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Schmidt

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[54] **FIRE EXTINGUISHER**

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[52] **U.S. Cl.** ..... **169/1 R,** 169/2 R

[51] **Int. Cl.** **A62c 7/00**

[58] **Field of Search** ..... 169/1 R, 2 R, 26, 169/30

[56] **References Cited**

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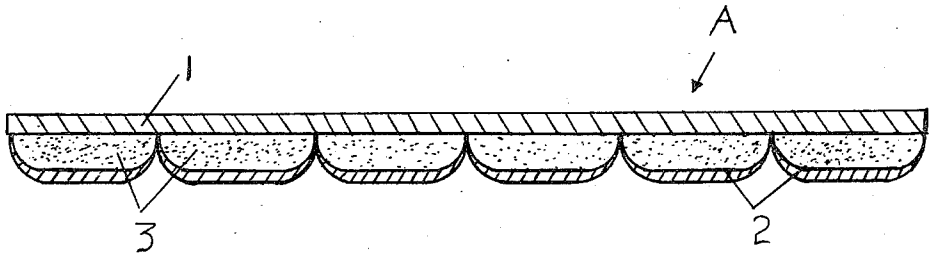
[57] **ABSTRACT**

The disclosure herein pertains to the fabrication and use of articles for extinguishing fires. More particularly, the disclosure, in its preferred embodiment, pertains to flexible sheeted structures having fire extinguishing material enclosed between sheets of heat-rupturable material and fire-proof or fire-resistant material; alternative embodiments are also disclosed. Such fire extinguisher structures are particularly suitable for small fires and may be fabricated into easily accessible household articles such as towels, tidys, blankets, tapestries, draperies, etc.

12 Claims, 4 Drawing Figures



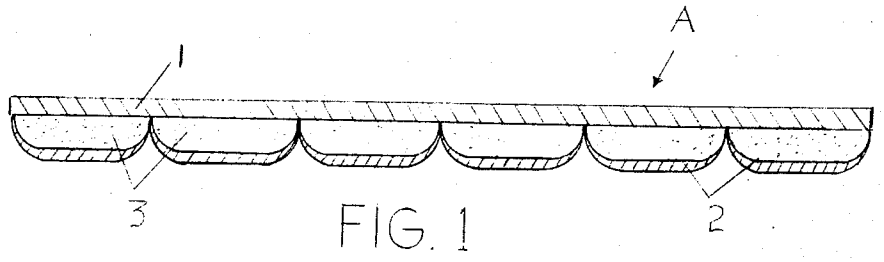


FIG. 1

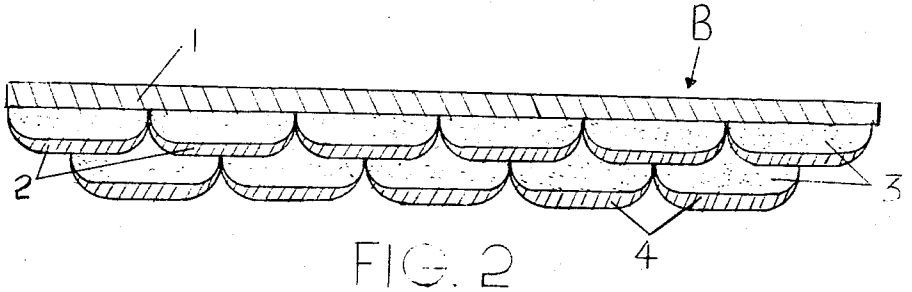


FIG. 2

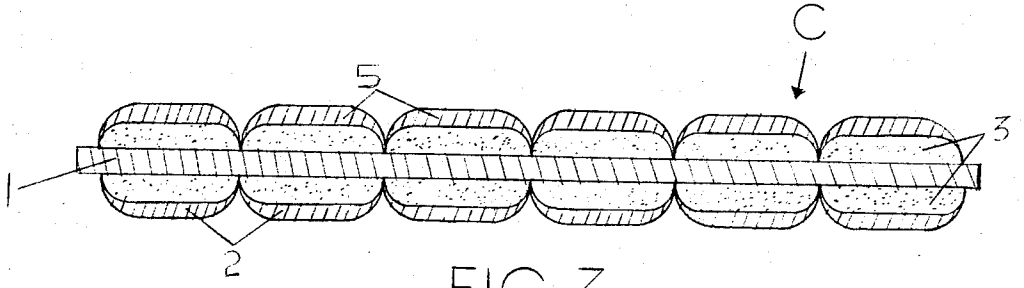


FIG. 3

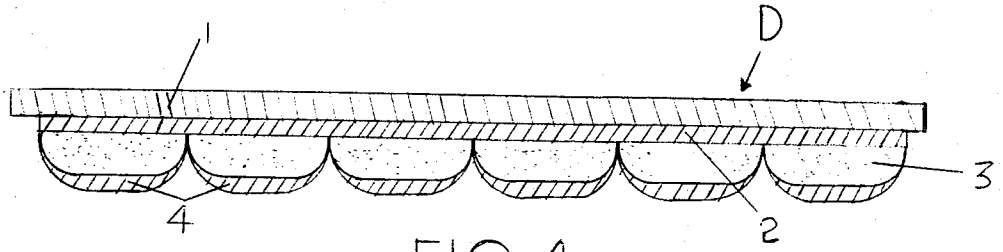


FIG. 4

FIRE EXTINGUISHER

BACKGROUND OF THE INVENTION

This invention relates to the field of fire extinguishers. More particularly, the invention relates to fire extinguishers of the blanket type suitable for use against small fires.

In the prior art, numerous varieties of fire extinguishers are described for use against small fires which commonly occur in homes, automobiles, on boats, etc. Many of the portable, mechanical fire extinguishers commonly available for home use are more or less effective when used according to the manufacturers' instructions. However, there are a number of problems and disadvantages associated with the use of many household fire extinguishers. For example, there is a necessity to maintain mechanical fire extinguishers in operable condition, which requires periodic testing and re-filling or replenishing of the fire-extinguishing material. The nuisance and cost factors of testing and refilling mechanical fire extinguishers can, and frequently does, lead to a neglect of testing and re-filling, to corrosion of parts and/or even to forgetfulness of the instructions as to how to operate the mechanical device in many cases.

