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(54) **COVERING ARTICLE FOR REACTIVELY EXTINGUISHING A FIRE**

(57) A cover article for reactive fire extinguishing is made from a material having a flexible, soft, fibrous woven or non-woven base with a reactive coating in the form of a flexible layer permanently applied on said fibrous base on the article side that is expected to come in contact with a fire hazard, said layer containing a soft, flexible polymer carrier with microcapsules dispersed therein, said microcapsules having a core that contains a fire ex-

tinguishing agent or a mixture of fire extinguishing agents characterized by the fact when they are heated to a temperature above their boiling point, they are subject to intensive gas evolution and thermal decomposition with formation of heavy free radicals, and a shell characterized by a narrow range of decomposition temperatures above the boiling point of the fire extinguishing agent.

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Description

Technical field

[0001] The present invention relates to the fire-fighting field, in particular, to fire-fighting means to be placed on a fire hazard area on objects having fire hazards, for protection of objects located in a fire zone, near the fire hazard, to protect a person in the fire zone, for example in residential, industrial and office buildings, in catering enterprises, at throng areas, in hotel complexes, in open fields, on the road, in the underground and other transport vehicles, on ships, gas stations and other objects.

Background of the invention

[0002] Known in the art is a simple and easily accessible passive fire extinguishing means such as fire-resistant blankets made of asbestos cloth, but their use is limited due to the harmful action of asbestos on the respiratory tract and lungs that lead to serious diseases.

[0003] Known in the art are means for passive fire protection of objects in potentially flammable areas whose use is based on prevention of contact of a fire hazard with oxygen of the environment and cease of fire after depletion the oxygen inside the protected zone. Typically such means are articles made of dense glass cloth or carbon fiber, or of multilayer non-combustible materials.

[0004] For example, known in the art is use of a protective cover mat as a flame arresting article (DE, 9410133, U1) consisting of a glass cloth and single-side non-woven lining made of non-combustible fibers such as carbon fibers or aramid fibers, wherein the lining and glass cloth are interconnected by non-woven fibrous strands passed through the textile glass fabric.

[0005] Known in the art are multilayer composite materials for passive fire protection articles comprising fire suppressing agents.

[0006] For example, known in the art is a fireproof blanket including glass fibers on a plastic substrate impregnated with a mixture of powdery hydrated aluminum silicate (kaolin) and liquid glass (DE 4120562, A), wherein the substrate may be made of metal and partly of aluminum foil and their mixtures, or made of glass fiber cloth impregnated with said mixture. The use of such a blanket provides additional cooling of the combustion area by extraction and evaporation of water from the hydrated components.

[0007] Also known in the art is application of a flexible fire retardant material (DE 102007014212, A) consisting of two layers of fibrous semi-finished product having a softening point of about 700°C, for example, fibers with a softening temperature of 1000°C, preferably of glass fibers and/or basalt fibers and an intermediate layer of a fire suppressing agent disposed between said two layers and selected from the group consisting of inorganic, halogenated or non-halogenated organic phosphorous compounds and/or fire suppressors based on nitrogen

having a gas ablation (mass loss) forming a swell in a confined space between the layers to prevent contact of the protected object with atmospheric oxygen.

[0008] However, all the above-described means are passive tools used for protection of objects in potentially fire dangerous areas by interrupting atmospheric oxygen supply to the combustion area or with additional cooling of the fire hazard by exudation and evaporation of water. The use of such tools in the presence of a fire hazard on the surface of the protected object in an oxygen atmosphere requires a strong adherence of the tool to the surface of the protected object to stop the air flow into the fire hazard area, which is problematic and potentially dangerous for the operator (rescuer). In case of violation of the protection conditions a repeated inflammation often takes place leading to fire development.

[0009] Known in the art are means for active fire protection of objects having potentially fire dangerous areas, whose use is based on injection in the combustion zone of microcapsules contained in solid, elastic or loose materials, called as a "thermoactive microencapsulated fire extinguishing agent" (OTV), liquid or gaseous products of thermal decomposition of extinguishing agents when the temperature of heating the microcapsules increases to a preset temperature of their destruction, which leads to blocking the development of a chain of chemical burning reaction by heavy free radicals, which serve as a main component of the reactive fire extinguishing.

[0010] Known in the art a microencapsulated extinguishing agent (RU 2469761, C1) containing microcapsules having a core of a fire extinguishing liquid placed inside a spherical polymer shell made of a cured spatially crosslinked polymeric material and having nanoparticles of a mineral filler in the form of platelets with a thickness of 1-5 microns, said agent being capable of explosive distraction in a temperature range of 90 to 230°C. The microcapsules can have an external diameter in a range of 50-400 microns, and the core of an extinguishing liquid constitutes 75-95% by weight of the microcapsule containing bromine or fluorine-bromine extinguishing liquid, or perfluoroethyl-perftorizopropyl ketone and/or dibromomethane, or a mixture of extinguishing liquids selected from the group consisting of perftoretil-perftorizopropil-ketone, dibromomethane, bromohydrocarbons fluorine-bromine hydrocarbons in a liquid state. The spherical polymer shell may be made, for example, as a complex of polyvinyl alcohol and urea-resorcinol-formaldehyde resin or crosslinked gelatin, and may contain mineral filler in an amount of 1-5% by weight of the shell, in the form of nanolayer with a size of platelets of natural montmorillonite aluminosilicate or its analogs in an exfoliated state. These microcapsules can be used in a composite fire extinguishing material.

