June 22, 1965 W. F. GAUSS 3,190,442

PACKAGING METHODS

Filed May 20, 1963

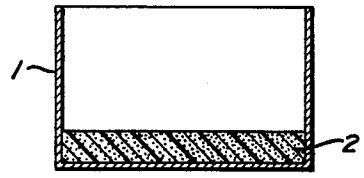


Fig. 1

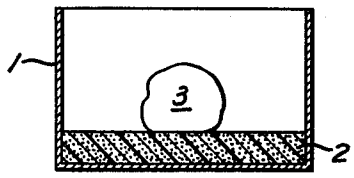


Fig. 2

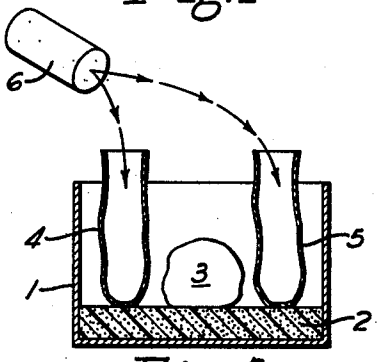


Fig. 3

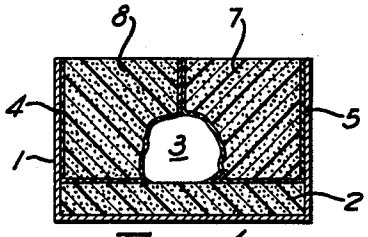


Fig. 4

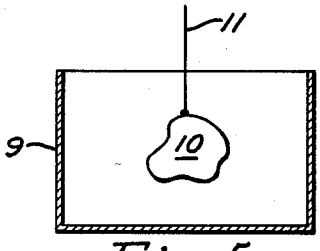


Fig. 5

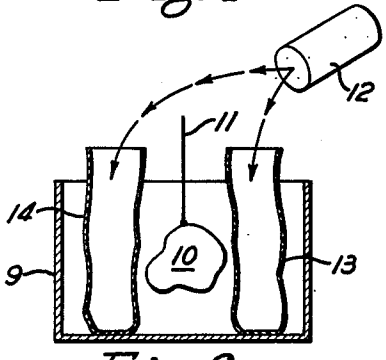


Fig. 6

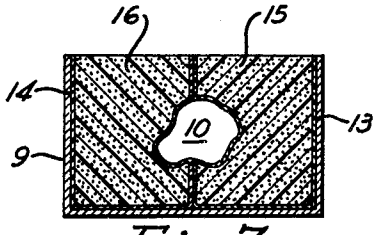


Fig. 7

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PACKAGING METHODS

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8 Claims. (Cl. 206—46)

This invention relates to packaging methods and more particularly to an improved method for protecting packaged articles.

Proper packaging of an article is of the utmost importance in industry in order that an article such as one that is quite delicate and frangible can be treated and handled in such a manner that the article will not be damaged no matter how breakable. A manufacturer of scientific instruments and the like cannot be plagued with the loss or damage of his products during transit or while in storage and for this reason great care is taken in the packaging of such frangible items and materials. Packaging of breakable articles is an expensive proposition and experts are continually searching for less expensive but also more efficient methods for accomplishing the packaging problem.

One of the heretofore known processes for packaging frangible articles or objects is a foam-in-place method wherein the article or object being packaged is wrapped in a protective covering or wrapping, after which the article or object is placed in a container. Then a liquid reaction mixture is poured thereupon and this mixture reacts and forms a foam which surrounds the article or object. However, this heretofore known "foam-in-place" technique has some disadvantages. The foam inherently has a tendency to stick to almost anything with which it comes in contact. It sticks not only to the wrapping which protects the article or object but also to the walls of the container. As a result of the stickiness of the foam, difficulties are encountered when removal of the article from the container and surrounding foam is attempted. The container most likely cannot be reused and the wrapping surrounding the article or object is often damaged when the package is opened. Furthermore, if the wrapping surrounding the article is bulky, the cushion formed by the foam-in-place reaction mixture does not conform to the same shape of the article and void spaces occur between the article and the foam cushion. These void spaces allow the article to move and vibrate within the wrapping causing damage to the article.