Still another problem, frequently associated with mechanical fire extinguishers in the home, is that of storing the device out of the way, if not out of sight, when not in use, yet be kept readily available and accessible when its use is required.

Yet another disadvantage of many mechanical fire extinguishers is their relatively high cost, hence, general unavailability to poor people, whose economic circumstances too often dictate that they live in "firetrap" abodes. While there are relatively inexpensive fire extinguishers available, e.g., aerosol-type can extinguishers, these are normally of small capacity and, being under pressure, introduce a potential explosive hazard, hence, the necessary cautions in storage.

As relates more pertinently to this invention, the prior art also describes a number of types of blanket-like fire extinguishers which, basically, are designed to exclude oxygen from the fire source by the bulk of the blanket. Still other fire extinguishers having a blanket structure are designed to be located in an elevated position, e.g., attached to or suspended from a ceiling, and to discharge a powdered fire-extinguishing material upon a fire when heat-rupturable plastic sheets containing the extinguisher material are heated sufficiently high to rupture the sheets.

Experience with fire blankets of the prior art has left much to be desired and efforts continue to be made to provide fire blankets which overcome the deficiencies, inadequacies and disadvantages attendant upon use of current and prior art blanket-like fire extinguishers in a variety of uses or environments. To illustrate some of the problems encountered with blanket-like fire extinguishers, reference is made, first, to ordinary fire blankets made of fire-proof material or treated with fire-proofing material. In the first place, the average householder does not possess a fire-proofed fire blanket for fighting home fires, and the unwitting or panic-stricken use of a flammable blanket, or other article, can often increase the fire danger. For some purposes and in some environments, the ordinary fire blanket has been more or less effective; for example, for wrapping around a person whose clothing has caught fire. However, for other purposes and in other enviroments, the ordinary fire blanket has been ineffective. To be effective, the fire blanket should completely cover the fire source in order to smother it out. However, many fires occur at such a location in the home, auto, boat, etc., that a fire blanket cannot suitably be used to completely cover the fire source; when this occurs, oxygen can get to the fire and sustain it. Even when a fire source is so located that it can be completely covered with a blanket, the hot gases of combustion rising from a fire can effectively "float" an ordinary blanket and prevent it from settling onto the fire to exclude oxygen therefrom and so extinguish the fire. To overcome the latter problem, one prior art fire blanket, described in U.S. Pat. No. 2,720,269, provides for weighted peripheral borders and reinforced openings in the blanket to permit the blanket to be thrown onto and settle over the fire, while permitting trapped gases to escape through the openings. A disadvantage of the type of blanket described in the '269 patent relates to its use against fires from low vapor pressure, low flash-point liquids, e.g., gasoline. The volatile, highly flammable vapors from such liquids readily penetrate through any openings in the blanket and are, or can be, easily ignited, or re-ignited, outside the blanket. Moreover, any openings in a fire blanket merely make available to a fire of any material additional oxygen which sustains combustion.

Blanket-like fire extinguishers, referred to above, which are designed to be located in an elevated position and to discharge a powdered fire-extinguishing material upon a fire source when the plastic container for the material is heated to its rupture temperature, are disclosed in U.S. Pat. Nos. 3,040,815 and 3,486,563. In use, the fire blankets in both of these patents are primarily intended to be mounted overhead, e.g., on or suspended from ceilings. In the '815 patent, a flat rectangular bag of heat meltable synthetic plastic material with fire-extinguishing material sealed therein is supported on an overhead framework; the bag has longitudinal pleats in the underside thereof along which run electrically conductive wire heating elements in a plurality of sections. The wire heating elements are connected to a heat detector which, when activated by heat, energizes the wire elements which melt the plastic material to release the entire bottom of the bag and discharge the fire-extinguisher material.

In the above '563 patent, a quantity of dry powder fire-extinguisher chemical is sealed in compartments formed between pairs of heat-rupturable plasticsheets. As described in that patent, in use, the blankets are formed to cover ceilings or passages and are secured thereto by various means, but preferably by wire netting.

An obvious disadvantage and limitation of blanket-type fire-extinguisher systems as disclosed in the above '815 and '563 patents is the non-portability, i.e., immobility, thereof. As described, the fire-extinguisher systems in these patents are designed to be located in fixed, overhead positions and can only be made operative when local environmental temperatures have reached levels sufficiently high to activate a heat detector/energizer/wire heating element system ('815 patent), or to melt heat-rupturable sheets containing fire-extinguisher powder ('563 patent). In connection with the operative conditions of these systems, the '815 system is comprised of, and dependent upon the proper

function of, mechanical and electrical components, e.g., heat detector, energy source, wire heating elements, support means for the flat bag containing the extinguisher powder, etc. In the event of mechanical or electrical failure of any critical part in the system, the system would become useless.

In connection with the fire-extinguisher blanket in the system of the '563 patent, experiments have shown that when such blankets are thrown directly onto a fire source, an extremely pronounced shrinking of the plastic sheets occurs, and that, unexpectedly, such shrinkage actually inhibits rupture of the plastic sheets and release of the fire-extinguisher powder.

With further reference to the fixed, overhead blanket-type fire extinguisher systems described in the above '815 and '563 patents, it is apparent that local enviromental temperatures required to activate the systems are generated by a lowerlevel fire source, presumably, on or near the floor level. In view of the upward pressures created by combustion gases rising from a fire, which are sufficiently strong to "float", or to billow up an unweighted fire blanket (reference the above patent, U.S. Pat. No. 2,720,269), it becomes problematical whether the limited quantity of dry powder chemicals contained in and released from plastic blankets located on, or in the vicinity of, the ceiling would, or could, ever reach a fire source on, or near, the floor level; at least in effective amounts. Morever, in those situations where a fire occurs in a confined, overhead-sheltered area, e.g., under a counter, sink, workbench, shelving, etc., or inside a drawer, closet, covered bin, or the like, any fire-extinguisher chemical which might be released from ceiling-mounted systems would wholly fail to reach the fire source. In addition to the above-mentioned, and other, limitations and disadvantages of ceiling-mounted, blanket-like fire extinguisher systems, there are obvious problems and costs of installing such systems which, in a home would have a negative esthetic quality.

It is, therefore, an object of this invention to provide a blanket-type fire extinguisher which is portable, inexpensive, simple to use and effective.

It is a further object of this invention to provide a blanket-like fire-extinguisher system which combats fires by the combined action of physically smothering them and releasing gas-generating extinguisher chemicals onto the fire.