Summary of the invention

[0011] An object of the present invention is to provide reusable rapidly unfolding efficient active fire extinguish-

ing means for fire-fighting on areas of various size, or be used as a fire control measure to prevent an increase of a fire hazard area, to provide fast extinguishing of fire in the fire hazard precluding a possibility of new flame formation and safety for persons in the fire area (victims) or operating on the fire hazard area (rescuers) through direct actions onto the fire hazard area, when its safe use in a domestic environment (apartments, houses, hotels, restaurants and other premises) and in industrial areas, gas stations, garages and transport areas.

[0012] In so doing, the inventing is aimed at creation of articles for reactive fire extinguishing by implementing a self-contained automatic inertia-free fire suppression system to be placed at an alleged fire zone a flexible cover article facing the fire hazard zone with an active fire extinguishing coating containing liquid extinguishing agents encapsulated in the microcapsule cores which, when reaching a certain thermal decomposition temperature in the microcapsule shell within a narrow range of temperatures above the boiling point of the used extinguishing agents produces gasified product of the thermal decomposition of the extinguishing agent to the environment.

[0013] An expected technical result is a simultaneous explosive release of a significant amount of gaseous products due to thermal decomposition of the extinguishing agent in the combustion zone thus blocking the chemical chain combustion reaction by heavy free radicals.

[0014] This task has been solved by creation of a cover article for reactive fire extinguishing made of a material having a woven or non-woven base with a coating including a polymer carrier with microcapsules dispersed therein and having a core disposed in a shell and consisting of a liquid extinguishing agent, characterized in that the material has a flexible, soft fibrous base, the coating is a reactive coating in the form a flexible layer disposed integrally on said fibrous base on the side of expected contact of the article with a fire hazard and comprising a soft flexible polymer carrier, wherein the dispersed microcapsules having a core with an extinguishing agent or a mixture of extinguishing agents which, when heated above its boiling point, is characterized by intensive gas evolution and thermal decomposition with formation of heavy free radicals, and a shell characterized by a narrow range of its decomposition temperature at a temperatures above the boiling point of the extinguishing agent.

[0015] Thus, according to the invention, it is preferable that the fibrous base of the article comprises a material of mineral or carbon or vegetable fibers or a combination thereof.

[0016] In so doing, according to the invention, it is possible that the fibrous base material is selected from the group including fiberglass, mineral fiber, carbon fiber, cotton cloth, sesame cloth, hemp fiber, woolen fiber, combined fiber cloth.

[0017] In so doing, according to the invention it is possible that the fibrous base material is selected from the group of engineering cloth such as canvas or belting.

[0018] In so doing, according to the invention, it is expedient that the reactive coating as a polymer carrier comprising rubber or a rubber-like polymer characterized by curing temperature not higher than 45°C.

5 **[0019]** In so doing, according to the invention, it is possible that the polymer carrier is selected from the group including silicone rubber, polyurethane, elastic epoxy resins, and polyesters.

10 **[0020]** Furthermore, according to the invention, it is possible that the polymer carrier is selected from the group including film-forming polymers characterized by curing temperature not higher than 45°C at drying.

15 **[0021]** In so doing, according to the invention, it is possible that the initial film-forming polymer is selected from the group including polyvinyl alcohol in an aqueous solution with a plasticizer; polyvinyl acetate in the form of an aqueous dispersion; polybutylacrylate in the form of a butylacrylate latex.

20 **[0022]** In so doing, according to the invention, it is expedient that the reactive coating polymer carrier includes dispersed microcapsules containing a core with an extinguishing agent such as a highly efficient extinguishing liquid selected from the group comprising the following fluorine, bromine, iodine compounds:

- 25 - perfluorocarbons having a formula of C_nF_{n+2} , where $n=5-7$;
- fluorodides having a formula of C_3F_7I , called Freon 217 I-1;
- 30 - tetrafluorodibromethane having the formula of $C_2F_4Br_2$ called Freon 114b2;
- octafluorodibrom butane having a formula of $C_2F_4Br_2$ called Freon 114B2;
- dibromomethane having a formula of CH_2Br_2 ;
- 35 - perfluoroethyl-perfluoropropyl-ketone having a formula of $C_6F_{12}O$ and called Novecl230 or PFC-49; and
- their mixtures in a shell providing prior to its decomposition overheating of the extinguishing agent in the microcapsule core at least by 40°C above the boiling point.
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[0023] In so doing, according to the invention, it is expedient that the reactive coating polymer carrier includes dispersed microcapsules with a diameter of 10-400 micron characterized by decomposition temperature of the shell in a range of 90 to 230°C.

45 **[0024]** In so doing, according to the invention, it is expedient that the content of the microcapsules in the polymer carrier is 50-90 percent by weight.

50 **[0025]** In so doing, according to the invention, it is expedient that the reactive coating polymer carrier has dispersed microcapsules having a shell made of a cured spatially crosslinked polymeric material formed by a complex of polyvinyl alcohol with urea-formaldehyde resin or crosslinked gelatin.

