Sept. 19, 1972 C. RÉ ET AL 3,692,682

HEAT BARRIER MATERIAL AND PROCESS

Filed Dec. 18, 1969

Fig. 1

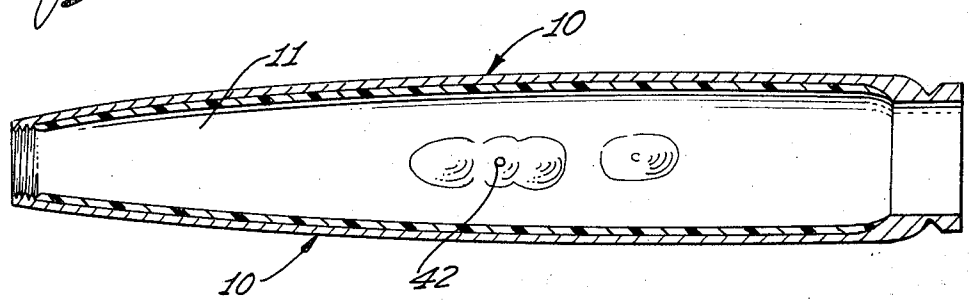



Fig. 2

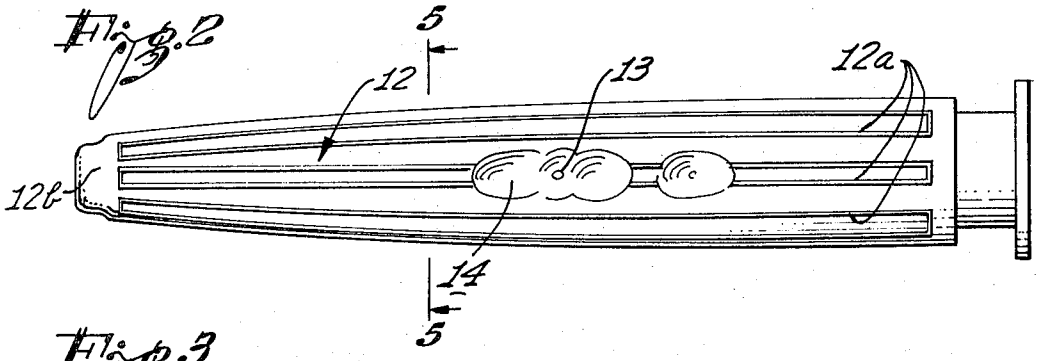



Fig. 3

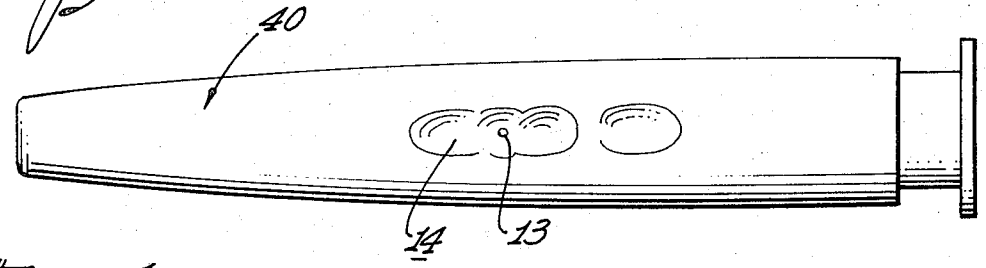



Fig. 4

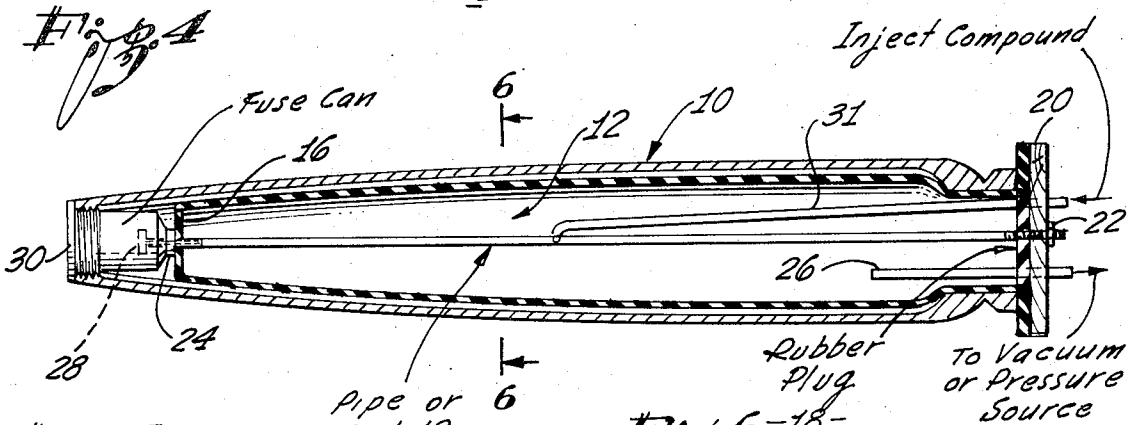



Fig. 5

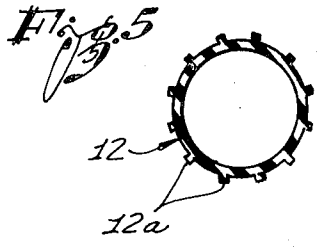
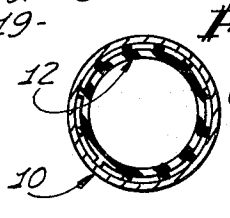



Fig. 6




INVENTORS:
Carlo Ré
Earl O. Conrad
Jack R. Conrad
Jennings and Beecher
By Keith D. Beecher
ATTORNEYS

United States Patent Office 3,692,682 Patented Sept. 19, 1972



3,692,682

# HEAT BARRIER MATERIAL AND PROCESS

Carlo Ré, Glendale, Earl O. Conrad, Santa Ana, and Jack R. Conrad, Costa Mesa, Calif., assignors to Dyna-Shield, Inc., Santa Ana, Calif.

Filed Dec. 18, 1969, Ser. No. 886,075
Int. Cl. C04b *43/00;* C09k *3/28;* E04b *1/94*
U.S. Cl. 252—62 2 Claims

## ABSTRACT OF THE DISCLOSURE

An improved material is provided which serves as a protective heat barrier for explosives, or other combustible products, and which may be applied, for example, as a paste or a liquid, to the external or internal surface of the casing containing the explosive, to create a hard coating for the casing of extremely low heat transfer characteristics and low heat rate transfer characteristics. Although the coating will be described herein in such an environment, it will be evident as the description proceeds, that it may be used in any application in which a heat barrier is required for protective, or other purposes. The material is composed of a mixture of water-extended polyester (WEP) and particles of a heat proofing material, such as powdered or fibrous asbestos, or powdered glass. An improved process and apparatus for applying the material is also provided.

## BACKGROUND OF THE INVENTION

The coating of the present invention has particular utility in conjunction with bomb casings, rocket casings, and shell casings, so as to prevent, at least for a substantial time interval, the explosive material within the casing from reaching its ignition temperature in the event of an external fire caused, for example, by jet fuel, or other high temperature combustibles. It will become evident, as the description proceeds, that the coating of the invention finds general utility, as mentioned above, wherever an effective heat barrier is required, and one which exhibits low heat transfer characteristics or low rate of heat transfer characteristics, in the presence of an extremely high external temperature condition and environment.

