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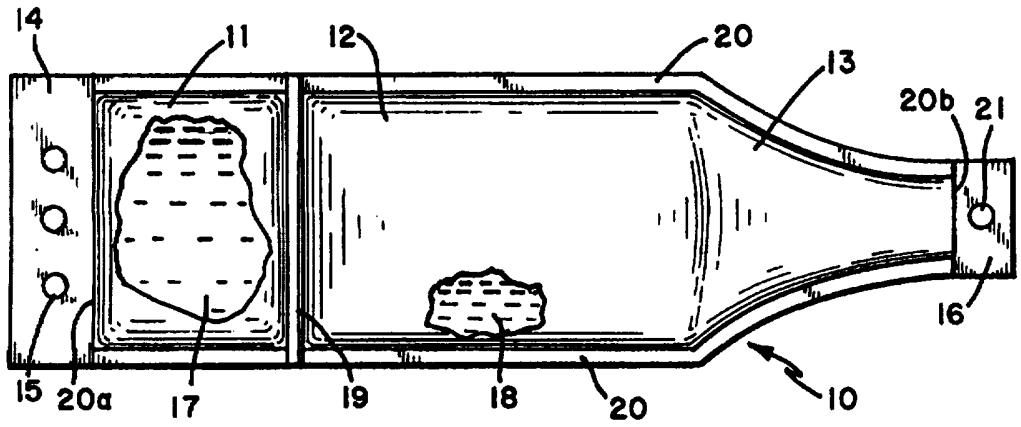

(57) Abstract

A method and system for preparing and dispensing to a screen printer a solder mask reaction product which product is made by reacting at least two components (17 and 18) comprises a single pliable container (10) which holds the components and is partitioned (19) to separate the reactive components, removing the partition when the solder mask is ready to be made, missing the reactive components in the container, transferring the mixed components to a mixing container if necessary and completing the mixing to form a substantially homogeneous solder mask blend and dispensing the homogeneous solder mask blend to the screen printing device. A package for making a solder mask reaction product, a package containing a mixed or partially-mixed solder mask reaction product and an apparatus for preparing and dispensing the solder mask reaction product are also provided.

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SOFT PACK PACKAGE AND DISPENSING SYSTEM FOR LIQUID PHOTOIMAGEABLE SOLDER MASK

Background Of The Invention

1. Technical Field

The present invention relates to a soft pack package holding components in separate compartments in the package which components when mixed react to form a reaction product and to a method for preparing the reaction product and for dispensing the reaction product to a device and, in particular, to preparing a solder mask reaction product which is made by mixing at least two reactive components which are held in separate compartments in a partitioned soft package and to dispensing the solder mask to a screen printer or other apparatus in the fabrication of electronic components such as printed wiring boards.

2. Background Art

Electronic components such as a printed wiring board (PWB) are fabricated using a substrate material such as a polyimide board, paper-epoxy board , glass-epoxy board and the like. Other substrates such as silicon semi-conductor wafers are used to make computer chips. Both type substrates require a series of steps to define and construct a circuit pattern on the substrate and for convenience the following description will be directed to PWBs. In one fabrication process, a cleaned board having a copper layer thereon (usually on both surfaces) is coated with a photoresist material which is exposed to define the desired circuit pattern . The resist is then developed to form the desired copper pattern which remains covered by the resist. The unwanted copper which is not covered is then etched. The resist is then etched to expose the desired circuit pattern as bare copper lines on the surface of the board. Boards having through-holes are used for the formation of two-sided boards. These boards can be laminated together to form multi-layer PWBs which have a plurality of inter-leaved parallel planar copper and board layers with the through-holes providing the inter-connections between the circuit patterns on each board. Other materials are also applied and coated on the board during the PWB manufacturing process such as a liquid photoimageable solder mask which is used to protect the circuitry from further fabrication processing. The above procedure is generally known as a subtractive process.

An additive process starts with a board having no copper foil on its surface and requires the deposition of a conductor such as copper by for example electroless and electrolytic deposition. After treating the board to promote

adhesion of the copper to the board, a photoresist layer is employed to define the desired circuit. After the resist is imaged and developed to expose the desired circuit pattern, copper is plated on the board to form the circuit. The remaining resist is then etched leaving a board having the desired circuit pattern thereon. Other PWB fabrication processes such as the semi-additive process may similarly be used to make PWBs. U.S. Patent No. 5,358,602 discusses the above processes in detail and is incorporated herein by reference.

An essential step in the manufacture of PWBs is coating on the board materials which are formed by reacting two or more components (usually a chemical reaction) and which have a relatively short pot life and/or work-life and which must be substantially homogeneous and free from particulate contaminants. Coating techniques such as screen printing, curtain coating and spray coating are used and materials such as plating resists and solder masks are exemplary of these type coatings. For convenience the following description is directed to solder masks and this term is meant to include photoimageable solder masks.