Still another object of this invention is the provision of a fire-extinguisher which can be fabricated into common household articles of otherwise functional utility and esthetic appearance.

These and other objects will become apparent from the detailed description of preferred embodiments given below.

SUMMARY OF THE INVENTION

The present invention pertains to the field of fire extinguishers of the blanket type.

The preferred fire extinguishers provided herein are comprised of a sandwich structure of a flexible sheet of fire-proof or fire-resistant material having attached to at least one side thereof a flexible sheet of heat-rupturable material; the mode of attachment of the sheets of fire-resistant and heat-rupturable material being such as to form at least one enclosure between the sheets with a fire-extinguisher material contained in the enclosure(s).

In an alternative embodiment of the invention, the fire-extinguisher material is contained within at least one enclosure formed by attachment together of flexible sheets of heat-rupturable material and this sandwich structure is then attached to at least one side of a flexible sheet of fire-resistant material.

A further alternative embodiment of this invention involves the additional layering onto the above preferred and first-mentioned alternative embodiments of additional sheets of heat-rupturable material enclosing additional fire-extinguisher material. A fire blanket of this structure provides a "time release" action in supplying sequential quantities of fire extinguisher material to the fire as the successive layer of heat-rupturable sheet containing successive layers of the material are ruptured.

The fire-extinguishers of this invention provide the dual fire-fighting techniques of physically smothering fires and supplying gas-generating chemicals to exclude oxygen from the fire.

The fire-extinguishers of this invention may be fabricated into esthetically designed, commonly used and readily accessible articles, e.g., blankets, draperies, tapestries, furniture covers, antimacassars, tidys, towels, calendars, etc., which may be placed, for immediate use, in any desired location, e.g., in homes, campers, automobiles, boats, etc.

BRIEF DESCRIPTION OF THE DRAWINGS

In FIGS. 1–4 are shown schematically cross-sectional views of several embodiments of the invention.

DESCRIPTION OF PREFERRED EMBODIMENTS

In preferred embodiments of the invention, a flexible sheet of fire-proof, or fire-resistant material, such as fiber glass, serves as the foundation support for the fire blanket extinguisher. The heat-rupturable flexible sheet enclosing the fire-extinguisher material by attachment to the fire-resistant sheet, in various alternative embodiments, is a low-melting, low-decomposition temperature material, such as polyethylene. In generally preferred embodiments, the fire-extinguisher material is a dry chemical powder capable of extinguishing Classes A, B, C and D fires.

Example 1

In the tests set forth in this example, comparative results are shown for a fire-extinguisher blanket embodiment of the present invention and two other types of blankets.

Referring to FIG. 1, the fire-extinguisher blanket A of this embodiment of the invention was fabricated by sewing a one mil thick sheet 2 of polyethylene 18 × 30 inches to a sheet of fiberglass cloth 1 also 18 × 30 inches, with baking soda ($NaHCO_3$) 3 uniformly dispersed between the two sheets. Thereafter, the top (fiberglass) surface of the blanket was sprayed with a solution of room temperature vulcanization silicone rubber to function as a sealer and render the blanket substantially impermeable to passage of both the fine-grained $NaHCO_3$ sewn into the blanket and to combustion gases.

For purposes of the tests herein, a plain sheet of fiberglass, 18 × 30 inches was also provided and sprayed with silicone rubber to seal the interstices in the fiberglass fibers.

Yet another blanket specimen was fabricated for test purposes by sewing sheets of polyethylene together with $NaHCO_3$ uniformly distributed between them; the top and bottom sheets were about 2 mils thick and 22 × 24 inches.

In the first test in the series, a fire was generated from a stack of wadded, double sheets of newspapers. When the fire was burning uniformly throughout the stack of newspapers, about 18 inches in diameter, an attempt was made to extinguish the fire by first placing the silicone-treated fiberglass sheet onto the fire. However, the up-draft of hot combustion gases was so strong that the fiberglass sheet would float on the column of rising gases and slide off to the side thereof, hence, could not even be applied to, much less extinguish, the fire.

The blanket fire extinguisher embodiment of the invention described above was then dropped onto the fire. Because of the weight of the fire-extinguisher powder, the blanket fell directly onto the fire of burning newspapers and immediately extinguished the mass of flames covered by the blanket; the flickering flames on the outer periphery of the blanket were extinguished by shifting the blanket over them. All glowing embers which remained after initial contact with the blanket were extinguished within a few seconds. Examination of the blanket showed that the top fiberglass surface was unaffected by the fire, whereas most of the polyethylene sheet in contact with the fire had ruptured and released the $NaHCO_3$ onto the fire.

Thus, the fire-extinguisher blanket of this invention serves to extinguish fires by the combined smothering action of inflammable gases generated from chemicals and a substantially gas-impermeable fire-resistant sheet material. The fire-resistant sheet material, in addition to excluding oxygen from the fire source, also serves to contain the gases generated from the extinguisher chemicals under it to provide a non-combustible, oxygen-excluding environment over the fire source.

In order to further compare the invention fire blanket, the above other blanket specimen fabricated with $NaHCO_3$ sewn between sheets of polyethylene ("specimen blanket" hereafter) was tested. Another fire was made, as above, from a stack of wadded, double sheets of newspapers. The specimen blanket was dropped onto the fire and, initially, appeared to extinguish all but several small flames around the periphery of the blanket. However, within seconds, holes began to appear through both layers of polyethylene film, and the entire blanket began to shrink markedly and expose more of the underlying paper which again burst into flames, both at the periphery of and through the holes in the blanket. As the fire gained in intensity, the blanket shrinkage increased, thus causing the holes to increase in size and through which additional oxygen was admitted to the fire. Within ten seconds from the time of application of the blanket, the polyethylene sheets themselves ignited. A water hose was then used to extinguish the fire. The specimen blanket remaining consisted of a viscid, tacky mass of blanket segments, 4 to 8 inches across, held together by strands of polyethylene. Apparently, the inflammable gases generated by the small amount of $NaHCO_3$ released were either insufficient to smother the flames and/or were expelled from the vicinity of the fire through holes in the blanket and around the shrunken periphery thereof by the updraft pressures of combustion.

