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Produced by the NASA Center for Aerospace Information (CASI)

NASA CASE NO. MSC-18,934-3

PRINT FIG. #1

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MAY 1982

N82-26387

JSC

(NASA-Case-MSC-18934-3) A METHOD AND TECHNIQUE FOR INSTALLING LIGHT-WEIGHT FRAGILE, HIGH-TEMPERATURE FIBER INSULATION Patent Application (NASA) 10 p HC A02/MF A01 CSCL 11D G3/24

Unclas 19947

NASA CASE NO. MSC-16934-3

APPLICATION FOR LETTERS PATENT

TO ALL WHOM IT MAY CONCERN:

BE IT KNOWN THAT I, Bhanu C. Patel, a citizen of the United States of America and resident of Downey, California, have invented certain new and useful improvements in a method and technique for installing light-weight, fragile, high-temperature fiber insulation of which the following is a specification:

ABSTRACT OF THE DISCLOSURE

A method of installing fragile, light-weight, high-temperature fiber insulation, particularly where the insulation is to be used as a seal strip providing a high order of thermal barrier insulation. The process is based on provision of a strip of the mineral batting cut oversize by a predetermined amount, saturated in a fugitive polymer solution, compressed in a mold, dried and cured to form a rigidized batting material which may be machined to required shape. The machined dimensions would normally be at least nominally less than the dimensions of the cavity to be sealed. After insertion in the cavity, which may be a wire-mesh seal enclosure, the apparatus is subjected to baking at a temperature sufficiently high to cause the resin to burn off cleanly, leaving the batting substantially in its original condition and expanded into the cavity or seal enclosure.

AWARDS ABSTRACT NASA Case No. MSC-16934-3

A METHOD AND TECHNIQUE FOR INSTALLING LIGHT-WEIGHT FRAGILE, HIGH-TEMPERATURE FIBER INSULATION

The invention relates to a method of installing fragile, light-weight, high-temperature fiber insulation, particularly where the insulation is to be used as a seal strip providing a high order of thermal barrier insulation.

According to the invention, light-weight insulation batting such as alumina/zirconia or preferably, saffil high-temperature insulation alumina fiber 4 is precut into oversize elongated shapes. These shapes are saturated in an acrylic polymer resin in water solution, and compressed in a mold (Fig 2) to the required thickness or cross-sectional dimensions. The saturated batting is then dried in the mold and the resin cured at an appropriate temperature. The resulting rigidized batting may then be machined to a particular required shape and required dimensions for installation in wire-mesh sleeving 7, or any cavity requiring the heat-barrier seal to be provided. The entire assembly is subsequently heated to a temperature much greater than the resin curing temperature to effect a clean burn-off of the resin material, leaving the original mineral batting material to expand into the interior shape of the containing cavity or wire-mesh sleeving if the insulation material is to be used as a heat seal around an openable door or hatch, for example.

In connection with certain recoverable space vehicles, high performance heat-sealing must be provided in places such as entry hatches, landing gear doors, etc., since the vehicle skin temperatures become extremely high during certain times in the atmospheric reentry and the return maneuvers. The method, which is the subject of the present invention, is particularly well adapted for that purpose as will be more fully understood as this description proceeds. The method and materials used therein, wherever a fragile fiber batting is impregnated with an organic resin binder, compressed and machined to a required shape for insertion into a cavity for insulation purposes, then heated whereby the resin binder burns off to permit the batting to expand and fill the cavity is considered novel.

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Initial Evaluator: Thomas J. Ballantine