Basically, a solder resist or solder mask is coated over those areas of the board to be protected from solder especially when soldering is conducted in mass techniques such as wave soldering or dip soldering where improper soldering and improper connections can occur. Solder masks may be applied using conventional screening, exposure, development and convection oven equipment to yield a solder mask film covering the desired areas of the board. The film is of controlled, uniform thickness which can withstand the rigors of a soldering operation and/or solvents, acid or alkaline post-assembly cleaning solutions. The controlled film thickness over the circuit conductors improves solderability of components, pads and through-holes and makes for easier solder paste application and post-assembly cleaning.

A solder mask is generally a highly resistant material made by reacting two or more viscous liquid or semi-solid components to form a liquid which is coated on a board and hardened by imaging to form a resistant film. The solder mask comprises a principle component such as an epoxide and a hardener component which is reactive with the epoxide to form the solder mask reaction product. The solder mask product is generally a viscous liquid having a viscosity up to about 60,000 cps or higher at room temperature. The solder mask reaction product, once made, hardens by itself into a solid form upon standing and/or exposure to light and may have a pot-life of up to about a week in a closed container stored at room temperature. In general, the two components used to make the solder mask are

mixed together when the solder mask is ready to be used and is preferably used within a short period of time after mixing to avoid problems associated with unwanted hardening of the composition. The components may vary greatly in consistency (viscosity) ranging from a high viscosity such as a semi-solid like putty to a lower viscous material such as syrup. In many cases the principle component and the hardener component have greatly different viscosities requiring significant care in handling , measuring and mixing to form the final reaction product. As can be appreciated, a solder mask must be homogeneous and substantially free of solid particles which would interfere with the coating process and resultant PWB product. It is important that the two components be thoroughly mixed as incomplete mixing will change process latitudes and final solder mask characteristics. If the solder mask is not substantially homogeneous this can affect the reliability of the fabrication process and result in defective PWBs.

Presently, the components used to make solder masks are two component epoxy systems and are sold as a two component pre-measured system with each component stored in a separate substantially rigid container. When ready for use, the contents of one container is emptied into the other container and the mixture stirred in the container for a period of time usually at least 5 minutes at 400 to 600 rpm to provide a homogeneous solder mask reaction product. The contents of the container may be poured into the coating device or used with a pumping device in which the container is placed and the solder mask pumped from the container to a coating device. Conventional ink or solder mask pumps may be used to dispense the solder mask to a screen printer designed for use with solder mask systems and can be partnered with a conveyerized oven to provide a fully automatic liquid photoimageable coating and drying system.

With all the safeguards and automatic equipment however, the reliability of the process depends to a large part on the skill of the worker preparing the solder mask product. For example, each component is highly viscous and when one component is transferred from its container to the other container the worker must carefully scrape the container to remove the contents of that container and not introduce any foreign matter into the mixture. Additionally, both components may cause skin and eye irritation and sensitization and usually have foul odors. In the time that it takes to empty and scrape the containers and mix the component mixture the work area may be permeated with an odor which is not only unpleasant, but potentially hazardous. The worker must wear safety gloves and the

work area requires ventilation to alleviate these problems. Another problem is the transfer of the solder mask product to a dispensing container for dispensing by pumping to the application device such as a screen printer unless a special pumping device as described above is employed. Waste disposal of the remaining solder mask components and solder mask reaction product is also a serious concern since each component of the solder mask is generally a hazardous material and must be disposed of according to specific environmental waste treatment procedures.

Bearing in mind the problems and deficiencies of the prior art, it is therefore an object of the present invention to provide a method for preparing a substantially homogeneous product which is the reaction product of two or more components, and to a system for dispensing the reaction product, the reaction product being in particular a material used to coat electronic components such as a liquid photoimageable solder mask.

It is another object of the present invention to provide an apparatus for preparing and dispensing such a reaction product.

A further object of the invention is to provide a method for coating electronic components such as PWBs with reaction products such as a solder mask by screen printing, curtain coating or spray coating.

It is yet another object of the present invention to provide a partially-mixed reaction product for use to make a reaction product such as a solder mask used in the fabrication of electronic components such as a PWB.

Another object of the present invention is to provide a single package container holding reactive components which components have been partially or completely mixed in the container with the mixture being used in the preparation of the final reaction product such as a solder mask or used directly to fabricate an electronic component.

Another object of the present invention is to provide a package holding reactive components which are used to make a reaction product used to fabricate electronic components.

Other objects and advantages of the present invention will be readily apparent from the following description.

3. Disclosure of the Invention

The above and other objects, which will be apparent to those skilled in the art, are achieved in the present invention which is directed in a first aspect to a method for preparing a substantially homogeneous reaction product and for,

optionally, dispensing the reaction product to a device, the reaction product comprising at least two components which when mixed react with each other to form the reaction product, the method comprising:

holding each of the reactive components in a single soft or pliable or otherwise deformable container which is partitioned to separate the reactive components;

removing the partition when the reaction product is to be made and mixing the components in the container either partially or to a substantially homogeneous blend ready for use by deforming the container to provide mixing therein;

transferring the partially-mixed components to a mixing container and completing the mixing to form a substantially homogeneous reaction product blend; and, when the blend is desired to be dispensed,

dispensing the homogeneous blend to the device.