The invention is also concerned with an improved method and apparatus for quickly and efficiently applying a coating of the aforesaid material to an internal irregular surface, such as the internal surface of a bomb casing, with a uniform coating thickness and without any tendency for the creation of dangerous thin spots or areas in the coating. More generally the improved process of the invention provides a means for controlling the thickness of the coating for any requirement of uniform or variable controlled thickness.

As mentioned above, the coating of the present invention comprises a mixture of a polyester resin designated as "water-extended polyester (WEP)," and particles of a fire proofing material, such as powdered asbestos or powdered glass. Water-extended polyester resins which are suitable for use in the material and process of the present invention are described, for example, in U.S. Pat. 3,256,-219. The plastic material described in the patent has a porous structure and a sponge-like consistency. As stated specifically in the U.S. patent, the porous plastic material is formed of a polymerized monomer whose pores are filled with a liquid material.

As described in one specific example in the aforesaid patent, the water-extended polyester resin may be formed by adding 2 g. of benzoylperoxide, and 100 cc. of water, to a mixture consisting of 65 g. of an unsaturated polyester of the acid #40 prepared from maleic acid, phthalic



acid and propylene glycol of a molar ratio of 2:1:3.3, as one constituent, and 35 g. styrene as another constituent.

The aforesaid mixture is stirred at a temperature of 10° C., for example, until a water-in-oil emulsion is formed. The emulsion is mixed with 0.18 g. of dimethyl-p-toluidine, and is subsequently polymerized and hardened by heating at 30° C. for ten minutes. The water in the pores of the resulting resin material can subsequently be evaporated by heat at a temperature between 80° C. and 100° C.

