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CAPT et al.

(54) **PLASTIC BAG WITH IMPROVED AIR EVACUATION STRUCTURE**

(75) Inventors: **Ludovic CAPT**, Montreal (CA); **Mark FROHLICH**, St. Leonard (CA); **Gonzalo GONZALES**, Montreal (CA); **Roger TAMBAY**, Rosemere (CA)

Correspondence Address:
OSLER, HOSKIN & HARCOURT, LLP (OTHER)
1000 DE LA GAUCHETIERE STREET WEST, SUITE 2100
MONTREAL, QC H3B-4W5

(73) Assignee: **MARKO I.R.D.C.**, St. Leonard (CA)

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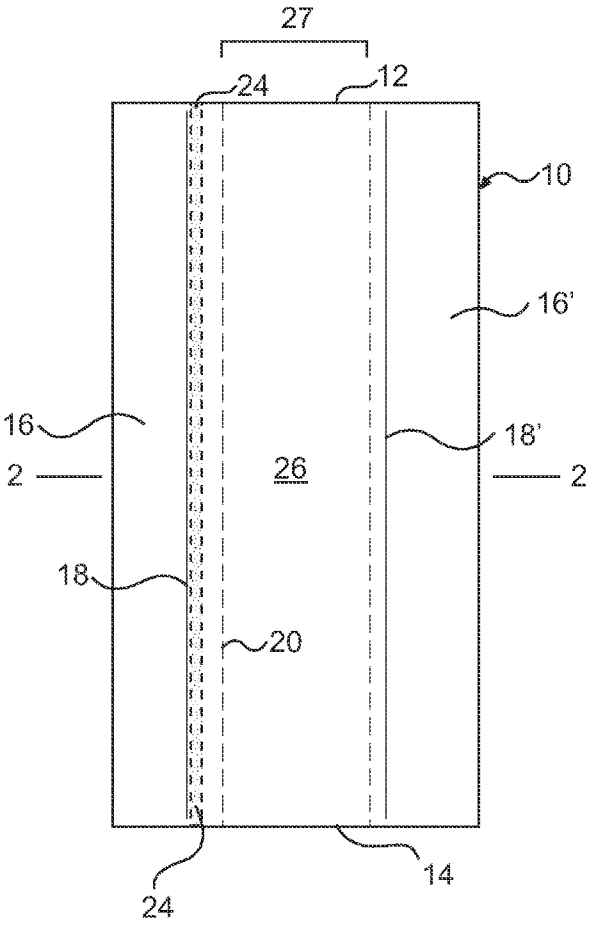
(57) **ABSTRACT**

A plastic bag comprising a first face and a second face, at least a portion of each being 2-ply and having an intermediate space therebetween, the 2-ply portion of the first face having an inner layer of air-impervious plastic material having openings therein; the 2-ply portion of the second face having an outer layer of air-impervious plastic material, the outer layer having openings therein permitting air to pass therethrough, the openings of the outer layer having a smaller average opening area than an average opening area of the openings of the inner layer of the first face; and a filtering chamber formed between the inner layer and the outer layer such that air in an interior of the bag may egress the bag by passing through the filtering chamber, the air being at least partially filtered of particulate matter as it egresses the bag.



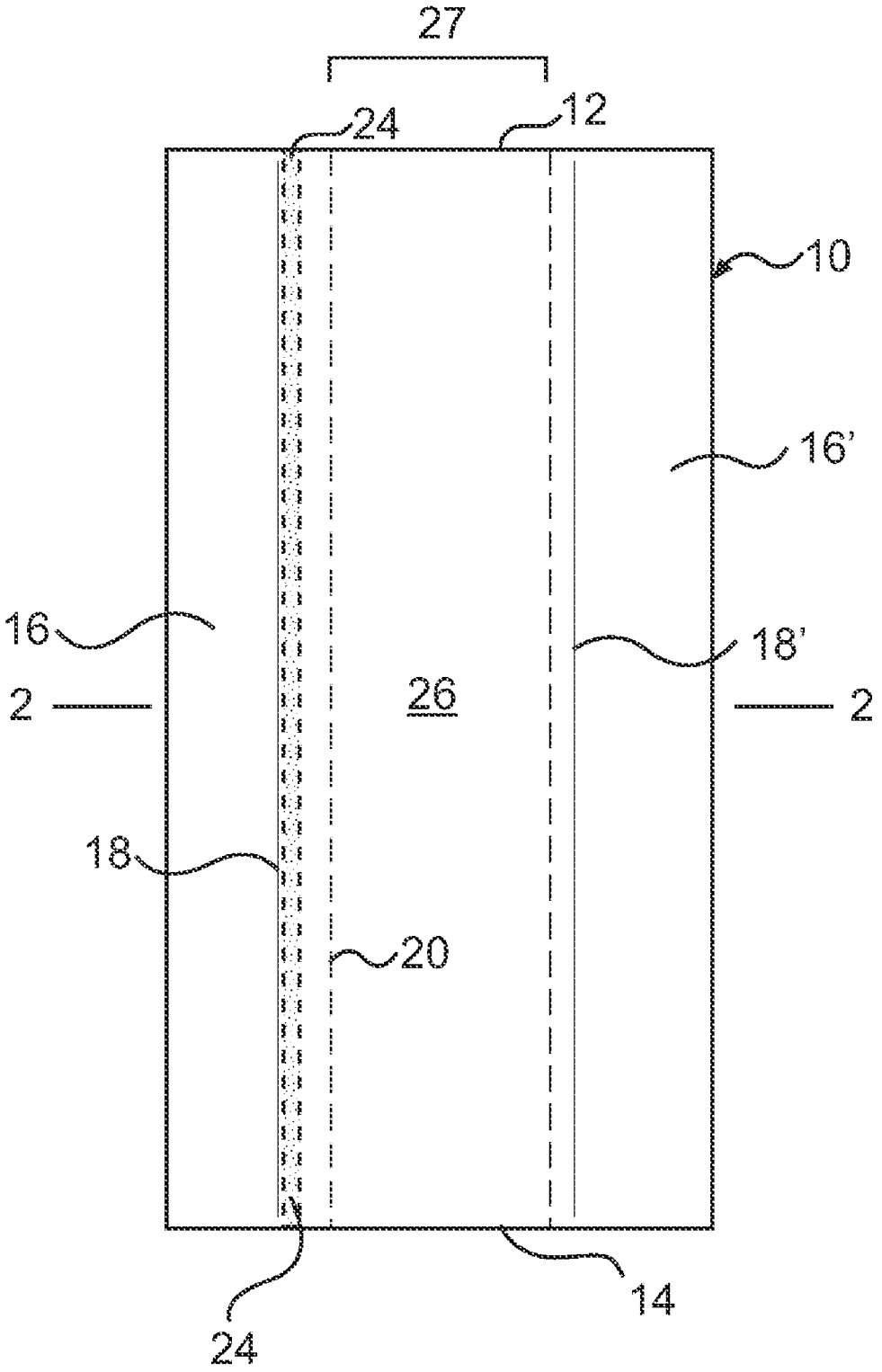
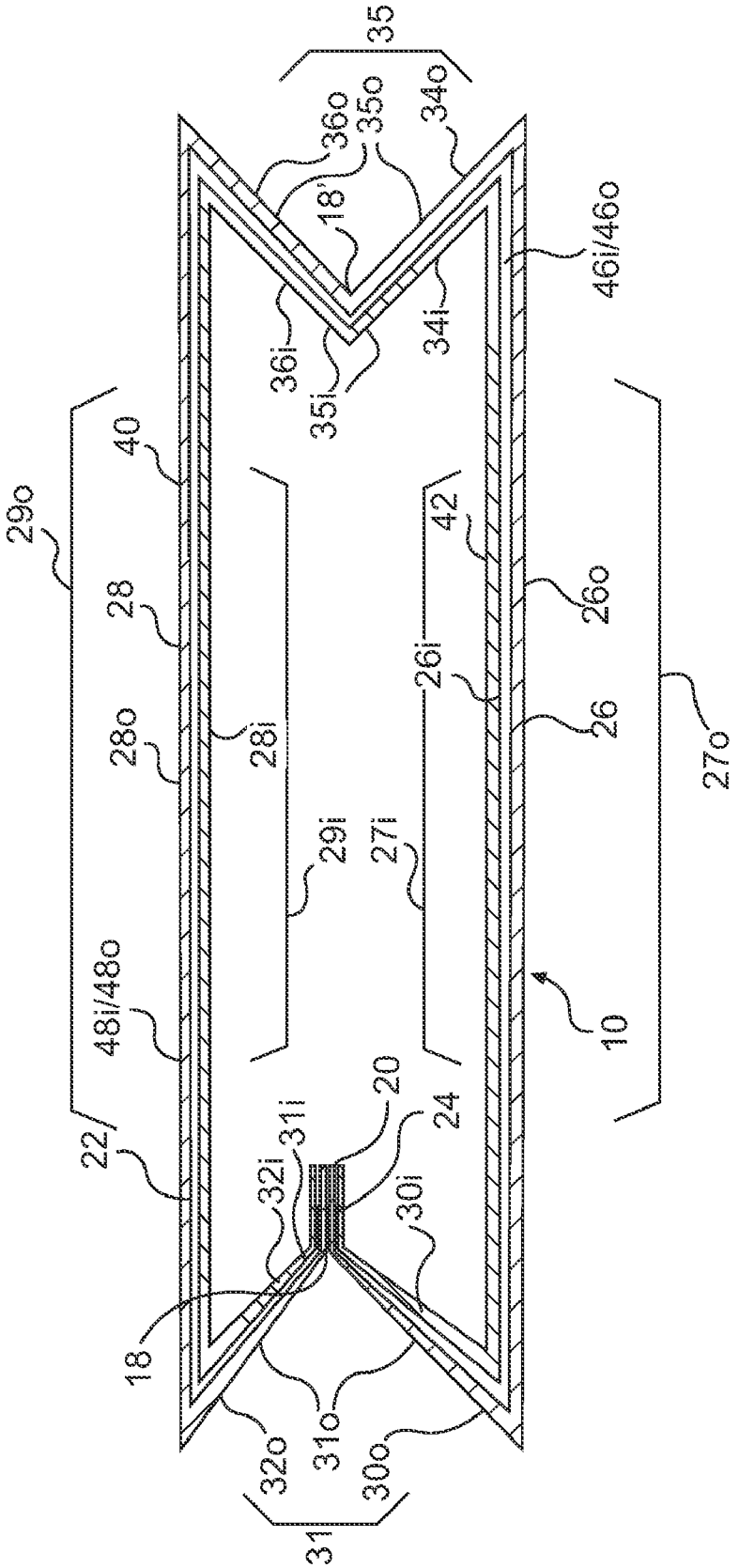