SN 361,711
Filed 3-25-82

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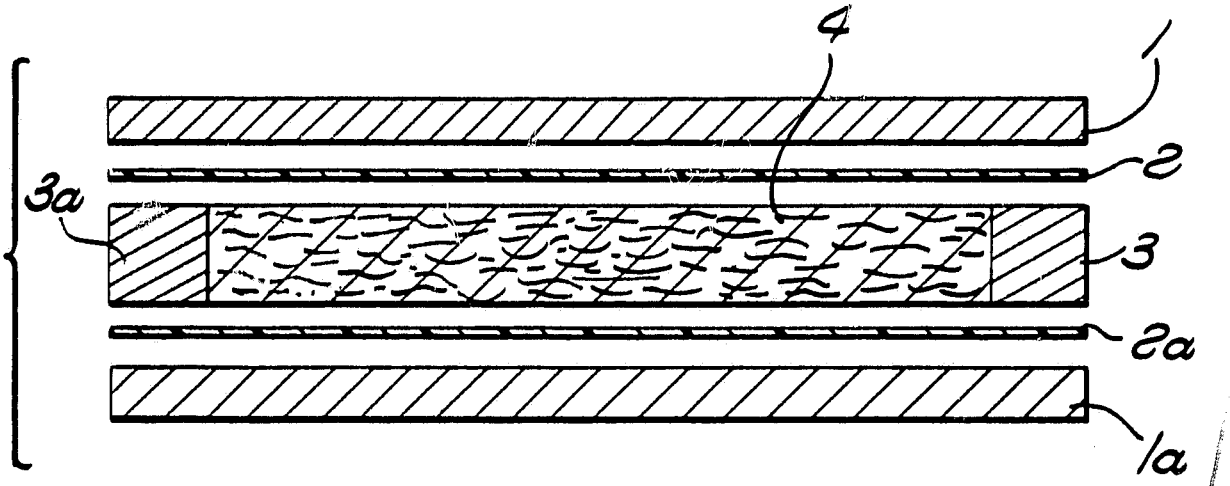

FIG. 1

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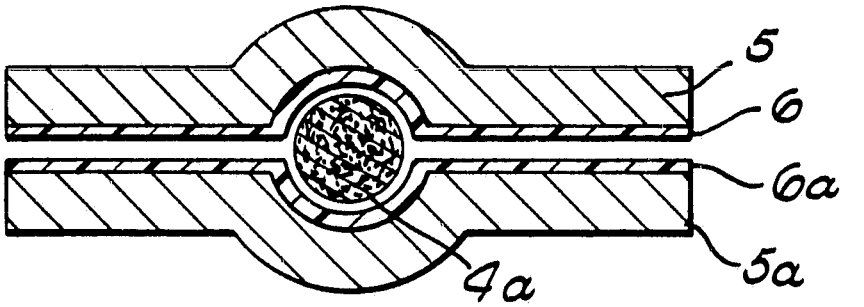

