US 20060182940A1

(19) United States

(12) Patent Application Publication (10) Pub. No.: US 2006/0182940 A1

Cline (43) Pub. Date: Aug. 17, 2006

(54) **FIRE-RESISTANT FIBER-CONTAINING ARTICLE AND METHOD OF MANUFACTURE**

(75) Inventor: **Anthony Joseph Cline**, Letts, IA (US)

Correspondence Address:
FAEGRE & BENSON, LLP
ATTN: PATENT DOCKETING
90 SOUTH SEVENTH STREET
2200 WELLS FARGO CENTER
MINNEAPOLIS, MN 55402 (US)

(73) Assignee: **HNI Technologies Inc.**, Muscatine, IA

(21) Appl. No.: **11/058,462**

(22) Filed: **Feb. 14, 2005**

Publication Classification

(51) **Int. Cl.**
D04H 1/00 (2006.01)

(52) **U.S. Cl.** **428/292.1**

(57) **ABSTRACT**

A fire resistance article comprises a bast fiber component, a thermoplastic component that acts as a binder, and a first fire retardant component, the article having a coating of a second fire retardant component, such that the article can be used in the manufacture of structures having a Class A fire resistance rating. In one method of manufacture, a fibrous mass of the bast fiber component and the thermoplastic binder has the first fire retardant dispersed therethrough, and is then heated, compressed to a desired thickness and density, and coated with the second fire retardant component.