FIG. 1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30o
31

FIG. 2

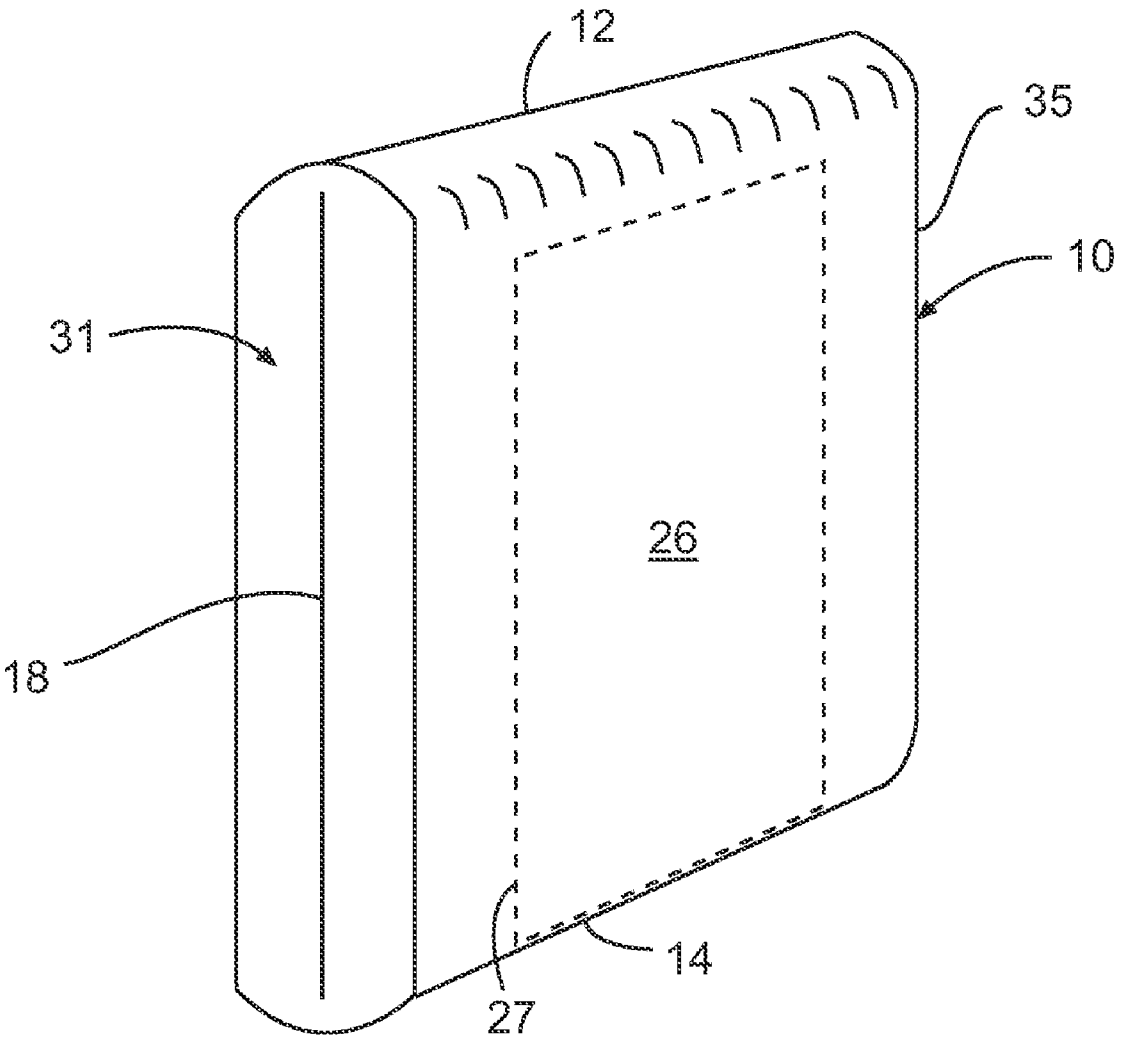


FIG. 3

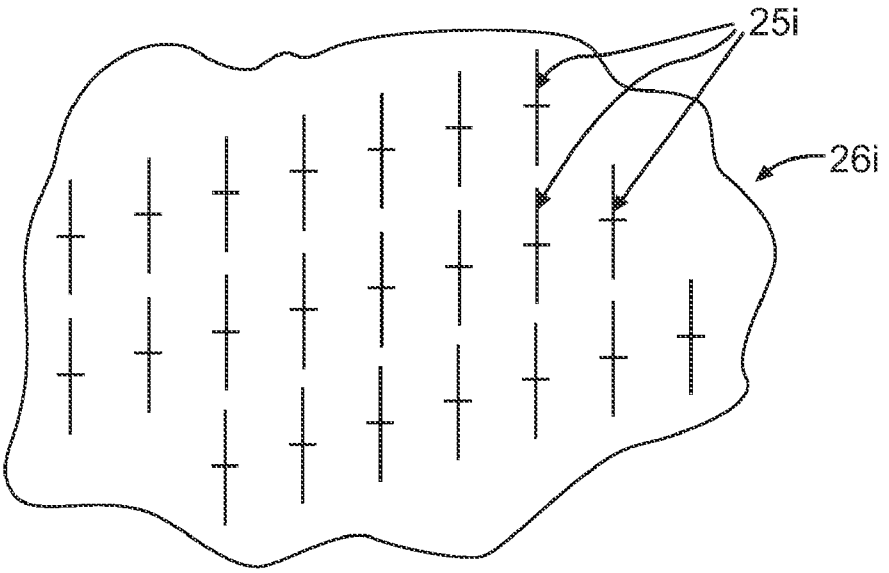


FIG. 4

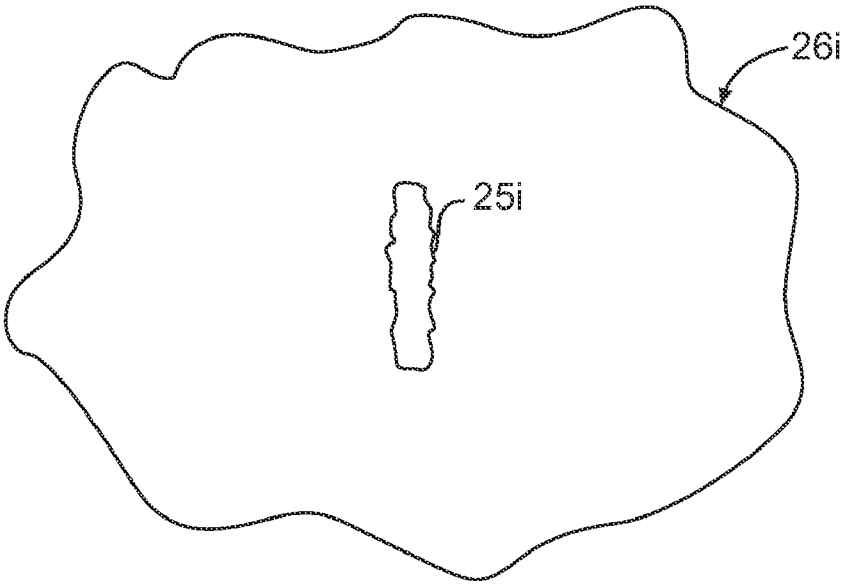


FIG. 5

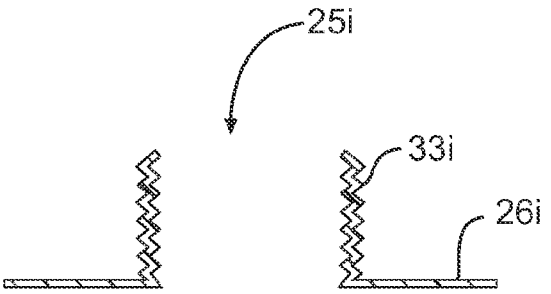


FIG. 6

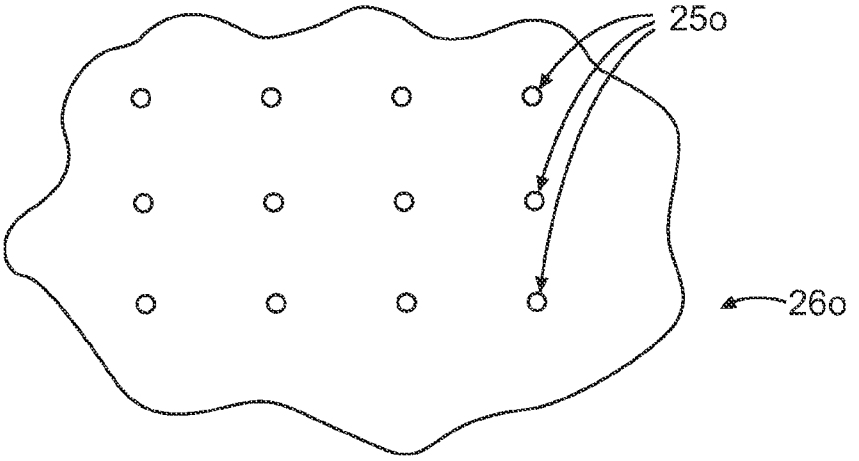


FIG. 7

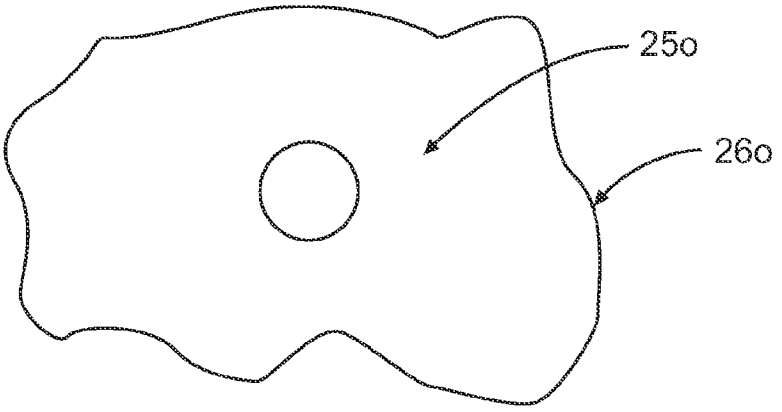


FIG. 8

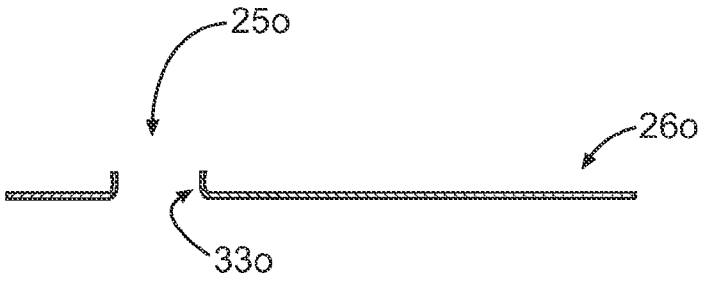


FIG. 9

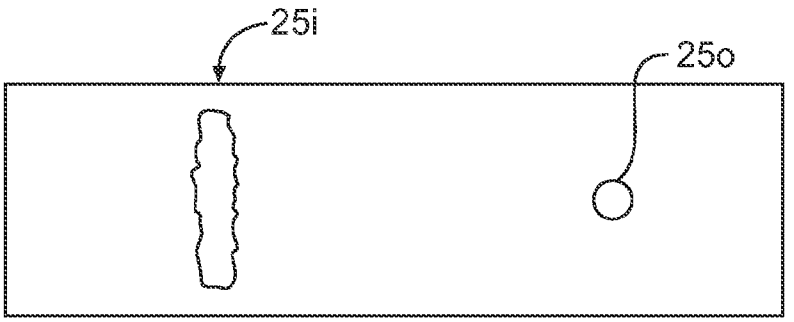


FIG. 10

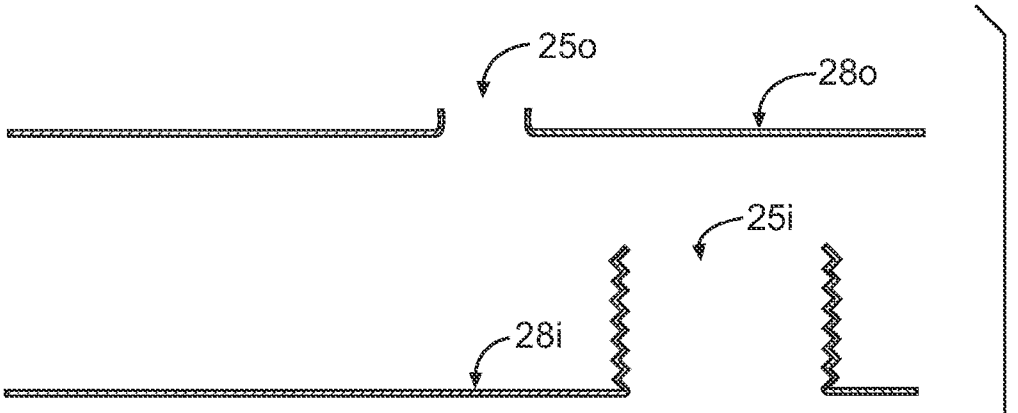
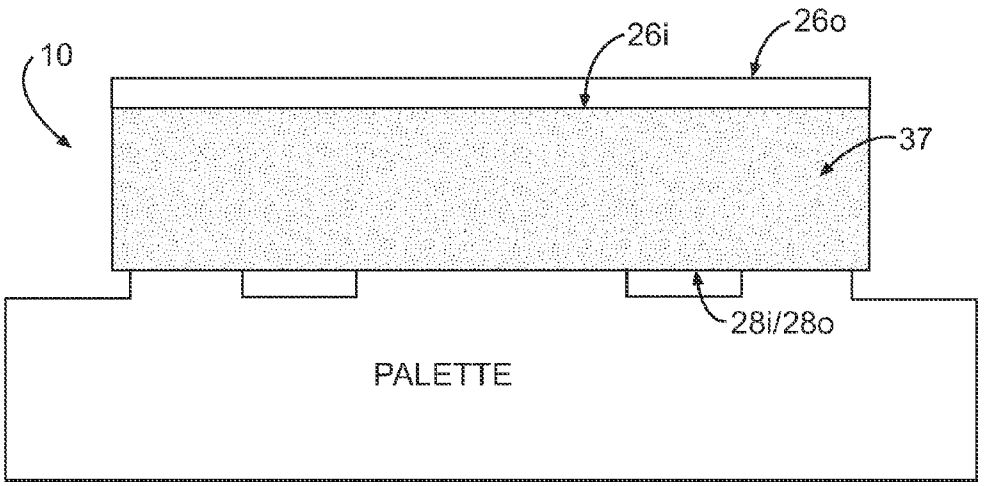


FIG. 11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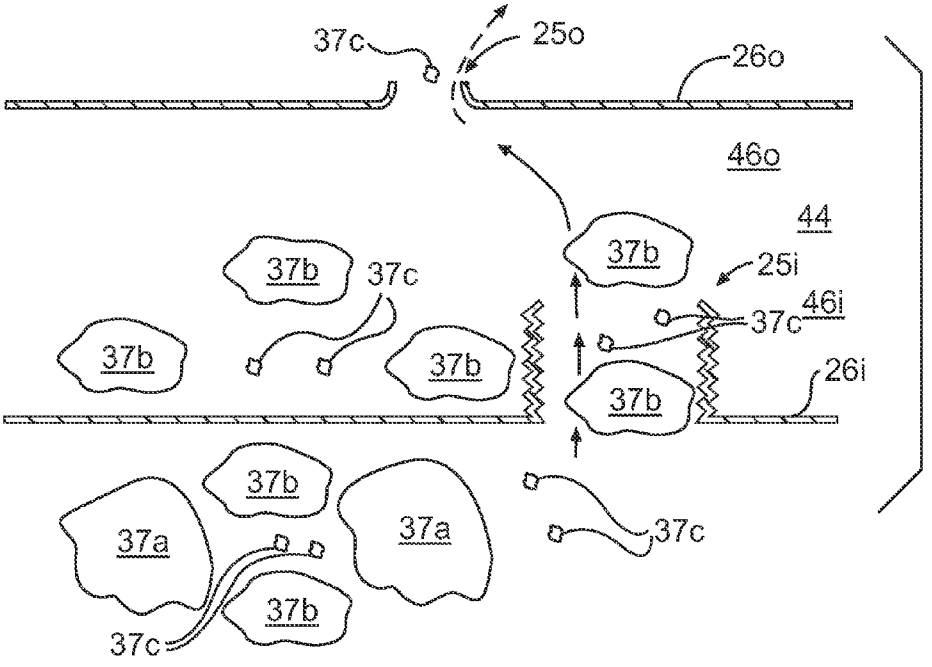
28i/28o
PALETTE