For reaction products substantially mixed in the bag and ready for use with little or no additional mixing, the mixed components may be dispensed directly to the desired device.

In another aspect, the invention is directed to making electronic components such as PWBs wherein one or more steps of the PWB manufacturing procedure requires the application of a reaction product as a coating on the PWB. When the reaction product is a solder mask, e.g., liquid photoimageable solder mask , the solder mask is prepared as described above and is applied to the circuitry of a PWB using a coating technique such as screen printing, curtain coating or spray coating.

In a further aspect, the present invention provides a single soft or pliable package holding reactive components in separate compartments of the package in the amounts needed to make a reaction product such as a solder mask. And further, the present invention provides a single soft or pliable package in which reactive components held in separate compartments of the package are partially mixed in the package to form a partially-mixed reaction, e.g., solder mask, product or mixed in the package to form a substantially homogeneous reaction product suitable for dispensing to a device such as a screen printer.

In another aspect of the invention, an apparatus is disclosed for preparing a reaction product such as a solder mask comprising a pliable container means (bag) holding the reaction components, which components are separated in the container by separating means; mixing means for partially or substantially completely mixing the components in the bag by deforming the bag (by e.g.,

kneading) when the separating means is removed; if the components are only partially mixed, transferring means for transferring the partially-mixed components from the container to a second container; and agitating means for forming a substantially homogeneous blend of the transferred partially-mixed components in the second container means. The apparatus also may include dispensing means for dispensing the solder mask to the surface of an electronic component such as a PWB.

4. Brief Description of the Drawings

The features of the invention are believed to be novel and the elements characteristic of the invention are set forth with particularity in the appended claims. The figures are for illustration purposes only and are not drawn to scale. The invention itself, however, both as to organization and method of operation, may best be understood by reference to the detailed description which follows taken in conjunction with the accompanying drawings in which:

Fig. 1 is a top elevational view of a package of the present invention.

Fig. 2 is a side plan view of the package of Fig. 1.

Fig. 3 is a side elevational view of the package of Fig. 1 in which the partition is removed and the contents of the package are partially mixed.

Fig. 4 is a side elevational view of an apparatus of the invention.

Fig. 5 is a partial top plan view of a roller device used for transferring the contents of a package of the invention.

5. Mode of Carrying Out the Invention

In describing the preferred embodiment of the present invention, reference will be made herein to Figs. 1 - 5 in which like numerals refer to like features of the invention. Features of the invention are not necessarily shown to scale in the drawings.

As shown in Fig. 1, a bag 10 which is soft or pliable or otherwise deformable to allow mixing of the components contained within the bag by deforming the bag, e.g., by kneading or rolling, has at least two compartments 11 and 12 separated by partition 19. Compartment 12 also comprises neck portion 13. Components 17 and 18 are shown therein in respective compartments 11 and 12 and 13. Separation (partition) of the components may be performed by any suitable type partition such as a frangible seal within the bag or by an external seal such as a clamping device 23 which clamps partition rod 19 as shown in Fig. 2. Essentially, the rod is placed across the width of the bag and the clamp secures the bag to the rod forming the partition. It will be understood that each of the

separated components may contain other ingredients normally used in solder mask formulations such as solvents, flowing agents, fillers , etc. with the important consideration being that the reactive components of the reaction product be separated until it is desired to mix the components and form the reaction product .

The package 10 is shown having handles 14 and 16 at opposite ends of the bag , which handles also seal the bag. Both handles preferably have openings 15 and 21 to facilitate positioning the bag for mixing and product transfer steps and for handling of the bag. The bag is shown having edges 20 which are sealed to define the bag. Basically, the bag 10 is formed by overlaying two films of plastic or other suitable material and joining the edges 20 along the longitudinal axis to form the bag which will be open at both ends at this point. The bag is then partitioned , filled and sealed as described herein below. For plastic bags the edges are usually sealed by heating. The bag package containing the components may be shipped easily and stored for long periods of time before use. When the reaction product is ready to be used, the partition 19 is removed or broken and the components of the bag mixed in the container 10 to form either a substantially homogeneous reaction product blend or a partial-mix of the components as shown in Fig. 3. Thus, in Fig. 3 the bag is shown without the partition 19 so that the contents of the bag may be mixed forming mixture 22 (which is a mixture of components 17 and 18). Number 24 of Fig. 3 represents the internal part of the bag encompassing compartments 11, 12 and neck portion 13. Fig. 2 shows a side view of the package of the invention. A rod 19 is positioned across the width of the bag and partitions the bag in conjunction with clamp 23. Mixing of the components may be done manually or mechanically such as by deforming the bag. In a preferred embodiment, the bag package is positioned horizontally and secured at its handles 14 and 16 on a flat solid surface. A roller apparatus as shown in Fig. 5 is then caused to move over the bag 10 and applies force to the bag to mix the components therein. Preferably, the roller device comprises a plurality of wheels or rollers 37 rotably attached to a rod 38 which is positioned transverse to the longitudinal axis of the bag and which rod is moved by a mechanism which travels back and forth over the length of the bag as shown by the arrows. The mechanism may be weighted or otherwise geared to provide a desired force on the bag and its contents to partially mix the contents. In a highly preferred embodiment, a mechanism comprising a plurality of parallel rods each carrying rotably attached rollers of different diameters or shapes is used to provide deformation of the bag and mixing of the components in all directions within the bag. Fig. 5 shows a preferred roller device comprising two parallel rods