[0026] Furthermore, according to the invention, it is possible that the reactive coating polymer carrier has dis-

persed microcapsules having a shell made of a cured spatially crosslinked polymeric material formed by a complex of polyvinyl alcohol with urea-formaldehyde resin or crosslinked gelatin filled with nanoparticles in the form of exfoliated montmorillonite plates having a thickness of 1-5 microns.

[0027] In so doing, according to the invention, it is possible that the article has a preset area and shape of the reactive coating and is made of a material with a fibrous base having a reactive coating on one side.

[0028] In so doing, according to the invention, it is possible that the article is adapted for compact storage and fast deployment over the fire hazard area and is selected from the group including napkin, blanket, carpet, curtains.

[0029] In addition, according to the invention, it is possible that the article may be adapted for compact storage, used as a preventive fire safety measure and is selected from the group including a tent, a cape or a cloak-tent canopy awning.

[0030] In addition, the cover article can be adapted for permanent placement above technical objects or inside them during their operation as a preventive measure to prevent fire, said article being selected from the group including an awning, a canopy, a wrap, a cover, and a sheath.

[0031] In so doing, according to the invention, it is possible that the article has a preset area and shape of the reactive coating and is made of a fibrous base material having a reactive coating on both sides thereof.

[0032] In so doing, according to the invention, the article can be adapted for placing over the protectable flammable objects during storage or transportation and is selected from the group including a cover, an awning, a canopy, a canvas, and a package.

[0033] The cover article for reactive fire extinguishing is further illustrated by examples of its embodiments. These examples are not exhaustive and not intended to limit the possibility of other methods of carrying the invention into effect without departing from the scope of the claims.

The best embodiment of the invention

[0034] The cover article for reactive fire extinguishing according to the invention is made of a material having a flexible, soft, woven or non-woven fibrous base with a reactive coating in the form of a flexible layer permanently disposed on said fibrous base on the side of expected contact of the article with a fire hazard. In so doing, the fibrous base consists of a material based on mineral or carbon, or vegetable fibers or a combination thereof, for example, selected from the group including fiberglass, mineral fibers, carbon fibers, cotton cloth, linen cloth, sesame cloth, and hemp fiber, combined fiber cloth. The fibrous base material can be selected from the group of industrial fabrics, such as tarpaulins or belting. The fibrous base provides flexibility of the article and a possibility of creating of sufficient extinguishing effect on the

surface of the integral thin coating. Depending on the application conditions, the base material may have different texture and density.

[0035] In so doing, the reactive coating includes a soft flexible polymer carrier with microcapsules dispersed therein and having a core containing an extinguishing agent or a mixture of extinguishing agents characterized by a boiling point significantly lower than the decomposition temperature of the microcapsule shell and by a high volume of gaseous products of their thermal decomposition forming heavy free radicals in the fire surrounding area. The difference between the boiling point of the extinguishing agent in the core and the decomposition temperature of the microcapsule shell provides superheating of the extinguishing agents in the core before destruction of the shell, increases the efficiency of gas formation and increases the rate of release of the products of the thermal decomposition of the extinguishing agents in the environment. The use of microcapsules with a shell being destructed at a temperature higher than the boiling point of the extinguishing agent contained in the core characterized by a narrow range of decomposition temperature of the shell provides development of shell destruction processes in a large amount of microcapsules simultaneously for obtaining a mass release of gaseous products of thermal decomposition of the extinguishing agents when heating the reactive cover article in the inflammation zone.

[0036] High efficiency of the cover article with a reactive coating at fire suppression is due to the chemical structure of the used extinguishing agents, which are decomposed in the fire zone forming heavy free radicals, which break the kinetic chain of the combustion process stopping its development in a few seconds. In addition, the gaseous products of the thermal decomposition of the extinguishing agents provide isolation of the fire hazard area from the air creating a gas "dome" of heavy decomposition products and reliably prevent re-ignition. Thus, the cover articles with a reactive coating, on the one hand, combine in their functions a self-contained automatic inertia-less fire suppression system fires and, on the other hand, have properties of a nonflammable material.

[0037] According to the invention, the reactive coating of the article includes microcapsules having a core with an extinguishing agent comprising a high-efficiency extinguishing liquid, for example, the microcapsules known from patents RU 2389525 C2, RU 2161520 C1 and RU 2469761 C1, comprising a fire extinguishing liquid selected from the group including the following fluorine, bromine and iodine compounds comprising:

- perfluorocarbons having a formula C_nF_{2n+2C} , where $n=5-7$, having a boiling point respectively: 29.3°C ($n=5$); 57.2°C ($n=6$); 82.5°C ($n=7$);
- fluoroiodides having a formula C_3F_7I called Freon-217 I-1 having a boiling point of 37°C;
- tetrafluorodibromomethane having a formula $C_2F_4Br_2$,

- called Freon 114b₂ having a boiling point of 47,3°C;
- octafluorodibrom butane having a formula C₄F₈Br₂ called Freon 318B₂ having a boiling point of 40,5°C;
- dibromomethane having a formula CH₂Br₂ having a boiling point of 97°C
- perfluoroethyl-perfluoroisopropyl-ketone having a formula C₆FO called Novec 1230 or PFC-49 and having a boiling point of 49.2°C and their mixtures in a shell providing its destruction overheating of the extinguishing agent in the microcapsule core at least by 40°C above the boiling point.

