Preferably a further sacrificial fabric is used to allow passage of CPSC 16 CFR 1633 with a peak heat release of less than 250 kilowatts in a 30 minute time period following ignition.

— with international search report

Title: FOAM CORE ARTICLE WITH FLEXIBLE HEAT-RESISTANT KNITTED FABRIC

Abstract: A foam core article such as a mattress or pillow is covered on a surface with a flexible heat-resistant knitted fabric. Preferably a further sacrificial fabric is used to allow passage of CPSC 16 CFR 1633 with a peak heat release of less than 250 kilowatts in a 30 minute time period following ignition.
TITLE OF THE INVENTION

FOAM CORE ARTICLE WITH FLEXIBLE HEAT-RESISTANT KNITTED FABRIC

BACKGROUND OF THE INVENTION

Field of the Invention

This invention is directed to an article having a foam core such as a mattress or pillow in combination with a flexible heat-resistant knitted fabric. In a preferred embodiment the invention also employs a sacrificial fabric.

Description of Related Art

The State of California has led the drive to regulate and reduce the flammability of mattresses and mattress sets in an attempt to reduce the number of lives lost in household, hotel, and institutional fires. In particular, the Bureau of Home Furnishings and Thermal Insulation of the Department of Consumer Affairs of the State of California issued Technical Bulletin 603 "Requirements and Test Procedure for Resistance of a Residential Mattress/Box Spring Set to a Large Open-Flame" to quantify the flammability performance of mattress sets.

A further test procedure to determine the suitability of a mattress construction with a fire barrier is set forth in test procedure CPSC 16 CFRI 633.

A mattress normally contains a mattress core covered by cushioning material or batting that is in turn covered with an outer fabric ticking. Most cushioning material or batting is made from foam or fiber materials that will burn when exposed to an open flame. Therefore a substantial effort has been made to cover a mattress with a fire resistant barrier to conform to flammability regulations.

A need is present for an improved fire barrier material and improved construction which retard burning of an article having a foam core.
SUMMARY OF INVENTION

The present invention in a preferred mode is directed to a mattress with a flexible heat-resistant knitted fabric comprising:

(I) a mattress having a foam core and
(II) a flexible heat-resistant knitted fabric covering at least a portion of a surface of the mattress wherein the knitted fabric comprises:

(a) para-aramid yarn; and
(b) cellulosic yarn wherein cellulosic material in the yarn has not been treated to improve fire resistance,

with the provisos:

(i) the para-aramid is present in an amount of at least 38 percent by weight of the knitted fabric on a basis of para-aramid and cellulosic material in the yarns,
(ii) the para-aramid yarn has a size in a range from 45cc to 20cc,
(iii) the cellulosic yarn has a size in a range from 45cc to 20cc and
(iv) the knitted fabric has a stitch density in a range from 300 to 700 stitches per square inch.

Also the present invention is directed to other articles with a foam core article with an example being a pillow or other furniture cushioning.

In a most preferred embodiment a sacrificial fabric is employed with the foam core article and the flexible heat-resistant knitted fabric.

DETAILED DESCRIPTION OF THE INVENTION

A preferred substrate of the present invention is a mattress having a foam core. Due to the flammability of the foam an added degree of protection is needed to resist burning particularly since a mattress may include more than one layer of foam with different densities, different materials and different degrees of resiliency. The mattress may or may not contain springs for resiliency. In a preferred embodiment, the mattress does not contain springs which conventionally denotes a need for a larger mass of foam.
In the present invention the mattress is at least partially covered on its outer surface (i.e. a surface which faces an observer) with a flexible heat-resistant knitted fabric. The knitted fabric contains para-aramid yarn and cellulosic yarn. The cellulosic material is not treated to impart fire resistance and accordingly does not impart an added degree of fire resistance to the yarn compared to a cellulosic material with, for example, a fire resistant chemical.

The para-aramid is present in an amount of at least 38 percent by weight on a basis of para-aramid and cellulosic material in the knitted fabric. Preferably the para-aramid will be at least 40 percent on this basis. Accordingly the weight ranges are 38 to 60 percent para-aramid and correspondingly 40 to 62 percent cellulosic material. A more preferred range is 40 to 60 percent para-aramid and 40 to 60 percent cellulosic material.

For purposes of the present invention, the following definitions are employed.

As employed herein a foam core denotes a resilient material having gas bubbles entrapped therein

Knitted fabric denotes a fabric which is knitted with yarns containing para-aramid and yarns containing cellulosic material wherein the yarns are intermixed in the fabric, i.e. the yarns do not lie in separate layers such as one fabric layer containing only para-aramid yarns and another separate layer containing only cellulosic material.