38 supporting alternating sized rollers 37 rotably attached thereto. The spacing between the rollers may vary with the rollers touching at their hubs providing satisfactory mixing.. In general, the spacing between rollers will be less than about 1 inch preferably less than 0.5 inch , e.g., 0.25 inch. Roller diameters of 6 and 4 inch have been successfully used. As can be seen from Fig. 5 it is preferred for opposing rollers on each rod 37 to be of different sizes to provide enhanced mixing.

The bag may be of any size and shape and is generally sized to contain the stoichiometric amounts of each reaction component needed to make the reaction product in the amount needed by the user. The size of compartments 11 and 12 will vary depending on the amount of each component 17 and 18 needed to make the reaction product and /or design considerations. For a solder mask product the total amount held in the bag will usually vary up to about 4 kilograms per bag but may be higher. For a 4 kilogram product size, the bag is generally rectangular and has internal dimensions of about 36 inch long and 12 inch wide. When the bag is filled the bag has a height of about 2 inch. In general the internal dimensions of the bag may vary in size from about 26 inch to 36 inch long and from about 10 inch to 14 inch wide although larger or smaller sizes may be used depending on the requirements of the user. The bag can be made of any suitable material inert to the components so as not to affect its properties and having sufficient strength to withstand shipping and mixing of the components in the bag and is typically a plastic material such as linear low density polyethylene (LLDPE). Sealing of the bag may be done by melting the edges of the bag using conventional techniques. The bag preferably has tabs (or handles) at each end for sealing of the bag and for handling and securing of the bag during mixing and reaction product transfer steps. The bag is preferably elongated at one end with a neck to facilitate opening the bag and transferring the mixture from the bag.

It is a preferred feature of the invention that the components of the bag be partially-mixed in the bag before transfer to a finishing mixing device. The components are usually of a different color and/or viscosity and it is generally preferred that the partial mixing provide a mixture where no one component , especially the more viscous component, be present in clumps or globs within the mixture. Determination of the extent of mixing may conveniently be done visually and it is highly preferred that there be no significant amount of streaks or striations in the mixture but that the mixture appear relatively uniform in color. The time required to form the partial-mix is usually about 5 to 15 minutes using mechanical

mixing such as the roller device described above. Hand kneading of the bag for about 1 to 20 minutes , preferably 5 to 15 minutes , usually provides suitable partial-mixing of the components in accordance with the invention.

Referring to Fig. 4, the components are partially-mixed in the bag 10 (or even if completely mixed therein), the bag is positioned on pivotal table 28 with the outlet side of the bag facing hinge 29. Apparatus 25 comprises vertical support members 26 and 26a fixedly connected to horizontal support members 27 and transverse support members (not shown) to form a rectangular apparatus with opposite vertical and horizontal support members (not shown). A table 28 is pivotally connected to the apparatus at hinge 29 to allow movement from a horizontal position A to a vertical position B. Table 28 is shown being moved from position A to position B or vice versa. The package or bag of the invention is placed on the table 28 when in the horizontal position A and secured thereto. The package components at this point could be unmixed, partially-mixed or substantially homogeneous. If the package is unmixed, the components could be now partially or substantially mixed. The apparatus could be extended to provide for a roller assembly as described above to mix the components. After the package has the desired mixing, the table is moved to position B and secured to member 26 by clamp 30. A squeegee or roller device 31 shown having a roller 32 is supported and moved downward over the package 10 along rail 33 forcing the contents of the package out of the package into mixing container 35. Agitator 34 provides the mixing needed to form the desired homogeneous reaction product mixture. The mixture is then dispensed to a device such as a screen printer using pump 36. Pump 36 is connected to mixer 35 through line 39 and the reaction product discharged from the pump through line 40. In detail, the bag in the vertical position B is opened (by, e.g., cutting of the bag neck at edge 20b) and the bag contents transferred to a mixing device or dispensed. It is preferred that the bag containing the mixture be secured at its handle 14 and openings 15 to provide a vertical bag position, the bag opened and the contents of the bag removed from the opening at edge 20b using the squeegee-type device 31 which travels downward over the bag and squeezes the reaction product out of the opening.