Example 2

In a second series of tests with blankets of the types described and used in Example 1, fires were generated in pillows to simulate similar fires caused by cigarettes or cigars carelessly dropped onto furniture cushions, pillows or bedding, or by charcoal embers expelled from a fireplace.

To prepare the test fires, a 15-inch square pillow 5 inches thick was fabricated of cotton cloth and stuffed with a commercial shredded polyurethane foam of flammable composition. The pillow was placed on the ground and a small piece of glowing charcoal set in the middle of the pillow. Within a short time the cotton sheet pillow case burst into flames; within one minute of onset of the flames, a hole was burned into the pillow about 8 inches wide and about 1 ½ inches deep, melting and burning the foam and giving off an acrid, choking odor.

In the first test in this series, a silicone treated fiberglass sheet was dropped over the pillow (the volume of combustion gases here was insufficient to "float" the sheet) and all evidence of flame immediately disappeared. However, when the sheet was removed after 3 or 4 seconds, flames burst forth from the pillow with an intensity as great as prior to application of the sheet; the sequence was repeated with identical results.

The invention fire-blanket embodiment of this example, i.e., polyethylene sheet sewn to silicone rubber-sprayed fiberglass sheet, with $NaHCO_3$ uniformly distributed in the enclosures sewn between the sheets, was then dropped onto the pillow fire, which by now had grown in diameter to about 10 inches and to a depth into the foam of about 2 inches. All flaming was immediately extinguished and, after 1 or 2 seconds, the fire blanket was removed from the pillow and no re-ignition or flaming occurred. The only discernible combustion remaining was a trace of glowing embers on the underside of the charcoal chip used to start the fire; the chip was removed and discarded. Had the fire blanket been permitted to remain on the pillow longer, undoubtedly, the small amount of glowing ember on the chip would have been extinguished. Examination of the fire blanket after this test showed the upper fiberglass sheet to be unaffected by the fire. However, the polyethylene sheet in contact with the fire showed a ½ inch ring of ruptured polyethylene about 10 inches in diameter, i.e., the approximate diameter of the hole burned in the pillow. Apparently, the fire was hotter at the periphery of the hole and the $NaHCO_3$ released from the ruptured ring of polyethylene was sufficient not only to blanket the fire, but to cool the foam sufficiently to prevent its re-ignition upon removal of the fire blanket.

A second pillow, identical to the first one used, was then ignited in the center with a match to generate a similar fire as above. In this test, a specimen blanket of $NaHCO_3$ sewn between sheets of polyethylene was dropped onto the pillow to cover the flame. Small holes, some ¼ inch in diameter, began to develop in a ring around the periphery of the hole burned in the center of the pillow. However, the fire was extinguished in this test. The appearance of holes completely through the specimen blanket indicates its unsuitability as a fire blanket, particularly, for residual, smouldering fire sources, such as a glowing charcoal ember, which could re-ignite upon cumulative heating under the mo-

mentarily largely-intact blanket and contact with oxygen admitted through the holes.

Example 3

In still another series of tests, blankets of the types described above were used to test their efficacy on gasoline fires. To prepare the test fires, a cast iron frying pan was used. The frying pan, 18 × 8 × 2 inches, was placed horizontally on the ground and gasoline was poured into the pan to a uniform depth of about ⅛ inch. To simulate an environment in which the fire source might be located adjacent to an object which would prevent a fire blanket from completely covering the fire source to form an air seal, a circular scrub bucket 8 inches high and 14 inches in diameter was set next to the frying pan; a situation which may be found, e.g., on the work benches, or floors, of many garages or, for grease fires adjacent to other utensils on kitchen stoves. The gasoline fumes were then ignited by carefully throwing a lighted match into the pan and the gasoline immediately burst into an intense flame about eighteen inches high.

In the first test in this series, a silicone rubber-sprayed fiberglass cloth sheet, 18 × 30 inches, was dropped over the bucket and the immediately adjacent pan; the sheet was placed with its longer dimension running from the bucket to drape over and cover most of the pan. Here, as in the pillow fire test above, the volume of combustion gases was insufficient to "float" the fiberglass sheet. Upon contact with the flaming gasoline, the fiberglass became coated with it and immediately burst into flame. The sheet was pulled from the bucket and pan and, still burning, thrown to one side. The result of this test was not one extinguished fire, but two intensely burning fires.

Following the preceding test, a fire blanket of this invention, as described above, of the same dimensions as the fiberglass sheet, was dropped over the bucket and pan containing the still flaming gasoline in the same manner and position as was the fiberglass sheet. By design, and for purposes of this test, an air seal, formed by direct contact of the fire blanket with the upper edges of the pan, could not be obtained in this position. In addition, the fire blanket, when dropped onto the bucket and pan, was so positioned that an area of the pan, about 3 × 8 inches, was not covered by the blanket. Upon contact with the fire, the fire-rupturable polyethylene sheet was ruptured, releasing the enclosed $NaHCO_3$ and immediately extinguished all of the fire under the fire blanket. The uncovered 3 × 8 inches area continued to burn, but with reduced intensity, until the fire blanket was shifted over the fire, immediately extinguishing it. The fire-blanket was then thrown onto the still-burning fiberglass sheet used in the preceding test; the fire was instantaneously extinguished.

In the third test in this series, another specimen blanket, i.e., $NaHCO_3$ contained as a uniformly dispersed layer between sheets of polyethylene sewn together, was dropped onto a gasoline fire set-up as in the two preceding tests of this series. Within seconds, both sheets of the specimen blanket shrank materially with holes appearing therethrough, rapidly reducing the blanket to a segmented viscid, tacky mass, which finally burst into flames; the burning mass was pushed into the fire. An invention fire blanket was then thrown onto the burning mass and extinguished it.

Example 4

In another preferred embodiment of this invention, a fire blanket was fabricated from flame-proofed paper as the fire-resistant sheet foundation component of the blanket and tested on a series of different fires.

Four paper towels were treated by saturating them with a solution of borax and boric acid, then drying. The towels were sewn in a quilted pattern to a one mil thick sheet of polyethylene with $NaHCO_3$ evenly dispersed between the sheets of polyethylene and treated paper towels. The fire blanket was 20 × 20 inches.