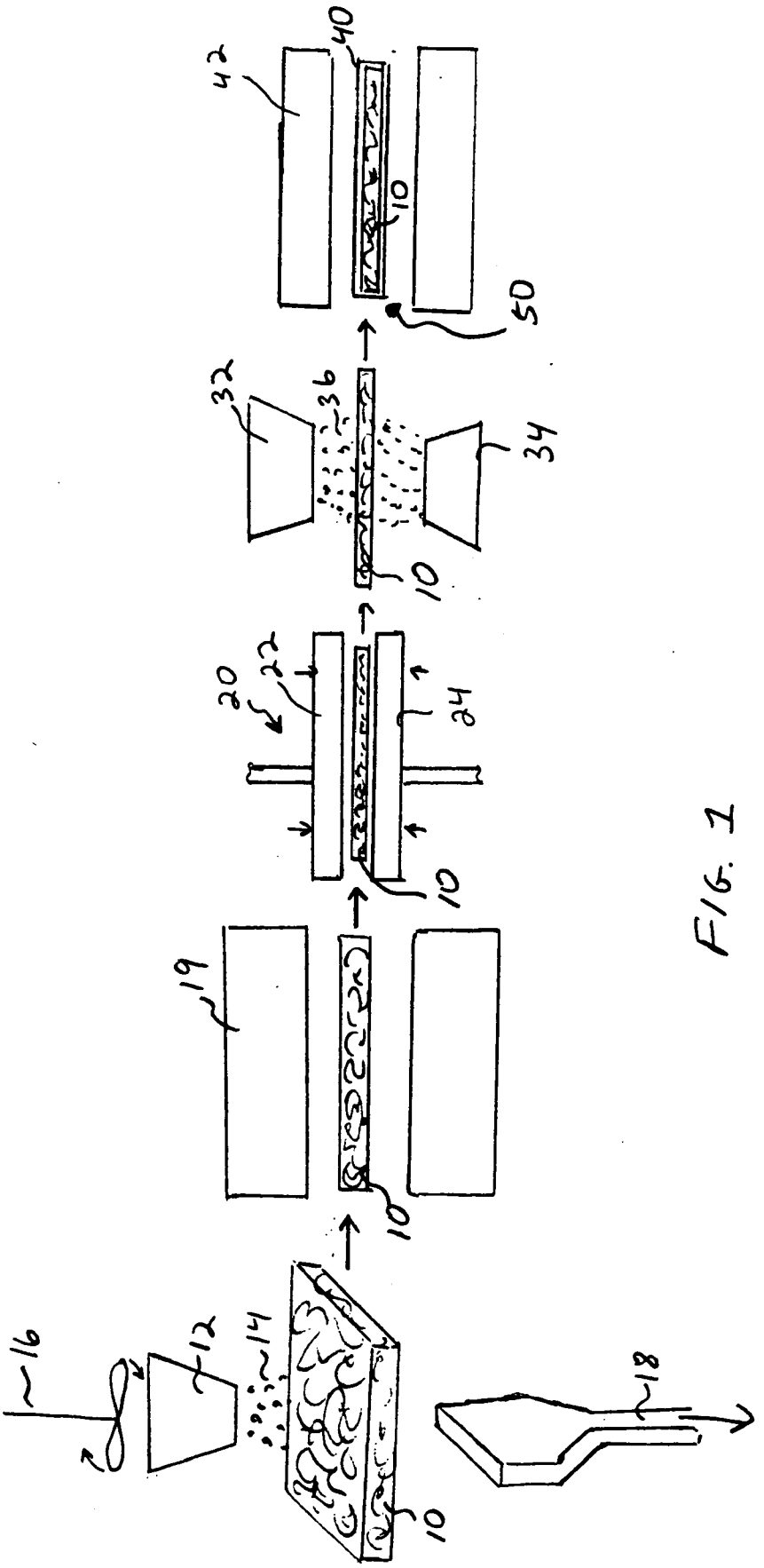

FIG. 1

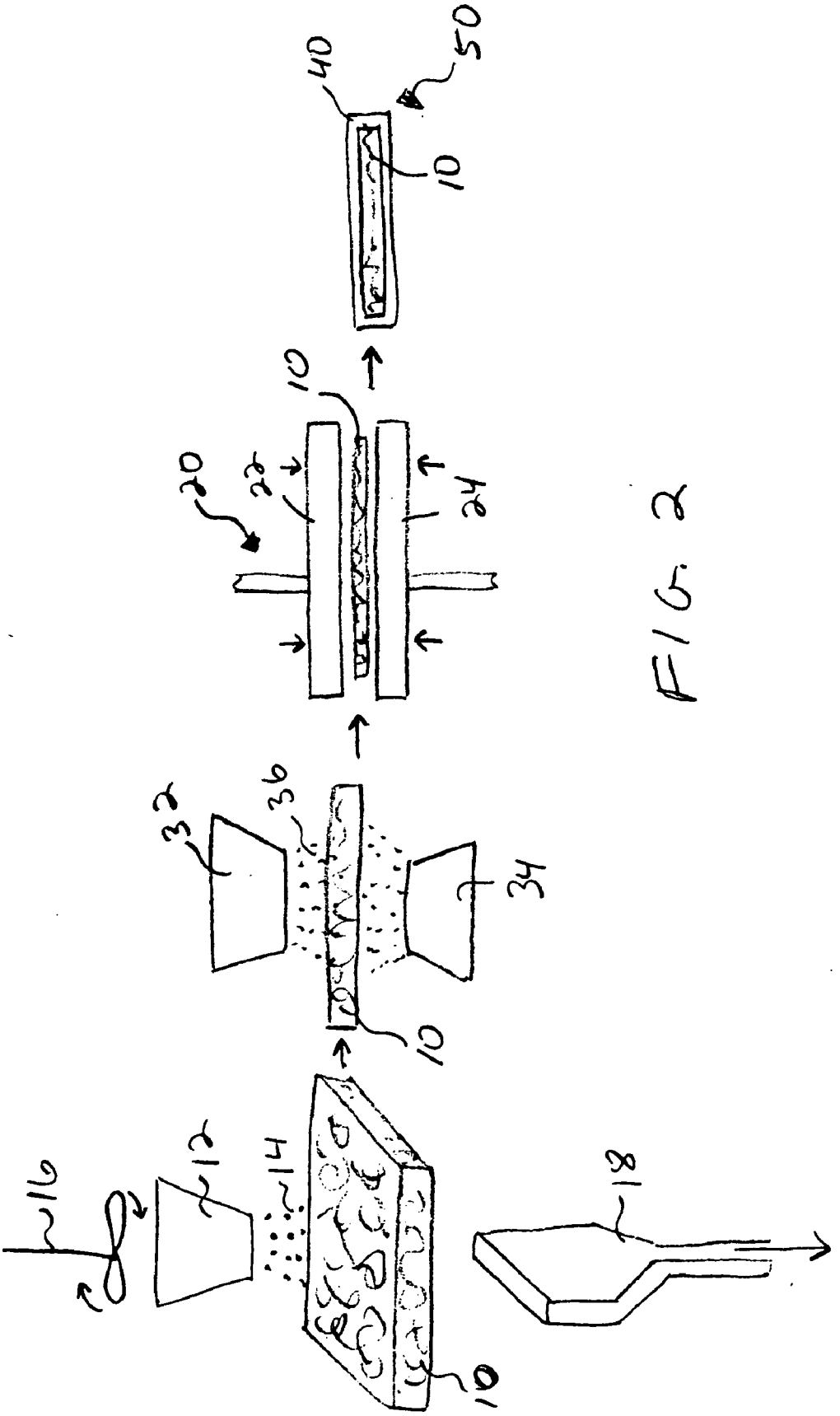

FIG. 2

FIRE-RESISTANT FIBER-CONTAINING ARTICLE AND METHOD OF MANUFACTURE

[0001] This invention relates to a fire-resistant article comprising a portion of natural fibers. More particularly, this invention relates to a fire-resistant article having a portion of natural fibers and being suitable for use in the manufacture of fire-retardant structures, and to a method of manufacturing such an article.

BACKGROUND OF THE INVENTION

[0002] Fiberglass is well known for use as a component of office furniture, office partitions, and other structures used in office, school, commercial, and industrial settings.

[0003] Fiberglass has many advantages for such applications. It is relatively inexpensive, it can be worked into a variety of shapes and densities, and it has good fire-resistance properties.

[0004] Recently, however, concerns have been raised about such ubiquitous uses of fiberglass. Some have expressed concerns about health or safety risks that might occur during the manufacture of fiberglass articles. Concerns also have been raised about the use of certain volatile organic compounds, such as aldehyde compounds and formaldehyde in particular, that are typically involved in fiberglass-containing structures. Thus there has been increased customer interest in office furniture and other office products that do not include fiberglass as a component.

[0005] Agricultural fibers are gaining interest as a natural, renewable resource with potential for use in a variety of manufactured products. In particular, bast fibers such as industrial hemp, kenaf, jute, sisal and flax can be made into non-woven sheet-like products in roll form that can then be used in subsequent manufacturing processes. In some situations, bast fiber