[0038] For example, if the extinguishing agent is Freon 114B₂ or PFC-49, heating the microcapsule shell to 100-120°C (or higher for other fire-extinguishing agents) leads to explosive destruction of the shell including superheated thermal decomposition products of the extinguishing agent, their gasification and active emissions into the environment.

[0039] In so doing, according to the invention, it is expedient that the microcapsules have a diameter of 10-400 microns and a shell fracture temperature in a range of 90-230°C.

[0040] For example, according to the invention, one may use in the reactive coating well known finished microcapsules (RU, 2469761, C1) whose core contains said extinguishing agents and has a microcapsule shell made of a cured spatially crosslinked polymeric material, preferably formed by a complex of polyvinyl alcohol with urea-resorcinol-formaldehyde resin or a crosslinked gelatin. To provide a long life of the coating and to decrease variation in the shell decomposition temperature, the shell may contain nanoparticles of mineral filler, preferably, exfoliated montmorillonite in the form of plates with a thickness of 1-5 nm.

[0041] It is expedient that the microcapsules have a diameter of 10-400 microns, and the content of the microcapsules in the reactive coating polymer carrier is 50 to 90 percent by weight.

[0042] According to the invention the polymer carrier includes rubber or rubber-like polymer characterized by curing temperature not higher than 45°C, for example, selected from the group including silicone rubber, polyurethanes, elasticized epoxy resins, polyesters.

[0043] Furthermore, the polymer carrier may be selected from the group including film forming polymers characterized by curing temperature not higher than +45°C at drying, for example, polyvinyl alcohol in an aqueous solution, an aqueous polyvinyl acetate, polybutylacrylate in the form of butylacrylate latex.

[0044] The flexible coating layer provides the necessary reversible deformation of the cover article its best disposition on the protected object, and a possibility of transformation of the cover article in the process of its use for fire extinguishing.

[0045] Moreover, according to the invention, and as follows from the above-described materials with a coating on one side of the above fibrous base and above-de-

scribed coating on both sides of the fibrous base, the cover articles can be made with a various area of the reactive coating and of different shapes.

[0046] The dimensions of the cover articles depend on convenience of their use during application. The thickness and area of a required reactive coating can be calculated taking into account the estimated volume of the object to be protected, a volume of the fire-extinguishing concentration of the used extinguishing agent and the requirements of single or several operations. For example, the coating thickness may be 0.3-5.0 mm or higher (for spatially extended articles).

[0047] Depending on the application of the cover article, it may have a preset shape and area of the reactive coating and can be made of a material with a fibrous base having a reactive coating on one side.

[0048] The cover article can be adapted for compact storage and fast deployment over the fire hazard area, for example, as a cloth, a blanket, a carpet, and curtains.

[0049] The articles with a reactive coating on one side can find application both for extinguishing burning clothing on a person (victim) when placing them by the reactive coating to the fire spot on the person, and for protection of the rescuer himself by placing the article with the reactive-coated side on the outside (to the fire hazard).

[0050] For use as a preventive safety measures of a human being under conditions of potential fire hazard the cover article may be a cloak, an all-weather raincoat, a tent, or a blanket.

[0051] Depending on the application of the cover article it may have a preset shape and area of the reactive coating and be made of a material with a fibrous base having a reactive coating on both sides thereof.

[0052] For example, the cover article may be intended to be placed on a flammable objects being protected, such as containers with flammable liquids or substances liable to spontaneous combustion in case of overheating or accidental fire hazard, for example, unquenched cigarette, as well as due to criminal action, for example, from hitting a bullet, under conditions of their storage or transportation, or for placing the article cover on an electrical equipment, and represent a veil, awning, canopy, an automobile cover, wrapping or packaging.

[0053] The manufacturing technology for making cover articles used for reactive fire extinguishing according to the invention can be implemented in the following ways:

- preparing a fibrous base material with application of a reactive coating on one or two sides thereof followed by curing, cutting, edging, and crosslinking to form a cover article of a required shape;
- cutting the fibrous base material, edging, crosslinking to form a preset shape of the cover article, and applying a reactive coating to selected portions of the cover articles, curing the coating.

[0054] In this case the technology of applying a reactive coating onto a woven or non-woven fibrous base

comprises:

- applying the initial uncured reactive coating on the fibrous base material placed horizontally on a hard surface manually using, for example, a brush, a roller, a trowel or spray from a spray gun with a nozzle diameter of not less than 500 microns or using a contact method on manual and automatic machines for screen printing;
- curing the reactive coating at room temperature or drying by blowing warm air at a temperature not higher than +45°C.

[0055] Samples of cover articles according to the invention were prepared of fibrous base materials with a reactive coating applied on one or both sides thereof followed by curing.

[0056] Given below are examples of fire extinguishing articles with a reactive coating and fire tests to determine their fire extinguishing efficiency.

Example 1.