Other examples of water-extended polyester resin material suitable for use in the process and material of the present invention are also set out specifically in the aforesaid patent.

A specific example of the consistency of the coating of the present invention is as follows:

(a) (One part) (by weight) a water extended polyester resin such as described in the aforesaid patent. This material is available commercially and may be purchased, for example, from the Ashland Chemical Company of Los Angeles, Calif. The particular material marketed by that company is designated by them as "WEP–27." Equivalent and similar materials, suitable for the process of coating of the present invention are available from other commercial sources.
(b) (.0075–.025) part by weight) cobalt.
(c) (.005–.01) part (by weight) dimethylanaline (DMA).
(d) (.8–1.2) part (by weight) water.
(e) (trace–$2\times10^{-4}$) parts (by weight) an inhibiter such as a mixture of methyl Cellosolve (80%) and hydroquinone (20%).
(f) (trace–$\frac{1}{16}$) part (by weight) powdered or fibrous asbestos or powdered glass (determined by specific requirements).
(g) (.004–.02) part (by weight) a catalyst such as methyl ethyl ketone (MEK) peroxide (determined by desired gel time).

As an example, the polyester resin, cobalt and the DMA are mixed together as one group which is designated as the carrier. The asbestos (or powdered glass), water inhibiter and catalyst are mixed as another group which designated as the heat retarder. The two components form the heat barrier coating of the present invention when mixed together. The above listed proportions of the various ingredients are not critical and may be varied considerably to meet specific requirements. For example, the various ingredients may be varied to meet the specific requirements of handling, heat resistivity, rigidity and gel time. That is, the catalyst and inhibiter percentages to the total mix affect gel time and are coordinated with the technical requirements of the process, and with production requirements. For example, if a fast gel time is required, more catalyst and less inhibiter is used. However, if a slower gel time is preferred for any reason, such as handling in production, more inhibiter and less catalyst are used. If a lower heat transfer rate or coefficient is required, the quantity of asbestos (or powdered glass) is increased. Another available variable for specific needs is the availablility of various grades of polyester resin, as described in the aforesaid patent, and which can be selected to provide anything from a very rigid material to a resilient material.

However, the components may be mixed in any combination and in any order; except, of course, the catalyst must be added last.

## BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a side sectional view showing the bomb casing in which a heat barrier coating incorporating the


Published by AsbestosClaims.Law
asbestosclaims.law/library/22665/2

concepts of the present invention has been formed over the internal surface of the casing;

FIGS. 2 and 3 show two types of elastomeric molds which may be used to apply the coating to the internal surface of the bomb casing;

FIG. 4 is a side section of a bomb casing and mold, prior to the formation of the coating;

FIG. 5 is a cross-section along the line **5—5** of FIG. 2; and

FIG. 6 is a cross-section along the line **6—6** of FIG. 4.

## DETAILED DESCRIPTION OF THE ILLUSTRATED EMBODIMENT

A typical casing **10** is illustrated in FIG. 1, and may be of the type, for example, used for shells, bombs, missiles, or the like, and which is filled with an explosive material. In the past, the shells and bombs have represented a continuous storage hazard, in that should fire break out within the storage area, there is a strong likelihood that the explosive material within the casings would be raised to its ignition temperature with resulting explosions. Accidents have occurred in the past, particularly on naval vessels, in which jet fuel is stored, wherein jet fuel fires have caused the explosion of the bombs and shells with substantial damage.

In the practice of the present invention, a coating **11** of the aforesaid heat barrier material is provided on the inner surface of the casing **10** by means of the apparatus shown in FIGS. 2 and 3. The illustrated apparatus is particularly advantageous, since it permits a uniform thickness of the coating to be formed over the internal surface of the casing, and regardless of irregularities of the inner surface. This is most important, since the entire effectiveness of the coating would be destroyed, should thin areas inadvertently be formed at any position over the internal surface of the casing.

In carrying out the concepts of the invention, insofar as a particular embodiment of the apparatus and process are concerned, a ribbed elastomeric mold **12** (FIGS. 2, 5) is inserted into the casing **10**. The mold **12** has a plurality of longitudinal ribs **12*a***, as shown, and a reservoir **12*b*** at one end. In the first step of the process, the material of the invention is injected from the interior of the mold through an inlet **13** which is located at the bottom of a depression **14**, and the material flows down the spaces between the ribs **12*a*** and into the reservoir **12*b***, so that all the spaces between the ribs may be filled with the material. Therefore, when the ribbed elastomeric mold **12** is inserted into the casing, as shown in FIGS. 4 and 6, the result of the molding process is the formation of a ribbed coating of a specified thickness within the interior of the casing **10**. If desired, however, the ribs may be formed on the interior of the casing **10** by placing or attaching solidified strips of the coating material.