FIG. 2

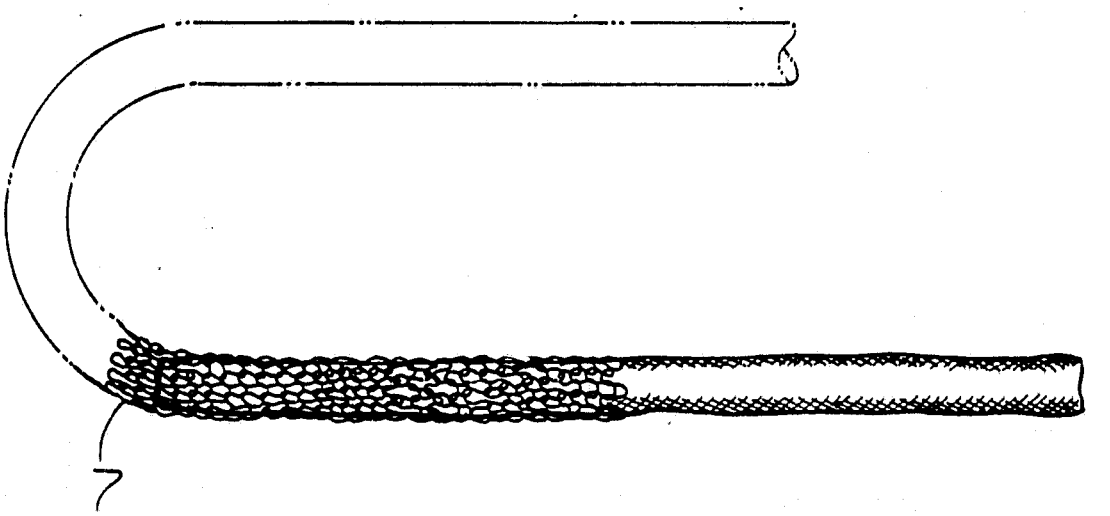

FIG. 3

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ABSTRACT OF THE DISCLOSURE

A method of installing fragile, light-weight, high-temperature fiber insulation, particularly where the insulation is to be used as a seal strip providing a high order of thermal barrier insulation. The process is based on provision of a strip of the mineral batting cut oversize by a predetermined amount, saturated in a fugitive polymer solution, compressed in a mold, dried and cured to form a rigidized batting material which may be machined to required shape. The machined dimensions would normally be at least nominally less than the dimensions of the cavity to be sealed. After insertion in the cavity, which may be a wire-mesh seal enclosure, the apparatus is subjected to baking at a temperature sufficiently high to cause the resin to burn off cleanly, leaving the batting substantially in its original condition and expanded into the cavity or seal enclosure.

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BACKGROUND OF THE INVENTION

1. Field of the Invention

The field of art to which the invention pertains generally, is the field of insulation installation, and more particularly, to installation of fragile fibrous, high-temperature insulation used as a high-temperature seal.

2. Description of the Prior Art

The concept of employing fugitive binders is known, per se, and has been employed in the ceramics industry. In the ceramics industry, intense heating or baking (firing) can be relied upon to evolve or drive off fugitive binder materials used for temporary convenience during manufacturing. In general, the fugitive binder material, per se, is not used to preform a compressible fibrous material in reduced volume, however.

In U.S. Patent 2,607,714 temporarily fabricated inorganic fiber shapes are described. The fiber materials are recognized as fragile and subject to damage in normal handling, transportation and application. For the purpose, a temporary adhesive material is applied to preserve the shape of the material, such as fiberglass, etc., and when in place in their intended use, the adhesive is flushed from the material, using a non-contaminating solvent, for example, water. A suggested fugitive adhesive or binder in that reference is hydroxy-ethyl cellulose, which is readily soluble in cold water.

In U.S. Patent 3,546,846, there is described a method and apparatus for packaging individual lengths of compressible integrated glass fiber mats. A length of such a fiberglass mat is compressed without breaking individual glass fibers in the mat by evacuating air from within it. An air impervious backing and top cover

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are then sealed together to retain the mat in its evacuated and compressed state. That reference may be thought of as describing an alternative "packaging" method for the fibrous insulation material, however, steps for the restoration of insulation material volume in order to have it fill voids or cavities into which it is emplaced, is not evident. Presumably, however, puncture of the packaging would permit expansion of the mats.

None of the aforementioned methods and apparatus provide a satisfactory method for inserting light-weight batting of fragile, high-temperature mineral fibers into assembly such as special fabric covered nozzle seals or wire sleeving.

In accordance with the foregoing, the manner in which the present invention provides a unique process for forming heat-barrier seals which are readily handled and installed without disintegrating the fibrous structure thereof, will be understood as this description proceeds.

SUMMARY OF THE INVENTION

According to the invention, light-weight insulation batting such as alumina/zirconia, or preferably, saffil high-temperature alumina fiber is precut into oversize elongated shapes. These shapes are saturated in an acrylic polymer resin in water solution, and compressed in a mold to the required thickness or cross-sectional dimensions. The saturated batting is then dried in the mold and the resin cured at an appropriate temperature. The resulting rigidized batting may then be machined to a particular required shape and required dimensions for installation in wire-mesh sleeving, or any cavity requiring the heat-barrier seal to be provided. The entire assembly is subsequently heated to a temperature much greater than the resin curing temperature to effect a clean burn-off of the resin

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material, leaving the original mineral batting material to expand into the interior shape of the containing cavity or wire-mesh sleeving if the insulation material is to be used as a heat seal around an openable door or hatch, for example.

In connection with certain recoverable space vehicles, high performance heat-sealing must be provided in places such as entry hatches, landing gear doors, etc., since the vehicle skin temperatures become extremely high during certain times in the atmospheric re-entry and the return maneuvers. The method, which is the subject of the present invention, is particularly well adapted for that purpose as will be more fully understood as this description proceeds.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an exploded view of the compression tooling used in the rigidizing step according to the invention.