[0057] Applied manually on one side of a fiberglass blanket with a size of 100x180 cm and thickness of 1 mm was a paste including in a mixture of liquid silicone rubber, a catalytic agent and a hardener dispersed finished microcapsules prepared, as described in Patent RU 2469761 C1, in an amount of 60 percent by weight of the total weight of the reactive coating with a size of 125-400 microns, a core with Freon 114b2 having a boiling point of 47.3°C in a shell having a decomposition temperature in a range of 129-130°C to obtain a reactive coating 0.5 mm thick. Then the reactive curing was cured at room temperature for 24 hours. For the specified article area and the reactive coating thickness of 0.5 mm cover the calculated volume of the fire hazard to be extinguished by the Freon 114b2 thermal decomposition products at an extinguishing concentration of Freon 114b2 of 5.0 percent by volume is up to 2.4 m³. The size of the cover article, in this case, a blanket, can be increased or decreased. For repeated use the thickness of the reactive coating must be proportionally increased to the maximum value of 5.0 mm. The flexibility and softness of the finished article made in the form of a blanket allows its reversible deformation to a convenient size, for example 30x50 cm, and manipulation for placing it in a packaging bag or its fast deployment for use.

Example 2.

[0058] Manually applied on both sides of a fiberglass blanket having a size of 100x180 cm and thickness of 1 mm (with a coating layer of 0.3 mm) was a paste comprising a mixture of liquid silicone rubber with catalyst and a hardener dispersed in the mixture in an amount of 60 percent by weight of the total weight of the reactive coating of the microcapsule (RU, 2469761, C1), having

a shell decomposition temperature in a range of 95-100°C, with a size of 125-250 microns as an extinguishing agent containing perfluoroketone called PFC-49 or Novecl230 having a boiling point of 49.2°C featuring an advanced ecological safety, and having a shell modified with nanoparticles of exfoliated montmorillonite in the form of plates 1-5 nm thick.

[0059] The flexibility and softness of the finished cover article made in the form of a blanket allows its reversible deformation to a convenient size, for example, 30x50 cm, and manipulation for placing it in a packaging bag or its fast deployment for use.

Example 3.

[0060] A cover article in the form of fiberglass blanket sized 100x180 cm and 1 mm thick (with a coating layer 0.5 mm thick) was made as described in Example 1, but with a reactive coating polymer carrier including finished microcapsules (RU, 2469761, C1) having a size of 20-250 microns in an amount of 60 percent by weight of the total weight of the reactive coating including dibromomethane with a boiling point of 97°C in a shell with a decomposition temperature in a range of 225-230°C. The flexibility and softness of the finished cover article made in the form of a blanket allows its reversible deformation to a convenient size, for example 30x50 cm, and manipulation for placing it in a packaging bag or its fast deployment for use.

Example 4.

[0061] A cover article in the form of fiberglass blanket sized 100x180 cm and thickness of 1 mm (with a coating layer of 0.3-0.5 mm) was made as described in Example 1, but the reactive coating polymer carrier had dispersed microcapsules (RU, 2469761, C1) of a size 20-200 microns in an amount of 60 percent by weight of the total weight of the reactive coating containing Freon 318B2 or 2171-1 in a shell with a decomposition temperature in a range of 90-100°C. The flexibility and softness of the final cover article made in the form of a blanket allows its reversible deformation to a convenient size, for example 30x50 cm, and manipulation for placing it in a packaging bag or its fast deployment for use.

[0062] Examples 5-7.

[0063] Cover articles in the form of fiberglass blankets with a size of 100x180 cm and a thickness of 1 mm (with a coating layer of 0.3 mm) were made as described in Example 1, but the reactive coating polymer carrier was dispersed in finished microcapsules (RU, 2469761, C1) with a size of 20-250 microns in an amount of 60 percent by weight of the total weight of the reactive coating with a core including various extinguishing agents having different boiling points placed in shells of the following composition:

- dibromomethane having a boiling point of 97°C (Ex-

ample 5);

- a mixture of dibromomethane with perfluorohexane having a boiling point of 57.2°C in a ratio of 80:20 by weight (Example 6);
- a mixture of dibromomethane with fluorocarbon C-5 having a boiling point of 29.3°C in a ratio of 80:20 by weight (Example 7).

[0064] The studies of the cover articles of Examples 5-7 has shown that when the extinguishing agents differing by composition and boiling point are placed in identical shells, the processes of shell destruction run differently: in Example 5 the shells had a decomposition temperature in a narrow range of 225-230°C; in Example 6 the shells had a decomposition temperature within a narrow range of 200-205°C; in Example 7 the shells had a decomposition temperature within a narrow range of 170-180°C.

[0065] Thus, by the combination of the mixture of extinguishing agents it is possible to achieve a desired superheating temperature of the gaseous products of the extinguishing agent thermal decomposition and the destruction temperature of the microcapsule shell allowing explosive release of a significant amount of the gaseous products into the environment.

[0066] The flexibility and softness of the finished cover article made in the form of a blanket allows its reversible deformation to a convenient size, for example 30x50 cm, and manipulation for placing it in a packaging bag or its fast deployment for use.

Example 8.

[0067] A cover article was made in the form of a blanket sized 100x180 cm with a base of 1.0-1.5 mm thick (with a coating layer of 0.5 mm) having a fibrous base of non-woven fabric of cotton fibers containing microcapsules similar to those in Example 1 whose technology is similar to that described in Example 1, with a reactive coating on one side of the fibrous base. The flexibility and softness of the finished cover article made in the form of a blanket allows its reversible deformation to a convenient size, for example 30x50 cm, and manipulation for placing it in a packaging bag or its fast deployment for use.