products are preferred as natural products that do not harm the environment and that do require the use of volatile organic compounds. It is known to manufacture articles using bast fibers and a thermoplastic binder, as disclosed for example, in U.S. Pat. No. 5,709,925, which discloses the use of such a composition for an interior trim panel for a motor vehicle.

[0006] Furniture and other structures intended for use in an office environment must have a Class A fire resistance rating. This means that such products must have a flame spread index of 25 or less, and a smoke generation index of 450 or less, as measured by the test procedures set forth in ASTM E 84 and UL 723. Agricultural fibers are inherently flammable. Thus, in order for order for agricultural fiber products to be used in an office environment, the products must include some treatment to provide for adequate flame resistance to meet Class A requirements.

[0007] One such effort to make a fire-resistant article with natural fibers is described in U.S. Patent Application Publication No. US 2004/0028958 A1, wherein a moldable batt comprises a fire-retardant cellulose, a fiber component, and a binder component, the batt being compressed and heated to form fire-resistant panels or other products that are said to be particularly useful in the office furniture industry.

[0008] It is thus one object of the invention to provide an article that can be used in the manufacture of office furniture, partitions, and other structures, which article does not include fiberglass.

[0009] It is thus another of the invention to provide an article that can be used in the manufacture of office furniture, partitions, and other structures, which article includes bast fibers as a component thereof yet which meets the standards for a Class A fire-resistance rating.