As used herein "cellulosic" and "cellulosic material" includes cotton, rayon and combinations. However this definition is employed to exclude cellulosic materials which have been treated for the purpose imparting flame resistance (FR). According FR cotton and FR rayon are excluded in calculating the above-stated weight percentage requirements.

The knitted fabric containing para-aramid yarns and cellulosic yarns imparts heat resistance such as from a flame (in air) due to an ability to retard burning for a period of time. This resistance is present even though the cellulosic material can readily burn.

However a further criteria for the heat-resistant knitted fabric is an ability to have flexibility and a degree of stretch. Illustratively the heat-resistant knitted fabric typically will cover one surface of a mattress with wrapping of the fabric
around corners of the mattress. A preferred use is where the fabric covers all exterior mattress surfaces. The flexibility and stretch of the heat-resistant knitted fabric allows such use.

The flexibility and stretch of the heat-resistant knitted fabric is imparted by use of para-aramid yarn and cellulosic yarn within a specific size range as well as within a specific stitch density range. Both the para-aramid yarn and the cellulosic yarn will have a size in a range from 45cc to 20cc (cc means cotton count in accordance with standard nomenclature). A preferred range for both yarns is 45cc to 20cc. Although a single ply yarn is preferred, it is understood that more than one ply may be employed in a yarn. The knitted fabric has a stitch density in a range from 300 to 700 stitches per square inch (47 to 109 stitches per square centimeter). A preferred range is 400 to 600 stitches per square inch (62 to 93 stitches per square centimeter).

The weave of the flexible heat-resistant knitted fabric is not critical provided the above criteria are present. Examples of suitable knitted fabrics include jersey (or single) knits, rib (or double) knits, terry knits and French terry knits.

In a preferred embodiment an article resulting from a mattress and flexible heat-resistant knitted fabric will pass CPSC 16 CFRI 633 which is a burning test. Accordingly in conformance with this test a maximum heat peak release is necessary, namely less than 250 kilowatts in a 30 minute time period following ignition.

In order to pass this test in the present invention a sacrificial fabric is needed in combination with the mattress and flexible heat-resistant knitted fabric wherein the sacrificial fabric faces a heat source employed in the test procedure. The sacrificial fabric denotes a material which burns in the test. The material typically employed is a cotton fabric.

To determine in a mattress and flexible heat-resistant knitted fabric will pass CPCS 16 CFRI 633 with a peak heat release of less than 250 kilowatts in a 30 minute time period, a terry cloth cotton fabric (untreated for fire resistance) is employed on a weight basis of 8 ounces per square yard and and use of such fabric is denoted herein as "test procedure A" which is useful for screening
purposes. It is understood in actual use by a consumer that another sacrificial fabric and/or another weight may be and would be expected to be used.

Although the above description of the invention is directed to a mattress with a foam core, it is understood that other materials which use a foam core are suitable. An example is a pillow or other furniture cushioning.

To further illustrate the present invention, the following examples are provided. All parts and percentages are by weight unless otherwise indicated.

**Comparative Example A**

In Comparative Example A, a foam core mattress made from a 8 ounces per square yard terry knit cover fabric comprising cotton and polyester yarns available from A Lava and Sons, Chicago, IL, a flame resistant, circular, jersey knit barrier comprising co-fed 18s/l cotton yarn available from Parkdale Mills, Gastonia, NC and 45s/l Kevlar yarn available from Charles Craft, Inc., Laurinburg, NC (equivalent to a 29% Kevlar, 71% cotton blend of yarns), and a foam core comprising a 3 inch visco-elastic polyurethane foam layer and a 7 inch dense polyurethane foam layer available from Leggett and Platt, Inc., Chicago, IL were collected. The foam core mattress was produced by inserting the foam core into the flame resistant, circular, jersey knit barrier, each end of the jersey knit tube was sewn closed with 60 Tex Kevlar thread available from Coats and Clark, Charlotte, NC, and finally inserting the flame resistant, jersey knit covered foam core into the terry knit cover fabric. The foam core mattress was then tested for overall mattress flammability per CPSC standard 16 CFR 1633. The foam core mattress had the following results: Two out of three foam core mattress sets failed the CPSC 16 CFR 1633 flammability standard by measuring a peak heat release rate of greater than 250 kW in the first 30 minutes after ignition. See Table 1.