FIG. 12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37c
37c

FIG. 13

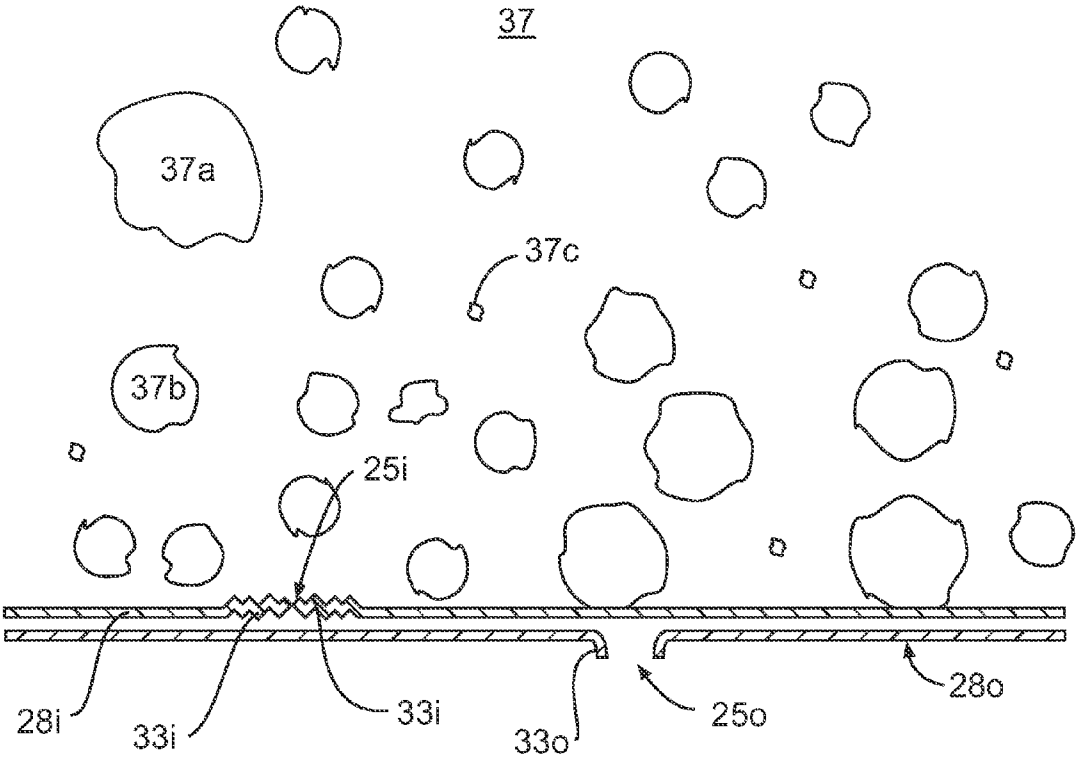

FIG. 14

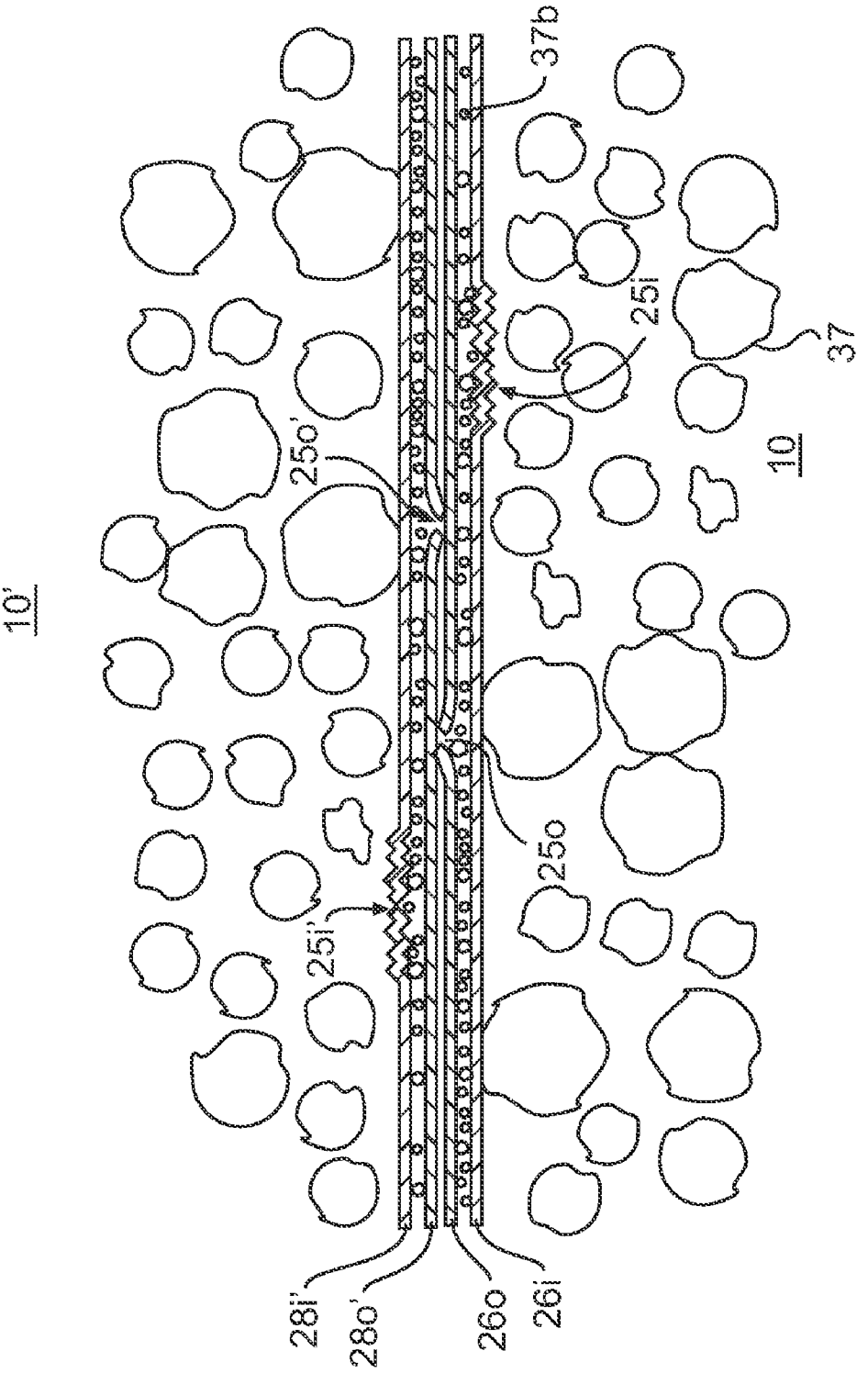

FIG. 15

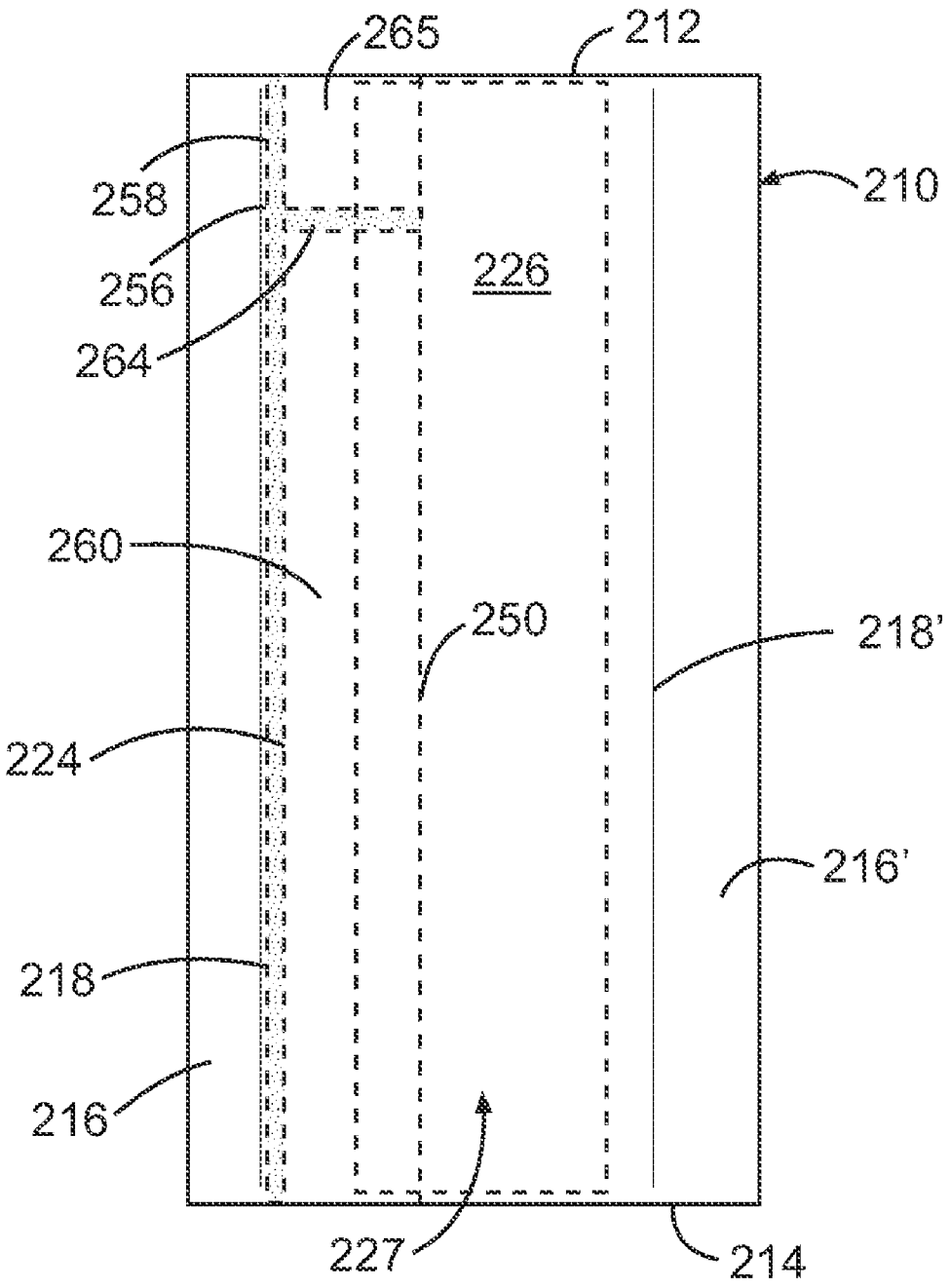

FIG. 16

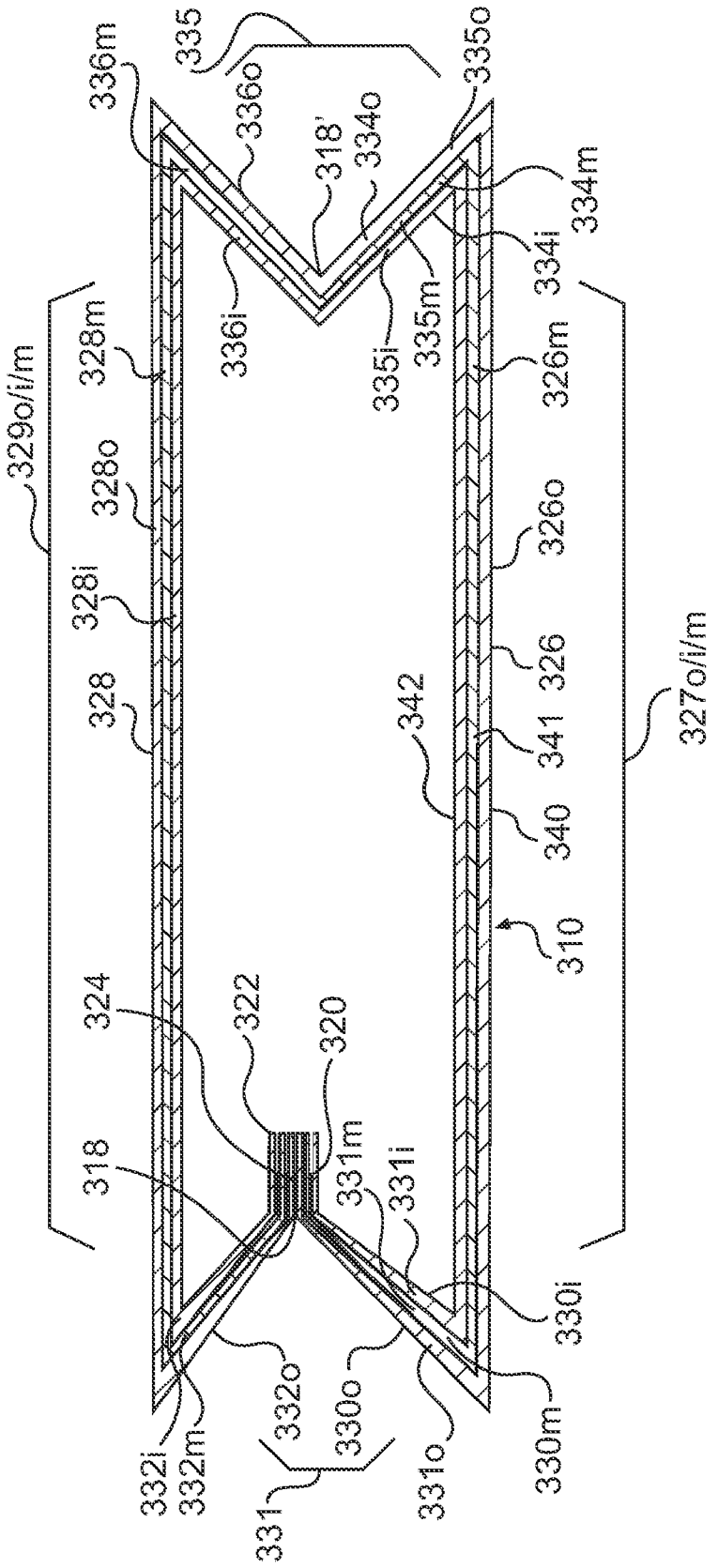