SUMMARY OF THE INVENTION

[0010] In accordance with the invention, a fire-resistant article comprises a fibrous mass having a fiber component and about 10-30 wt. % of a first fire retardant component mixed therein, the fiber component comprising about 1-50 wt. % thermoplastic and about 50-99 wt. % natural fiber, the fibrous mass having a coating of a second fire retardant component on the exterior surfaces thereof. By appropriate selection of the natural fibers, the thermoplastic, and the first and second fire retardant components, it is possible to make an article having both flame spread index values and smoke generation index values that fall within the Class A fire rating. Moreover, the article is made free of fiberglass and free of the formaldehyde commonly used with fiberglass.

[0011] The fiber component preferably comprises about 10-50 wt. % thermoplastic to about 50-99 wt. % natural fiber and most preferably comprises about 10-30 wt. % thermoplastic and 70-90 wt. % natural fiber. The fibrous mass preferably comprises about 10-30 wt. % of the first fire retardant component and most preferably about 18-22 wt. % of the first fire retardant component.

[0012] The natural fiber content of the fiber component can be made up of a variety of bast fibers, including fibers such as kenaf, jute, industrial hemp, sisal, flax, and mixtures thereof. Particularly preferred is a mixture of kenaf and industrial hemp. The natural fiber content is preferred as a renewable resource, and one which does not emit potentially hazardous materials into the environment. The thermoplastic material is mixed with the natural fiber in sufficient quantity to bind the fibers together upon the application of heat. Suitable thermoplastics include polypropylene, polyethylene, polyesters, nylon, copolymers, and mixtures thereof. The thermoplastics can be in the form of fibers, bi-component fibers, powders, or pellets.

[0013] One embodiment of the inventive method of making a fire-resistant article comprises the steps of providing a fibrous mass comprising a mixture of thermoplastic material and natural fibers, dispersing a first fire retardant component in the fibrous mass, compressing and heating the fibrous mass to form a shaped article, and applying a coating of a second fire retardant component to the shaped article. The first fire retardant component can be in a powder form that is either blown through the fibrous mass or drawn through under reduced pressure. After the first fire retardant is dispersed through the fibrous mass, the mass is heated to a temperature above the softening temperature of the thermoplastic but below the flash temperature of the natural fibers, and then compressed. The second fire retardant can be applied to the outer surfaces of the compressed mass such as in a liquid medium. In a preferred method, the article can be heated again to drive off the liquid medium.

[0014] In an alternative method, the first flame retardant component can be dispersed through the fibrous mass, the second flame retardant component can be applied to the outer surfaces of the fibrous mass, and the mass can be compressed with heat to both soften the thermoplastic to

bind the natural fibers and drive off any liquid medium from the application of the second flame retardant component.

[0015] Through appropriate choices of materials and processing conditions, the resulting article can be made to have a flame propagation index and smoke generation index low enough to merit a Class A rating. The article can be used in the manufacture of office dividers, ceiling tiles, bulletin boards, and other structures requiring a Class A rating that are used in office, school, commercial and industrial settings.

DESCRIPTION OF THE DRAWINGS

[0016] The present invention can be more readily understood by reference to the drawings, wherein

[0017] **FIG. 1** is a schematic drawing of one method of making the fire-resistant article of the present invention, and

[0018] **FIG. 2** is a schematic drawing of an alternative method of making the fire-resistant article of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0019] A fire-resistant article of the present invention comprises a fibrous mass having a fiber component and about 10-30 wt. % of a first fire retardant component mixed therein; the fiber component comprising about 1-50 wt. % thermoplastic and about 50-99 wt. % natural fiber, the fibrous mass having a coating of a second fire retardant component on the exterior surfaces thereof.

[0020] The fibrous mass used in the manufacture of the fire-resistant article can be provided in the form of long sheets shipped as rolls. Such rolls can be commercially fabricated to include natural fibers and thermoplastic materials to a purchaser's specifications.