**Example 1**

In Example 1, a foam core mattress made from a 8 ounces per square yard terry knit cover fabric comprising cotton and polyester yarns available from A Lava and Sons, Chicago, IL, a flame resistant, circular, jersey knit barrier comprising co-fed 30s/l cotton yarn available from Parkdale Mills, Gastonia, NC and 30s/l Kevlar yarn available from Charles Craft, Inc., Laurinburg, NC (equivalent to a 50% Kevlar, 50% cotton blend of yarns), and a foam core
comprising a visco-elastic polyurethane foam layer and a dense polyurethane foam layer available from Leggett and Platt, Inc., Chicago, IL were collected. The foam core mattress was produced by inserting the foam core into the flame resistant, circular, jersey knit barrier, each end of the jersey knit tube was sewn closed with 60 Tex Kevlar thread available from Coats and Clark, Charlotte, NC, and finally inserting the flame resistant, jersey knit covered foam core into the terry knit cover fabric. The foam core mattress was then tested for overall mattress flammability per CPSC standard 16 CFR 1633. The foam core mattress had the following results: three foam core mattress sets passed the 16 CFR 1633 test requirements that included a heat release rate of less than 250 kW in the first 30 minutes after ignition and a total heat release of less than 15 MJ in the first 10 minutes after ignition. See Table 1.

**Example 2**

In Example 1, a foam core mattress made from a 8 ounces per square yard terry knit cover fabric comprising cotton and polyester yarns available from A Lava and Sons, Chicago, II, a flame resistant, circular, jersey knit barrier comprising co-fed 30s/l cotton yarn available from Parkdale Mills, Gastonia, NC and 45s/1 Kevlar yarn available from Charles Craft, Inc., Laurinburg, NC (equivalent to a 40% Kevlar, 60% cotton blend of yarns), and a foam core comprising a visco-elastic polyurethane foam layer and a dense polyurethane foam layer available from Leggett and Platt, Inc., Chicago, IL were collected. The foam core mattress was produced by inserting the foam core into the flame resistant, circular, jersey knit barrier, each end of the jersey knit tube was sewn closed with 60 Tex Kevlar thread available from Coats and Clark, Charlotte, NC, and finally inserting the flame resistant, jersey knit covered foam core into the terry knit cover fabric. The foam core mattress was then tested for overall mattress flammability per CPSC standard 16 CFR 1633. The foam core mattress had the following results: two foam core mattress sets passed the 16 CFR 1633 test requirements that included a heat release rate of less than 250 kW in the first 30 minutes after ignition and a total heat release of less than 15 MJ in the first 10 minutes after ignition. The one sample failure was caused by the incorporation of a head to toe seam in the flame resistant, jersey knit barrier. This seam was
included for the express purpose of creating a flame resistant, jersey tube for full scale mattress testing. This seam will not be apart of the proposed final product and thus this blend of Kevlar® and cotton fiber is considered to pass the CPSC standard 16 CFR 1633. See Table 1.
### Table 1: FR Mattress CPSC 16 CFR 1633 Test Results

<table>
<thead>
<tr>
<th></th>
<th>Comparative Example A</th>
<th>Example 1</th>
<th>Example 2</th>
</tr>
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<tbody>
<tr>
<td><strong>Barrier</strong></td>
<td>Co-fed 29% Kevlar, 71% Cotton circular, jersey knit</td>
<td>Co-fed 50% Kevlar, 50% Cotton circular, jersey knit</td>
<td>Co-fed 40% Kevlar 60% Cotton circular, jersey knit</td>
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<tr>
<td><strong>Foam Core Construction</strong></td>
<td>Visco-elastic foam top with polyurethane foam base</td>
<td>Visco-elastic foam top with polyurethane foam base</td>
<td>Visco-elastic foam top with polyurethane foam base</td>
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<tr>
<td><strong>Cover Fabric Knit Composition</strong></td>
<td>60% Cotton, 40% polyester</td>
<td>60% Cotton, 40% polyester</td>
<td>60% Cotton, 40% polyester</td>
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<td><strong>Peak HRR (kW) in 30 min</strong></td>
<td>178.1*</td>
<td>39.8</td>
<td>42.9</td>
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<tr>
<td></td>
<td>40.9</td>
<td>39.7</td>
<td>256.6**</td>
</tr>
<tr>
<td></td>
<td>539</td>
<td>41.6</td>
<td>99.8</td>
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<tr>
<td><strong>Total Heat Release (MJ) in 10 min</strong></td>
<td>8.4*</td>
<td>12.1</td>
<td>5.9</td>
</tr>
<tr>
<td></td>
<td>6.7</td>
<td>10.4</td>
<td>17.5**</td>
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<td></td>
<td>9.9</td>
<td>5.3</td>
<td>10.7</td>
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</table>

* Test stopped for safety reasons due to samples imminent failure.
** Test failed due to a seam in the barrier incorporated for purpose of testing.