In order to facilitate the introduction of the mold **12** into the interior of the casing **10**, the mold is initially plugged at each end by means of plugs **16** and **18**, which may be composed of rubber, or other suitable elastomeric material. A rigid rod **19** extends through the length of the mold, and extends through the plug **16** at one end of the mold and through the plug **18** at the other. A disc **20** is positioned coextensive with the right end of the mold, and the assembly is held together by means, for example, of a nut **22** which is threaded onto the right hand end of the rod **19**, and which draws a disc **24** on the other end of the rod against the plug **16**. A tubular member **26** extends into the interior of the mold, and that member may be coupled to an appropriate vacuum source which draws the mold closely down around the rod **19**. The mold may then be easily inserted through the right hand end of the casing **10** into the interior of the casing. The mold may be held in place by means, for example, of a bolt **28** which is threaded through the end of a usual fuse can **30** and into the end of the rod **19** through the flange **24**. The tubular member **16** may then be coupled to an appropriate pressure source, so that the ribs **12*a*** of the mold may be forced closely against the inner surface of the shell **10**. The material of the invention may then be injected through a tubular member **31** which is coupled to the inlet **13**, so that the aforesaid ribbed coating may be formed on the inner surface of the shell **10**.

The resulting ribs formed by the mold **12**, as described above, serve as spacers for a subsequent mold **40** (FIG. 3), which is inserted in like manner into the interior of the casing **10**, after the mold **12** has been removed. The mold **12** may be removed by again introducing a vacuum into its interior, and the mold **40** may be inserted in like manner. The mold **40** may be similar in most respects to the mold **13**, except that it has a smooth surface, instead of a ribbed surface.

Once the mold **40** is in place, a suitable pressure may be introduced into its interior, so that its outer surface is held firmly against the ribs formed on the inner surface of the shell **10**. Additional compound may now be introduced into the interior through, for example, a port **42** (FIG. 1) on the side of the shell, and the compound flows through all the spaces between the ribs, so as to complete a smooth coating of uniform thickness on the interior surface of the shell, despite any irregularities which may exist on that surface.

It will be appreciated that the ribs formed on the mold **12** have a particular predetermined thickness, which determines the ultimate thickness of the coating to be formed on the inner surface of the casing. The purpose of the ribbed mold **12** is to permit the initial ribs to be formed, which subsequently serve as spacers for the mold **40**. The mold **40** then serves to complete the coating **12** on the inner surface of the shell **10**, and of a uniform thickness determined by the ribs.

The mold elements **12** and **40** may be formed by initially splitting a shell casing, similar to the casing **10**, into two longitudinal half sections. The two half sections are then clamped together, and are then filled with a suitable plastic mold material, which, in this instance, can be the same basic water-extended polyester used in the formation of the material of the invention.

However, in the construction of the mold element, an appropriate material is placed between the resin and the inner surface of the casing, so that the resulting member formed by the hardened resin may be removed. The resin is then allowed to harden, and the two half-sections of the shell casing are opened to permit the resulting element to be removed from the casing. This element constitutes the male master for forming the elastomeric molds **12** and **40**.

The male master is reduced in diameter by turning it on a lathe, for example, by an amount equal to the thickness of the heat barrier required. The male master is then placed in the aforesaid longitudinally split casing, and held in position so that it is coaxial with the casing and spaced from its interior surface. The two halves of the casing are again clamped together, and the cavity between the male master and the inner surface of the casing is filled with a polyester resin which simulates the desired heat barrier. The latter heat barrier is formed on the internal surface of the casing, and is adhesively attached thereto.

The male master is again turned down to reduce its diameter as required to allow adequate wall thickness to the mold, such as, for example, approximately one-half inch, and it is reinstalled into the split casing. The cavity between the male master and the coating within the split casing is filled with any appropriate elastomeric mold material, such as urethane elastomer, butyl rubber, or any other suitable resilient mold material, and allowed to cure.

The resulting elastomeric mold is the mold **40** referred to above. The mold **12** may be made in a similar way,


Published by AsbestosClaims.Law
asbestosclaims.law/library/22665/3

except that ribs are mounted on the inner surface of the coated split casing, before the elastomeric material is introduced into the mold. These ribs, for example, may be formed of the material of the invention, in solidified form, and may be adhesively, or otherwise attached to the inner surface of the coated casing, so that the desired longitudinal ribs may be formed on the elastomeric mold **12**.