Example 9.

[0068] A cover article was made in the form of a blanket sized 100x180 cm with a woven fibrous base of carbon fiber of 0.25 mm thick was made using the technology similar to that described in Example 1 with a reactive coating 0.3-0.5 mm thick on one side of the blanket containing microcapsules similar to those in Example 1 with a similar extinguishing agent in the core and with a similar shell. The flexibility and softness of the finished cover article made in the form of a blanket allows its reversible deformation to a convenient size, for example 30x50 cm, and manipulation for placing it in a packaging bag or its

fast deployment for use.

Example 10.

[0069] A cover article in the form of fiberglass blanket sized 100x180 cm and 0.7 mm thick was made as described in Example 1, but the polymer carrier consists of polyvinyl acetate emulsion (PVA adhesive) dispersed with finished microcapsules (RU, 2469761, C1) with a size of 125-300 microns in an amount of 80-90 percent by weight of the total weight of the reactive coating (after drying) with a core containing Freon 114B2 and a shell with a decomposition temperature of 129-130°C. In so doing, the thickness of the coating was equal to 0.3 mm. The flexibility and softness of the finished cover article made in the form of a blanket allows its reversible deformation to a convenient size, for example 30x50 cm, and manipulation for placing it in a packaging bag or its fast deployment for use.

Example 11.

[0070] A cover article in the form of a fiberglass blanket sized 100x180 cm and 0.7 mm thick was made as described in Example 1, but the polymer carrier consists of a polyvinyl alcohol solution (PVA) plasticized with polyalcohol, for example glycerol, in which there were dispersed finished microcapsules (RU, 2469761, C1) with a size of 125-300 microns in an amount of 80-90 percent by weight of the total weight of the reactive coating (after drying) comprising Freon 114b2 a core, the shell having a decomposition temperature of 129-130°C. The thickness of the reactive coating was 0.3-0.5 mm. The flexibility and softness of the finished cover article made in the form of a blanket allows its reversible deformation to a convenient size, for example 30x50 cm, and manipulation for placing it in a packaging bag or its fast deployment for use.

Examples 12-14.

[0071] Cover articles in the form of fiberglass blankets sized 100x180 cm and 0.8 mm thick were made as described in Example 1, but the polymer carrier consists of elasticized epoxy resin (Example 12), cold curing polyurethane composition (Example 13), a cold cured polyester composition (Example 14), wherein finished microcapsules with a size of 125-400 microns (RU, 2469761, C1) were dispersed in the polymer carrier in an amount of 80-90 percent by weight of the total weight of the reactive coating (after drying). The thickness of the reactive coating was equal to 0.5 mm. The flexibility and softness of the finished cover article made in the form of a blanket allows its reversible deformation to a convenient size, for example 30x50 cm, and manipulation for placing it in a packaging bag or its fast deployment for use.

Example 15.

[0072] A cover article was made in the form of a blanket sized 100x180 cm. The blanket has a fibrous base of industrial fabric - canvas 1.0 mm thick, technologically similar to that described in Example 1, with a reactive coating 0.3-0.5 mm thick on one side of the blanket, comprising microcapsules similar to those described in Example 1 with the same extinguishing agent in the core and the same shell. The flexibility and softness of the finished cover article made in the form of a blanket allows its reversible deformation to a convenient size, for example 30x50 cm, and manipulation for placing it in a packaging bag or its fast deployment for use.

Example 16.

[0073] Samples of cover articles designed for reactive fire extinguishing and having a fibrous base with a reactive coating on one or both sides thereof were subjected to fire test. For comparison, a fire test was also used for testing samples of cover articles without any reactive coating and made of fiberglass and carbon, and samples of cover articles with a woven fibrous base consisting of vegetable fibers having no coating.

[0074] The fire tests were carried out on an experimental laboratory bench having a test box sized 200x200x200 mm and made of stainless steel, in which the vertical walls were perforated for air circulation and a removable lid had an opening for ignition. On the box bottom there was placed a Petri dish with 30 ml of diesel fuel. The lid was closed and the diesel fuel was ignited through the opening in the removable cap. After firing up within 5 seconds, the lid was removed and replaced with a member cut from a fire extinguishing cover articles described in the examples 1-15 or with a sample of a cover articles made of fiberglass and carbon fiber free of a reactive coating. A stopwatch was used for measuring the flame out time.

[0075] All tested samples described in Examples 1-15 demonstrated a fire extinguishing time within a range of 5-12 seconds. The diesel fuel practically did not combust completely and remained in the Petri dish. The test results indicate to a reactive character of fire extinguishing by the proposed embodiments of the cover articles of Examples 1-15, which do not even require a sealed fit to the burning object. The samples of the cover articles after testing had only slight damage on their inner surface, facing the inner space of the box. There is a sooty spot of deposited fuel combustion products and visible "micro-craters" from the destroyed microcapsules, the reactive coating is not fully utilized through its thickness, no marked changes in the base structure and in color on the external side were noted, which indicates an unchanged temperature on the external side of the samples. On the bottom surface of the box there was found a slight amount of intact microcapsules withdrawn from the reactive coating layer by the explosive release

of gaseous products of thermal decomposition that at the same time are fast cooled.