The contents of the bag emptied into the mixing container 35 is further mixed to provide the desired substantially liquid homogeneous reaction product. The final product will have a substantially uniform color. Any type mixing device 34 such as a propeller type stirrer may be used. Any pump which provides a mixing effect may in some cases be employed to mix the transferred partially-mixed

components, especially where the partial-mixing provides a relatively or substantially homogeneous mixture. The product is then dispensed (e.g., by pouring or pumping) to a device such as a screen printer for applying the reaction product to the PWB. The final dispensing may be performed using a device like a pump.

It is an important feature of the invention that the components used to make the reaction product and or the reaction product may be easily and safely waste treated and disposed of. For example, unmixed components or mixed components remaining in the bag after transfer to the finish mixing container or dispensed to a device are cured directly in the bag by heating or other suitable means and the bag disposed of. It has been found that partial-mixing or complete mixing of the bag components in the bag results in any remaining bag components being easily cured so that curing of the product depleted bag contains no significant hazardous residue components and the bag may be safely disposed of.

The following example is given for purposes of illustration only and the present invention is in no way deemed to be as limited thereby.

A bag 10 was made by overlaying two sheets of LLDPE plastic each sheet having a thickness of about 5 mil. Each sheet has 3 bonded layers comprising 2 LLDPE layers 2 mils thick each and a 1 mil nylon interlayer. Referring to Fig. 1, the overall length of each sheet is about 39 inches and 14 inch wide except for the neck portion 13. Compartment 11 is about 7 inch, compartment 12 about 21 inch, neck 13 about 8 inch and each handle 14 and 16 about 1.5 inch. The width of the neck portion at edge 20b is about 3 inch. The plastic was heat sealed along edges 20 forming a seal width of about 1 inch. The bag was then partitioned by rod 19 positioned across the width of the bag and rod 19 secured to the bag by clamp 23. The bag , which is open at both ends, was now filled with the components needed to make a solder mask product. The epoxy component 17 was added to the bag in compartment 11 and the bag sealed along edge 20a forming handle 14. The hardener component was then added to the bag in compartment 12 and neck 13 and the bag sealed at edge 20b forming handle 16. In a preferred embodiment, the handle 16 and neck 13 are rolled up forcing any component 18 in the neck portion into compartment 12 and clamped at the juncture of compartment 12 and neck 13. This configuration has been found to facilitate handling , shipping and storage of the bag. The bag could also be folded about the partition 19 or laid flat for shipment or storage. A solder mask reaction product was then made by removing the clamp 23 and rod 19 and mixing the components using a device as shown in

Fig. 5 which traveled over the bag and kneaded the bag contents. The bag was positioned on a flat surface and secured to the surface by the bag handles 14 and 16. The bag contents were partially mixed after about 10 minutes and the bag contents appeared a mottled green color, component 17 being white and component 18 being green. The bag was then removed from the mixing device and secured in a vertical position by hanging the bag from the handle 14 as shown in Fig. 4. The neck of the bag was cut at edge 20b and the contents of the bag removed by squeegee device 31 and transferred to a mixing container 35 in which the contents were mixed using a propeller stirrer 34 for about 5 minutes. The solder mask was homogeneous and was substantially uniform in color and was dispensed to a screen printing machine and PWBs coated . Excellent coating and solder mask properties meeting commercial specifications were obtained.

While the present invention has been particularly described, in conjunction with a specific preferred embodiment, it is evident that many alternatives, modifications and variations will be apparent to those skilled in the art in light of the foregoing description. It is therefore contemplated that the appended claims will embrace any such alternatives, modifications and variations as falling within the true scope and spirit of the present invention.

Thus, having described the invention, what is claimed is:

Claims

1. A method for preparing a reaction product for use in making electronic components, the reaction product comprising at least two components which when mixed react with each other to form the reaction product, the method comprising:

holding each of the reactive components in a single pliable container which is partitioned to separate the reactive components; and

removing the partition when the reaction product is to be made and mixing the components in the container by deforming the container to provide mixing therein.

2. The method of claim 1 wherein the reaction product is a solder mask and the solder mask is dispensed to a screen printer, curtain coater or spray coater and the solder mask is applied to an electronic component.

3. The method of claim 2 wherein the components are partially-mixed in the container and the partially mixed components are transferred to a mixing container and the mixing completed to form a substantially homogeneous reaction product blend.

4 The method of claim 3 wherein the components are partially-mixed using a mixing device comprising at least one roller which moves over the container and deforms the container.

5. The method of claim 4 wherein the mixing device comprises rollers of different diameters.

6. The method of claim 5 wherein the partially-mixed components are transferred by squeezing the partially-mixed components out of the container using a roller or squeegee.

7. The method of claim 6 wherein the homogeneous blend is dispensed to a device.

8. An apparatus for preparing a reaction product comprising:

a pliable container holding reaction components, which components are separated in the container by separating means;

mixing means for mixing the components in the bag by deforming the bag when the separating means is removed; and

dispensing means for dispensing the mixed components from the container to a device.