As mentioned above, the molds **12** and **40** are inserted into the casing **10** by initially evacuating them so as to cause them to collapse and facilitate their insertion into the casting. The vacuum pressure is then terminated, as mentioned above, and the interior of the mold is subjected to an air or hydraulic pressure, or it may be filled with any suitable fluid (liquid or gas) such as any usual mold back-up material, so that the elastomeric mold will hold its shape against the pressure of the material introducde into the cavity between the mold and the inner wall of the casing **10**.

It will be appreciated that an external coating may be applied to the casing **10**, for example, merely by reversing the mold fabricating sequence, but following the same steps as described above.

The coating material is introduced in a paste-like form, and it is polymerized in a manner described above, while it is actually within the casing. The result is a hard pervious resinous coating on the surface of the casing which is intimately bonded to the surface, and which provides the desired heat barrier.

The aforesaid process and material has particular application to ordnance items for military applications, as described above, and especially for providing protection to explosive and propellants from inadvertent or unscheduled detonation when subjected to high temperature environment caused, for example, by aircraft jet fuel fires. The coating has particular application in this respect, for example, to bombs, rockets, fuses, shells and fuel tanks. However, as mentioned above, the coating has general and universal application wherevere a heat barrier is required.

It has also been found that when the water extended polyester is treated in accordance with the teaching of the invention, not only does it exhibit the aforesaid heat barrier characteristics, but it also exhibits generally improved resiliency and water retention capabilities for all uses; and also its consistency can be easily controlled from a liquid to a paste by the addition of selected amounts of the heat proofing material for facilitating different application requirements, even when heat barrier is not a factor.



The process described above is applicable to a wide variety of structures and material. It has particular utility in applications where it is necessary to control the thickness of the heat barrier layer over non-uniform surfaces and yet maintain uniform thickness, or even variable thickness if so desired.

What is claimed is:

**1.** A heat barrier material having a low heat transfer characteristics and low heat rate transfer characteristics comprising a polyester resin carrier consisting of a polymerized monomer yielding a porous plastic film whose pores are filled with a liquid material, and a heat retarder intermixed with said carrier and containing a mixture of asbestos or powdered glass, methyl Cellosolve (80%) and hydroquinone (20%) as an inhibitor, and methyl ethyl ketone peroxide as a catalyst, said heat retarder containing of the order of $2\times10^{-4}$ parts by weight of said inhibitor, of the order of $\frac{1}{16}$ part by weight of said asbestos or powdered glass, and .004–.02 part by weight of said catalyst.

**2.** The heat barrier material defined in claim **1**, in which said carrier contains one part of said polyester resin by weight, .0075–.025 part of cobalt by weight, .005–.01 part of dimethylanaline by weight, and 0.8–1.2 part by weight of water.


**References Cited**

UNITED STATES PATENTS

| | | | |
|---|---|---|---|
| 3,560,253 | 2/1971 | Ashton | 117—137 X |
| 3,510,323 | 5/1970 | Wismer et al. | 252—62 X |
| 3,055,831 | 9/1962 | Barnett et al. | 252—62 |
| 3,301,785 | 1/1967 | Ratliff et al. | 252—62 |
| 3,320,087 | 5/1967 | Erickson | 161—403 X |
| 3,510,429 | 5/1970 | Iserson et al. | 106—15 FP |
| 3,560,323 | 2/1971 | Zwickert | 106—15 FP |
| 3,256,219 | 6/1966 | Will | 260—2.5 N |
| 3,553,132 | 1/1971 | Dunay et al. | 252—62 |
| 3,543,460 | 12/1970 | Stastny et al. | 161—403 X |
| 3,574,646 | 4/1971 | Wismer et al. | 260—2.5 N |
| 3,577,298 | 5/1971 | Glauco et al. | 161—403 |
| 3,585,254 | 6/1971 | Buck | 260—2.5 N |
| 3,595,732 | 7/1971 | Tingerthal | 161—162 X |
| 3,598,672 | 8/1971 | Heller | 262—62 X |
| 3,598,771 | 8/1971 | Davis el al. | 117—137 X |


HAROLD ANSHER, Primary Examiner

U.S. Cl. X.R.

106—15 FP; 117—137; 161—159, 162, 403; 260—2.5 N


Published by AsbestosClaims.Law
asbestosclaims.law/library/22665/4