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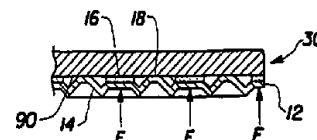
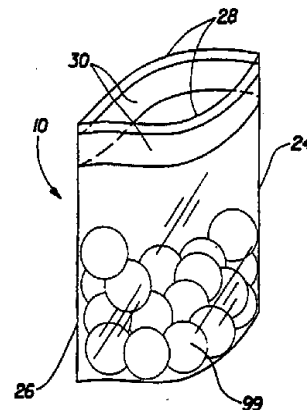
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(54) Title: FLEXIBLE STORAGE BAG WITH SELECTIVELY-ACTIVATIBLE CLOSURE

(57) Abstract

The present invention provides a flexible storage bag (10) comprising at least one sheet of flexible sheet material assembled to form a semi-enclosed container. The bag has an opening (28) and a closure means (30) for sealing the opening to convert the semi-enclosed container to a closed container. The closure means (30) comprises a strip of material forming at least a portion of the periphery of the opening having a first side facing inwardly toward the opening and a second side facing outwardly of the opening. The first side exhibits an adhesion peel force (F) after activation by a user which is greater than an adhesion peel force exhibited prior to activation by a user. In a preferred embodiment, the flexible storage bag includes at least one auxiliary venting opening located remotely from the primary opening and having an auxiliary closure means for sealing the auxiliary opening. The auxiliary opening has a periphery, and the auxiliary closure means comprises a piece of material forming at least a portion of the periphery and having a first side facing inwardly toward the opening and a second side facing outwardly of the opening. The first side exhibits an adhesion peel force after activation by a user which is greater than an adhesion peel force exhibited prior to activation by a user. In another preferred embodiment, the flexible storage bag is self-supporting with the opening extending upwardly away from a horizontal supporting surface. The flexible storage bag may further include at least one pair of opposed gussets formed in the sheet material extending in a direction normal to the opening and a substantially planar bottom extending in a direction substantially parallel to the opening, such that when the bottom is placed on a horizontal surface the flexible storage bag is self-supporting and maintains the opening in an upwardly-extending condition. Preferably, the bag maintains the opening in a substantially open condition.



**FLEXIBLE STORAGE BAG WITH
SELECTIVELY-ACTIVATIBLE CLOSURE**

FIELD OF THE INVENTION

The present invention relates to flexible storage bags, particularly those suitable for use in the containment and protection of various items including perishable materials. The present invention further relates to such flexible storage bags having improved sealability for containment and protection of items contained within under a wide range of in-use conditions.

BACKGROUND OF THE INVENTION

Flexible storage bags for use in the containment and protection of various items, as well as the preservation of perishable materials such as food items, are well known in the art. Such bags typically comprise a rectangular sheet of polymeric film folded upon itself and sealed along two edges to form a semi-enclosed container having two flexible opposed sidewalls, three sealed or folded edges, and one open edge. A closure integrally formed with the bag such as an interlocking rib-type seal or separately provided such as a plastic or paper-clad-wire tie completes the containment assembly.

As utilized herein, the term "flexible" is utilized to refer to materials which are capable of being flexed or bent, especially repeatedly, such that they are pliant and yieldable in response to externally applied forces. Accordingly, "flexible" is substantially opposite in meaning to the terms inflexible, rigid, or unyielding. Materials and structures which are flexible, therefore, may be altered in shape and structure to accommodate external forces and to conform to the shape of objects brought into contact with them without losing their integrity. Flexible storage bags of the foregoing variety are typically formed from polymeric film, such as polyethylene or other members of the polyolefin family, in thicknesses of between about 0.0002 inches to about 0.002 inches. Such films are frequently transparent but sometimes are opaque and/or colored.

Flexible storage bags of the currently commercially available variety provide a means of conveniently storing a wide range of objects and materials in a generally disposable containment device. While flexible storage bags of the foregoing variety have enjoyed a fair degree of commercial success, their reliance upon mechanical closures tends to cause difficulty in operation for individuals having impaired manual dexterity such as children, the elderly, arthritis patients, etc. Moreover, such mechanical closures typically require alignment of mechanical elements for operation which can prove

challenging for those with impaired vision or impaired hand-eye coordination. Many mechanical closure mechanisms also provide leakage sites at such locations as the end of interlocking channels where liquid or gases can leak into or out of the bag.

5 In an attempt to address this issue alternative closure mechanisms have been developed which rely upon strips or regions of adhesive to bond superimposed regions of the bag. While these closures address some of the difficulties in utilizing separate closure elements or interlocking mechanical elements, some adhesive closure mechanisms require removable liners to protect
10 the adhesive from premature activation, thus adding additional elements for assembly and an additional activation step before use. Moreover, some protected adhesive configurations require interlocking grooves, channels, or protrusions which must be properly registered to engage the adhesive, thus again raising the visual and coordination requirements of known mechanical closure
15 mechanisms.

While such flexible storage bags are generally highly efficient for storage before use, for many storage situations it is desirable to minimize the amount of air and/or free space above or around the contents which is trapped within the bag after closure to minimize storage space of filled bags and to aid the
20 effectiveness of the bag in preservation of perishable items. Notwithstanding the type of closure mechanism employed, it is often difficult with known flexible storage bags to only partially close the bag and expel trapped air before completing the closure as this again requires a certain amount of manual dexterity and visual aptitude.

25 Known flexible storage bags also create an inherent challenge in terms of being able to hold the flexible or flaccid bag in an open condition with at most one hand so that the other hand can manipulate another container to pour the contents into the bag or peel, cut, or trim items for insertion into the bag. It is also difficult to maintain the proper (usually upright) orientation of the opening of the
30 bag during such filling operations. While rigid containers and flaccid containers with reinforced opening perimeters have been developed for such uses, their



comparatively higher cost and limited economical disposability leave room for improvement. Notwithstanding the issue of maintaining the container or bag opening in an open condition, there also remains a need for a flexible yet self-standing container with the foregoing attributes to facilitate easy hands-free filling.

5 Flexible storage bags on the other hand which are constructed of more inexpensive materials to promote disposability typically lack the structure necessary for stable stacking of bags after filling.

With regard to rigid or semi-rigid containers, it is well recognized that such containers have also realized a fair degree of commercial success in providing a
10 means for storing a wide variety of contents. Such containers typically have an opening which maintains an open condition for filling and are typically self-supporting with the opening in the proper orientation for filling. Such containers also are frequently provided with flat bottoms and tops to provide stackability. However, such containers are typically constructed of more expensive materials
15 such that disposability is limited. At the same time, the useful life of such containers is limited by damage, soiling, or other degradation naturally occurring in use, including degradation of the typical mechanical closure mechanisms. Storage of such three-dimensional, rigid or semi-rigid containers when empty is also a concern, since, they occupy as much volume empty as they do in a filled
20 condition. Due to their comparatively fixed-volume construction, it is also difficult to minimize the amount of air or free space above or around the contents to minimize storage space of filled containers and to aid the effectiveness of the container in preservation of perishable items. Another concern is the task of matching usually-separate lids or closures with their respective containers for use.

25 An object of the present invention is to overcome or ameliorate one or more of the problems in the prior art, or to provide an improved alternative.

It would be a preferred object to provide a flexible storage bag combining the desirable qualities of both flexible bags and storage containers and minimizing the less desirable qualities of both approaches.

30 More particularly, it would also be preferable to provide a flexible storage, bag having improved sealability in use.



It would also be preferable to provide a flexible storage bag which facilitates venting of trapped air before completion of closure.

It would further be preferable to provide such a bag which is capable of being self-supporting in an open condition for filling purposes, yet stores easily by
5 folding into a compact form.

It would still further be preferable to provide a bag constructed from inexpensive materials to facilitate disposability which still promotes stable stacking of bags in a filled condition.

It would be yet further preferable to provide such a bag which provides the
10 foregoing attributes in a convenient unitary form, obviating the need for separate closure devices.