[0021] The natural fiber component of the fibrous mass is derived from the family of bast fiber plants in which a plant stalk has bast fibers and a core. The preferred bast fiber plants will be those in which the bast fibers are readily separated from the core of the stalk. Particularly suitable bast fiber plants for this purpose include kenaf, jute, industrial hemp, sisal, and flax. Any of these plant materials may be used alone or in combination with each other, and in various proportions. The selection of the plant materials to be used will be based on ease of manufacture into the fibrous mass for use in the invention, cost, availability, and fire resistance in the finished article based on empirical tests. One particularly preferred combination is a mixture of kenaf and industrial hemp. Further, while various proportions of the different fibers can be used, a fibrous mass in which the natural fiber component comprises kenaf and industrial hemp fibers in about equal proportions by weight is especially preferred.

[0022] The thermoplastic component should have a softening temperature below the combustion temperature of the natural fibers. Suitable thermoplastic components can be selected from the group consisting of polypropylene, polyethylene, polyesters, nylon, copolymers, and mixtures thereof. Of these, polypropylene is preferred for its ready availability and its low cost. The thermoplastic component is preferably in the form of fibers so that it can be readily incorporated in the fibrous mass in the initial manufacture thereof. In one embodiment, the fibers can include bicomponent fibers, in which fibers of a first thermoplastic material are coated or encased within a second thermoplastic material having a lower softening temperature. Alternatively, the thermoplastic component can be in other forms such as powders or pellets that can be readily incorporated in the fibrous mass.

[0023] Because of the inherent flammability of both the natural fibers and the thermoplastic materials used in the fibrous mass, a first fire-retardant is dispersed throughout the fibrous mass. The first fire retardant component can be selected from the group consisting of borates, polyborates, boric acid, borax, phosphates, and mixtures thereof. Of these, sodium polyborate is especially preferred.

[0024] A second fire retardant is applied as a coating to the exterior surfaces of the fibrous mass. Sodium silicate has been found to be particularly well suited to this purpose.

[0025] The present invention further encompasses two methods of making the fire resistant article. The first inventive method comprises the steps of (a) providing a fibrous mass comprising a mixture of thermoplastic material and natural fibers, (b) dispersing a first fire retardant component in said fibrous mass, (c) heating said fibrous mass to a temperature above the softening temperature of the thermoplastic material, (d) compressing said fibrous mass to form a shaped article, and (e) applying a coating of a second fire retardant component to said shaped article.

[0026] The first fire retardant can be dispersed through the fibrous mass by any of several methods. Where the first fire retardant is provided in the form of a powder, such methods can include blowing the fire retardant powder into sheets of the fibrous mass, or drawing the fire retardant powder through sheets of the fibrous mass with a reduction in pressure on one side thereof, or using a combination of blowing on one side of the sheet of fibrous mass and creating a region of reduced pressure on the other side. Alternatively, the first fire-retardant can be incorporated into the fibrous mass during the production thereof such as by pre-mixing with the natural fiber component, pre-mixing with the thermoplastic component, or by mixing together with the natural fiber and thermoplastic component, prior to or during the formation of the fibrous mass. After the first fire retardant is dispersed in the fibrous mass, the fibrous mass is then heated to a temperature above the softening temperature of the thermoplastic component to allow the thermoplastic to soften and bind the natural fibers of the mass. The heated mass is compressed to a desired thickness and then optionally cooled for a period of time while in the compressed state so that the mass retains the desired thickness and achieves the desired rigidity.

[0027] The exterior surfaces of the compressed mass are then coated with a second fire retardant composition. Preferably the second fire retardant is present in a liquid medium as either a solution, a suspension or a mixture. This composition can be applied onto the surfaces of the compressed fibrous mass by techniques such as spraying, brushing, roll coating, curtain coating, froth coating and dipping. In a preferred embodiment, the coating is applied by spraying an aqueous solution of above 40% sodium silicate. The coating is then allowed to dry, optionally with heating to drive off the liquid carrier so that the coating sets.