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FIG. 17

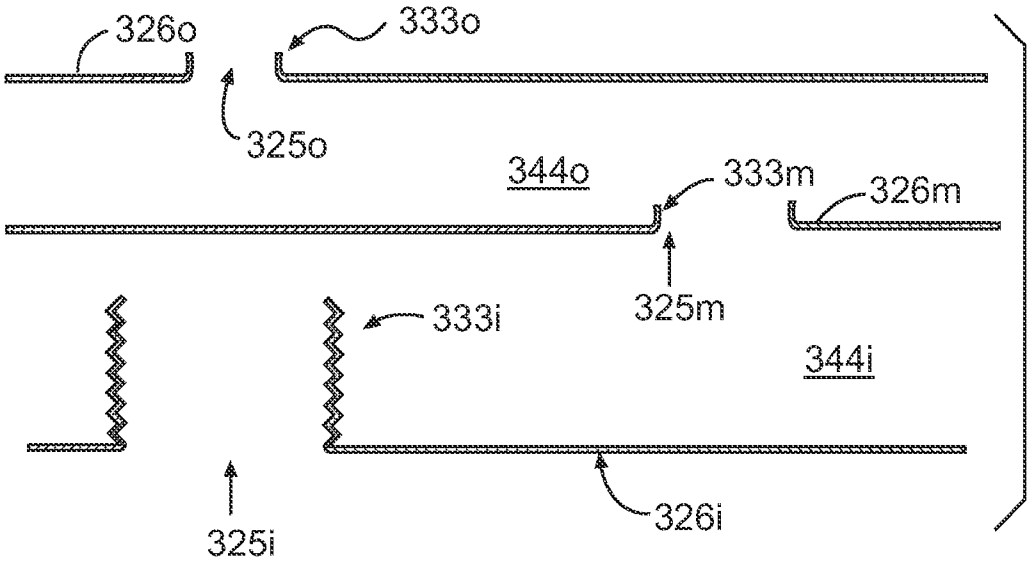

FIG. 18

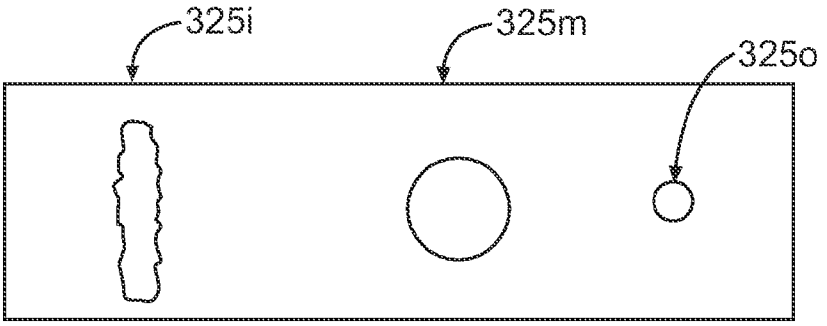
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FIG. 19

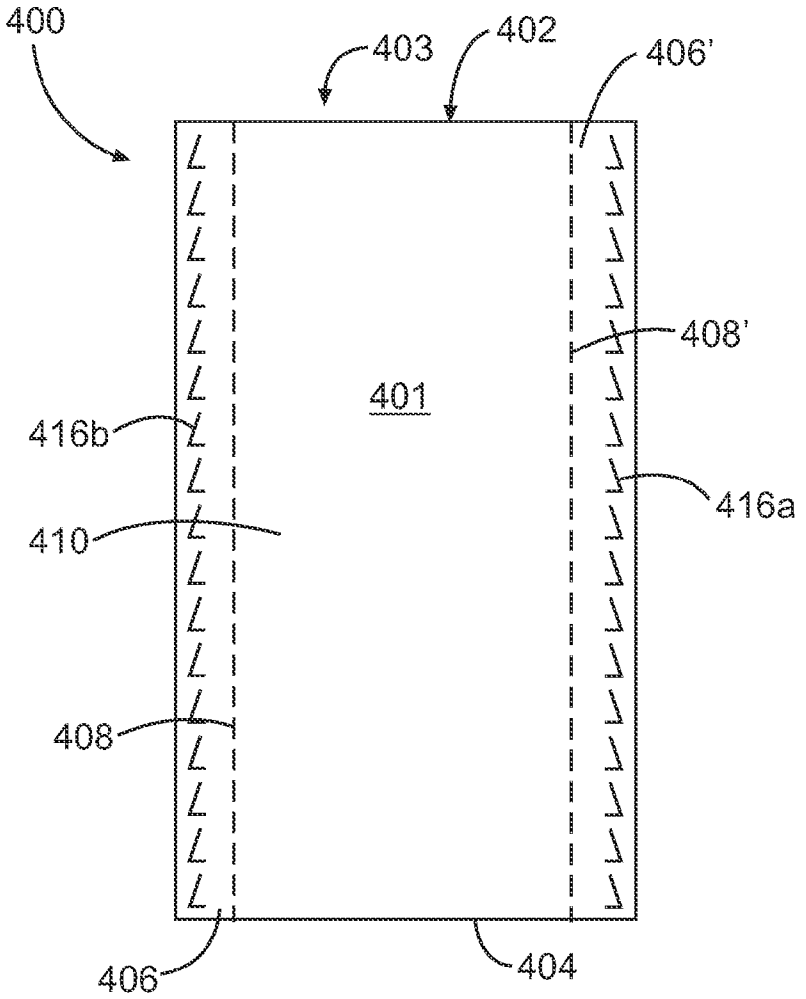
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FIG. 20