SUMMARY OF THE INVENTION

According to the present invention, there is provided a flexible storage bag comprising at least one sheet of flexible sheet material assembled to form a semi-
15 enclosed container having an opening and a closure means for sealing said opening to convert said semi-enclosed container to a closed container, said opening having a periphery, wherein said closure means comprises a piece of material forming substantially all of said periphery, said piece of material having a first side facing inwardly toward said opening and a second side facing outwardly
20 of said opening, said first side exhibiting an adhesion peel force after activation by a user which is greater than an adhesion peel force exhibited prior to activation by a user, such that said first side is adherable to any opposing surface, said closure being a selectively activatable adhesive structure and comprising a three-dimensional, deformable material comprising an adhesive protected from external
25 contact by the three-dimensional surface topography, and which is convertible to a substantially two-dimensional sheet material upon activation by a user to expose an adhesive layer to contact with an opposing surface of said semi-enclosed container across said opening.

Preferably, said bag includes at least one pair of opposed gussets formed
30 in said sheet material extending in a direction normal to said opening and a substantially planar bottom extending in a direction substantially parallel to said



opening, such that when said bottom is placed on a horizontal surface said container is self-supporting and maintains said opening in an upwardly-extending condition.

Preferably, said closure means is operable to seal said opening with said 5 gussets folded inwardly toward one another or with said gussets folded outwardly away from one another.

Preferably, said closure means is activatable by an externally applied compressive force exerted in a direction substantially parallel to said opening.

Preferably, said piece of material forms substantially all of said periphery.

10 Preferably, said closure means is unitarily formed from said sheet material.

Preferably, said opening comprises a primary opening and wherein said bag includes at least one auxiliary opening located remotely from said primary opening and having an auxiliary closure means for sealing said auxiliary opening, said auxiliary opening having a periphery, said auxiliary closure means 15 comprising a piece of material forming at least a portion of said periphery, said piece of material having a first side facing inwardly toward said opening and a second side facing outwardly of said opening, said first side exhibiting an adhesion peel force after activation by a user which is greater than an adhesion peel force exhibited prior to activation by a user, such that said first side is 20 adherable to any opposing surface.

Preferably, said auxiliary closure means is activatable by an externally applied compressive force exerted in a direction substantially parallel to said auxiliary opening.

Preferably, said piece of material forms substantially all of said periphery of 25 said auxiliary opening.

Preferably, said auxiliary closure means is unitarily formed from said sheet material.

BRIEF DESCRIPTION OF THE DRAWINGS

While the specification concludes with claims particularly pointing out and 30 distinctly claiming the present invention, it is believed that the present invention will be better understood from the following description of exemplary



embodiments in conjunction with the accompanying Drawing Figures, in which like reference numerals identify like elements, and wherein:

Figure 1 is a perspective view of a flexible storage bag in accordance with an embodiment of the present invention in a closed, empty condition;

5 Figure 2 is a perspective view of the flexible storage bag of Figure 1 in an open condition and partially filled with solid objects;

Figure 3 is a plan view of the flexible storage bag of Figure 1, also in a closed, empty condition, and depicting a secondary venting opening and secondary closure;

10 Figure 4 is a plan view similar to Figure 3 of a flexible storage bag according to an embodiment of the present invention depicting an alternative secondary venting opening configuration;

Figure 5 is a top plan view of a preferred embodiment of a material suitable for use as a closure means of the embodiment of the present invention, disclosing
15 a piece of material having truncated conical protrusions surrounded by an interconnected pattern of substance;

Figure 6 is an enlarged partial top plan view of the material of Figure 5, showing an array of protrusions;

Figure 7 is an elevational sectional view, taken along section line 7-7 of
20 Figure 6, showing the protrusions acting as standoffs for a substance layer between protrusions, such that a target surface contacting the outermost ends of the protrusions does not contact the substance layer;

Figure 8 is an elevational sectional view similar to Figure 7, showing the effect of pressing the material against the target surface, such that protrusions
25 deform by substantially inverting and/or crushing to allow the substance layer between protrusions to contact the target surface;

Figure 9 is an elevational sectional view of the material of Figures 5-8, showing preferred dimensional relationships of protrusions; and

Figure 10 is a schematic view of a suitable method of making a material
30 suitable for use as a closure means of the embodiment of the present invention,



showing a forming screen as a belt wrapped around a vacuum drum and a drive pulley.

Figure 11 is an edge view of the flexible storage bag of Figure 3 illustrating the secondary venting opening in an open condition;

5 Figure 12 is an edge view similar to Figure 11 of the flexible storage bag of Figure 3, but depicting the secondary venting opening in a closed condition;

Figure 13 is an edge view similar to Figure 11 of the flexible storage bag of Figure 4;

Figure 14 is an edge view similar to Figure 12 of the flexible storage bag of 10 Figure 4;

Figure 15 is a perspective view of another embodiment of a flexible storage bag of the embodiment of the present invention, in an open configuration;

Figure 16 is a perspective view of the flexible storage bag of Figure 15 in a partially folded condition;

15 Figure 17 is a perspective view of the flexible storage bag of Figure 15 in a fully-folded, flattened condition;

Figure 18 is a perspective view similar to Figure 17 of an alternative flexible storage bag having no reinforcing panel;

Figure 19 is a perspective view of the flexible storage bag of Figure 15 in a 20 closed and sealed condition after filling;

Figure 20 is a perspective view of the flexible storage bag of Figure 15 with the sealed edge of the bag being optionally folded over to provide a flat upper surface for stacking; and

Figure 21 is a perspective view of the flexible storage bag of Figure 15 25 illustrating an alternative approach to folding and sealing the opening of the bag.

DETAILED DESCRIPTION OF EMBODIMENTS OF THE INVENTION

Figure 1 depicts a presently preferred embodiment of a flexible storage bag 10 according to an embodiment of the present invention. In the embodiment depicted in Figure 1, the flexible storage bag 10 includes a bag body 20 formed 30 from a piece of flexible sheet material folded upon itself along fold line 22 and bonded to itself along side seams 24 and 26 to form a semi-enclosed container



having an opening along edge 28. Flexible storage bag 10 also includes closure means 30 located adjacent to edge 28 for sealing edge 28 to form a fully-enclosed container or vessel as shown in Figure 1. Closure means 30 is selectively openable, sealable, and resealable, as will be described hereinafter.

5 Bags such as the flexible storage bag 10 of Figure 1 can be also constructed from a continuous tube of sheet material, thereby eliminating side seams 24 and 26 and substituting a bottom seam for fold line 22.

In the preferred configuration depicted in Figure 1, the closure means 30 completely encircles the periphery of the opening formed by edge 28. However, 10 under some circumstances a closure means formed by a lesser degree of encirclement (such as, for example, a closure means disposed along only one side of edge 28) may provide adequate closure integrity.

Flexible storage bag 10 is suitable for containing and protecting a wide variety of materials and/or objects contained within the bag body. Figure 2 15 depicts the storage bag 10 in an open condition wherein the closure means 30 has been released such that edge 28 may be opened to admit materials and/or objects into the interior of the bag body portion of the storage bag 10. In Figure 2 a plurality of generic solid objects 99 are shown within the storage bag 10.

Figures 3 and 4 are plan views of the flexible storage bag 10 in an empty, 20 closed condition so as to depict with greater clarity the geometrical details of another feature according to the present embodiment which may be employed in conjunction with the closure means 30 associated with the present embodiment or with other known closure mechanisms. Figure 3 in particular depicts a flexible storage bag 10 of the type shown in Figure 1, which is shown to include a 25 secondary venting opening 50 which is located remotely from and non-contiguously with the primary opening which lies along edge 28. Secondary venting opening 50 comprises a selectively openable, sealable, and resealable aperture in the material of the bag body portion 20 of flexible storage bag 10 in accordance with the present embodiment.

30 As shown in Figure 3, the secondary venting opening 50 has its own secondary closure means 40 located remotely from primary closure means 30.



This configuration provides the ability to select different materials and/or structures for the primary and secondary closure means.

In contrast, Figure 4 is a view similar to Figure 3 of a flexible storage bag 10 having a secondary venting opening 50 located within the region of the bag 5 body 20 which comprises the primary closure means 30 but is still remotely located from and non-contiguously with the primary opening. The secondary closure means is still separately operable from the primary closure means 30. While this reduces the number of treatments or elements necessary to complete the bag, it also limits the type of closure means which may be utilized for the 10 primary and secondary closure means. In such a configuration the closure means 30 must be compatible with the type of closure means required for operation of the secondary closure means 40.