FIG. 2 is an end-view of tooling used in the rigidizing process according to the invention, for the production of rigidized batting of circular cross-section.

FIG. 3 shows the step of inserting a rigidized resin-filled fiber member into a wire sleeve.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The method of the invention will be described with particular reference to the aerospace application aforementioned, and the materials referred to will be those appropriate to that application. It is to be understood however,

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that other less exotic materials might be substituted in less demanding industrial applications.

Before referring to the drawings in detail, it must be first realized that a roughly cut elongated shape of the saffil high-temperature alumina fibrous material is first provided. The size of such a strip exceeds the cavity into which it is to be placed, since in the final analysis it will have been permitted to expand and fill the said cavity completely.

The pre-cut or roughly cut alumina batting strip is next saturated in the acrylic polymer resin solution, for example, a material identified as A-3 as manufactured by Rohm and Haas Company. That material is prepared in a water solution, preferably with distilled water, diluted to about five percent solid content. Saturation of the fiber batting in that solution is a simple matter requiring only its immersion in the solution. The saturated fiber strips are then placed in the compression tool which may be relatively simple, and will vary in shape according to the application. Figs. 1 and 2 illustrate tooling suitable for this compression step and will be described hereinafter. The compression provided by the tooling not only compresses the fibrous batting to a dimension in accordance with which it is easily placed in the cavity or wire sleeve for which it is intended, and also serves to squeeze out excess resin solution. The compressed bats are allowed to remain in the compression fixture, typically for a time of sixteen hours or more at ambient temperatures. Without removing the compressed bats from the fixture, the resin is next cured in a pre-heated air-circulating oven preferably at 250° F $\pm$ 10°. The curing-drying time at that temperature is continued for a time dependent upon the size of the batting strip being processed, but ordinarily for a period on the order of four to eight hours.

Disassembly of the fixture and removal of the cured compressed batting strip is undertaken when cooling to 150° (F) or below has occurred.

Referring now to Fig. 1, an axially or longitudinally sectioned view

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of typical tooling (fixture) for producing a fiber strip of essentially rectangular cross-sectional shape is shown. A solution impregnated fiber material (shown in the compressed shape for convenience) is essentially inserted between two caul plates, 1 and 1a with separator films, 2 and 2a between, as shown. These separator films might be of a fluorocarbon or fiberglass material to avoid adherence of the compressed fibrous material strip to the caul plates 1 and 1a, the latter being metal plates ordinarily. Spacer blocks 3 and 3a are used to predetermine the length of each compressed fibrous material strip produced, although the impregnated compressed and cured material can be cut to length if it is processed without spacers 3 and 3a according to Fig. 1.

Referring now to Fig. 2, an equivalent tooling for producing the compressed fibrous strip 4a in circular cross-section is shown. The caul plates 5 and 5a are appropriately shaped and the separator films 6 and 6a are similarly shaped or may be of a sprayed on fluorocarbon material equivalent in composition and function to films 2 and 2a of Fig. 1.

Referring now to Fig. 3, a compressed and cured fibrous insulation member as might have been produced by the fixture of Fig. 2 is shown being inserted into a tubular-shaped wire mesh. Sufficient clearance is extant to permit easy insertion of the stiffened fibrous strip 4a into the wire sleeve 7.

Once the element 4a has been fully inserted into wire sleeve 7, that assembly is baked or fired at a temperature on the order of 800 ^{o}F. The organic resin binder being thoroughly and cleanly driven off. In the absence of the fugitive binder material, the batting expands to uniformly and completely fill the wire mesh sleeving, the resulting product being easily handled and effectively contained for emplacement as a door heat-sealing material, or the like.

In the event that the shaped rigidized batting is to be placed in a structural cavity directly, it can be cut, milled or otherwise machined in this

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rigidized form to effect conformance to the said cavity.

The method of the invention permits rapid and improved placement of light-weight thermo-barrier insulation batting with substantially no hazard of damage to the fiber and with minimal labor expenditure. The 800 ^{o}F firing step for driving off the fugitive binder is, of course, applied in all cases as a final step.

The process will be recognized as basically applicable to the production of improved heat-barriers and seals, such as might be required in industrial ovens, autoclaves, kilns, and the like.