9. The apparatus of claim 8 wherein the pliable container is a plastic bag wherein the reaction components are separated using clamping means.

10. The apparatus of claim 8 further including transferring means for transferring the mixed components to a mixing container and agitating means for forming a substantially homogeneous blend of the transferred components in the mixing container.

11. The apparatus of claim 10 wherein the device is a screen printer and the reaction product is a solder mask

12. The apparatus of claim 11 wherein the mixing means is a plurality of rollers of different diameters.

13. The apparatus of claim 10 wherein the apparatus comprises a pivotable table upon which the container holding the mixed reaction components is positioned and the table pivoted to a vertical position.

14. A package for making reaction products used to fabricate electronic components comprising a pliable container holding components which when mixed react to form the reaction product, the container being partitioned to separate the components until the reaction product is to be made.

15. The package of claim 14 wherein the reaction product is a solder mask used in the manufacture of printed wiring boards.

16. The package of claim 14 wherein the components are partially mixed in the container.

17. The package of claim 16 wherein the reaction product is a solder mask used in the fabrication of printed wiring boards.

18. The package of claim 14 wherein the components are substantially mixed in the container.

19. The package of claim 18 wherein the reaction product is a solder mask used in the fabrication of printed wiring boards.

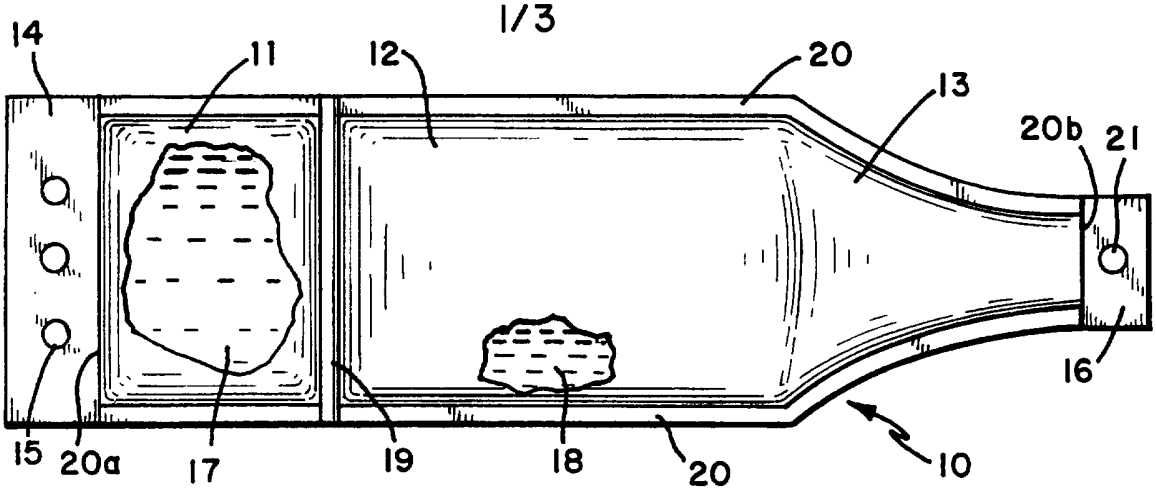

FIG. 1

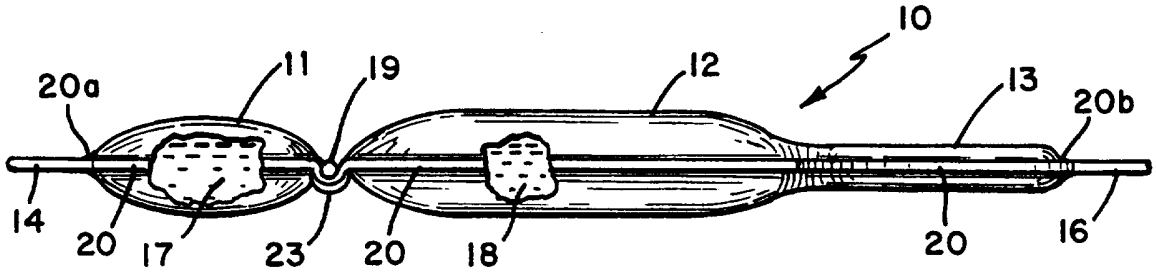

FIG. 2

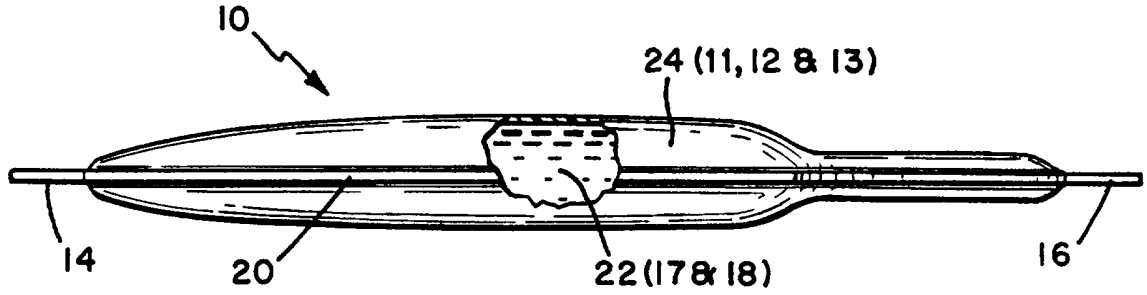

FIG. 3

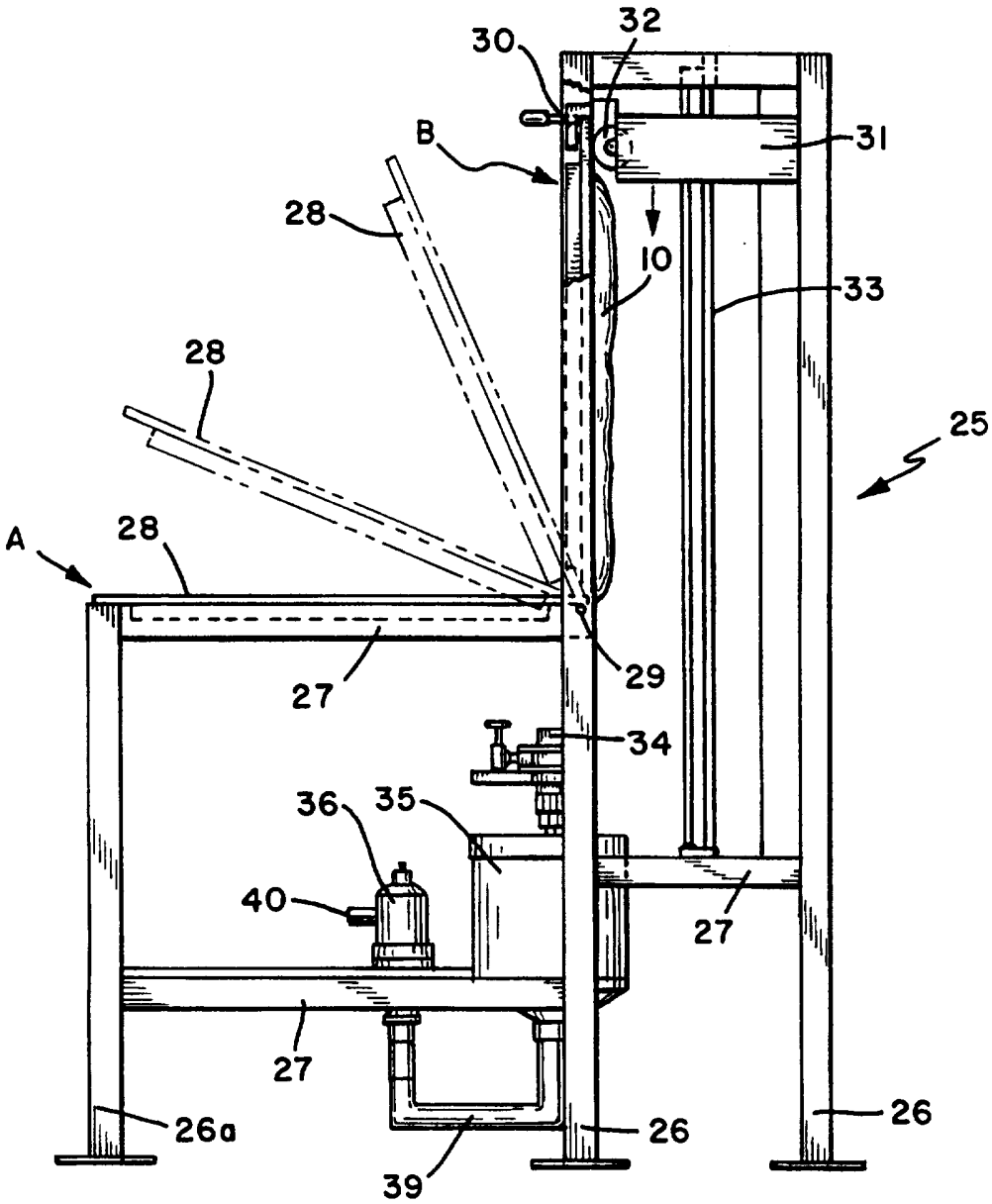

FIG. 4

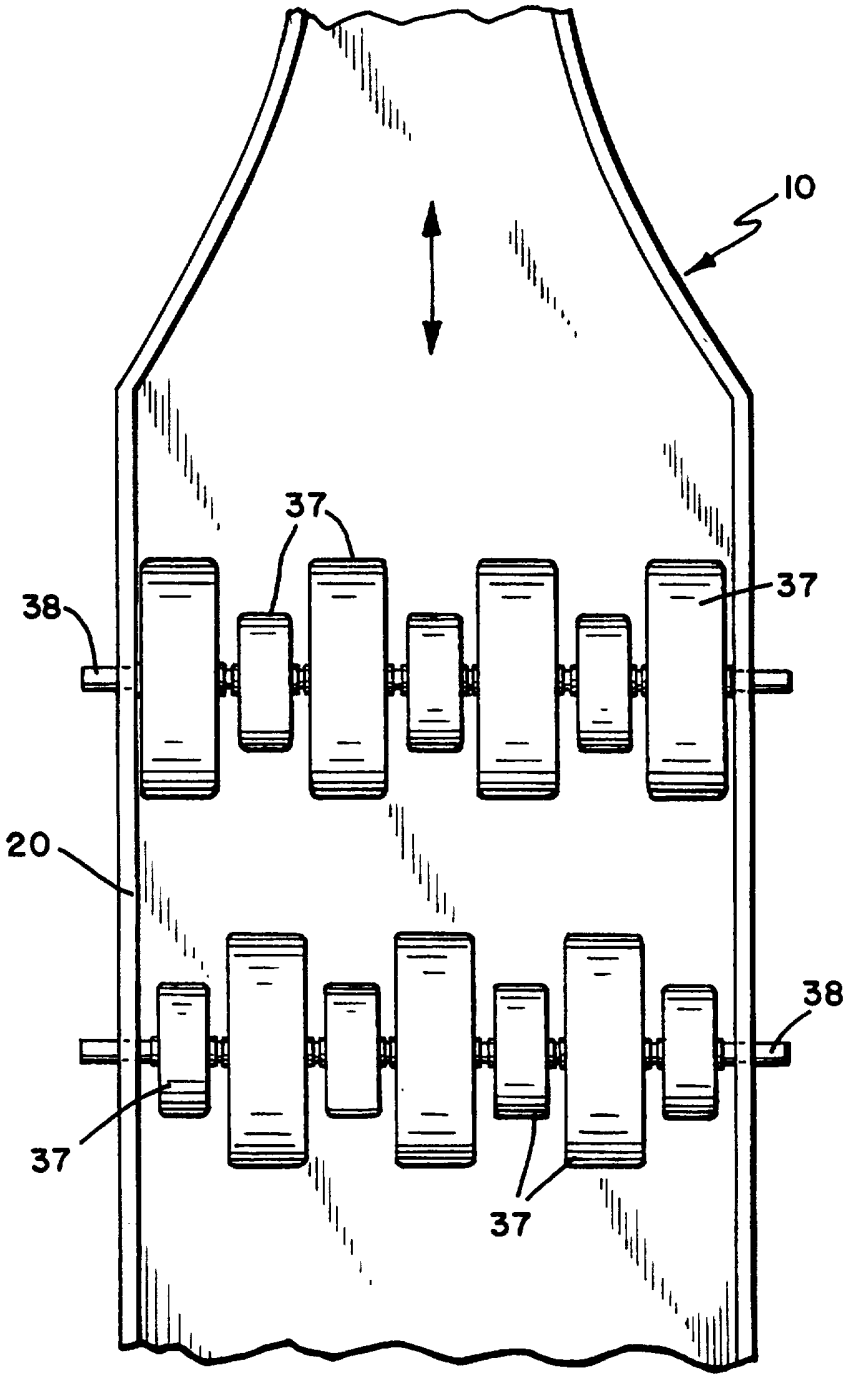

FIG. 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US97/00319

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :B65D 25/08
US CL :206/219,222

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 206/219,221,222; 366/130,189; 427/96,272,282

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

N/A

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

N/A

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y,P	US 5,564,570 A (JASZAI) 15 OCTOBER 1996, SEE ABSTRACT, FIGS. 11A-11C, COL. 5, LINES 54-67	1-19