Various compositions suitable for constructing the flexible storage bags of the present embodiment include substantially impermeable materials such as 15 polyvinyl chloride (PVC), polyvinylidene chloride (PVDC), polyethylene (PE), polypropylene (PP), aluminum foil, coated (waxed, etc.) and uncoated paper, coated nonwovens etc., and substantially permeable materials such as scrims, meshes, wovens, nonwovens, or perforated or porous films, whether 20 predominantly two-dimensional in nature or formed into three-dimensional structures. Such materials may comprise a single composition or layer or may be a composite structure of multiple materials, including a substrate material utilized as a carrier for a substance. Materials found suitable for use in accordance with the present embodiment include a low density polyethylene film, 0.004 or 0.006 inch thickness, commercially available from Huntsman Film Products Corp. under 25 the manufacturer's designation X420, and a low density polyethylene film, 0.0015 inch thickness, commercially available from Tredegar Film Products under the manufacturer's designation X10266.

Once the desired sheet materials are manufactured in any desirable and suitable manner, comprising all or part of the materials to be utilized for the bag 30 body, the bag may be constructed in any known and suitable fashion such as those known in the art for making such bags in commercially available form. Heat



or adhesive sealing technologies may be utilized to join various components or elements of the bag to themselves or to each other. In addition, the bag bodies may be thermoformed, blown, or otherwise molded rather than reliance upon folding and bonding techniques to construct the bag bodies from a web or sheet of material. Two recent U.S. Patents which are illustrative of the state of the art with regard to flexible storage bags similar in overall structure to those depicted in Figures 1 and 2 but of the types currently available are Nos. 5,554,093, issued September 10, 1996 to Porchia et al., and 5,575,747, issued November 19, 1996 to Dais et al.

10 In accordance with the present embodiment, the closure means depicted in Figures 1-4 is constructed from a selectively activatable adhesive structure which provides a secure closure seal upon activation. Accordingly, the closure means comprises a selectively activatable adhesive-like material which bonds opposing material surfaces to one another across the opening formed by open edge 28 in Figure 1. The bond between the closure means and a target surface is also sufficient to provide a barrier seal against transmission of oxygen, moisture/moisture vapor, odor, etc. such that perishable items may be satisfactorily enclosed and preserved to the extent of the barrier properties of the material itself. The target surface may comprise a separate element of the bag or 20 may comprise another region of the closure means itself.

As utilized herein, the term "selectively activatable" is used to refer to materials which exhibit substantially non-adherent properties when brought into contact with target surfaces until some action is taken by a user to "activate" the material to reveal adhesive properties. Accordingly, selectively-activatable properties differ from permanently-active strips of adhesive which rely upon removal of liner materials (typically silicone-coated paper strips) to expose the adhesive for use.

Selective activation of such materials allows the user to properly position opposing surfaces before activation and adhesion are accomplished, as well as minimizing the likelihood of contamination of the closure means by bag contents during filling operations. This characteristic permits the flexible storage bag to be



opened, filled, and/or manipulated in any desired mode without encountering the difficulties of premature clinging or adhering of the closure means to itself or to other portions of the opening or bag body, and without the need for separate release sheets, liners, spacers, or the like. Preferably, the selective activation
5 process is reversible such that the closure means may be de-activated and the bag opened for filling or removal of contents and then re-activated for further closure without significant loss of adhesive capability.

Although material utilized for the closure means may be provided with two active sides or surfaces, if desired for particular applications, in accordance with
10 the present embodiment it is presently preferred to provide such material with only one active side and one inactive or inert side. While under some circumstances it may be acceptable or desirable to design the closure material so as to form a discontinuous bond pattern with itself or another target surface, such as by having an intermittent or discontinuous layer of adhesive on its active
15 surface, it is presently preferred that the closure material be designed so as to exhibit the ability to form a continuous seal or bond with itself and with any sufficiently continuous target surface.

Various means of activation are envisioned as being within the scope of embodiments of the present invention, such as: mechanical activation by
20 compression, mechanical activation by tensile forces, and thermal activation. However, it is envisioned that there may be or be developed other means of activation which would trigger an adhesive or adhesive-like character which would be capable of functioning as herein described. In a preferred embodiment the active side is activatable by an externally applied force exerted upon the sheet of
25 material. The force may be an externally applied compressive force exerted in a direction substantially normal to the sheet of material, an externally applied tensile force exerted in a direction substantially parallel to the sheet of material, or a combination thereof

Regardless of the manner of activation, materials useful as a closure
30 means in accordance with embodiments of the present invention will exhibit an adhesive, adherent, or tacking character as opposed to merely a clinging or



affinity character. As utilized herein, therefore, the term "adhesive" is utilized to refer the ability of a material to exhibit an adherent character whether or not it actually includes a composition commonly understood and labelled as an adhesive. Accordingly, such materials will form a bond or seal when in contact
5 with itself or another target surface as opposed to merely being attracted to such surface. While a number of approaches such as the use of selectively adherent materials may be utilized to provide the desired adhesive properties, a presently preferred approach is to utilize a pressure-sensitive adhesive.

When designing materials useful as a closure means in accordance with
10 embodiments of the present invention, it may be desirable to tailor the particular choice of adhesive agent so as to provide either a permanent bond or a releasable bond as desired for a particular application. Where a permanent bond is desired, opening of the flexible storage bag for access to the item(s) therein requires destruction of the bag. Releasable bonds, on the other hand, provide
15 access by permitting separation of the closure means from itself or other portions of the bag at the bond site without destruction. Moreover, depending upon the activation mechanism employed in the design of the material, the releasable bond may additionally be refastenable if sufficient adhesive character remains after the initial activation/bonding/release cycle.

20 The closure materials useful in embodiments of the present invention exhibit an adhesion sufficient to survive the likely degree of handling and external or internal forces the flexible storage bag is likely to encounter in use while maintaining the desired level of sealing engagement with the opposing surface such that preservation of perishable items is ensured. In general, minimum
25 adhesion which maintains a seal is desired for a closure means, so that the closure means easily peeled open for access to the stored item(s). At the same time, in a preferred embodiment the closure means is a substantially clingless material. Suitable methods of measuring and quantifying adhesive and cling properties are described in greater detail in commonly-assigned, co-pending U.S.
30 Patent Application Serial No. 08/744,850, filed Nov. 8, 1996 in the names of Hamilton and McGuire, entitled "Material Having A Substance Protected by



Deformable Standoffs and Method of Making", the disclosure of which is hereby incorporated herein by reference.

The closure means utilized in accordance with the present embodiment comprises a sheet of material having a first side and a second side. The first side
5 comprises an active side exhibiting an adhesion peel force after activation by a user which is greater than an adhesion peel force exhibited prior to activation by a user. The active side of the closure means preferably exhibits an adhesion peel force of at least about 1 ounce per linear inch, more preferably between about 1 and about 2.5 ounces per linear inch, after activation by a user.

10 One such material of current interest for use as a closure material in accordance with the present embodiment comprises a three-dimensional, conformable web comprising an active substance such as adhesive on at least one surface protected from external contact by the three-dimensional surface topography of the base material. Such materials comprise a polymeric or other
15 sheet material which is embossed/debossed to form a pattern of raised "dimples" on at least one surface which serve as stand-offs to prevent an adhesive therebetween from contacting external surfaces until the stand-offs are deformed to render the structure more two-dimensional. Representative adhesive carrier structures include those disclosed in commonly assigned, co-pending U.S. Patent
20 Application Serial Nos. 08/584,638, filed January 10, 1996 in the names of Hamilton and McGuire, entitled "Composite Material Releasably Sealable to a Target Surface When Pressed Thereagainst and Method of Making", 08/744,850, filed November 8, 1996 in the names of Hamilton and McGuire entitled "Material Having A Substance Protected by Deformable Standoffs and Method of Making",
25 08/745,339, filed November 8, 1996 in the names of McGuire, Tweddell, and Hamilton, entitled "Three-Dimensional, Nesting-Resistant Sheet Materials and Method and Apparatus for Making Same", 08/745,340, filed November 8, 1996 in the names of Hamilton and McGuire, entitled "Improved Storage Wrap Materials".
The disclosures of each of these applications are hereby incorporated herein by
30 reference.