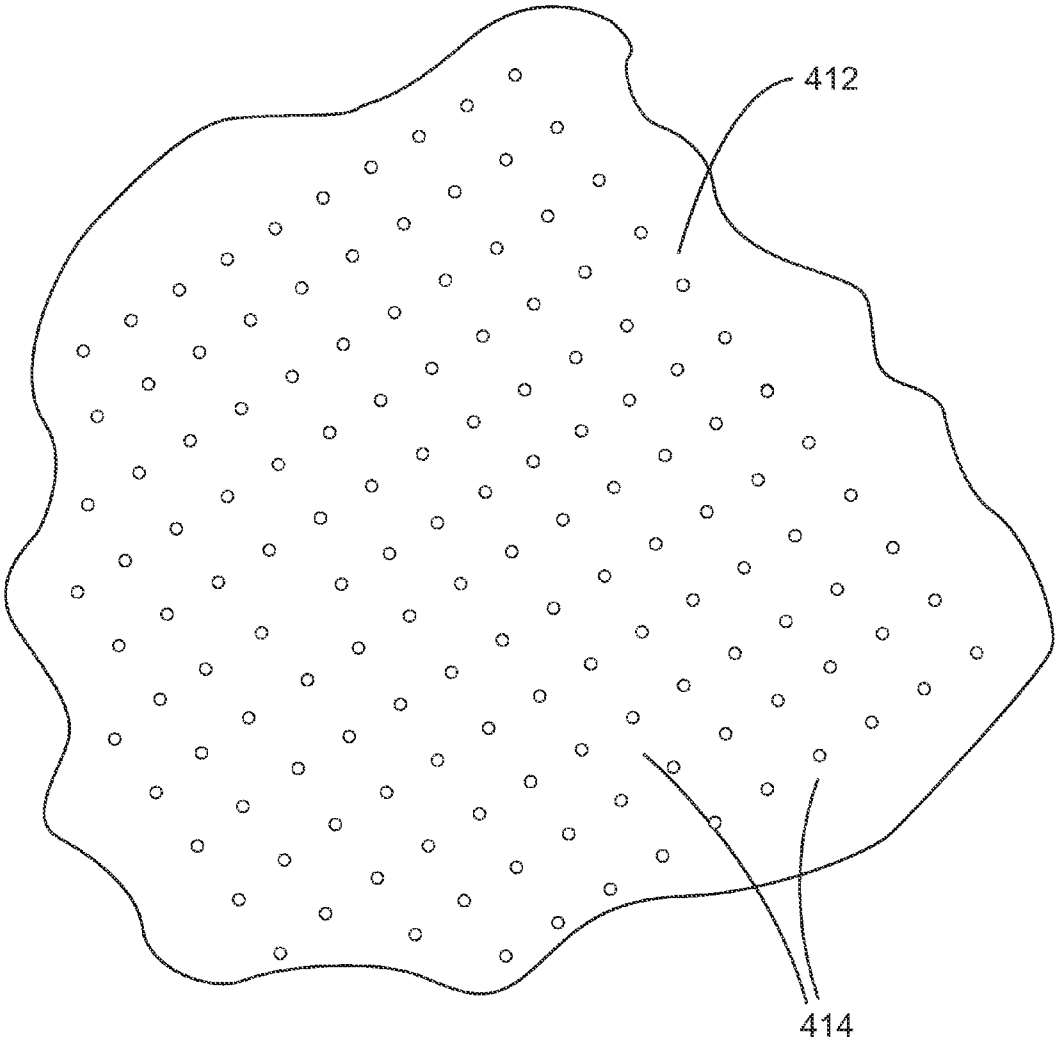

FIG. 21

PLASTIC BAG WITH IMPROVED AIR EVACUATION STRUCTURE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present invention claims priority to U.S. Provisional Patent Application Nos. 60/864,589 filed Nov. 6, 2006 and 60/954,145 filed Aug. 6, 2007, both entitled "Plastic Bag with Improved Air Evacuation Structure". The entirety of each of these documents is incorporated herein by reference.

FIELD OF THE INVENTION

[0002] The present invention relates to plastic bags such as those that may be used for packaging bulk products.

BACKGROUND OF THE INVENTION

[0003] Bulk products, such as concrete, plaster, foodstuffs, pet foods and litters, lawn care products, salt, and many others, are conventionally transported, distributed, and sold in bags. Depending on the application, these bags are typically made of paper or plastic, both of which have their advantages and drawbacks, which may either be inherent and/or dependent on the particular product being packaged.

[0004] Most bags used with cement and concrete products and other heavy flowable contents are large multi-wall paper bags with fill valves, like those commonly seen palletized in home improvement centers throughout the U.S. They typically contain products, such as 60# mortar and concrete mix and 94# cement and concrete mix, sold to consumers for use in home, garden and yard applications. The chief reason paper valve bags are used for these applications is primarily due to per unit costs and productivity factors. Paper valve bags cost more than standard, top-loading plastic bags, but the paper bags are much faster to fill, thus substantially improving productivity and output.

[0005] Nonetheless, as anyone experienced in the art knows, there are several problems associated with conventional paper bags. In addition to the high cost, other disadvantages of paper packaging include the consumption of five times the storage space of plastic, the vulnerability of cement and concrete products stored in paper to weather conditions (especially rain and moisture), and the vulnerability of paper to pest infestations. Another significant disadvantage of paper packaging is that it often rips or breaks, spilling out its contents. Indeed, this occurs so often that in some home improvement centers, an employee is assigned the full-time task of cleaning up bulk materials spilled from ripped or broken paper bags. Both the wasted material and the time spent cleaning it up are a significant wasted expense.

[0006] To improve this situation, one prior art solution was to use a plastic bag for packaging such materials. International Patent Publication No. WO 03/000005 entitled "Flowing Bag Filling System and Bag Therefor" published on Jan. 3, 2003 (herein incorporated by reference in its entirety) describes a bag particularly adapted for this purpose. It provides a bag having an inwardly disposed seam manufactured from a sheet of plastic bag material having two major surfaces and two parallel side edges. A first seam seals the two parallel side edges together at the same major surface with the side edges disposed inwardly of the tube to form the sheet of plastic bag material into a tube with internal flap portions extending interiorly of the tube. At least one seal across the tube is provided for forming at least a three-sided bag structure (and preferably two seals across the tube for forming a closed four-sided bag structure) whereby pressure in the interior of the bag acts against the internal flap portions disposed inwardly of the tube to enhance the sealing of the seam. The bag is filled at an opening defined along the opposite side edges of the seam facing inwardly of the tube.

[0007] The bag of the '005 publication was an improvement over the then conventional paper bags. Being made of plastic, it was lightweight, took up less storage space, and was significantly less prone to ripping or breaking. Moreover, these bags were not subject pest infestation. They were impervious to fluids, meaning that rain water could not cause the bags to deteriorate; nor could unwanted moisture pass through the bags and into the contents thereof (it being particularly important to keep contents such as cement or concrete moisture-free).

[0008] However, fluid-imperviousness, while clearly helpful in some ways, is a major problem in others, particularly in the filling of the bag with its contents. In order to fill the bag with its contents, the bulk material to be put into the bag (such as cement or concrete) must be fluidized by being mixed with and suspended in moving air to form a flowing stream of material/air mixture. The more fine the particles of the material, the more air that is required to fluidize them and create the flowing material/air stream. Fine materials in powder form require a significant amount of air to be fluidized and moved.

[0009] Once the flowing fluidized mixture is created it is directed into the bag, wherein the material is deposited and the air must be withdrawn. Given the plastic material of the bag, the plastic material being impervious to fluids, some means for removing the air must be provided. The means described in the '005 publication (at paragraph 54 and in FIG. 15) is an air evacuation system combined with the filling system to withdraw air from the bag during filling operations. While adequate for its intended purpose, that system is not optimal. The difficultly is that its does not completely "defluidize" the air/material mixture, and leaves some air entrapped in the bag. This makes these bags unwieldy and difficult (and in some instances very difficult or nearly impossible) to stack. This situation is undesirable for bags that are destined to be palletized for transportation and/or distribution, as stackablity of the bags is extremely desirable. Simple and economical means for allowing air entrapped in the bag after the bag has been filled would be desirable.

[0010] One such means for allowing air to escape from a plastic bag is described in European Patent No. 0,444,261, entitled "Flexibles Verpackungsbehältnis in Form eines Sackesoder Beutels aus Kunststoffolle" ("Flexible Packaging Container in the Form of a Bag or Pouch, Made from Plastic Film") published on Aug. 11, 1993 (herein incorporated by reference in its entirety). The '261 patent provides a flexible packaging container in the form of a bag or pouch made from plastic film or similar material which is impermeable to air, which has in the bag wall an air outlet region in which the bag material as an outside wall part is provided with perforations for passage of air from the filling space of the bag. The perforated bag material is covered on the inside by an air-permeable inside wall part. The inside wall part consists, in turn, of material, such as plastic film, which is impermeable to air and, for its air-permeable construction, is likewise provided with perforations which, however, although being the same size, have a construction and arrangement for a greater air passage than the perforations of the outside wall part in the

air outlet region of the bag wall, the inside wall part and the outside wall part jointly bounding an air chamber which is closed all round at the edge. The difficulty with the bag described in the '261 patent is that, while air is indeed permitted to escape from the interior, so is the material that the bag is supposed to contain unless some kind of external filter is added. This escape of material is undesirable where the material is a fine power such as cement or plaster; and external filters are expensive and needlessly complicate the manufacture process.

[0011] There is thus a need in the art for a fluid-impervious bag made from a plastic material having structure allowing for air entrapped in the interior of the bag to escape therefrom, while at the same time preventing an undesirable quantity of material contained within the bag from escaping.

STATEMENT OF THE INVENTION

[0012] It is therefore an object of the present invention to provide a plastic bag with an improved air evacuation structure over plastic bags of the prior art.

[0013] Thus, in one aspect, as embodied and broadly described herein, the present invention provides a plastic bag comprising a first face, at least a portion thereof being 2-ply and having a first intermediate space therebetween, the 2-ply portion of the first face having an inner layer of air-impervious plastic material having openings therein permitting air to pass therethrough; a second face, at least a portion thereof being 2-ply and having a second intermediate space therebetween, the 2-ply portion of the second face having an outer layer of air-impervious plastic material, the outer layer having openings therein permitting air to pass therethrough, the openings of the outer layer having a smaller average opening area than an average opening area of the openings of the inner layer of the first face, the first intermediate space and the second intermediate space being fluidly interconnected; whereby a first filtering chamber is formed between the inner layer and the outer layer such that air in an interior of the bag may egress the bag by passing through the openings of the inner layer and through the openings of the outer layer, the air being at least partially filtered of particulate matter as it egresses the bag.