[0028] The first method of making the fire-resistant article of the present invention is schematically illustrated in **FIG.**

1. A sheet **10** of a fibrous mass comprising natural fibers and a thermoplastic material is conveyed beneath a dispenser **12** that dispenses the first fire retardant to be dispersed within the fibrous mass. The dispersal of the first fire retardant **14** into the body of fibrous mass **10** can be facilitated by a blower system **16**, and/or a vacuum assist **18** to pull air and fire retardant through the fibrous mass. The choice of whether to use a blower system **16**, a vacuum assist **18**, or both, may depend on the types of fibers in the fibrous mass, the type of fire retardant used, and the density of the fibrous mass. After the first fire retardant is applied, the fibrous mass **10** is passed through an oven **19** where it is heated to a temperature greater than the softening temperature of the thermoplastic component. This allows the thermoplastic material to soften and bind the natural fibers. The heated mass is then passed to a press **20** where it is pressed between two press platens **22**, **24**, which decreases the thickness and increases the density of fibrous mass **10**. The mass is held at the thickness while it is allowed to cool. Fibrous mass **10** is then conveyed to a coating application apparatus, which in the illustrated embodiment is in the form of two spray heads **32**, **34**, although it will be appreciated that an apparatus with one spray head could be used if the mass **10** is sprayed first on one side and then on the other. The spray heads **32**, **34** spray both surfaces of fibrous mass **10** with a composition **36** containing a second fire retardant material that forms a coating **40** on the exterior surfaces of fibrous mass **10**. Article **50** is the compressed fibrous mass **10** with the first fire retardant dispersed therein and having a coating **40** of the second fire retardant. The coating **40** on article **50** is allowed to set; this last step can be facilitated by heating article **50** with a heat source **42** to drive off any liquid medium from mixture **36**, with or without a vacuum assist or forced air.

EXAMPLE

[**0029**] A fibrous mass is provided comprising about 20% by weight of polypropylene fibers and about 80% by weight of a natural fiber component, the component containing 50 percent by weight of kenaf fiber and 50 percent by weight of industrial hemp fiber. Sodium polyborate powder is blown through the mass. The mass is heated to a temperature of about 375°-380° F. for about 10-15 minutes in a conventional oven. The mass is compressed to a desired thickness and allowed to cool. The compressed mass is sprayed on all surfaces with a 40% by weight aqueous solution of sodium silicate, at about 1-2 oz. solution per square foot of surface area. The mass is then heated to a temperature of about 390° for about 1-2 minutes to drive off the water and allow the sodium silicate coating to set. The resulting article can be used in the manufacture of a structure having a flame spread index of less than 25 and a smoke generation index of less than 450, which meets the requirement for a Class A rated fire resistant article. Structures made with the article can be useful in furniture, office partitions, ceiling tiles, and the like.

[**0030**] The second method of making a fire-resistant article of the present invention comprises the steps of (a) providing a fibrous mass comprising a mixture of thermoplastic material and natural fibers, (b) dispersing a first fire retardant component in the fibrous mass, (c) applying a coating of a second fire retardant component to the fibrous mass, (d) heating the fibrous mass, and (e) compressing the fibrous mass to form a shaped article, and allowing the compressed mass to cool. In this method, the heating and compression steps can be conducted separately or simultaneously. The materials that can be used in this second method are the same as those that can be used in the first method The second method is illustrated in **FIG. 2**, wherein the same elements as are shown in **FIG. 1** are indicated by the same reference numerals. Referring to **FIG. 2**, a sheet **10** of a fibrous mass comprising natural fibers and a thermoplastic material is conveyed beneath a dispenser **12** that dispenses the first fire retardant **14** to be dispersed within fibrous mass **10**. The dispersal of the fire retardant **14** into the body of fibrous mass **10** can be facilitated by a blower system **16**, and/or a vacuum assist **18** to pull air and fire retardant through the fibrous mass. The choice of whether to use a blower system **16**, a vacuum assist **18**, or both, may depend on the types of fibers in the fibrous mass, the type of fire retardant used, and the density of the fibrous mass. After the first fire retardant is applied, fibrous mass **10** is then conveyed to a coating application apparatus, which in the illustrated embodiment is in the form of two spray heads **32**, **34**, although it will be appreciated that an apparatus with one spray head could be used if the mass **10** is sprayed first on one side and then on the other. The spray heads **32**, **34** spray both surfaces of fibrous mass **10** with a mixture **36** containing a second fire retardant material present in a liquid medium that forms a coating **40** around fibrous mass **10**. The fibrous mass **10** is then passed to a heating press **20** where it is pressed between two press platens **22**, **24** with heat to a temperature greater than the softening temperature of the thermoplastic component. This allows the thermoplastic material to bind the natural fibers, while decreasing the thickness and increasing the density of fibrous mass **10**. This step also can drive off the liquid medium from coating **40**. The resulting article can be used to produce a satisfactory Class A rated fire resistant structure.