The three-dimensional structure comprises a piece of deformable material which has a first side formed to have a plurality of hollow protrusions separated by valleys. The plurality of hollow protrusions have outermost ends. The piece of material has a second side. The second side has a plurality of depressions 5 therein corresponding to the plurality of hollow protrusions on the first side. The substance adheres to and partially fills the valleys between the plurality of hollow protrusions. The substance has a surface below the outermost ends of the plurality of hollow protrusions, so that when a portion of the first side of the piece of deformable film is placed against a target surface, the plurality of hollow 10 protrusions prevent contact between the substance and the target surface until the portion is deformed at the target surface. Preferably, the plurality of protrusions deform by modes which are selected from the group consisting of inverting, crushing, and elongating. Preferably, in the inverting and/or crushing modes, each of the plurality of protrusions will not substantially deform until 15 exposed to a pressure of at least 0.1 pounds per square inch (0.69 kPa).

Figures 5-9 illustrate a preferred embodiment of a material useful as a closure means for flexible storage bags, which comprises a three-dimensional sheet-like structure generally indicated as 30. Material 30 includes a deformed material 12 having hollow protrusions 14 and a layer of substance 16 located 20 between protrusions 14. Protrusions 14 are preferably conical in shape with truncated or domed outermost ends 18. Protrusions 14 are preferably equally spaced in an equilateral triangular pattern, all extending from the same side of the material. Protrusions 14 are preferably spaced center to center a distance of approximately two protrusion base diameters or closer, in order to minimize the 25 volume of valleys between protrusions and hence the amount of substance located between them. Preferably, the protrusions 14 have heights which are less than their diameters, so that when they deform, they deform by substantially inverting and/or crushing along an axis which is substantially perpendicular to a plane of the material. This protrusion shape and mode of deforming discourages 30 protrusions 14 from holding over in a direction parallel to a plane of the material



so that the protrusions cannot block substance between them from contact with a target surface.

Figure 7 shows a target surface 90, which is smooth but which may have any surface topography, being spaced away from layer of substance 16 by 5 outermost ends 18 of protrusions 14. Target surfaces in accordance with the present embodiment will preferably comprise an opposing portion of the closure periphery which may or may not itself comprise a selectively-activatable adhesive-carrying closure means of similar type. Figure 8 shows target surface 90 10 contacting layer of substance 16 after protrusions 14 have been partially deformed under pressure applied to the non-substance side of material 12, as indicated by force F.

The more protrusions per unit area, the thinner the piece of material and protrusion walls can be in order to resist a given deformation force. Preferred 15 layer of substance 16 is preferably a latex pressure sensitive adhesive or a hot melt adhesive, such as that available under specification no. Fuller HL-2115X, made by H. B. Fuller Co. of Vadnais Heights, MN. Any adhesive can be used which suits the needs of the material application. Adhesives may be refastenable, releasable, permanent, or otherwise. The size and spacing of protrusions is preferably selected to provide a continuous adhesive path 20 surrounding protrusions so that air-tight seals may be made with a target surface and a desired level of adhesion with a target surface, while also providing the optimum pattern of standoffs for selective activation.

Film materials may be made from homogeneous resins or blends thereof. Single or multiple layers within the film structure are contemplated, whether co- 25 extruded, extrusion-coated, laminated or combined by other known means. The key attribute of the film material is that it be formable to produce protrusions and valleys. Useful resins include polyethylene, polypropylene, PET, PVC, PVDC, latex structures, nylon, etc. Polyolefins are generally preferred due to their lower cost and ease of forming. Other suitable materials include aluminum foil, coated 30 (waxed, etc.) and uncoated paper, coated and uncoated nonwovens, scrims,



meshes, wovens, nonwovens, and perforated or porous films, and combinations thereof.

Different applications for the formed closure means will dictate ideal size and density of protrusions, as well as the selection of the substances used therewith. It is believed that the protrusion size, shape and spacing, the web material properties such as flexural modulus, material stiffness, material thickness, hardness, deflection temperature as well as the forming process determine the strength of the protrusion. A "threshold" protrusion stiffness is required to prevent premature activation of the closure means due to the weight of overlaying layers of sheets or other forces, such as forces induced by shipping vibrations, mishandling, dropping and the like.

Inversion of protrusions minimizes protrusion spring back so that higher adhesion isn't necessary in order to prevent the failure of relatively weak seals. A resilient protrusion could be used, for example, where it is intended for the bond to be permanent, where aggressive adhesive overcomes spring back. Also, a resilient protrusion may be desirable where repeat use of the material is intended.

Figure 9 shows a preferred shape of the protrusions and valleys of closure means of the present embodiment, which enables protrusions to substantially invert and/or crush as a mode of deforming. The preferred shape minimizes protrusion fold-over and interference with substance placed in valleys between protrusions, or inside hollow protrusions, or both. Also, the preferred shape helps to ensure a repeatable, predictable, resistance to protrusion deformation. Figure 9 shows that each protrusion is defined by a height dimension A and a base diameter dimension B. A preferred ratio of base diameter B to height A, which enables protrusions to substantially invert and/or crush without fold-over, is at least 2:1.

Figure 10 shows a suitable method for making a material such as the material 30 useful in accordance with an embodiment of the present invention, which is generally indicated as 180 in Figure 10.

The first step comprises coating a forming screen with a first substance. The forming screen has a top surface and a plurality of recesses therein. The



coating step applies the first substance to the top surface without bridging the recesses. A second step includes introducing a piece of material, which has a first side and a second side, onto the forming screen such that the first side is in contact with the first substance on the top surface of the forming screen. The first substance preferentially adheres to the first side of the piece of material. A third step includes forming the piece of material to create a plurality of hollow protrusions extending from the first side into the recesses of the forming screen. The plurality of hollow protrusions are spaced apart by valleys into which the first substance is transferred from the forming screen. The plurality of hollow protrusions are accurately registered with the first substance by use of a common transfer and forming surface. The first substance forms an interconnected layer in the valleys between the protrusions.

Forming screen 181 is threaded over idler pulley 182 and a driven vacuum roll 184. Forming screen 181 is preferably a stainless steel belt, having the desired protrusion pattern etched as recesses in the belt. Covering the outer surface of vacuum roll 184 is a seamless nickel screen which serves as a porous backing surface for forming screen 181.

For producing a pressure sensitive adhesive containing material, a substance 186, preferably hot melt adhesive, is coated onto forming screen 181 by a substance applicator 188 while forming screen 181 rotates past the applicator. A web of material 190 is brought into contact with the substance coated forming screen at material infeed idler roll 192. Hot air is directed radially at material 190 by a hot air source 194 as the material passes over vacuum roll 184 and as vacuum is applied to forming screen 181 through vacuum roll 184 via fixed vacuum manifold 196 from a vacuum source (not shown). A vacuum is applied as the material is heated by hot air source 194. A formed, substance coated material 198 is stripped from forming screen 181 at stripping roll 200. Because the same common forming screen is used to transfer the substance to the material as is used to form the protrusion, the substance pattern is conveniently registered with the protrusions.



Stainless steel forming screen 181 is a fabricated, seamed belt. It is fabricated in several steps. The recess pattern is developed by computer program and printed onto a transparency to provide a photomask for photoetching. The photomask is used to create etched and non-etched areas.

5 The etched material is typically stainless steel, but it may also be brass, aluminum, copper, magnesium, and other materials including alloys. Additionally, the recess pattern may be etched into photosensitive polymers instead of metals. Suitable forming structures are described in greater detail in the above-referenced and above-incorporated Hamilton et al. and McGuire et al. patent
10 applications.

Materials of the foregoing variety when utilized as a closure means in accordance with the present embodiment may be unitarily formed and constructed as part of the body of the flexible storage bag either before, during, or after assemblage of the bag from its material components. Alternatively, such
15 closure means may also be separately formed and joined to the body of the flexible storage bag either before, during or after assemblage of the bag. Such joining may be edge-wise or may be accomplished as a lamination or bonding of the material facially onto a superposed portion of the bag body, such lamination being particularly advantageous when it is desired to add additional thickness,
20 stiffness, and/or resiliency to the region of the bag comprising the closure means. The material utilized for the closure means may be the same as or different from the material utilized to form the bag body either in dimensions or in composition.