[0014] Although many different bag constructions are contemplated (some of which are described hereinbelow), it is preferred for most embodiments of the present invention that the bag simply be of a two-layer construction (i.e. 2-ply) in order to simplify manufacturing and to avoid increasing costs. In bags of a two-layer construction there will be an inner layer (i.e. the layer to be in contact with the contents of the bag), an outer layer (i.e. the layer surrounding the inner layer and in contact with the environment), and an intermediate space therebetween. The term "intermediate space" should be understood as encompassing the situation where the inner layer and the outer layer are in direct contact, and thus there is no actual space between them (i.e. bags of the present invention should be understood to have an intermediate space even if situations exist during the course of their use during which there is no actual space between the relevant layers).

[0015] Typically bags of the present invention (when filled with material) will be three-dimensional rectilinear bodies, most commonly rectangular parallelepipeds. As would be apparent to those of ordinary skill in the art, in such cases the bags will have **6** faces: a front face, a rear face, a left side face, a right side face, a bottom face and a top face. The front face and the rear face will typically be the two parallel rectangular faces with the greatest surface area, and the remainder of the faces will be defined to be consistent with the front face and the rear face. In cases where the bags are cubes, the same 6 faces will be present, however, any two parallel faces may be the front face and the rear face, with the remainder of the faces being consistently defined therewith. Where the bag is a three-dimensional curvilinear body, for example, a right circular cylinder, the front face and the rear face may be opposing portions of an appropriate exterior surface.

[0016] For greater certainty it should be understood that a "face" of a bag of the present invention includes all of the layers comprising the face and not just the outer layer. Thus for example for 2-ply bags the front face includes both the front face outer layer and the front face inner layer. The front face inner layer is termed "front face" even though it actually faces the front face outer layer.

[0017] An "opening" in a layer of material should be understood to mean an absence of material, however caused or formed, that allows air to pass through the layer. For example openings may be formed by needle perforation (the preferred method for forming the openings in the outer layer) or by a slicing with spinning blade (the preferred method for forming the openings in the inner layer). The average opening area of the openings of a face is calculated by determining the effective cross-sectional open area of each of the openings of a face, and averaging them.

[0018] Bags of the present invention provide a filtering chamber between the inner layer of the first face and the outer layer of the second face such that air in an interior of the bag may egress the bag by passing through the openings of the inner layer into the filtering chamber and then through the openings of the outer layer, such that the air is at least partially filtered of particulate matter as it egresses the bag. Preferably, what occurs is that the inner and outer layers act as a progressive sieve. Thus, the inner layer will allow air to escape but will filter out all particles over a certain size allowing only (generally) very fine particles to pass therethrough entrained with the air. The openings in the outer layer are however smaller and will again allow to air to pass therethrough while filtering out particles over a certain size even smaller than that of the inner layer. Ideally, if possible, the size of the outer layer is such that no particles will be allowed to pass therethrough, only air. If not possible, the size is calculated to keep particle passage below a desired maximum.

[0019] This construction is beneficial in that because the particles capable of reaching the outer layer of are a much smaller size than those filtered out by the inner layer; clogging of the openings of the outer layer is less likely to occur than if the bag consisted of a single layer equivalent to the outer layer.

[0020] In should be understood that merely because the average opening area of the openings of the outer layer is smaller than the average opening area of the openings of the inner layer, it does not mean that the total opening area of the openings (i.e. the sum of the opening area of each of the openings) of the outer layer is smaller than the total opening area of the openings of the inner layer. Indeed, preferably, it is larger (i. e. the total opening area of the openings of outer layer is greater than the total opening area of the openings of the inner layer). In this manner, control of the air flow through the filtering chamber and out of the bag is controlled by the total opening area of the openings of the inner layer. Thus depending on the application of the bag, a desired airflow can

be created or controlled by increasing or decreasing the size and/or number of openings in the inner layer.

[0021] It is not required that the inner-layer openings and the outer-layer openings be on the same face of the bag. They may be on different faces. For example, it may be that the left side face inner layer has openings and the front face outer layer has openings. What is important is that there be some pathway for air to egress the interior of the bag passing through both the openings of the inner layer and the openings of the outer layer; the intermediate spaces of 2-ply areas (of the left side inner layer and the front face outer layer - from the previous example) thus must be fluidly connected. It may be that in such situations no other faces of the bag have layers with openings. Alternatively, it may that there are other faces that do have openings, but that their intermediate spaces are not in fluid communication with the faces in question (the left side inner layer and the front face outer layer—from the previous example), and thus they provide for filtering chambers that are fluidly distinct from others on the bag.

[0022] Nonetheless, for most applications it is preferred that the first face and the second face are the same face of the bag and that the first intermediate space and the second intermediate space are the same intermediate space. I.e. it is the inner layer and the outer layer of the same face that have openings and a filtering chamber is formed directly therebetween.

[0023] In such cases, it is highly preferred that the openings of the outer layer be offset from the openings of the inner layer. This will discourage the openings of the outer layer from becoming clogged with particles or having particles become lodged therein. Particles travelling through the openings of the inner layer will impact on the material of the outer layer itself and will (hopefully) ricochet back into the filter chamber where they will harmlessly remain trapped. This is contrasts with the situation where particles travelling through the inner layer would be directed (with some force) directly towards an opening in the outer layer, greatly increasing the chances that the outer-layer opening will become clogged.

[0024] It is further preferred that in the absence of air and particulate matter in the filtering chamber the outer layer of the second face and the inner layer of the first face lie flat against one another.

[0025] It is also highly preferred that the plastic bag further comprises: a third face, at least a portion thereof being 2-ply and having a third intermediate space therebetween, the 2-ply portion of the third face having an inner layer of air-impervious plastic material having openings therein permitting air to pass therethrough; a fourth face, at least a portion thereof being 2-ply and having a fourth intermediate space therebetween, the 2-ply portion of the fourth face having an outer layer of air-impervious plastic material, the outer layer having openings therein permitting air to pass therethrough, the openings of the outer layer having a smaller average opening area than an average opening area of the openings of the inner layer of the third face, the third intermediate space and the fourth intermediate space being fluidly interconnected; whereby a second filtering chamber is formed between the inner layer and the outer layer such that air in an interior of the bag may egress the bag by passing through the openings of the inner layer and through the openings of the outer layer, the air being at least partially filtered of particulate matter as it egresses the bag.

[0026] As was previously described hereinabove with respect to the first and second faces, it is not required that the third-face inner-layer openings and the fourth-face outer-layer openings be on the same face of the bag. They may be on different faces. Nonetheless, for most applications it is preferred that the third face and the fourth face are the same face of the bag and that the third intermediate space and the fourth intermediate space are the same intermediate space. I.e. it is the inner layer and the outer layer of the same face that have openings and a filtering chamber is formed directly therebetween. In such cases, it is highly preferred that the openings of the outer layer be offset from the openings of the inner layer as was also described hereinabove.

[0027] It should be understood that there may or may not be any correlation between the first, second, third and fourth faces. That is to say that none, some or all of the faces may be the same face. Further, their intermediate spaces may or may not be fluidly connected (provided at least one pathway for air to egress the interior of the bag is provided). Thus, many different constructions within the scope of the present invention are possible.

[0028] By way of non-limiting example, it may be that all of the faces are the same face, yet the first and second intermediate spaces are not fluidly connected with the third and fourth intermediate space. Thus two independent filtering chambers would be formed on the same face. Alternatively, it may be that only the second and third face are the same face. In such as case, the first and second intermediate spaces may or may not be fluidly connected with the third and fourth intermediate spaces such that one or more than one filtering chamber will be formed.

[0029] For most applications it is preferred that the first intermediate space, the second intermediate space, the third intermediate space, and the fourth intermediate space are all fluidly interconnected forming such that the first filtering chamber and the second filtering chamber are the same filtering chamber. This will maximize the chances of air egressing the interior of the bag as many pathways will be formed.

[0030] It is highly preferred that the layers with openings therein be the front face and rear face inner layer and the front face and the rear face outer layer. Where such is the case, it is also preferred that no other layer of any other face have openings. Bags of the present invention are likely destined to be palletized for transport and distribution. Where this is the case, they will be laid on the pallet (or on another bag lower down on the pallet) either on their front face or on their rear face, such that the material in the bag will lie on the face of the bag facing the pallet (or the bag below as the case may be) and the air will rise to the above and be permitted to egress the bag through the filter chamber described hereinabove. If both the front faces and rear faces of all layers of the bag having openings, it is not necessary for the person placing the bag to ensure that a particular face is oriented in a particular direction; either face may be face-up, simplifying packing operations.

[0031] In such cases, it is highly preferred that the bag have no structure that would keep the layers of the faces in a spaced-apart relationship, i.e. in the absence of air and/or particulate matter in the filter chamber, the outer layer and the inner layer should lie flat against one another (i.e. be touching such that there is no volume therebetween). The openings of the outer layer being misaligned with the openings of the inner layer will cause the openings of the inner layer to be blocked by the outer layer when the two layers are in contact. This is desirable to occur in the scenario described above for the face-down face of the bag. In this manner, the face-down

face of the bag is sealed by the weight of the material in the bag, and the air will have to pass through the openings in the face-up face of the bag (the overpressure of air will force the inner and outer layers to separate and create the filter chamber). When the next bag is placed on top of the bag on the pallet, the weight of material in the second bag will then seal (at least until that bag is removed) both its own face-down face and the face-up face of the bag on which it was placed. This will have the effect of sealing the first bag (ideally completely) so as to prevent moisture from re-entering the bag through any of the openings. In situations where this described occurrence is desired, it is preferred that none of the other faces of the bags have openings so that the bags may be completely sealed once stacked on one another.

[0032] It is also preferred the openings of the inner layer (of whatever face) have a jagged edge (i.e. a jagged-edge that opens inward toward the interior or outward away from the interior of the bag). It has been found that this structure will discourage particles from clogging the openings of the inner layer. Jagged edges may be formed by any suitable method.

[0033] It should be understood that bags of other physical constructions are within the scope of the present invention. In this respect, it is not necessary that bags of the present invention be completely 2-ply (i.e. that each and every one of their faces is 2-ply). Also possible is a construction where only a portion or portions of the bags are 2-ply. The portion or portions may be on a single face or may be on multiple faces. Where the later is the case, it is not necessary that the portion of the inner layer having openings and the portion of the outer layer having openings be on the same face. It may be that these portions are remote from one another and it also may be that they are on different faces. What is important is that there be some pathway for air to egress the interior of the bag; the intermediate spaces of 2-ply areas must be fluidly connected.

[0034] For some applications (particularly those requiring cleanliness), it may be preferred that the openings of the outer layer are arranged with respect to each other such that the outer layer of the bag may be ripped apart (and removed from the bag) along a tear line including such openings. In such cases, the openings of the outer layer are preferably serrations (that may be easily torn) running across the length of the bag. In this manner, it may not be necessary to ship and store the bag in any particular fashion. The outer layer will be exposed to the environment but the inner layer will not. At an appropriate time, the outer layer may be removed and the clean inner layer and its contents may be used as desired.