Y	US 5,370,221 A (MAGNUSSON ET AL.) 06 DECEMBER 1994, SEE ABSTRACT AND FIGS. 2,6,7 AND 9	1-19
Y	US 5,287,961 A (HERRAN) 22 FEBRUARY 1994, SEE ABSTRACT, FIGS. 1-3 AND COL. 1, LINE 55 - COL. 4, LINE 65	1-19
Y	US 5,158,214 A ((VOLPE ET AL.) 27 OCTOBER 1992, SEE ABSTRACT AND FIGS. 1-3	1-13
Y	US 4,795,265 A (DAHLBERG ET AL.) 03 JANUARY 1989, SEE ABSTRACT AND FIGS. 4A-C,6,9A	5,6 AND 12

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E"	earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"O"	document referring to an oral disclosure, use, exhibition or other means		
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search 20 MARCH 1997	Date of mailing of the international search report 14 MAY 1997
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer Brian K. Talbot Telephone No. (703) 305-3775

Form PCT/ISA/210 (second sheet)(July 1992)*

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US97/00319

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4,805,767 A (NEWMAN) 21 FEBRUARY 1989, SEE ENTIRE REFERENCE	1-19
A	US 3,983,994 A (WYSLOTSKY) 05 OCTOBER 1976, SEE ENTIRE REFERENCE	1-19