To facilitate separation of adhered or bonded overlying portions of the closure means material, various adaptations or modifications may be
25 accomplished in terms of integration of the material into the overall structure of the flexible storage bag. For example, it may be desirable to provide extension tabs on opposing sides of the opening periphery to facilitate manual initiation of closure separation. It may also be desirable to leave a small but finite portion of the bag body immediately adjacent to the opening periphery free of closure
30 material, such that there is a non-adherent rim of material which may be utilized



to initiate material separation and hence opening of the flexible storage bag. The closure means 30 depicted in Figures 1-4 are consistent with the latter approach.

In accordance with an embodiment of the present invention, the use of selectively-activatable adhesive materials for the closure means 30 provides the user with an easy-to-operate closure means for closing and sealing an opening in a flexible storage bag. The closure means 30 is easy to manipulate with one or two hands, as the only dexterity required is to grasp or pinch the closure means with a pair of opposed digits to activate the material against an opposing surface of the bag body or closure means. Moving the grasping digits across the extent of the opening provides secure adhesion of the closure means across the extent of the opening, thereby converting the flexible bag from a semi-enclosed container to a fully closed container. Particularly when the closure means fully encircles the opening in the bag body, the closure means 30 is highly tolerant to misalignment as it will adhere to any opposing surface unlike mechanical closure mechanisms which typically require precise alignment of mating elements.

The ability of the closure means to be activated by pinching or grasping superimposed portions of the bag body is particularly advantageous with flexible, conformable structures such as the flexible storage bags of embodiments of the present invention. More particularly, such structures are yieldable under applied forces and accordingly, it would be difficult to activate a seal by exerting pressure upon the bag as a whole against a surface, particularly when filled, as such would tend to expel bag contents as sealing of the closure is attempted. Therefore, the use of a closure means as herein described permits secure, reliable sealing of even highly flexible storage bags.

Because the closure means in a preferred configuration employs a layer of adhesive protected by a plurality of three-dimensional protrusions, rather than a three-dimensional mating pair of interlocking elements, it is possible to employ such a closure means successfully in a confined, non-parallel region of the bag body such as the region near the side seams 24 and 26 without providing leakage sites such as the ends of the mechanical elements. Accordingly, the closure



means 30 of the present embodiment provides additional security and confidence in the level of sealing obtained for situations where a leakproof seal is important.

Figures 11 and 12 depict in greater detail the structure and operation of the secondary venting opening and closure means. Figure 11 is an edge-on view of the flexible storage bag 10 shown in Figure 3. Accordingly, the side edge 26 shown in Figure 3 forms the central line of the bag in Figure 11. The flexible storage bag is shown in a condition wherein the primary opening along edge 28 is open as shown in Figure 2 so that the sidewalls of the bag are parted to highlight the view of opening 50.

As shown in Figure 11, the secondary venting opening 50 comprises a slit in the material of the bag body 20 which, when subjected to a slight pulling force normal to the direction of the slit, forms a somewhat elliptical opening. As used herein, the term "slit" is utilized to refer not only to openings formed by severing of the surrounding material but also to adjacent non-joined portions of surrounding material forming an elongated opening resembling a slit. In the embodiment depicted in Figure 11 the secondary closure means 40 fully laterally surrounds the secondary venting opening 50.

Figure 12 depicts the flexible storage bag of Figure 11 after the secondary venting opening 50 has been closed by the secondary closure means 40. As discussed above with the primary closure means 30, the closure means 40 completely encircles the periphery of the opening 50. However, under some circumstances a closure means formed by a lesser degree of encirclement (such as, for example, a closure means disposed along only one side of edge 26 around opening 50) may provide adequate closure integrity.

In accordance with the present embodiment, the secondary closure means 40 comprises a selectively activatable adhesive-like material which bonds opposing material surfaces to one another across the secondary venting opening 50. Materials suitable for secondary closure means 40 are described above with regard to closure means 30. Therefore, as shown in Figure 12 the secondary closure means 40 has been activated and adhesively bonded to material on the opposite side of the opening 50 to seal the opening. Correspondingly to the



discussion above regarding the closure means 30, activation and sealing of the secondary closure means 40 may also be accomplished simply by pinching or grasping the overlying regions of the bag body surrounding the secondary opening 50 over a broad enough area to surround the opening 50 with a sealed region of closure material.

Figure 13 is a view similar to that of Figure 11 of a flexible storage bag according to Figure 4. Accordingly, as shown in Figure 13 the opening 50 is located within the region forming the closure means 30 for the primary opening along open edge 28. The portion of the primary closure means 30 which at least partially, and preferably fully, surrounds the opening 50 forms the secondary closure means analogous to the secondary closure means 40 depicted in Figures 11 and 12. The closure means 30 thereby forms both the primary and secondary closure means for the primary opening (formed by open edge 28) and the secondary venting opening 50, although permitting independent activation of the closure means in order to selectively effect closure of either one or both openings as desired.

With or without the desirable venting features of the present embodiment, the use of the selectively-activatable closure means of the present embodiment for the primary closure facilitates greater ease of venting or expelling air and/or free space above or around the contents prior to sealing by providing an easy-to-use sealing mechanism. Alternatively, the venting aspects of embodiments of the present invention described above with regard to Figures 11-14 may be employed with known primary closure mechanisms including mechanical interlocking closures, although for maximum benefit it is presently preferred to utilize selectively-activatable closure means for both types of openings.

Figure 15 depicts another embodiment of a flexible storage bag. The flexible storage bag 110 of Figure 15 includes a closure means 130 analogous to the closure means described with regard to the flexible storage bags of Figures 1-4, but also includes an additional feature to enable the bag to assume a self-supporting configuration to facilitate product access and product filling without manual support.



While the flexible storage bags described above with regard to Figures 1-4 and 11-14 provide many advantages compared with flexible storage bags and storage containers commonly available, it would further be desirable to adapt such a bag to be more self-supporting in use to additionally provide for greater
5 ease of use.

As utilized herein, the term "self-supporting" is utilized to refer to materials, structures, or containers which are capable of maintaining their orientation in a plane parallel to the direction of the force of gravity. For example, a self-supporting material, particularly a sheet material, may be held so that it extends
10 upwardly parallel to the direction of the force of gravity and maintain its orientation without folding over or collapsing. Non-self-supporting materials typically will fold over or collapse and not be capable of being held parallel to the force of gravity (i.e., "vertically") unless they are held so that they extend downwardly from their point of support. Correspondingly, a self-supporting bag or container is capable
15 of maintaining its orientation with surfaces extending upwardly from their base of support in opposition to the force of gravity without folding over upon itself or collapsing.

In the embodiment of Figure 15, the flexible storage bag 110 comprises two generally planar side panels 120, two generally planar, gusseted end panels
20 140, and a generally planar bottom panel 150, which panels form a semi-enclosed container having an opening defined by upper edge 128. Side panels 120 include side edges 122 and bottom edges 126, while end panels 140 include bottom edges 148 and gussets of generally known design having converging base creases 142 and 144 and medial creases 146. In the configuration depicted
25 in Figure 15, the bag is in its self-supporting, open condition.

As is known in the art, gusseted bags typically provide a self-supporting, open bag which may be readily filled or emptied with a minimum of difficulty. However, unlike most known gusseted bags the flexible storage bags of embodiments of the present invention include a selectively-activatable closure
30 means 130 as described above. Accordingly, in addition to being self-supporting



the gusseted flexible storage bags 110 also provide the desirable sealing attributes described herein.

The combination of gusseted bag design with sealing (and preferably re-sealing) technology is made possible by the use of the selectively-activatable closure means of the present embodiment. Unlike the flexible storage bags depicted in Figures 1-4, the gusseted bags include a plurality of creases in the material of the bag body which would be difficult if not impossible to effectively seal with mechanical interlocking seals, or by gathering the upper portion of the bag for a mechanical tie or binder. Since the closure means is selectively activatable and will adhere to any complementary surface, so long as the closure means encircles a sufficient proportion of the periphery of the bag opening the seams and pleats present in the bag walls (such as side edges 122 and medial creases 146) will all be securely adhered and sealed to provide the desired level of sealability.