[0076] Thus, we may make a conclusion that all the tested cover articles of Examples 1-15 are suitable for re-use under conditions similar to fire tests: the distance to the fire hazard zone 200 mm, the reactive coating area of 200x200 mm, in the process of fire extinguishing subjected to destruction was a part of the microcapsules of the reactive coating and the volume of the reactive coating gaseous products of thermal decomposition of the extinguishing agents injected from the surface layer was sufficient to stop the burning of fuel at a distance of 200 mm from the reactive coating within 5-12 seconds. The presence of intact microcapsules on the surface of the fire hazard area prevents re-ignition.

[0077] The results of the fire tests of the reference cover articles with a fibrous base of mineral fibers (carbon, glass cloth) without a reactive coating has shown that these samples had no effect on the fire hazard during the time of complete burning of the complete burnout of the diesel fuel, while the samples with a fibrous base of vegetable fibers without coating start burning after a while or start to smolder.

[0078] Those skilled in the fire extinguishing field understand that at placement of the described cover articles directly in contact with a burning surface the rate of temperature increase in the reactive coating to the decomposition temperature of the shells of the microcapsules will be in a larger volume and, therefore, the release of gaseous products of thermal decomposition of the extinguishing agents will occur in a higher volume that will provide fast fire extinguishing on the contact surface.

[0079] Making the reactive cover articles for fire extinguishing flexible and soft provides a possibility of their placement on the surface of the protected or burning objects and constructions of various configurations to fit them on the entire necessary contact area.

[0080] Those skilled in the fire extinguishing field understand that, depending on the application conditions, the cover articles may have different shapes with a different surface area of the reactive coating. The cover articles for extinguishing larger fire hazard may have large dimensions, such as fire extinguishing blankets, fire protection blankets for use in transport vehicle and metro. For domestic use, for example, in rooms of apartments and houses cover articles of any dimensions can be used. Effective use of the described articles in the form of an all-weather raincoat or a cloak a traditional style for rescue personnel, or in the form of a tent in a forest zone. Extinguishing napkins, for example, with a size of 500x500 mm are suitable for use in hospitals and nursing homes for the instant elimination of fire from a match, an unquenched cigarette, ignition of wiring or a heating pad on a bedside lamp.

[0081] When using the above-described cover articles for protection of a person in the fire hazard the thermal decomposition products when in contact with skin do not adversely affect the person, protect the skin from thermal

burns, which is useful for the application of these articles by firefighters and rescuers in overcoming rooms or areas wrapped in flames.

[0082] Those skilled in fire fighting understand that the above described cover article can be used in various fields for preventing proliferation of fires, for example, in cable channels, ducts, floor decks.

Industrial Applicability

[0083] The cover articles for reactive fire extinguishing according to the invention can be made using well known technology of making coatings on finished woven or non-woven fibrous bases using known polymeric material and microcapsules having a shell including a core with well-known fire extinguishing agents, and can find wide application as means for fast extinguishing both local sources of fire and spatially extended fires (as a defense for rescuers), as well as a means of preventive protection of objects subject to a high fire risk during their operation, storage and transportation.

Claims

1. A cover article for reactive fire extinguishing made of a material having a woven or non-woven base with a coating including a polymer carrier with microcapsules dispersed therein, said microcapsules having a shell with a core of a liquid extinguishing agent, **characterized in that** said material has a flexible soft fibrous base, the coating is a reactive coating made in the form of a flexible layer permanently applied on said fibrous base on the side of expected contact of the article with a fire hazard and comprises a soft flexible polymer carrier, wherein microcapsules the dispersed, said microcapsules having a core containing an extinguishing agent or a mixture of extinguishing agents which, when heated above their boiling point, are **characterized by** intensive gas evolution and thermal decomposition resulting in formation of heavy free radicals, and a shell **characterized by** a narrow range of its decomposition temperature at a temperature above the extinguishing agent boiling point.
2. An article as claimed in claim 1, **characterized in that** the fibrous base comprises a material selected from the group of materials of mineral or vegetable fibers or carbon or a combination thereof.
3. The article as claimed in claim 2, **characterized in that** the fibrous base material is selected from the group including fiberglass, mineral fiber cloth, carbon fiber, cotton cloth, sesame fibers, hemp fibers, woolen fibers, or composite fibers.
4. The article as claimed in claim 2, **characterized in**

that the fibrous base material is selected from the group of engineering cloth such as canvas or belting.