It is an object of this invention to provide an improved method for packaging which is devoid of the foregoing disadvantages. It is another object of this invention to provide a package that will protect an article from any type of shock, vibration and the like, which might damage the article. It is still another object of this invention to provide a package that is efficient, easy to prepare and also inexpensive. It is a further object of this invention to provide a packaging method whereby the materials that are employed can be reused.

Other objects will become apparent from the following description with reference to the accompanying drawings in which:

FIGURES 1 through 4 illustrate a cross-sectional view of the steps of preparing a package in accordance with one embodiment of the present invention; and

FIGURES 5 through 7 illustrate a further embodiment of a method of preparing a package by a process in accordance with the present invention.

The foregoing objects and others are accomplished by providing a container, a frangible article and a foam cushion enclosed in a dilatable bag wherein the dilatable bag is filled with a suitable foam-in-place material and this bag containing the expanded foam maintains the

frangible article or object in cushioned and spaced relation to the container. This method of enclosing an article in a housing of foam protects the article against any type of damage such as that resulting from shocks, vibrations and the like while in transit, storage and the like.

The term "dilatable" as used herein identifies the bag into which the foamed resin is inserted as one that will respond to the influence of the expanding foam so that it can be deformed in any direction without rupturing. The bag can be of a stretchable type or it can be oversized as long as it is deformed by the force of the expanding resin and is able to substantially conform to the intricacies, crevices, cracks and the like of the frangible article thereby assuring complete isolation of the article from vibrations and the like.

Referring to the particular embodiment of the present invention illustrated in FIGURES 1 through 4 wherein a container 1 which is of any suitable size and shape, such as, for example, square, rectangular, oblong and the like, and which can be constructed of any suitable material such as, for example, cardboard, wood, metal, plastic, corrugated paper and the like, has a foam cushion 2 disposed in the bottom thereof. The foam cushion 2 can be a precut slab of foam measured to the dimensions of the base or bottom portion of the container 1 or the foam can be prepared by pouring just enough of the foamable reaction mixture into the container to create the desired thickness of foam on the bottom portion of the container 1. It may be desired to enclose this foam in a dilatable bag such as one that was discussed previously. The article 3 which is to be protectively packaged is placed into the container 1 and rests on the foam cushion 2 as shown in FIGURE 2. It is important that the foam cushion 2 be of the proper rigidity and thickness so that it will adequately support and protect the frangible article 3. After the frangible article 3 has been placed in the container 1, dilatable bags 4 and 5 are also inserted into the container between the frangible article and the walls of the container. A sufficient amount of a foamable reaction mixture 6, so that no more is used than that required to fill the area within the container not occupied by the article 3 when the reaction mixture has expanded, is inserted into the bags 4 and 5. The foamable reaction mixture is allowed to react and expand thus surrounding and taking the configuration of the external surface of the frangible article 3. The dilatable bags should be pliable, flexible and capable of conforming as close as possible to the external configurations of the frangible article as the force of the expanding foam conforms the bags and the foam to the dimensions of the frangible article. The dilatable bags can be of any suitable size or shape and can be constructed of any type of material such as, for example, plastic such as polyethylene, polypropylene, polyvinylchloride, paper, cotton, rubber and the like. Any suitable dilatable bag can be employed in the practice of the present invention as long as it meets the requirements of being able to contain the expanding foam and conform to any particular irregularity of an article being wrapped or packaged. Preferably, the bag should not adhere in any way to the article and it should be non-reactive with the foam-in-place resin or any of the reactive components thereof.

The amount of foamable reaction mixture being inserted into the dilatable bags 4 and 5 should preferably be calculated prior to inserting it into the dilatable bags so that preferably no more than that required to completely fill the cavity in the container not occupied by the frangible article is used. When more than this required amount of foamable mixture has been inserted into the bags, a lid can then be placed on the container in order to limit the foaming to the area within the container. If just the amount of foamable mixture required to fill the area in the container not occupied by the frangible article is

inserted into the dilatable bags, a lid need not be used. If desired, the container 1 may be closed by providing a lid, for example, the flap of a corrugated container immediately after the introduction of the foam-in-place material 6. Thus, the foam filled bags 7 and 8 substantially conform to the crevices, indices and irregularities characteristic of the frangible article and with the inner wall of the container thereby holding the article in place in cushioned relationship within the container as in FIGURE 4. The package is now ready for storage, shipping and the like. The package can be easily opened by merely removing the bags containing the foam cushions from the container and when articles of the same size and dimensions are being stored and shipped, the foam cushions which are enclosed in and protected by the dilatable bags can be reused.