This head to toe seam is not intended to be apart of the final mattress construction.
What is claimed is:

1. An article of a mattress with a flexible heat-resistant knitted fabric comprising:
   (I) a mattress having a foam core; and
   (II) a flexible heat-resistant knitted fabric covering at least a portion of a surface of the mattress wherein the knitted fabric comprises:
      (a) para-aramid yarn; and
      (b) cellulosic yarn wherein cellulosic material in the yarn has not been treated to improve fire resistance, with the provisos:
         (i) the para-aramid is present in an amount of at least 38 percent by weight of the knitted fabric on a basis of para-aramid and cellulosic material in the yarns,
         (ii) the para-aramid yarn has a size in a range from 45cc to 20cc,
         (iii) the cellulosic yarn has a size in a range from 45cc to 20cc and
         (iv) the knitted fabric has a stitch density in a range from 300 to 700 stitches per square inch.

2. The article of claim 1 wherein, the mattress does not contain springs.

3. The article of claim 1 wherein, the para-aramid is poly(paraphenylene terephthalamide).

4. The article of claim 1 wherein, the cellulosic material is cotton or rayon.

5. The article of claim 4 wherein, the cellullosic material is cotton.

6. The article of claim 1 wherein, the para-aramid yarn has a size in a range from 40cc to 24cc and the cellulosic yarn has a size in a range from 40cc to
24cc and the knitted fabric has a stitch density in a range from 400 to 500 stitches per square inch.

7. The article of claim 1, which additionally contains a sacrificial fabric with a construction in order (a) mattress, (b) flexible heat-resistant knitted fabric and (c) sacrificial fabric, wherein, the article passes CPSC 16 CFR 633 with a peak heat release of less than 250 kilowatts in a 30 minute time period after ignition.

8. The article of claim 7 wherein, the sacrificial fabric comprises cotton.

9. An article comprising in order:
   (I) a foam core,
   (II) a flexible heat-resistant knitted fabric covering at least a portion of a surface of the foam core wherein the knitted fabric comprises
       (a) para-aramid yarn and
       (b) cellulosic yarn wherein cellulosic material in the yarn has not been treated to improve fire resistance, with the provisos:
       (i)  the para-aramid is present in an amount of at least 38 percent by weight of the knitted fabric on a basis of para-aramid and cellulosic material in the yarns,
       (ii) the para-aramid yarn has a size in a range from 45cc to 20cc,
       (iii) the cellulosic yarn has a size in a range from 45cc to 20cc and
       (iv) the knitted fabric has a stitch density in a range from 300 to 700 stitches per square inch and
   (III) a sacrificial fabric,
   with the proviso the article passes CPSC 16 CFR 633 with a peak heat release less than 250 kilowatts in a 30 minute time period after ignition.
10. The article of claim 9 wherein, the sacrificial fabric comprises cotton.
**INTERNATIONAL SEARCH REPORT**

**A. CLASSIFICATION OF SUBJECT MATTER**

INV. D04B1/16 A47C27/00

According to International Patent Classification (IPC) and national classification, and IPC.

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

D04B A47C

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

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

EPO-Internal

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

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<td>A</td>
<td>WO 00/57738 A (BEKAERT SA NV [BE]; HEIRBAUT GUIDO [BE]; GUCHT ANN V D [BE]; STEENLAND) 5 October 2000 (2000-10-05) page 21, line 24 - line 30; figure 5a</td>
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<td>A</td>
<td>US 2005/023509 A1 (BASCOM LAURENCE N [US]; ET AL) 3 February 2005 (2005-02-03) claims 1, 3, 4</td>
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**X** Further documents are listed in the continuation of Box C.  
**X** See patent family annex.

Special categories of cited documents:

A document defining the general state of the art which is not considered to be of particular relevance

E earlier document but published on or after the international filing date

L document which may throw doubts on priori t claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

O document referring to an oral disclosure, use, exhibition or other means

P document published prior to the international filing date but later than the priority date claimed

T later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

X document of particular relevance, the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

Y document of particular relevance, the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

Z document member of the same patent family

Date of the actual completion of the international search

11 November 2008

Date of mailing of the international search report

28/11/2008

Name and mailing address of the ISA/EB: European Patent Office, P.B. 5818 Palentiaan 2 NL - 2280 HV Rijswijk Tel: (+31-70) 340,2040, Fax: (+31-70) 340,3016

Authorized officer

Pieracci, Andrea
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