In addition to being self-supporting, gusseted flexible storage bags 110 are also readily foldable or collapsible to provide easy storage occupying minimal space. Figure 16 depicts a gusseted flexible storage bag 110 as shown in Figure 15 but in a partially folded or collapsed condition. Accordingly, medial creases 146 have been pushed inwardly toward one another, bringing side edges 122 toward one another on opposite sides of the medial creases 146 and somewhat parallel to the base creases 142 and 144 in their vicinity. Such a predictable folding feature independent of the closure means also permits the volume of the container to be diminished after the contents are inserted to minimize the amount of air and/or free space above or around the contents which is trapped within the bag after closure to minimize storage space of filled bags and to aid the effectiveness of the bag in preservation of perishable items. Figure 17 shows a gusseted flexible storage bag 110 in a more fully folded condition wherein folding continues until the bottom 150 is substantially parallel with the sides. Also depicted in Figure 17 is the optional reinforcing bottom panel 155 which adds additional integrity and stability to the generally rectangular, planar bottom panel 150.



The addition of additional reinforcement to the bottom panel lowers the center of gravity of the empty bag for greater stability prior to and during filling, increases the stiffness of the bottom of the bag for added stability in most circumstances filled or empty, and reduces the likelihood of the bottom of the bag 5 bowing when filled with heavier contents. The inward folding of the flaps forming the bottom panel 150 of the bag body as shown in Figure 18 also performs a similar role. The reinforcing panel may be of a similar material to the bag material or may be of a different more or less durable material, and is secured to the bottom panel by adhesive application or other suitable means. It is presently 10 preferred that when a reinforcing panel is employed that it be placed on the exterior surface of the bottom panel rather than on the interior surface in order to provide support and reinforcement without adding additional surfaces, joints, and crevices on the interior of the bag where they may provide sites for trapping portions of the bag contents and creating cleaning difficulties.

15 Figure 18 depicts a bag similar to that of Figure 17, but without the optional reinforcing panel on the bottom 150. In Figure 18, therefore, the seam and folding structure of the bottom 150 is clearly visible. Such a folding configuration is typical of known folded, gusseted bags having a square or rectangular bottom and is sealed appropriately by adhesives, heat seals, or the like so as to provide 20 a substantially liquid-tight and gas-tight bottom structure.

Figure 19 depicts a flexible storage bag typical of that shown in Figures 15-18, but in a sealed condition such as after insertion of a product into the interior of the bag. Accordingly, the medial creases 146 of the gussets have been pushed inwardly from the configuration of Figure 15 in a manner similar to that of Figure 25 16. However, the closure means 130 has been subjected to activation by a user so that overlying superimposed regions of the closure means are adhesively bonded to one another to form a secure, substantially fluid- and vapor-impervious seal for the opening formed by the open edge 128 of the bag. In the preferred configuration shown in Figures 15-19, the closure means entirely encircles the 30 open edge 128 of the bag so that complete adhesion of the entire periphery is assured upon activation.



As will become apparent by viewing the sequence of steps depicted in Figures 15-21, the flexible sheet material utilized to form the body of the bag is sufficiently flexible and yieldable to accommodate the motion of the gusseted end panels 140 as they move between the open configuration of Figure 15 and the closed configurations of Figures 19 and 21. More particularly, the end panels 140 are sufficiently flexible to fold or pleat upon themselves as needed to accommodate the folding inwardly or outwardly of the medial creases to accomplish activation of the closure means.

To open the bag of Figure 19, a user may grasp one pair of diagonally opposite edge creases 122 and pull them in diagonally opposite directions to initiate and propagate separation of the closure means in the central region. The other pair of diagonally opposite edge creases 122 may then be grasped and pulled in similar fashion to further propagate the separation of the closure means. Alternatively, marginal edges (which as mentioned above are preferably partially adhesive-free) of the bag above the closure means may be grasped and pulled apart.

Figure 20 depicts the closed and sealed bag of Figure 19 with the top portion optionally folded over substantially parallel to the bottom 150, so that a stable stackable configuration is obtained whereupon other containers, articles, or the like may be stably placed upon the bag. Again, the flexible nature of the material of the bag body makes such a folding-over a viable option for efficient storage. The gusseted, pleated sidewall structure with spaced, defined corners adds additional integrity and stability to the filled bag, improving stackability in use and adding stability as well in terms of overturning or the like.

While Figures 19 and 20 depict one approach to achieving closure of the flexible storage bag, the closure means of embodiments of the present invention provides for an additional approach to closure. As shown in Figure 20, the medial creases 146 of the gussets may be pulled outwardly from one another rather than pushed inwardly, so that a straight line closure of two substantially parallel facing surfaces may be obtained in similar fashion to the flexible storage bags of Figures 1-4. In this fashion closure may be achieved by a simple sweep of a hand across



the entire upper open edge 128 with a simpler line of sealing than if the gussets were maintained as shown in Figures 19 and 20. Like the bag of Figures 19 and 20, the bag sealed as shown in Figure 21 may also be folded over to form a stable stackable configuration. As discussed above, it is the selectively-
 5 activatable adhesive nature of the closure means of the present embodiment which makes this dual-functionality, dual-mode closure, for pleated flexible storage bags a reality.

Although the self-supporting flexible storage bags illustrated in the foregoing Figures 15-21 have been constructed of flexible sheet material along
 10 the lines of the approach typically taken for paper grocery-type bags, as illustrated for example in U.S. Patent No. 584,555, issued June 15, 1897 to Lorenz, a wide variety of other constructions may be utilized in keeping with the self-supporting approach in conjunction with the use of a closure means in accordance with the present embodiment. Examples of such other illustrative bag
 15 designs include U.S. Patent No. 3,970,241, issued July 20, 1976 to Hanson, 5,061,500, issued October 29, 1991 to Mendenhall, 5,195,829, issued March 23, 1993 to Watkins et al., and 5,314,252, issued May 24, 1994 to Happ. Also illustrative is commonly-assigned U.S. Patent No. 4,898,477, issued February 6, 1990 to Cox et al., the disclosure of which is hereby incorporated herein by
 20 reference.

In addition to such use of sheet material folded and sealed to form the bag body, the bag may be constructed in any known and suitable fashion such as those known in the art for making such bags in commercially available form. Heat or adhesive sealing technologies may be utilized to join various components or
 25 elements of the bag to themselves or to each other. In addition, the bag bodies may be thermoformed, blown, or otherwise molded from a starting blank or sheet of material rather than reliance upon folding and bonding techniques to construct the bag bodies from a web or sheet of material.

While particular embodiments of the present invention have been
 30 illustrated and described, it would be obvious to those skilled in the art that various other changes and modifications can be made without departing from the



spirit and scope of the invention as defined by the appended claims. It is therefore intended to cover in the appended claims all such changes and modifications that are within the scope of this invention.

The terms "comprise", "comprises", "comprised" and "comprising" when
5 used in this specification are taken to specify the presence of stated features, integers, steps or components but does not preclude the presence or addition of one or more other features, integers, steps, components or groups thereof.

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THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A flexible storage bag comprising at least one sheet of flexible sheet material assembled to form a semi-enclosed container having an opening and a closure means for sealing said opening to convert said semi-enclosed container to a closed container, said opening having a periphery, wherein said closure means comprises a piece of material forming substantially all of said periphery, said piece of material having a first side facing inwardly toward said opening and a second side facing outwardly of said opening, said first side exhibiting an adhesion peel force after activation by a user which is greater than an adhesion peel force exhibited prior to activation by a user, such that said first side is adherable to any opposing surface, said closure being a selectively activatable adhesive structure and comprising a three-dimensional, deformable material comprising an adhesive protected from external contact by the three-dimensional surface topography, and which is convertible to a substantially two-dimensional sheet material upon activation by a user to expose an adhesive layer to contact with an opposing surface of said semi-enclosed container across said opening.

2. The flexible storage bag of claim 1, wherein said bag includes at least one pair of opposed gussets formed in said sheet material extending in a direction normal to said opening and a substantially planar bottom extending in a direction substantially parallel to said opening, such that when said bottom is placed on a horizontal surface said container is self-supporting and maintains said opening in an upwardly-extending condition.

3. The flexible storage bag of claim 2, wherein said closure means is operable to seal said opening with said gussets folded inwardly toward one another or with said gussets folded outwardly away from one another.