Referring now to another embodiment of the present invention illustrated in FIGURES 5 through 7 wherein a frangible article 10 is suspended by a suitable suspending means 11 in a container 9 of any suitable size, shape and fabrication in such a manner that it occupies the same position in the container as it will when the packaging process is completed and the article and container are ready to be shipped, stored and the like. The foam cushioning is prepared around the frangible article by first inserting a plurality of dilatable bags such as 13 and 14 into the container 9 after which a foamable reaction mixture 12 is poured therein. Again, it is preferred to insert only that amount of the reaction mixture into the bags 13 and 14 such as those described hereinbefore, as that which will be required to completely fill the cavity in the container not occupied by the frangible article 10. After the foamable reaction mixture has been inserted into the dilatable bags which surround the frangible article between the walls of the container and the external surface of the article, the reaction mixture is allowed to react and expand within these bags. The foam cushions 15 and 16 which are contained in the bags 13 and 14 substantially surround the frangible article 10 and protect it from substantially any damaging effects that might be transmited to the container 9. The article is now packaged and can be shipped, stored, and the like. The package can be easily opened by merely removing the bags containing the foam cushions from the container and when articles of the same size and dimensions are being stored and shipped, the foam cushions which are enclosed in and protected by the dilatable bags can be reused.

Foodstuffs and the like which are not capable of retaining their shape while the exothermic heat of reaction is being released by the expanding foam can be prepared in a slightly different manner. A molding type procedure can be followed wherein a mold made of wood or the like is positioned in a container substantially in the same likeness as if the actual article were present. After the foam cushions are prepared in plastic bags around the mold, the mold can be removed and the foodstuffs or other article to be packaged can be substituted therefor. The foam cushioning not only protects the article from vibrations, shocks and the like, it also insulates the article from extreme temperatures along with providing a substantially flameproof packaging.

Any suitable resin capable of foaming-in-place in accordance with the foregoing description of the present invention can be used, such as, for example, polyurethanes, polyethylenes, polyesters, epoxy resins, polypropylene, styrene, polystyrene, polyvinyl alcohol and the like. In selecting a suitable foam, one having the proper rigidity or flexibility should be used since the foam-in-place resin not only holds the frangible article in place in a container, it also tends to absorb any shocks, vibrations and the like that might be transmitted to the package. Of all the suitable foamable resins mentioned above, it is especially preferred to employ a polyurethane type resin because of its superior sound and vibration absorbing properties. Also, the dilatable bags which surround the foam cushions tend to act as a liquid and vapor barrier for the article enclosed therein.

The polyurethane foams preferred in accordance with the present invention can be prepared by reacting an organic polyisocyanate with an organic compound containing at least two active hydrogen containing groups as determined by the Zerewitinoff method and a blowing agent. Any suitable organic polyisocyanate can be used for the preparation of the polyurethane foam of this invention, such as, for example, those disclosed in United States Reissue Patent 24,514 to Hoppe et al., issued August 12, 1958. Arylene diisocyanates are preferred, such as, for example, 2,4-toluylene diisocyanate, 2,6-toluylene diisocyanate, isomeric mixtures thereof, p,p'-diphenylmethane diisocyanate, 1,5-naphthalene diisocyanate, triphenylmethane triisocyanate and the like. Particularly suitable arylene diisocyanates for this reaction is a mixture of about 20 percent 2,6-toluylene diisocyanate and about 80 percent 2,4-toluylene diisocyanate.

Unrefined isocyanates may also be used, such as, the crude mixture of isocyanates obtained by the phosgenation of the reaction product of aniline and formaldehyde which contains a mixture of di- and higher polyisocyanates or by phosgenating a mixture of toluylene diamines which is primarily a mixture of ortho- and para-toluylene diamines. A preferred product is one having from about 26 to about 33 percent free —NCO and an amine equivalent of about 120 to about 150, such as, for example, a product having about 32 percent free —NCO and an amine equivalent of about 140.