[**0031**] The fire-resistant article disclosed herein avoids the use of fiberglass and formaldehyde. The article so made can be used in the manufacture of furniture, office partition panels, ceiling tiles, bulletin boards, and other articles and structures useful in office, school, and industrial environments that require Class A fire-resistant structure. Modifications and variations of the inventive article and methods are possible in light of the above teachings. It is therefore to be understood that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described herein.

What is claimed is:

1. A fire-resistant article, said article comprising a fibrous mass having a fiber component and about 10-30 wt. % of a first fire retardant component mixed therein, said fiber component comprising about 1-50 weight percent thermoplastic and about 50-99 weight percent bast fiber, said fibrous mass having a coating of a second fire retardant component on the exterior surfaces thereof.

2. The article of claim 1 wherein said thermoplastic component is selected from the group consisting of polypropylene, polyethylene, polyesters, nylon, copolymers, and mixtures thereof.

3. The article of claim 2 wherein said thermoplastic is polypropylene.

4. The article of claim 1 wherein said bast fibers are selected from kenaf, jute, industrial hemp, sisal, flax, and mixtures thereof.

5. The article of claim 4 wherein said bast fibers comprise a mixture of kenaf and industrial hemp.

6. The article of claim 1 wherein said first fire retardant component is selected from the group consisting of borates, polyborates, boric acid, borax, phosphates and mixtures thereof.

7. The article of claim 6 wherein said first fire retardant component comprises sodium polyborate.

8. The article of claim 1 wherein said coating comprises sodium silicate.

9. A method of making a fire-resistant article, said method comprising the steps of

(a) providing a fibrous mass comprising a mixture of thermoplastic material and bast fibers,

(b) dispersing a first fire retardant component in said fibrous mass,

(c) heating said fibrous mass to a temperature above the softening temperature of the thermoplastic material,

(d) compressing the mass to form a shaped article, and

(e) applying a coating of a second fire retardant component to said shaped article.

10. The method of claim 9 wherein said fibrous mass comprises about 1-50 weight present thermoplastic and about 50-99 weight percent natural fiber.

11. The method of claim 9 wherein said bast fibers are selected from kenaf, jute, industrial hemp, sisal, flax, and mixtures thereof.

12. The method of claim 11 wherein said natural fibers comprise a mixture of kenaf and industrial hemp fibers.

13. The method of claim 9 wherein said thermoplastic is in a form selected from the group consisting of fibers, bicomponent fibers, powder, and pellets.

14. The method of claim 9 wherein said thermoplastic component is selected from the group consisting of polypropylene, polyethylene, polyesters, nylon, copolymers, and mixtures thereof.

15. The method of claim 14 wherein said thermoplastic is polypropylene.

16. The method of claim 9 wherein said first fire retardant is selected from the group consisting of borates, polyborates, boric acid, borax, and phosphates.

17. The method of claim 16 wherein said first fire retardant component comprises sodium polyborate.

18. The method of claim 9 wherein said second fire retardant component is applied as a liquid composition.

19. The method of claim 9 comprising the further step of heating the article after the application of the second fire retardant component to allow said second fire retardant component to set as a coating on the article.

20. The method of claim 9 wherein said second fire retardant component comprises sodium silicate.

21. A method of making a fire-resistant article, said method comprising the steps of

(a) providing a fibrous mass comprising a mixture of thermoplastic material and bast fibers,

(b) dispersing a first fire retardant component in said fibrous mass,

(c) applying a coating of a second fire retardant component to said fibrous mass,

(d) heating said fibrous mass, and

(e) compressing said fibrous mass to form a shaped article.

22. A structure comprising the fire-resistant article of claim 1.

* * * * *