[0035] In another aspect, as embodied and broadly described herein, the present invention also provides a multi-ply plastic bag comprising: an inner layer of air-impervious plastic material, at least a portion of which has openings therein permitting air to pass therethrough; an intermediate layer of air-impervious plastic material, at least a portion of which has openings therein permitting air to pass therethrough; and an outer layer of air-impervious plastic material, at least a portion of which has openings therein permitting air to pass therethrough.

[0036] It is preferred that the openings of the outer layer have an average opening area that is smaller than an average opening area of the openings of the intermediate layer; and the average opening area of the openings of the intermediate layer is smaller than an average opening area of the openings of the inner layer, whereby a filtering chamber is formed such that air in an interior of the bag may egress the bag by passing through the openings of the inner layer, through the openings of the intermediate layer, and through the openings of the outer layer, the air being at least partially filtered of particulate matter as it egresses the bag.

[0037] It is further preferred that the openings of the outer layer are offset from the openings of the intermediate layer; and the openings of the intermediate layer are offset from the openings of the inner layer. It also preferred that in the absence of air and particulate matter in the filtering chamber, the outer layer, the intermediate layer and the inner layer lie flat against one another. It is still also preferred that the total opening area of the openings of outer layer and the total opening area of the openings of the intermediate layer are each individually greater than the total opening area of the openings of the inner layer.

[0038] Preferably, as described herein above in relation to other aspects of the invention, the plastic bag has a plurality of faces including a front face and a rear face, and the openings are located solely on the front face and the rear face of the bag. Further, the inner-layer openings have a jagged edge and the outer-layer openings have a non-jagged edge.

[0039] Embodiments of the present invention each have at least one of the above-mentioned objects and/or aspects, but do not necessarily have all of them. It should be understood that some aspects of the present invention that have resulted from attempting to attain the above-mentioned objects may not satisfy these objects and/or may satisfy other objects not specifically recited herein.

[0040] Additional and/or alternative features, aspects, and advantages of the embodiments of the present invention will become apparent from the following description, the accompanying drawings, and the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0041] For a better understanding of the present invention, as well as other aspects and further features thereof, reference is made to the following description which is to be used in conjunction with the accompanying drawings, where:

[0042] FIG. **1** is a front elevation view of an unfilled bag of a first embodiment of the present invention;

[0043] FIG. **2** is cross-sectional view of the bag of FIG. **1** taken along the line **2-2** therein;

[0044] FIG. **3** is a rear left perspective view of a filled bag of FIG. **1**;

[0045] FIG. **4** is a close-up top plan view of the front surface of the inner layer of the bag of FIG. **1**;

[0046] FIG. **5** is a close-up top plan view of an opening on the front surface of the inner layer of the bag of FIG. **1**;

[0047] FIG. **6** is a cross-sectional view of the opening of FIG. **5**;

[0048] FIG. **7** is a close-up top plan view of the front surface of the outer layer of the bag of FIG. **1**;

[0049] FIG. **8** is a close-up top plan view of an opening on the front surface of the outer layer of the bag of FIG. **1**;

[0050] FIG. **9** is a cross-sectional view of the opening of FIG. **8**;

[0051] FIG. **10** is top plan view showing a comparison of the openings of FIGS. **5** and **8**;

[0052] FIG. **11** is close-up cross sectional view of the front surfaces of the inner and outer layers of the bag of FIG. **1**, showing the offset of the openings therein;

[0053] FIG. **12** is a schematic cross-sectional view of a filled bag of the present invention on a pallet;

[0054] FIG. **13** is a close-up cross sectional view of the front surfaces of the inner and outer layers of the bag of FIG. **12**, showing the action of the filtering chamber therebetween;

[0055] FIG. **14** is a close-up cross sectional view of the rear surfaces of the inner and outer layers of the bag of FIG. **12**;

[0056] FIG. **15** is a close-up cross sectional view of the front surfaces of the inner and outer layers of the bag of FIG. **12** as well the rear surfaces of the inner and outer layers of a second bag of similar construction placed on top of the bag of FIG. **12** on the pallet;

[0057] FIG. **16** is a front elevation view of a bag of a second embodiment of the present invention;

[0058] FIG. **17** is cross-sectional view of a bag of a third embodiment of the present invention;

[0059] FIG. **18** is close-up cross sectional view of the bag of FIG. **17**;

[0060] FIG. **19** a top plan view showing a comparison of the openings of FIG. **18**;

[0061] FIG. **20** is a front elevation view of an unfilled bag of a fourth embodiment of the present invention; and

[0062] FIG. **21** is a close-up top plan view of the front surface of the inner layer of the bag of FIG. **20**.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0063] In FIG. **1** of the present invention there is shown a bag **10** similar (albeit constructed according to the teachings of the present invention) to one described in the '005 publication. It should be understood that this bag is described herein only as a preferred embodiment. Other embodiments are possible in accordance with the teachings of the present invention.

[0064] In FIG. **1**, bag **10** (collapsed) has a top face **12** and a bottom face **14**, left- and right side gussets **16'** and **16**, respectively, with left- and right-side center gusset creases **18'** and **18** respectively. (For ease of understanding, it should be noted that the left side of the bag is closer to the right edge of the drawing page (and vice versa), as it is the bag's left, and not the viewer of the drawing's left, that is being referred to.) Extending inward from the right-side center gusset crease **18** are internal flap edges **20** and **22** (the latter not shown in FIG. **1** as it lies directly underneath internal flap edge **20**). Internal lap sealed portion **24** (the shaded strip) is the narrow strip of material in between right-side center gusset crease **18** and internal flap edges **20** and **22**, and runs continuously from bag top **12** to bottom **14**. As viewed, the lap sealed portion **24** lies inside of the bag **10** adjacent to the right-side center gusset crease **18**, and the lap seal defining right-side center gusset crease **18**. With the lap seal facing inward, inside the bag, the outer surface of the bag has no ridges or seals pointed outward.

[0065] As can be seen in FIG. **2**, bag **10** is of a 2-ply construction, having an outer layer **40** and an inner layer **42**. (The 2-ply nature of the bag **10** is not shown in FIG. **1** simply for ease of understanding.) The outer layer and the inner layer may be of plastic material suitable for the intended use of the bag. Thermoplastic resins blends such as polyolefin resin blends and polyethylene resin blends are non-limiting examples of preferred materials.

[0066] The bag **10** has front face **26** and a rear face **28**. The front face **26** has an outer layer **26***o* (being a portion of the outer layer **40**) and an inner layer **26***i* (being a portion of the inner layer **42**). Similarly, the rear face **28** has an outer layer **28***o* (being a portion of the outer layer **40**) and an inner layer **28***i* (being a portion of the inner layer **42**).

[0067] The bag **10** also has a right side face **31** and a left side face **35**. The right side face **31** has an outer layer **31***o* (being a portion of the outer layer **40**) and an inner layer **31***i* (being a portion of the inner layer **42**). The right side face outer layer **31** o is formed from a right side front gusset outer layer **30***o*, a right side rear gusset outer layer **32***o*, and a right side center gusset crease **18**. The right side face inner layer **31***i* is formed from a right side front gusset inner layer **30***i*, a right side rear gusset inner **32***i*, and the right side center gusset crease **18**. The left side face **35** has an outer layer **35***o* (being a portion of the outer layer **40**) and an inner layer **35***i* (being a portion of the inner layer **42**). The left side face outer layer **35***o* is formed from a left side front gusset outer layer **34***o* and a left side rear gusset outer layer **36***o*. The left side face inner layer **35***i* is formed from a left side front gusset inner layer **34***i* and a left side rear gusset inner **36***i*. (For ease of understanding there is a gap shown in FIG. **2** between the inner layer **42** and the outer layer **40** layers of the bag **10**. It should be understood however, that ideally there is no such gap when the bag **10** is flat and unfilled. The gap illustrates intermediate spaces associated with of the various layers of the faces. For example, there is an intermediate space **46***o* associated with the front face outer layer **26***o*, an intermediate space **46***i* associated with the front face inner layer **26***i*, an intermediate space **48***o* associated with the rear face outer layer **28***o*, and an intermediate space **48***i* associated with the rear face inner layer **28***i*. These intermediate spaces will form part of the filtering chamber **44**, best shown in FIG. **13**.)

[0068] In between the right side center gusset crease **18** and internal flap edges **20** and **22** is internal lap-sealed portion **24**. (The lap-sealed portion sealing the inner layer **42** and outer layer **40** together, each of these portions of the bag is labelled as a single common portion.) This lap-sealed portion may be a strip as narrow as 3 mm or may be wider.

[0069] In FIG. **3** bag **10** has been filled with a flowable material (air and material mixture under pressure) and sealed at the top edge **12**. Right side center gusset crease **18** is one continuous crease formed by the internal lap-sealed portion **24** (the latter not shown since it is inside bag **10**). The outer appearance of center gusset crease **18** looks much like that of any other side gusset crease commonly seen in standard tube-type bags, that is, one clean, continuous fold.

[0070] Referring still to FIGS. **1** to **3**, there are marked areas (**27** in FIGS. **1** & **3**) on the front face outer layer **26***o* (marked area being **27***o* in FIG. **2**), front face inner layer **26***i* (marked area being **27***i* in FIG. **2**), rear face outer layer **28***o* (marked area being **29***o* in FIG. **2**), and rear face inner layer **28***i* (marked area **29***i* in FIG. **2**). These areas have openings therein (described hereinbelow), although the openings have been omitted in these figures for ease of illustration.

[0071] FIG. **4** shows a close-up view of the marked area **27***i* of front surface inner layer **26***i*. Openings **25***i* can be seen. The openings are preferably slits being 500 microns long and 100 microns wide. The openings **25***i* are shown at a regularly-spaced intervals (which is preferably along a grid 1.25 cm apart in both directions), but this is merely a preferred configuration. FIG. **5** shows a close-up view of single opening **25***i* shown in FIG. **4**. The opening **25***i* is irregular in shape, again this being a preferred configuration. Finally, FIG. **6** shows a cross-sectional view of the opening **25***i* of FIG. **5**. The opening **25***i* has an (outwardly) jagged edge **33***i*. The marked area **29***i* of the rear surface inner layer **28***i* has similar openings.

[0072] FIG. **7** shows a close-up view of the marked area **27***o* of front surface outer layer **26***o*. Openings **25***o* can be seen. The opening are preferably circular and have a diameter of between **20** and 100 microns, with 50 microns being most preferred. The openings **25***o* are shown at a regularly-spaced intervals (which is preferably along a grid 5 mm apart in both directions), but this is merely a preferred configuration. FIG. **8** shows a close-up view of single opening **25***o* shown in FIG. **7**. The opening **25***o* is regular in shape, again this being a preferred configuration. Finally, FIG. **9** shows a cross-sectional view of the opening **25***o* of FIG. **8**. The opening **25***o* has a smooth edge **33***o*. The marked area **29***o* of the rear surface outer layer **28***o* has similar openings.

[0073] FIG. **10** shows the relative size difference between the openings **25***i* of the inner layer **26***i*/**28***i* and the openings **25***o* of the outer layer **26***o*/**28***o*.

[0074] FIG. **11** shows the relative positioning of the openings **25***i* of the rear face inner layer **28***i* and the openings **25***o* of the rear face outer layer **28***o*. As can be seen, the openings **25***i* are offset from the openings **25***o*.