In the first test of the fire blanket embodiment of this example, a fire was generated from diesel fuel. Using the frying pan described in the preceding example, diesel fuel was poured into the pan to a uniform depth of about ⅛ inch. Two untreated paper towels were placed in the fuel to act as a wick covering much of the bottom of the pan. The wick was ignited and the fuel was soon burning vigorously, with greatest intensity in the vicinity of the fuel-soaked paper towel wick. The fire blanket of this embodiment, polyethylene side down, was then dropped over the pan, deliberately to cover all of the pan except a small area about 3 × 8 inches. The fire was immediately extinguished in the area of the fuel under the blanket. A few smaller flames flickered from the uncovered portion of the pan for several seconds and then self-extinguished. Examination of the fire blanket showed that the polyethylene sheet had ruptured and released the $NaHCO_3$ in that area of the blanket over the fire, but most completely in the area of the paper towels wick where the combustion was most intense. The flame-proofed paper towel foundation sheet (upper surface sheet of the blanket) had only brown scorch marks in areas where the sheet had made contact with the diesel fuel; no charring or rupturing of this sheet occurred. The fire blanket was removed and the diesel fuel re-ignited, but burned only in those areas not covered by the $NaHCO_3$. Sheets of paper towels, flame-proofed as above, were used in an unsuccessful attempt to extinguish the fire, but these were merely floated by combustion gases, until the size and intensity of the fire was so reduced as to permit settling of the treated towels onto the fire to extinguish it.

In the second test of the fire blanket embodiment of this example, a wood fire was generated in a camp stove and allowed to burn down to red hot coals of charcoal. The same fire blanket used in the preceding test was dropped onto the coals in such position as to cover the coals with the areas of the polyethylene sheet unruptured in the preceding test. The red hot coals ruptured additional areas of the polyethylene sheet to release a coating of $NaHCO_3$ over the coals. Combustion of the coals was reduced to a lower surface layer which the $NaHCO_3$ could not reach and where air holes in the bottom of the stove admitted oxygen to maintain some combustion. Again, the flame-proofed foundation sheet of the fire blanket was uncharred and unruptured, with only some additional scorching apparent. Thus, the fire blanket of this invention can be used to control, e.g., patio grill fires, camp stove fires, campfires, etc. The fire blanket itself may be fabricated into aprons, tablecloths, etc. for ready access and use on these fires.

In a third test of the fire blanket embodiment of this example, a grease fire was used. The fire blanket was modified only to the extent of coating the upper surface

of the boric acid/borax-treated paper with a solution of room temperature vulcanization silicone rubber to act as a seal against passage of both the powdered chemical extinguisher and gases.

The grease fire in the test of this example was generated by heating a frying pan, 18 × 8 × 2 inches, containing used vegetable shortening to a depth of about ⅛ to ½ inch, over a wood fire in a camp stove. When the grease was heated to its boiling point, a lighted wooden match was thrown onto the grease, thus igniting the grease vapors evolved, and flames spread over the entire surface of the grease. At the apparent height of intensity of the grease fire, the fire blanket was thrown onto the fire to cover about three-fourths of the pan. All flaming under the blanket was extinguished. However, the leading edge of the blanket dipped into the grease which covered an area of about 4 × 8 inches of the blanket and flames flickered across this area on top of the blanket. As soon as the blanket edge was removed from the grease and the blanket shifted over the remaining flames in the pan, all flames were extinguished immediately. Examination of the fire blanket after this test showed that extensive areas of the polyethylene sheet had ruptured and released the enclosed $NaHCO_3$ onto the grease fire. The treated-paper foundation sheet, though stained by the hot grease, was neither charred nor ruptured. The efficacy of this fire blanket is particularly shown by the fact that most greases have flash points above 200° C; vapor pressures below this temperature are generally insufficient to support combustion.

In connection with the preceding grease fire test, the functional versatility of the fire blankets of this invention is further exemplified by using the fire blanket as a heat-insulating pot holder to remove the heated grease pan from the stove after the grease fire has been extinguished.

In a final test of the fire blanket embodiment of this example, a fire was made from oil and grease soaked rags. The fire blanket of this example, like the one used in the preceding grease fire test, was coated with silicone rubber. For comparative purposes, a fiberglass sheet, also sprayed on the top surface with silicone rubber, was used. The test fire consisted of a circular stack, 18 inches in diameter and 4 inches high in the center, of oil and grease-soaked rags, over which was poured diesel fuel, which soaked into the rags. The rags were then ignited and within a minute the whole pile was burning intensely with flames reaching about eighteen inches in height. First, the fiberglass sheet was thrown onto the fire, but it immediately burst into flames, presumably from the diesel fuel it had picked up from the rags; the fiberglass sheet was pulled from the fire to one side where it burned itself out. The invention fire blanket was then thrown over the pile of burning rags and immediately extinguished all flames except a few small flickering flames of rags burning outside the periphery of the blanket; these were extinguished by shifting the blanket over them. Examination of the fire blanket after the test showed that about 60–70 percent of the polyethylene sheet immediately over the flames had ruptured and released the enclosed $NaHCO_3$ onto the fire. The top surface of the fire blanket showed no effects from the fire, such as charring, scorching, staining or discoloration.

For further comparative purposes, a specimen blanket, consisting of $NaHCO_3$ uniformly sewn between sheets of polyethylene as described in Example 1, was tested on a fire of diesel fuel-soaked oily and greasy rags identically prepared as in the preceding test. This blanket was dropped onto the fire to completely cover all the burning rags; all flaming was immediately extinguished. However, within a few seconds, holes began to penetrate the blanket, some increasing in size to 2 inches, admitting additional oxygen to the rags and permitting diesel fumes to escape. Although the fire did not re-ignite in this test, conditions for re-ignition were established by holes being burned through the blanket. A burning match was touched to the rags through a hole in the blanket; the rags immediately burst into flames with the blanket melting, burning and shrinking out of the path of the advancing flames. Attempts to extinguish the fire by shifting the blanket were fruitless, because of the deteriorated condition of the blanket.

For a more definitive comparison of the above specimen blanket, another fire, identical to that in the preceding test, was kindled. However, in this test, the specimen blanket was dropped askew of the diesel fuel-saturated oily and greasy rags, allowing an edge portion of the rags to burn around the periphery of the blanket as was the case in the similar test of the invention blanket. The edge of the specimen blanket, nearest the burning rags at its periphery, immediately started to shrink away from the flames. In a few seconds, when the specimen blanket was raised to shift it over the peripheral burning rags, the blanket had shrunk to about two-thirds its original dimensions and had deteriorated by rupture, melting and shrinking to such an extent that it was ineffective to extinguish the fire, which had resumed in the bulk of the rag pile by re-ignition from the initial peripheral flames.