Any suitable organic compound containing at least two active hydrogen containing groups as determined by the Zerewitinoff test may be used, such as, for example, hydroxyl polyesters, polyhydric polyalkylene ethers, polyhydric polythioethers, polyacetals and polyester amides. It is preferred that the organic compound have a molecular weight above about 500 and most preferably within the range of about 1000 to 5000, a hydroxyl number of not more than about 225 and preferably within the range of about 20 to 112 and acid numbers, where applicable, preferably below about 10 and most preferably below about 1.

Any suitable hydroxyl polyester may be used, such as, for example, the reaction product of a polycarboxylic acid with an excess of a polyhydric alcohol. Any suitable polycarboxylic acid may be used, such as, for example, adipic acid, sebacic acid, phthalic acid, terephthalic acid, maleic acid, malonic acid, thiodipropionic acid and the like. Any suitable polyhydric alcohol may be used, such as, for example, ethylene glycol, propylene glycol, butylene glycol, amylene glycol, glycerine, trimethylol propane, pentaerythritol and the like.

Any suitable polyhydric polyalkylene ether may be used, such as, for example, the condensation product of alkylene oxides and a polyhydric alcohol. Any suitable alkylene oxide may be used, such as, for example, ethylene oxide, propylene oxide, butylene oxide, amylene oxide and the like. It is preferred to employ polyhydric polyalkylene ethers prepared from alkylene oxides having from two to five carbon atoms, such as, for example, polypropylene ether glycol, polyethylene ether glycol, polybutylene ether glycol or mixtures thereof having a molecular weight of at least about 500. Moreover, the condensation products of the aforementioned alkylene oxides and other compounds such as polyhydric alcohols, such as, for example, ethylene glycol, propylene glycol, trimethylol propane, glycerol, triethanol amine, pentaerythritol, sugars, such as glucose, fructose, sucrose and the like, ammonia, diamines and the like may be used. The polyhydric polyalkylene ethers may be prepared by any known process, such as, for example, by the process described by Wurtz in 1859 and in "Encyclopedia of Chemical Technology," Vol. 7, pages 257–262, published by Interscience Publishers, Inc., 1951, or in U.S. Patent 1,922,459.

Any suitable polyhydric polythioether may be used,

such as, for example, the reaction product of a polyhydric alcohol with a thioether glycol. Any suitable polyhydric alcohol may be used, such as, for example, ethylene glycol, propylene glycol, butylene glycol, trimethylol propane, pentaerythritol and the like. Any suitable thioether glycol may be used, such as, for example, diethylene glycol thioether and the like.

Any suitable polyacetal may be used, such as, for example, the reaction product of an aldehyde, such as, for example, formaldehyde, with a polyhydric alcohol, such as, for example, ethylene glycol or one of the other polyhydric alcohols disclosed above for reaction with the polycarboxylic acids and/or alkylene oxides used in the preparation of the hydroxyl polyesters and polyethers respectively.

Any suitable polyester amide may be used, such as, for example, the reaction product of an amine, such as, ethylene diamine and an alkylene glycol such as ethylene glycol with a polycarboxylic acid as disclosed for the preparation of the hydroxyl polyesters.

One may also employ halo hydrocarbons either alone or with water in conjunction with the balance of the components of the cellular polyurethane plastic. Any suitable blowing agent, which is a gas at the reaction temperature, such as, for example, dichlorodifluoromethane, trichlorofluoromethane, dichlorofluoromethane, dichlorotetrafluoroethane and the like may be used.

It is often advantageous to carry out the reaction in the presence of a catalyst. Any suitable catalyst may be used, such as, for example, dibutyl tin di-2-ethyl hexoate, stannous octoate, triethylene diamine, N-ethyl morpholine, N-methyl morpholine, dimethyllauryl amine, ferric acetylacetonate, mixtures thereof and any other catalyst which will promote the reaction between the isocyanate groups and active hydrogen atoms as determinable by the Zerewitinoff method such as those disclosed in "Catalysis of the Isocyanate-Hydroxyl Reaction," J. W. Britain and P. G. Gemeinhardt, Journal of Applied Polymer Science, Volume IV, Issue No. 11, pages 207 to 211 (1960).