4. The flexible storage bag claim 1, wherein said closure means is activatable by an externally applied compressive force exerted in a direction substantially parallel to said opening.
5. The flexible storage bag of any one of claims 1 to 4, wherein said piece of material forms substantially all of said periphery.
6. The flexible storage bag of any one of claims 1 to 5, wherein said closure means is unitarily formed from said sheet material.
7. The flexible storage bag of any one of claims 1 to 6, wherein said opening comprises a primary opening and wherein said bag includes at least one auxiliary opening located remotely from said primary opening and having an auxiliary closure means for sealing said auxiliary opening, said auxiliary opening having a periphery, said auxiliary closure means comprising a piece of material forming at least a portion of said periphery, said piece of material having a first side facing inwardly toward said opening and a second side facing outwardly of said opening, said first side exhibiting an adhesion peel force after activation by a user which is greater than an adhesion peel force exhibited prior to activation by a user, such that said first side is adherable to any opposing surface.
8. The flexible storage bag of claim 7, wherein said auxiliary closure means is activatable by an externally applied compressive force exerted in a direction substantially parallel to said auxiliary opening.
9. The flexible storage bag of claim 7 or claim 8, wherein said piece of material forms substantially all of said periphery of said auxiliary opening.
10. The flexible storage bag of any one of claims 7 to 9, wherein said auxiliary closure means is unitarily formed from said sheet material.



11. A flexible storage bag of claim 1 substantially as hereinbefore described and illustrated with reference to the accompanying drawings.

DATED this 23rd day of May, 2001

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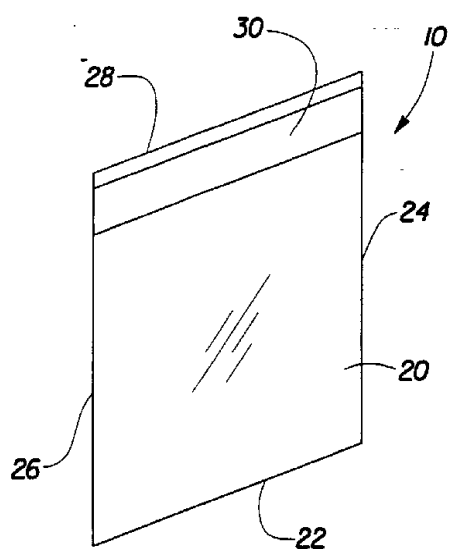


Fig. 1

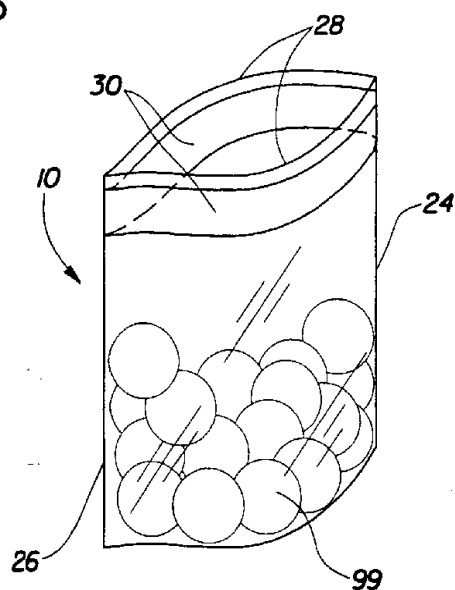


Fig. 2

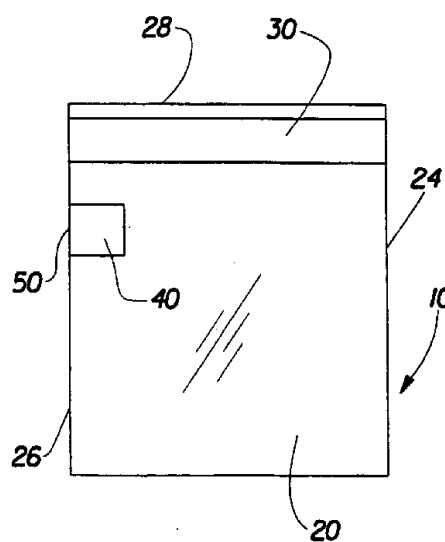


Fig. 3

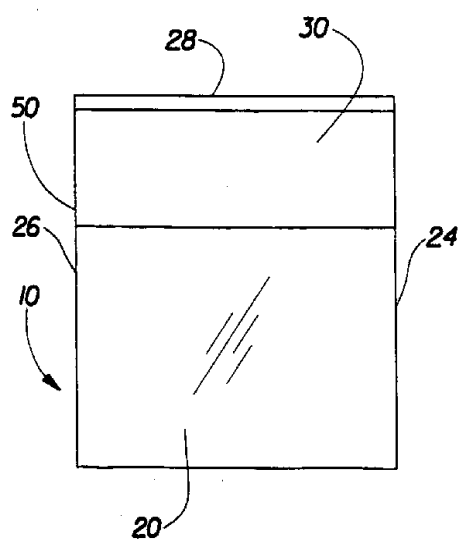


Fig. 4

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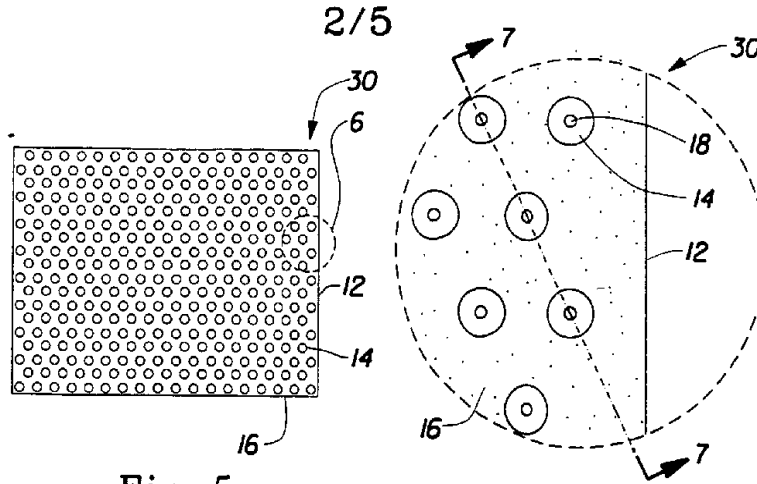


Fig. 5

Fig. 6

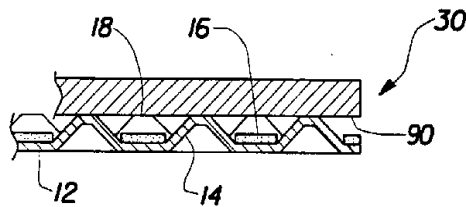


Fig. 7

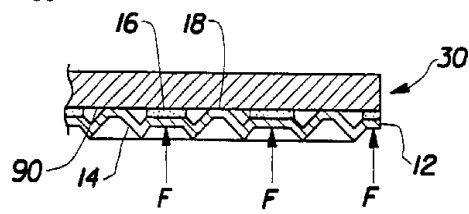


Fig. 8

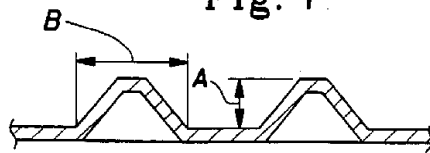


Fig. 9

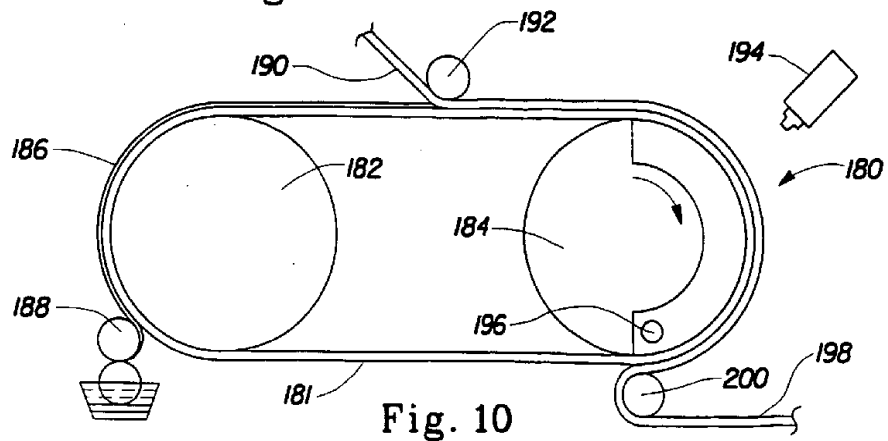


Fig. 10

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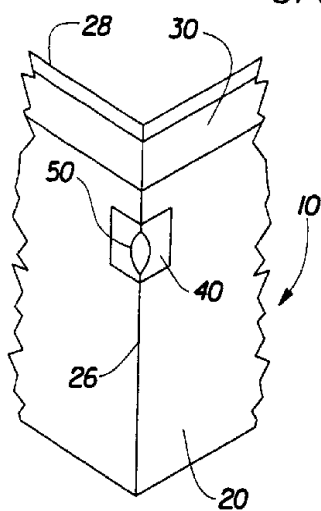