An advantage of the fire blanket structure of this invention is that the fire-resistant foundation sheet is neither fire-rupturable nor shrinkable, and maintains not only its own outer dimensions, but also, the outer dimensions of any discrete area of heat-rupturable plastic sheet attached to it to form enclosures for the fire extinguisher chemical. When discrete segments of the heat-rupturable sheet begin to shrink, they can only do so outwardly toward their periphery (which is bonded to the foundation sheet), resulting in rupture and discharge of the enclosed fire extinguisher material.

Example 5

In another preferred embodiment of this invention, a fire blanket was fabricated by use of flame-proofed paper (treated with boric acid/borax solution) coated with silicone rubber as the fire-resistant foundation sheet to which was sewn a specimen blanket consisting of sheets of polyethylene enclosing uniformly-distributed $NaHCO_3$.

A fire was generated in a pile of eight double sheets of wadded newspaper. When the fire was burning intensely, the fire blanket was dropped onto the fire leaving a small peripheral amount of burning paper uncovered. The fire was immediately extinguished under the blanket and the blanket was raised to extinguish the flames at the periphery. In raising the blanket, some re-ignition of the paper occurred, but this was extinguished by shifting the blanket over the fire. Examination of the fire blanket after the test showed that about 40 percent of the polyethylene sheet in contact with the flames had been ruptured and released the enclosed $NaHCO_3$ onto the fire and about 30 percent of the

polyethylene sheet in contact with the fire-resistant foundation sheet of treated paper had been ruptured also.

In a second test of the fire blanket embodiment of this example, a fire was made from oily, greasy rags soaked with diesel fuel as in the preceding example. In this test the fire blanket was not coated with silicone rubber. After the rags had been ignited and the fire burning intensely, the fire blanket was dropped over the fire, again leaving a few burning rags at the periphery of the blanket, which were extinguished by shifting the blanket over the flames. Initial application of the blanket resulted in extinguishing most of the fire immediately upon rupture of the lower polyethylene layer and release of the $NaHCO_3$. The flickering flames around the periphery of the blanket and some small flames licking up between the rags from combustion within the lower region of the pile were extinguished by moving the blanket over the remaining flames. Examination of the fire blanket after the test again showed that about 40 percent of the lower polyethylene sheet and 30 percent of the upper polyethylene had ruptured; although the fire-resistant foundation sheet of treated paper remained intact.

In a third test of the fire blanket of this example, a gasoline fire was used. The set-up for the fire test was the same as described in Example 1, i.e., a frying pan and bucket sitting side by side. After the gasoline was ignited, the fire blanket was dropped onto the fire, draping from the bucket to the opposite side of the pan covering all but an area about 3 × 8 inches. It was observed that flames of gasoline appeared over the top surface of the blanket, which burst into flames over the hottest part of the fire. Assuming, among other possibilities, that the intermediate polyethylene layer may have contributed to the combustion, another experiment was run with a fire blanket in which the intermediate polyethylene layer was omitted and silicone rubber was applied to the top surface. The result of this experiment was essentially the same as that of the preceding test. With this second test unsuccessful, it was assumed that the such failures were due to inadequate flame-proofing of the paper sheet or even that a flame-proofed paper foundation sheet was not sufficiently resistant to the high temperatures present in gasoline fires to prevent rupture.

Since gasoline fires had been extinguished with fire blankets using a fiberglass foundation sheet previously, another two such tests were run to confirm earlier tests. In these tests, one of the fire blankets D, shown in FIG. **4**, had an intermediate polyethylene sheet **2** between the fiberglass sheet **1** and baking soda **3**, whereas the intermediate sheet was omitted in the other fire blanket. In the tests of each of these fire blankets with gasoline fires, the blanket was dropped over the bucket and frying pan, as above, as soon as the fire was ignited and burning full force. In both cases, the polyethylene sheet **4** ruptured and released the $NaHCO_3$ to extinguish the fire under the blanket, but flames spread over the top of the blanket, and when the blanket was lifted to turn it over and cover the entire pan, the full surface of the gasoline re-ignited. The flaming gasoline adhering to the bottom of the blanket was extinguished by laying the blanket on the ground, after which the blanket was dropped on the full area of the pan and extinguished the fire.

It was observed in these latter gasoline tests that much of $NaHCO_3$ released onto the gasoline sank to the bottom of the pan prior to decomposition, and that the initially quenched fires flared up to a greater degree than in previous successful tests. It was concluded that, in contrast to the latter gasoline fire tests, in the previous tests the quantity of gasoline consumed prior to application of the invention fire blanket was sufficient to lower the level of the gasoline in the pan to such a level that enough of the $NaHCO_3$ remained on the surface of the gasoline to decompose and generate enough carbon dioxide to extinguish the fire.

Therefore, in using the fire blankets of this invention on gasoline (or other low flash point liquids) fires, it is recommended that either the entire surface of flaming liquid be covered with the blanket, or that a chemical extinguisher be used that floats on the liquid when released from the fire-rupturable sheet.

In view of the problems associated with flaming liquids flowing onto the top surface of a fire blanket dropped askew of, and not completely covering, the container of flaming liquid, an alternative fire blanket embodiment of the invention is provided to, at least, ameliorate these problems. In this alternative embodiment C, shown in FIG. **3**, any of the fire blankets referred to in the preceding examples are modified by adding to the top surface of the fire-resistant foundation sheet **1** a uniformly distributed layer of fire-extinguisher material **3** contained between a heat-rupturable sheet **5** sewn, or otherwise attached, to the fire-resistant sheet. The easiest way to fabricate such blankets is to merely join together two of the aforementioned blankets with their fire-resistant sheets in surface-to-surface contact; this may be accomplished, e.g., by use of suitable adhesives. With such a fire blanket, when a flaming liquid flows onto the surface, the upper heat-rupturable sheet is ruptured, thus exposing the top surface layer of fire extinguisher material which decomposes to generate a non-combustible atmosphere for the flaming liquid.