5. The article as claimed in claim 1, **characterized in that** the reactive coating as a polymer carrier comprises rubber or rubber-like polymer, **characterized by** a curing temperature not higher than 45°C.
6. The article as claimed in claim 5, **characterized in that** the polymer carrier is selected from the group including silicone rubber, polyurethanes, elasticized epoxy resins, polyesters.
7. The article as claimed in claim 1, **characterized in that** the reactive coating as a polymer carrier includes film-forming polymers **characterized by** a curing temperature at drying not higher than 45°C.
8. The article as claimed in claim 7, **characterized in that** the film-forming polymer in the initial state is selected from the group including polyvinyl alcohol in aqueous solution with the plasticizer; polyvinyl acetate in the form of an aqueous dispersion with a plasticizer; as polybutylacrylate butylacrylate latex.
9. The article as claimed in claim 1, **characterized in that** the polymer carrier of the reactive coating is dispersed with microcapsules comprising a core with an extinguishing agent having a high-efficiency extinguishing liquid selected from the group including:
 - perfluorocarbons having a formula of C_nF_{n+2} , where $n=5-7$;
 - fluorodides having a formula of C_3F_7I , called Freon 217 I-1;
 - tetrafluorodibromomethane having the formula of $C_2F_4Br_2$ called Freon 114b2;
 - octafluorodibromobutane having a formula of $C_2F_4Br_2$ called Freon 114B2;
 - dibromomethane having a formula of CH_2Br_2 ;
 - perfluoroethyl-perfluoropropyl-ketone having a formula of $C_6F_{12}O$ and called Novecl230 or PFC-49; and
 - their mixtures in a shell providing prior to its decomposition overheating of the extinguishing agent in the microcapsule core at least by 40°C above the boiling point.
10. The article as claimed in claim 9, **characterized in that** the polymer coating of the reactive coating has dispersed microcapsules with a diameter of 10-400 microns, **characterized by** the decomposition temperature of the shell in a range of 90 to 230°C.
11. The article as claimed in claim 10, **characterized in that** the polymer carrier of the reactive coating has

dispersed microcapsules having a shell of the microcapsules formed of a cured spatially crosslinked polymeric material formed by a complex of polyvinyl alcohol with urea-formaldehyde resin or crosslinked gelatin.

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12. The article as claimed in claim 10, **characterized in that** the polymer carrier of the reactive coating has dispersed microcapsules having a shell made of a cured spatially crosslinked polymeric material formed by a complex of polyvinyl alcohol with urea-resorcinol-formaldehyde resin or a crosslinked gelatin filled nanoparticles exfoliated montmorillonite in the form of platelets having a thickness of 1-5 nm. 10
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13. The article as claimed in claim 10, **characterized in that** the content of microcapsules in the polymer carrier is 50 to 90 percent by weight.
14. The article as claimed in claim 1, **characterized in that** the reactive coating has a preset shape and area and is made of a material with a fibrous base having a reactive coating on one side. 20
15. The article as claimed in claim 14, **characterized in that** it is adapted for compact storage and fast deployment over the fire hazard area and is selected from the group including napkin, blanket, carpet, curtains. 25
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16. The article as claimed in claim 14, **characterized in that** it is adapted for compact storage and use as a preventive fire safety measure and is selected from the group including a tent, a cape, cloak-tent canopy awning. 35
17. The article as claimed in claim 14, **characterized in that** it is adapted to the permanent placement over technical objects or inside the objects during their operation as a preventive measure to prevent fire and is selected from the group including awning, canopy, wrap, coating, pad coating. 40
18. The article as claimed in claim 1, **characterized in that** the reactive coating has a preset shape and area and is made of a material with a fibrous base having a reactive coating on both sides thereof. 45
19. The article as claimed in claim 18, **characterized in that** it is adapted for placement above the protected inflammable objects during their storage, operation or transportation, and is selected from the group including a cover, awning, canopy, canvas, or a package. 50
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INTERNATIONAL SEARCH REPORT

International application No.
PCT/RU 2014/000531

5	A. CLASSIFICATION OF SUBJECT MATTER		
	A62C 8/06 (2006.01)		
	According to International Patent Classification (IPC) or to both national classification and IPC		
	B. FIELDS SEARCHED		
10	Minimum documentation searched (classification system followed by classification symbols)		
	A62C 1/00, 8/00, 8/06, A62D 1/00		
	Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
15	Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
	Espacenet, JAP, USPTO, RUPTO		
20	C. DOCUMENTS CONSIDERED TO BE RELEVANT		
	Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
25	X	WO 2012/177181 A1 (OBSHESTVO S OGRANICHENNOI OTVETSTVENNOSTJU "DELSI" et al.) 27.12.2012, p. 7, paragraph 3 - p. 17, paragraph 2, p. 27, the last paragraph - p. 28, the last paragraph, examples 1, 2, 12-16	1, 5-14, 18
	Y		2-4, 15-17, 19
	D, Y	DE 102007014212 A1 (BRANDCHEMIE GMBH) 25.09.2008, paragraphs [0005]-[0025], fig. 1	2-3, 15-17, 19
30	Y	MARTYNIENKO V. I. Pozharnaya bezopasnost v sudostroitelnom proizvodstve. Spravochnik. "Sudostroenie", 1987, p. 265, paragraph 6	4
35	A	RU 2469761 C1 (OBSHESTVO S OGRANICHENNOI OTVETSTVENNOSTJU "DELSI") 20.12.2012	1-19
	A	JP 2009/119240 A (YAMATO GRAND KK) 04.06.2009	1-19
40	☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.		
45	* 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 application or patent but published on or after the international filing date "L" document which may throw doubts on priority 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 "&" document member of the same patent family		
50	Date of the actual completion of the international search		Date of mailing of the international search report
	11 December 2014 (11.12.2014)		25 December 2014 (25.12.2014)
	Name and mailing address of the ISA/RU		Authorized officer
55	Facsimile No.		Telephone No.

REFERENCES CITED IN THE DESCRIPTION

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[0060] [0061] [0063] [0069] [0070] [0071]
- RU 2389525 C2 [0037]
- RU 2161520 C1 [0037]