Fig. 11

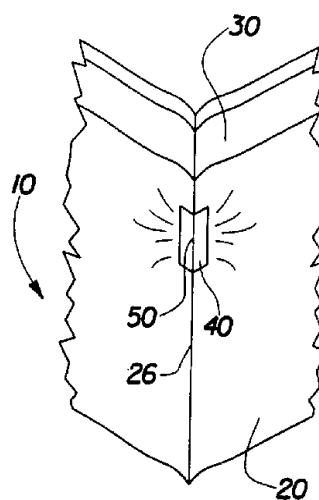


Fig. 12

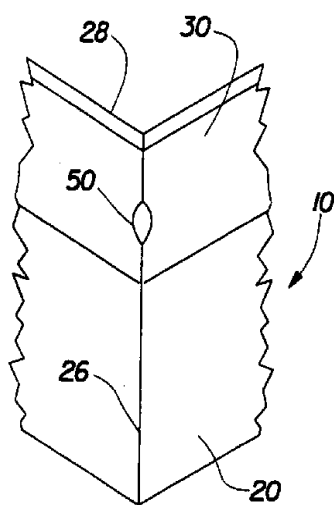


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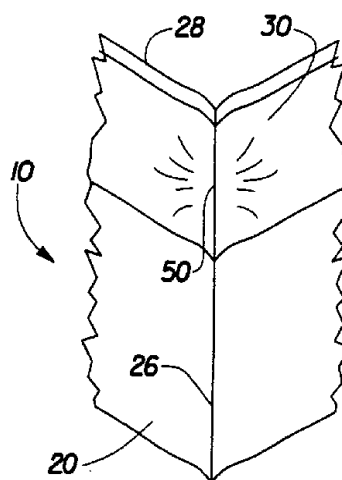


Fig. 14

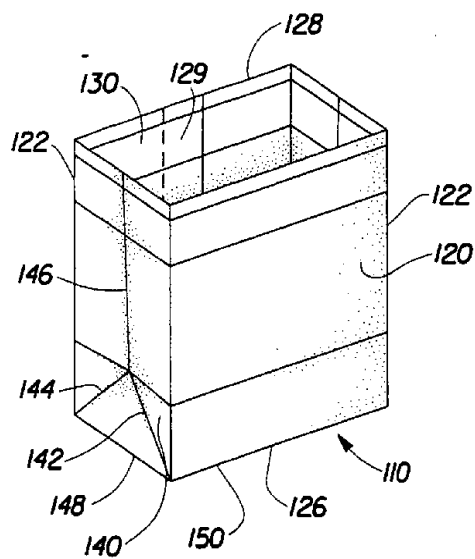


Fig. 15

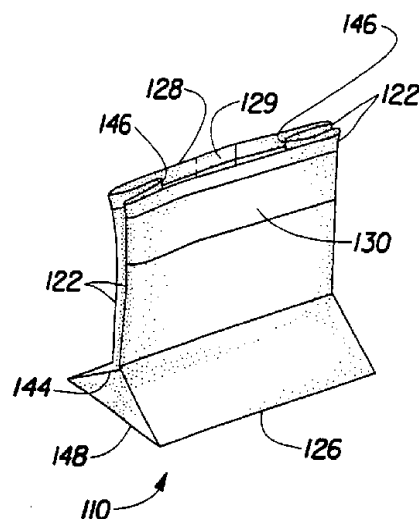


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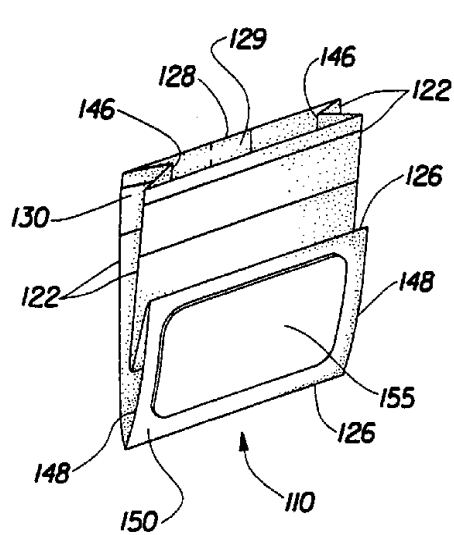


Fig. 17

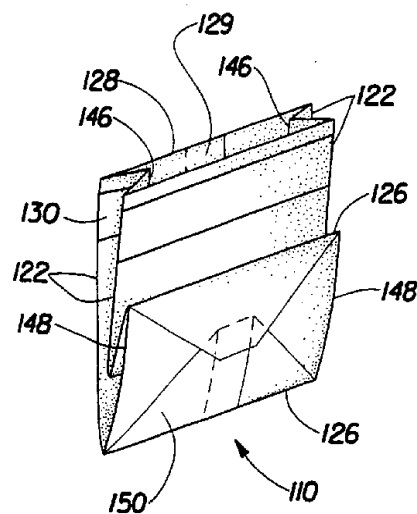


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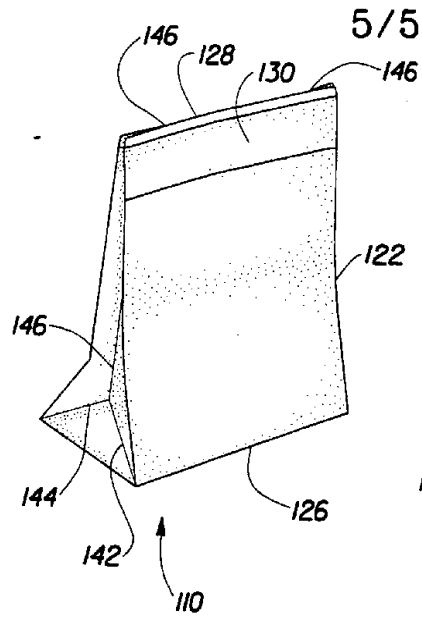


Fig. 19

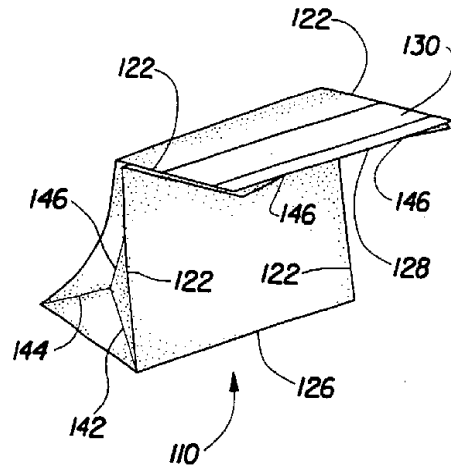


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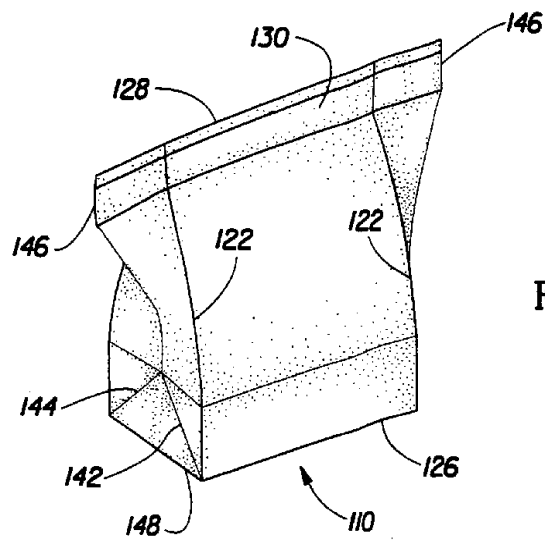


Fig. 21