The last-mentioned alternative fire blanket modification is also suitably used for other types of fires. For example, the blanket may be thrown onto a fire source which ruptures the heat-rupturable sheet and releases the fire-extinguisher material contained on one side of the fire-resistant foundation sheet; thereafter, the blanket may be turned over and dropped onto another fire or another section of the same fire, with rupture of the heat-rupturable sheet and release of the fire-extinguisher material contained on the other side of the fire-resistant sheet.

Example 6

In still another test of a fire blanket embodiment of this invention, a magnesium fire was used. The fire blanket used in this test was fabricated from a sheet of fiberglass cloth 12 × 12 inches to which was sewn a sheet of polyethylene 0.001 inch thick with crushed and powdered rock salt uniformly distributed between the sheets in enclosures formed by the sewing operation. The fiberglass sheet was sprayed with silicone to seal the surface.

A strip of magnesium ribbon ⅛ inch wide, 0.004 inch thick and 24 inches long was twisted into concentric bows to form a "daisy" 4 inches in diameter. The daisy was laid on a sheet of plywood and then ignited with a propane torch in the center of the daisy. When the

magnesium fire had burned outwardly to a circular pattern about 1½ inches in diameter in the center of the daisy, the fire blanket was dropped over the fire; the fire was immediately extinguished. The outer sections of the magnesium daisy were unaffected. Although the plywood under the daisy had been burned and charred from the intensely burning magnesium, flaming of the wood was prevented by application of the fire blanket.

Therefore, it will be appreciated that the fire blankets of this invention have valuable utility in chemical laboratories or industrial plants where metal fires most frequently occur. These relatively light-weight, flexible blankets may be used in place of heavy buckets of sand commonly found where metal fires occur.

Example 7

In this example is described a fire blanket embodiment of the invention which features a "time release" structure and application.

A typical fire blanket B according to this embodiment of the invention is shown in FIG. 2 and is fabricated by sewing, or otherwise bonding or attaching, a sheet of heat-rupturable material 2, e.g., polyethylene, to a foundation sheet of fire-resistant material 1, e.g., fiberglass, with fire-extinguisher material, e.g., $NaHCO_3$ 3, uniformly distributed between the sheets in enclosures formed by attachment means for the sheets. One, or more, successive layers of fire-extinguisher material 3 contained between successive sheets of heat-rupturable material 4 are then attached to preceding sheets of heat-rupturable material. Thus, such a typical fire blanket is comprised of, e.g., a sheet of fiberglass, a first layer of $NaHCO_3$, a first sheet of polyethylene attached to the fiberglass sheet, a second layer of $NaHCO_3$, a second sheet of polyethylene attached to the first sheet of polyethylene, a third layer of $NaHCO_3$, a third sheet of polyethylene, etc.

A modification of the fire blanket embodiment of this example provides for successive layers of fire-extinguisher material contained between successive sheets of heat-rupturable material on both sides of the fire-resistant foundation sheet.

In practice, the particular function and utility of the fire blanket embodiments of this example is to provide additional, successive reservoirs (layers) of fire-extinguisher material when one or more preceding reservoirs have been exhausted. For example, when the dimensions of a fire source are greater than those of the fire blanket, the latter may be dropped onto one section of the fire source to release the lower layer of fire-extinguisher material enclosed by the lower sheet of heat-rupturable material to extinguish that portion of the fire covered by the blanket; thereafter, the blanket is shifted or moved to cover another, or the remaining, source of the fire and the next layer of fire-extinguisher released from the next sheet of fire-rupturable material to extinguish another, or the remaining section of the fire, etc. Still another application of the present fire blanket embodiment is for fires that may be re-ignited after initially being extinguished. For example, in the situation of a cushion, pillow, mattress or similar fire, where the depth of penetration of the fire, the nature of the combustible material or the cause of the fire, e.g., cigarette, glowing charcoal, etc., leaves a smouldering condition within the burned article after application of the first layer of fire-extinguisher material, any re-ignition of the fire within the article will rupture the next lower sheet of heat-rupturable material to release the next layer of fire-extinguisher material onto the re-ignited fire.

In further connection with the materials of construction for the fire blankets of this invention, as indicated above the foundation sheet of the blanket, basically, must be substantially fire-proof or fire-resistant and impermeable to gases. The foundation sheet material characteristically is non-flammable and non-meltable, either by its inherent nature and composition or by treatment with fire-proofing compositions. Materials with the required characteristics at temperatures of about 400° C and higher are preferred. Exemplary materials for the foundation sheet include fiberglass, epoxy resins with stainless steel matrices, fire-proofed natural or synthetic fiber fabric materials, asbestos-containing papers and the like. Typical fire-proofing materials for various papers and fabrics include aqueous solutions of borax/boric acid, ammonium sulphate, diammonium phosphate or mixtures of the latter two chemicals, antimony trichloride, etc.

Since the weave of various fabrics, used as the fire resistant foundation sheet, may be insufficiently close to prevent leakage therethrough of finely divided fire-extinguisher powders or substantial quantities of combustion gases, the surface of such fire-resistant fabric sheets should be treated with an appropriate material, e.g., silicone rubber, to seal the interstices in the sheet fabric. In some fabrication operations, the fire-resistant sheet and the heat-rupturable sheet are sewn together; in such cases, the sewing needles may leave holes in the sheets through which the extinguisher powder may leak. Hence, the sealer preferably should be applied after the fabrication operations are completed. However, the fire-resistant foundation sheet can be fabricated from material having such close weave that no sealer or filler is required. Further, the fire-resistant sheet may be constructed of non-woven material, e.g., extruded and/or calendered organic or inorganic films, which require no sealer or filler. The foundation sheet need not be absolutely leak-proof or impermeable to gases, but adequately so to effect the objective intended.

The heat-rupturable sheet component of the present fire blankets can be any of a large variety of low melting or decomposition material, e.g., thermoplastic resins, which melt and/or rupture at elevated temperatures. Materials suitable herein should be selected from those which melt and/or rupture above about 100° C and below about 300° C. In general, the heat-rupturable material should readily melt and/or rupture when exposed to flames or temperatures generated by, or indicative of, fires of any origin. Suitable heat-rupturable materials useful herein include such thermoplastic materials as cellophane, polyethylene, polyethylene-coated cellophane, cellulose acetate, polypropylene, polystyrene, polyesters, vinyl film, vinyl chloride and the like.