In many cases it is desirable and indeed in some cases it may be necessary to carry out the reaction in the presence of a stabilizer or emulsifier. The foam stabilizer results in a foam having a smaller cell size than would be obtained with a comparable reaction mixture not containing the stabilizer. Any suitable alkyl silane oxyalkylene block copolymer such as one having the formula.

$$R'Si\begin{Bmatrix} O(R_2SiO)_p(C_nH_{2n}O)_zR'' \\ O(R_2SiO)_q(C_nH_{2n}O)_zR'' \\ O(R_2SiO)_r(C_nH_{2n}O)_zR'' \end{Bmatrix}$$

wherein R, R' and R'' are alkyl radicals having from one to four carbon atoms; *p*, *q*, and *r* each have a value of from four to eight and $(C_nH_{2n}O)_z$ is a mixed polyoxyethylene oxypropylene block containing from 15 to 19 oxyethylene units and from 11 to 15 oxypropylene units with *z* equal to from about 26 to about 34 or similar stabilizer can be used in the process of the present invention. Other suitable silicone oils for this purpose may be found in U.S. Patent 2,834,748 to Bailey et al., issued May 13, 1958. In the preparation of cellular polyurethane plastics from organic polyisocyanate modified polyhydric polyalkylene ethers having terminal —NCO groups by reaction thereof with water, it is advantageous to employ a substantially linear dimethyl polysiloxane having a viscosity of about 50 csts. at 25° C. The same silicone oil may be used as a stabilizer in the production of a cellular polyurethane plastic based on polyesters. Emulsifiers such as the sulfonated oils, for example, sulfonated castor oil, are also suitable.

Polystyrene foams to be used in accordance with the process of the present invention can be produced by introducing a foaming agent, such as, methylene chloride under high pressure into molten polystyrene. Polystyrene foams have many tiny, noninterconnected cells, low densities, low thermal conductivity, good structural strength, form excellent water vapor barriers and can be made with self-extinguishing characteristics.

Polyvinyl alcohol foams to be used in accordance with the present invention can be prepared by foaming a water solution of polyvinyl alcohol with air or the like in the presence of a wetting agent, an inorganic acid and formaldehyde. Toughness, resiliency, and softness are characteristic of this type of foam.

Although the foregoing description tends to limit the present packaging methods to frangible items, those items or articles which are not frangible but require some sort of packaging can also be packaged according to the present invention. Any suitable container and foam-in-place resin can be used to package an article according to the present invention providing the teachings of the preceding disclosure are followed.

Any suitable item can be packaged according to the present invention such as, for example, sensitive electrical equipment, scientific instruments, china, books, furniture, foodstuffs, and the like.

The invention is further illustrated by the following examples in which the parts and percentages are by weight unless otherwise specified.

Example 1

About 85 parts of a mixture of about 65 parts of the propylene oxide adduct of 1,1,3-para-hydroxyphenyl propane having an hydroxyl number of about 223 and about 35 parts of the propylene oxide adduct of glycerine having an hydroxyl number of about 652 mixed with about 15 parts of the propylene oxide adduct of diethylene triamine having a molecular weight of about 400 and an hydroxyl number of about 700 are combined on a machine mixer as disclosed in Reissue Patent 24,514 with about 109 parts of the organic polyisocyanate obtained by the phosgenation of the condensation product of aniline and formaldehyde which has an amine equivalent of about 140 and which contains about 31 percent free —NCO with about 40 parts of trichlorofluoromethane, about 1.1 parts of 1-methyl-4-dimethyl amino ethyl piperazine and about 1 part of a silicone oil having the formula:

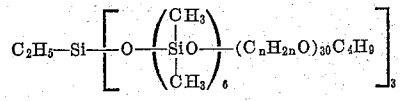
$$C_2H_5-Si\left[-O-\left(\begin{matrix}CH_3\\|\\SiO\\|\\CH_3\end{matrix}\right)_6-(C_nH_{2n}O)_{30}C_4H_9\right]_3$$

wherein $(C_nH_{2n}O)$ is a mixed polyoxyethylene and oxypropylene block copolymer containing about 17 oxyethylene units and about 13 oxypropylene units. The reaction mixture is discharged into two polyethylene bags, one on each side of a 12" x 8" x 8" box containing a microscope. The foam rises and sets to produce a rigid polyurethane foam having a density of about 1.5 lbs./ft.^{3}. The foam rises in about 100 seconds and is tack-free in about three minutes. Furthermore, the cellular polyurethane foam produced by this process has a compression strength of about 20 lbs. at yield at about 8 percent deflection and this foam maintains the microscope in cushioned and spaced relationship to the box. The microscope is now suitably packaged and protected by the foam cushion from any vibrations and shocks which might be transmitted to the box during shipping or storing.

Example 2

About 100 parts of the reaction product of alpha-methyl-D-glucoside with 1,2-propylene oxide having a molecular weight of about 445 and an hydroxyl number of about 525 are mixed with about 110 parts of crude toluylene diisocyanate containing about 36.3 percent free —NCO, about 0.054 percent hydrolyzable chlorine, about 0.77 percent total chloride, an assay of about 77 percent, an amine equivalent of about 115.6 and having a viscosity of about 220 centipoises at 30° C., about 25 parts of trichlorofluoro methane, about 2 parts of 1-methyl-4-di-

methyl amino ethyl piperazine and about 1 part of a silicone oil having the formula:



wherein ($C_nH_{2n}O$) represents about 17 oxyethylene units and about 13 oxypropylene units in a machine mixer such as that disclosed in Reissue Patent 24,514. After a uniform mixture is obtained, the liquid is discharged from the mixer into a polypropylene bag which surrounds a 200 watt electric light bulb suspended in a 7" x 4" x 4" paper box. Expansion of the liquid mixture occurs with the formation of a very dark in color rigid polyurethane foam having a density of about 2 lbs./ft.^{3} and a softening point of about 150° C. substantially surrounding the light bulb yet still enclosed within the polypropylene bag. The paper box containing the foam cushion and light bulb is dropped several times about 6 feet onto a concrete floor. When the bulb is removed from the foam packaging it still lights.

Although the invention has been described in considerable detail in the foregoing for the purpose of illustration, it is to be understood that such detail is solely for this purpose and that variations can be made therein by those skilled in the art without departing from the spirit and scope of the invention except as set forth in the claims.

What is claimed is:

1. A package comprising an article in a container, said container having inner walls and outer walls, and at least one bag positioned between the inner walls of the container and the external surfaces of the said article, said bag having disposed therein a cellular plastic material which substantially fills the volume of the container and maintains the said bag in intimate contact with the exterior surfaces of the article and the inner surfaces of the container.

2. The package of claim 1 in which the cellular plastic material is a polyurethane foam.

3. A package comprising an article in a container, said container having inner walls and outer walls, and a plurality of bags positioned in said container between the inner walls of the container and the external surfaces of the article, said bags having disposed therein a cellular plastic material which substantially fills the container and maintains the bags in intimate contact with and conformance to the surface irregularities of the said article and the inner walls of the container.

4. The package of claim 3 in which the cellular plastic material is a polyurethane foam.

5. A package comprising an article, a container having inner walls and outer walls, a foam cushion, said foam cushion being situated in said container with the said article positioned thereon, and a bag located between the inner walls of the container and the external surface of the article and having a foam plastic material enclosed therein which substantially fills the volume of the container and maintains the bag in intimate contact with the surfaces of the article and the inner walls of the container.

6. The package of claim 5 in which the cellular plastic material is a polyurethane foam.

7. The package of claim 5 wherein the foam cushion is formed in at least one bag in the container, the article is positioned thereon, and the remainder of the volume of the container is substantially filled with foam plastic material which is substantially enclosed in a bag.

8. The package of claim 7 in which the cellular plastic material is a polyurethane foam.

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Notice of Adverse Decision in Interference

In Interference No. 95,263 involving Patent No. 3,190,442, W. F. Gauss, PACKAGING METHODS, final judgment adverse to the patentee was rendered June 29, 1966, as to claims 1, 2, 3, 4, 5 and 6.

[*Official Gazette August 9, 1966.*]