product to pass the 16 CFR 1633 test.

[0076] Certain modifications and improvements will occur to those skilled in the art upon a reading of the foregoing description. The above-mentioned examples are provided to serve the purpose of clarifying the aspects of the invention and it will be apparent to one skilled in the art that they do not serve to limit the scope of the invention. All modifications and improvements have been deleted herein for the sake of conciseness and readability but are properly within the scope of the present invention.

What is claimed is:

1. A fire barrier knit fabric with non-woven properties, the fabric comprising:
   a circular single knit fabric having 4-way stretch and recovery, and further including a jersey side and a looped terry side,
   wherein the jersey side includes a fire retardant yarn and a melting yarn,
   wherein the looped terry side includes a fire retardant yarn; and
   wherein the loops in the jersey side are between about 4 mm and about 8 mm, thereby providing a fire barrier fabric that provides 4-way stretch and recovery.
2. The fabric of claim 1, wherein the loops are between about 5 mm and about 6 mm.
3. The fabric of claim 1, wherein the loops are between about 6 mm and about 8 mm.
4. The fabric of claim 1, wherein the melting yarn includes nylon, polyester and combinations thereof.
5. The fabric of claim 1, wherein the fire retardant yarn is selected from the group consisting of modacrylic, flame resistant rayon, flame retardant viscose, meta-aramid, para-aramid, fiberglass, melamine, poly-benzimidazole, oxidized polyacrylonitrile, novoloid, pre-oxidized and carbon fibers, wool, and combinations thereof.
6. The fabric of claim 1, wherein the melting yarn is between about 5% and about 20% of a total fabric composition of the circular knit fabric.
7. The fabric of claim 6, wherein melting yarn is about 10% of the total fabric composition.
8. A fire-resistant mattress comprising: a mattress enclosed by a knit fabric fire barrier, the knit fabric fire barrier comprising: a circular single knit fabric having 4-way stretch and recovery, and further including with a jersey side and a looped terry side; wherein the jersey side includes a fire retardant yarn and a melting yarn; wherein the looped terry side includes a fire retardant yarn; and wherein the loops in the jersey side are between about 4 mm and about 8 mm; thereby providing a mattress with a fire-resistant covering that provides 4-way stretch and recovery.
9. The mattress of claim 8, wherein the loops are between about 5 mm and about 6 mm.
10. The mattress of claim 8, wherein the loops are between about 6 mm and about 8 mm.
11. The mattress of claim 8, wherein the melting yarn includes nylon, polyester and combinations thereof.
12. The mattress of claim 8, wherein the melting yarn is selected from the group consisting of modacrylic, flame resistant rayon, flame retardant viscose, meta-aramid, para-aramid, fiberglass, melamine, poly-benzimidazole, oxidized polyacrylonitrile, novoloid, pre-oxidized and carbon fibers, wool, and combinations thereof.
13. The mattress of claim 8, wherein the melting yarn is between about 5% and about 20% of the total fabric compositions.
14. The mattress of claim 13, wherein melting yarn is about 10% of the total fabric composition.
15. The mattress of claim 8, wherein the mattress is selected from the group consisting of full-foam, full-latex and latex-foam mattresses.
16. A method for making a knit fabric fire barrier comprising: providing a circular single knit terry machine having a sinker, constructed and configured for knitting a circular single knit fabric having 4-way stretch and recovery, and further including a jersey side and a looped terry side; providing a fire retardant yarn and a melting yarn for a jersey side; providing a fire retardant yarn for a looped terry side; knitting a circular single knit fabric having 4-way stretch and recovery, and further including with a jersey side and a looped terry side; thereby providing a fire-resistant fabric that provides 4-way stretch and recovery.
17. The method of claim 16, wherein the sinker has a height between about 4 and about 8 mm.
18. The method of claim 16, wherein the sinker has a height of about 5 mm.
19. A method for making a double-knit fabric fire barrier, comprising: providing a circular double knit machine, constructed and configured for knitting a circular double knit fabric having 4-way stretch and recovery; the machine having a tuck stitch setting, a first feed, second feed and a third feed; wherein the first feed is on the on the cylinder side of the double knit machine, wherein the second feed is on the dial side of the double knit machine, and wherein the third feed feeds the middle yarn of the double knit fabric; providing a fire retardant yarn and a melting yarn for the first feed; providing a fire retardant yarn for the second feed; and providing the middle yarn for the third feed; setting the tuck stitch setting to between about 2 and about 8 mm; knitting the double knit fabric; thereby providing a fire-resistant fabric that provides 4-way stretch and recovery.
20. The method of claim 19, wherein the middle yarn is a fire retardant yarn.
21. The method of claim 19, wherein the fire retardant yarns are selected from the group consisting of modacrylic, flame resistant rayon, flame retardant viscose, meta-aramid, para-aramid, fiberglass, melamine, poly-benzimidazole, oxidized polyacrylonitrile, novoloid, pre-oxidized and carbon fibers, wool, and combinations thereof.
22. The method of claim 19, wherein the melting yarn is between about 5% and about 20% of a total fabric composition of the circular knit fabric.
23. The method of claim 19, wherein melting yarn is about 10% of the total fabric composition.
24. The method of claim 19, wherein the tuck stitch setting is between about 6 mm and about 8 mm.
25. The method of claim 19, wherein the tuck stitch setting is about 8 mm.
26. A fire bather knit fabric with non-woven properties, the fabric comprising: a double knit fabric having 4-way stretch and recovery, the fabric having a first side, a second side, and a middle; wherein the first side includes a fire retardant yarn and a melting yarn; wherein the second side includes a fire retardant yarn; and wherein the middle includes a middle yarn; and wherein the fabric further includes tuck stitches that are between about 2 mm and about 8 mm; thereby providing a fire barrier fabric that provides 4-way stretch and recovery.
27. The fabric of claim 25, wherein the tuck stitches are between about 6 mm and about 8 mm.
28. The fabric of claim 25, wherein the tuck stitches are about 8 mm.
29. The fabric of claim 25, wherein the melting yarn includes nylon, polyester and combinations thereof.
30. The fabric of claim 25, wherein the fire retardant yarn is selected from the group consisting of modacrylic, flame resistant rayon, flame retardant viscose, meta-aramid, para-
aramid, fiberglass, melamine, poly-benzimidazole, oxidized polyacrylonitrile, novoloid, pre-oxidized and carbon fibers, wool, and combinations thereof.

31. The fabric of claim 25 wherein the melting yarn is between about 5% and about 20% of a total fabric composition of the circular knit fabric.

32. The fabric of claim 25, wherein melting yarn is about 10% of the total fabric composition.

33. A fire-resistant mattress comprising:
   a mattress enclosed by a knit fabric fire barrier, the knit fabric fire barrier comprising:
   
a double knit fabric having 4-way stretch and recovery, the fabric having a first side, a second side, a middle;
   wherein the first side includes a fire retardant yarn and a melting yarn;
   wherein the second side includes a fire retardant yarn; and
   wherein the middle includes a middle yarn; and
   wherein the fabric further includes tuck stitches between about 2 mm and about 8 mm;
   thereby providing a fire resistant mattress with a knit fabric fire barrier that provides 4-way stretch and recovery.

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