With further respect to both the fire-resistant sheet and the heat-rupturable sheet, these sheets can be single sheets or laminated layers of any operable thickness. For most utilitarian purposes, the fire-resistant and heat-rupturable sheets, and the fire blankets fabricated therefrom, should have a high degree of flexibility, although for some embodiments within the purview of this invention the fire-blanket may be less flexible, even approaching rigidity.

In fabricating the present fire blankets, fire-extinguisher materials are contained in a sandwich structure between the fire-resistant sheet and the heat-rupturable sheet, or in some embodiments, between the sheets of heat-rupturable material, e.g., in the "time release" embodiments described above. The sheets are attached together by any suitable means, e.g., by sewing, heat-sealing, adhesive bonding, ultra-sonic bonding, etc. In some fabrication operations, the fire blanket is fabricated by attaching the fire-resistant and heat-rupturable sheets together leaving open enclosures, e.g., tube-like openings running laterally and/or longitudinally of the blanket, available for filling with the fire-resistant material, after which the enclosure openings are closed. Alternatively, the fire-extinguisher material is uniformly distributed on the surface of the fire-resistant sheet and the heat-rupturable sheet placed over the fire-extinguisher material. The sheets are then attached, or bonded, together in any suitable pattern of attachment, e.g., a quilted pattern, with the fire-extinguisher material uniformly distributed between the sheets in enclosures, or compartments, formed by the sheet-attaching operation. The latter fabrication embodiment is readily performed, e.g. by sewing or ultra-sonic bonding in which the fire-extinguisher material, e.g., $NaHCO_3$, does not interfere with the attachment process. On the other hand, this fabrication operation is not particularly amenable to a heat-sealing operation in which the chemical powder interferes with the heat-sealing process.

The fire-extinguisher materials useful herein include any of the approved conventional and commercially available chemicals suitable for fighting Classes A, B, C and D fires. These chemicals may be incorporated into the fire blankets as described above as solids (typically powdered), liquids, gels, foams or inert gases which, under the influence of heat or flame, generate or release inert or non-combustible gases or foams to blanket the fire source. In one form, the fire-extinquishing agent may be contained within microcapsules as described in Defensive Publication No. 685,682, published Apr. 22, 1969. The microcapsules comprise heat-rupturable envelopes containing the fire-extinguishing agent and, in preferred embodiments, have a density equal to or less than the flammable liquid upon which the microcapsules float.

Suitable fire-extinguisher chemicals are listed and/or described in various texts, technical and patent literature on the subject, as well as the toxicity problems and other hazards associated with the use of certain chemicals and fire types, e.g., metals, electrical, gas, oil, etc. Naturally, for the widespread, general use intended for the fire blankets of this invention, chemicals, such as baking soda, are preferred which present the layman user with no toxicity problems.

Particularly desirable features and advantages of the instant fire blankets are the esthetic appearance and functional utility thereof. The fire-resistant and/or heat-rupturable sheets used herein may be fabricated with any design or color of choice initially, or the design may be impressed upon or formed in plain, transparent, or translucent forms of these sheets. The designed fire-blankets may be fabricated into any number of utilitarian articles such as towels, tapestries, drapes, curtains, blankets, antimacassars, seat covers, pot holders, etc., and any desired number of these articles placed in any desired location in the home, office, laboratory, hotels, motels, automobile, camper, boat, or wherever else desired. Obviously, the term "fire blanket" as used herein is generic to such other articles, as exemplified above, having a generally flat, planar configuration of any shape, polygonal or curvilinear, e.g., square, rectangular, triangular, hexagonal, octagonal, circular, ovular, etc.

The foregoing detailed description of the invention may suggest other modifications and variations thereof to those skilled in the art without departing from the spirit and scope of this invention.

I claim:

1. A fire extinguisher consisting essentially of:
a. a sheet of fire-resistant material,
b. a sheet of heat-rupturable material attached by direct contact to at least one side of said fire-resistant material to form at least one enclosure therebetween, and
c. fire-extinguisher material contained within said at least one enclosure.

2. Fire extinguisher according to claim **1** wherein an additional quantity of fire-extinguisher material is contained within at least one additional enclosure formed between said heat-rupturable sheet in (*b*) and an additional heat-rupturable sheet attached thereto.

3. Fire extinguisher according to claim **2** wherein additional successive quantities of fire-extinguisher material are contained within additional enclosures formed between additional successive sheets of heat-rupturable material attached to preceding sheets of heat-rupturable material.

4. Fire extinguisher according to claim **1** wherein sheets of heat-rupturable material are attached by direct contact to both sides of said fire-resistant sheet to form at least one enclosure on both sides thereof and said fire-extinguisher material is contained within said at least one enclosure on both sides of said fire-resistant sheet.

5. Fire extinguisher according to claim **4** wherein at least one additional successive quantity of fire-extinguisher material is contained within at least one additional enclosure formed between at least one additional successive sheet of heat-rupturable material attached to the preceding sheet of heat-rupturable material.

6. Fire extinguisher according to claim **1** further including an additional combination of said components in (*a*), (*b*) and (*c*), wherein the fire-resistant sheets thereof are attached in surface-to-surface contact.

7. Fire extinguisher according to claim **6** wherein at least one additional successive quantity of fire-extinguisher material is contained within at least one additional enclosure formed between at least one additional sheet of fire-rupturable material on at least one side of said fire extinguisher.

8. Fire extinguisher according to claim **1** wherein said fire-resistant sheet is fiberglass and said heat-rupturable sheet is polyethylene.

9. A fire extinguisher consisting essentially of:
a. a sheet of fire-resistant material
b. a sheet of heat-rupturable material attached by direct contact to at least one side of (*a*),
c. a sheet of heat-rupturable material attached by direct contact to (*b*) to form at least one enclosure therebetween, and
d. fire-extinguisher material contained within said at least one enclosure.

10. Fire extinguisher according to claim 9 wherein at least one additional successive quantity of fire-extinguisher material is contained within at least one additional enclosure formed between said heat-rupturable sheet in (*c*) and an additional heat-rupturable sheet attached thereto and successive sheets of heat-rupturable material.

11. Fire extinguisher according to claim 9 wherein the components of (*b*), (*c*) and (*d*) are attached to both sides of (*a*).

12. Fire extinguisher according to claim 9 wherein said fire-resistant sheet is fiberglass and said heat-rupturable sheet is polyethylene.

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