[0075] FIG. **12** shows a bag **10** that has been filled with particulate material **37** and has been placed on a palette rear face **28** down. (The filling of the bag could have been by any conventional means, including those described in the '005 publication.). Air is entrapped within the particulate matter **37**. FIG. **13** shows a close-up of the front face of the bag. As can be seen, particulate matter **37** is made up a particles of different sizes, for ease of illustration shown as large particles **37***a*, medium particles **37***b*, and small particles **37***c*. Air under pressure inside the bag a result of the filling of the bag, will flow out of the bag in the path shown, first through an opening **25***i* of the front face inner layer **26***i* and into filter chamber **44** between the front face inner layer **26***i* and the front face outer layer **26***o* (the air will force the inner layer **26***i* and the outer layers **26***o* apart to create the filter chamber **44**) and then from the filter chamber **44** through an opening **25***o* of the front face outer layer **26***o* to the environment. As can be seen, the opening **25***i* is of such as size so as to prevent large particles **37***a* from entering the filter chamber **44**. Further, opening **25***o* is of such as size so as to prevent medium particles **37***b* from exiting the filter chamber. (Those particles will remain in the filter chamber **44** or flow back into the interior of the bag **10** through an opening **25***i*.) Only small particles **37***c* are of a size that can exit the bag **10** through the opening **25***o* (and only then if they actually reach the opening **25***o*. Some will impact the outer layer **26***o* and be deflected into the filter chamber **44** to a point where they cannot reach an opening **25***o*). In this manner, air is filtered as it exists the bag **10**.

[0076] FIG. **14** shows a close-up of the rear face **28** of the bag **10** of FIG. **12**. The weight of the particles **37** maintains the rear face outer layer **28***o* and rear face inner layer **28***i* together such the openings **25***i* and **25***o* are effectively sealed on that face **28**. (The edge **33***i* of the opening **25***i* of the rear face inner layer **28***i* has collapsed into the opening **25***i*.) No filter chamber is formed and no air can escape the bag through the rear face **28** of the bag.

[0077] FIG. **15** shows a close up of the front face **28** of the bag **10** after a second bag **10'** has been placed on top. In this case, the weight of the second bag **10'** helps to seal and discourage moisture from entering the first bag **10** as it forces the front face of the outer layer **28***o* of the first bag **10** against the front face inner layer **28***i* of the first bag **10**, sealing off the openings **25***i*/**25***o*. (Some small **37***c* and medium particles **37***b* remain trapped between the layers.) In addition, adding to this effect, the rear face outer layer **28***o'* of the second bag **10'** blocks off the openings **25***o* of the front surface the outer layer **28***o* of the first bag **10**.

[0078] FIG. **16** shows a second embodiment of the present invention, a gusset valve bag **210**. Valve bag **210** is similar to the previously described first embodiment of the present invention gusset bag **10**, with the exception of the presence of a valve portion similar to that found on conventional paper valve bags. In valve bag **210**, internal lap-sealed portion **224** (shaded portion) is a narrow sealed strip that lies adjacent to side center gusset crease **218** and spaced from internal flap edges **250**, but runs continuously only from bag bottom face **214** up to a point **256** where it stops. Valve opening **258** is the unsealed portion that lies along the center gusset crease **218** in between point **256** and bag top face **212**, and is suitable for allowing entry of a fill nozzle much like those used to fill standard paper valve bags. With valve opening **258** positioned at the center gusset crease, it is easy and natural for the user to find the valve opening **258** of bag **210** and mount it on a fill nozzle. In between lap-sealed portion **254** and valve opening **258**, and internal flap edges **250**, lie internal flap portions **260** that run continuously from bag top face **212** to bag bottom face **214**. Typically flap portions **260** may extend inward, inside bag **210**, about 5 cm to 7.5 cm depending on bag size, but could be more or less. Horizontal seal **264** begins at point **256** and runs approximately horizontally into internal flap portions **260**. The area in between horizontal seal **264** and sealed bag top **212** forms a valve sleeve **265**, which sleeve, along with valve opening **258**, typically measure about the same overall circumference, or slightly greater, as an existing prior art fill nozzle. Thus, valve opening **258** and valve sleeve **265** may be mounted onto a fill nozzle with a reasonably snug fit, preventing leakage as the bag is filled, and subsequently collapsing upon itself after filling, so that the flowable material contained inside will not leak out. In other respect, for instance the presence of openings in area **227**, the bag **210** is similar to bag **10** of the first embodiment.

[0079] FIG. **17** shows a third embodiment of the present invention, multi-ply bag **310**. As can be seen in FIG. **17**, bag **310** is of a 3-ply construction, having an outer layer **340**, an inner layer **342**, and an intermediate layer **341** therebetween. The bag **310** has front face **326** and a rear face **328**. The front face **326** has an outer layer **326***o* (being a portion of the outer layer **340**), an intermediate layer **326***m* (being a portion of the intermediate layer **341**) and an inner layer **326***i* (being a portion of the inner layer **342**). Similarly, the rear face **328** has an outer layer **328***o* (being a portion of the outer layer **240**), an intermediate layer **328***m* (being a portion of the intermediate layer **341**) and an inner layer **328***i* (being a portion of the inner layer **342**).

[0080] The bag **310** also has a right side face **331** and a left side face **335**. The right side face **331** has an outer layer **331***o* (being a portion of the outer layer **340**), an intermediate layer **331***m* (being a portion of the intermediate layer **341**) and an inner layer **331***i* (being a portion of the inner layer **342**). The right side face outer layer **331***o* is formed from a right side front gusset outer layer **330***o*, a right side rear gusset outer layer **332***o*, and a right side center gusset crease **318**. The right side face intermediate layer **331***m* is formed from a right side front gusset intermediate layer **330***m*, a right side rear gusset intermediate layer **332***m*, and a right side center gusset crease **318**. The right side face inner layer **331***i* is formed from a right side front gusset inner layer **330***i*, a right side rear gusset inner **332***i*, and the right side center gusset crease **318**. The left side

face **335** has an outer layer **335***o* (being a portion of the outer layer **340**), an intermediate layer **335***m* (being a portion of the intermediate layer **341**) and an inner layer **335***i* (being a portion of the inner layer **342**). The left side face outer layer **335***o* is formed from a left side front gusset outer layer **334***o* and a left side rear gusset outer layer **336***o*. The left side face intermediate layer **335***m* is formed from a left side front gusset intermediate layer **334***m* and a left side rear gusset intermediate layer **336***m*. The left side face inner layer **335***i* is formed from a left side front gusset inner layer **334***i* and a left side rear gusset inner **336***i*. (In FIG. **17** the layers are shown as flat and lying together with no gap therebetween. This is the preferred state before the bag is filed.

[0081] In between the right side center gusset crease **318** and internal flap edges **320** and **322** is internal lap-sealed portion **324**. The lap-sealed portion sealing the inner layer **342**, intermediate layer **341**, and outer layer **340** together. This lap-sealed portion may be a strip as narrow as 3 mm or may be wider.

[0082] As shown in FIG. **18**, when the bag **310** is filled and has air entrapped therein, the inner layer **342** and the intermediate layer **341** will separate from each other forming an inner filter chamber **344***i*. Similarly the intermediate layer **341** and the outer layer **342** will separate from each other forming an outer filter chamber **344***o*. Air will egress the bag by flowing from the interior into the inner filter chamber **344***i*, then into the outer filter chamber **344***o*, and finally to the environment. FIG. **18** also shows the relative positioning of the openings **325***i* of the front face inner layer **326***i*, the openings **325***m* of the front face intermediate layer **326***m*, and the openings **325***o* of the front face outer layer **326***o*. As can be seen, the openings **325***o* are offset from the openings **325***m* and the openings **325***m* are offset from the openings **325***i*.

[0083] FIG. **19** shows the relative size difference between the openings **325***i* of the inner layer **342**, the openings **325***m* of the intermediate layer **341**, and the openings **325***o* of the outer layer **340**. The openings **325***i* of the inner layer **342** are preferably irregularly-shaped slits being 500 microns long and 100 microns wide, being formed by slicing with a spinning blade. They preferably have an (outwardly) jagged edge **333***i* (FIG. **18**). The openings **325***o* of the outer layer **340** and the openings **325***m* of the intermediate layer **341** are preferably circular and have a diameter of between 20 and 100 microns (with openings **325***m* of the intermediate layer **341** being larger than those **325***o* of the outer lawyer **340**), preferably being formed by needle perforation. They preferably have an (outwardly) smooth edge **333***o*/**333***m*. In this manner the inner filter chamber **344***i* and outer filer chamber **344***o* progressively filter air egressing the bag therethrough.

[0084] In FIG. **20**, There is shown a bag **400** (collapsed) of a 2-ply construction in accordance with a fourth embodiment. Bag **400** has a top face **402** and a bottom face **404**, a front face **401** and a rear face **403** (not shown) which is identical to the front face **401**, Bag also has right- and left side gussets **406** and **406'**, respectively, with right- and left-side center gusset creases **408** and **408'** respectively. Bag **400** has an outer layer **410** and an inner layer **412** (FIG. **21**). The 2-ply nature of the bag **400** is not shown in FIG. **20** for ease of understanding. The inner layer **412** of the bag **400** is micro-perforated with openings **414** having a diameter of between 20 and 100 microns, with 50 to 75 microns being the most preferred. The outer layer **410** is not perforated but includes four serrations. Each serration extending substantially the entire length of the bag **400** from the top face **402** to the bottom face **404**. Specifically, there is a first serration **416***a* extending the length of bag **400** on the right side of the front face **401**, a second serration **416***b* extending the length of bag **400** on the left side of the front face **401**, and two similarly positioned serrations on the right side and the left side of the rear face **403** of the bag **400**.

[0085] Bag **400** is destined to be used in a food application, where a virtually impermeable (although not quite) outer layer **410** is required to prevent dust from entering into the bag **400** at all. Air evacuation is slower than previous embodiments since the inner layer **412** includes micro-openings **414** of between 20 and 100 microns and air can only evacuate through the serrations **416** of the outer layer **410**. The serrations **416** are preferably larger in size than the openings **414**. However, the openings **414** of the inner layer **412** could be larger than the serrations **416** for food products that are not powdery such as grains and flakes.

[0086] The serrations **416** are designed so that the outer layer **410** can be removed just before the bag **400** is emptied. For example bags **400** is filled with a food product such as batter mix, then shipped to a user and stored. When the bag **400** is ready to be used, it is placed in a clean room where it is opened and the product is dumped into the batch mix. Just before going into the clean room, an operator rips the outer layer **410** of the front face **401** and the rear face **403** along a tear line including the serrations **416**, removes outer layer **410** from the bag and discards it. The bag **400** is now clean since the inner layer **412** remains and it was never exposed to the outside environment. The bag **400** is then brought into the clean room, cut open and the product is dispensed into an appropriate processor for processing.

[0087] A bag **400** provided with outer layer **410** including serrations that allow removal of the outer layer **410** may be, for example, either an open-mouth bag which is sealed after being filled or a valve bag as previously described.

[0088] Modifications and improvements to the above-described embodiments of the present invention may become apparent to those skilled in the art. The foregoing description is intended to be exemplary rather than limiting. The scope of the present invention is therefore intended to be limited solely by the scope of the appended claims

1. A plastic bag comprising:

a first face, at least a portion thereof being 2-ply and having a first intermediate space therebetween, the 2-ply portion of the first face having an inner layer of air-impervious plastic material having openings therein permitting air to pass therethrough;

a second face, at least a portion thereof being 2-ply and having a second intermediate space therebetween, the 2-ply portion of the second face having an outer layer of air-impervious plastic material, the outer layer having openings therein permitting air to pass therethrough, the openings of the outer layer having a smaller average opening area than an average opening area of the openings of the inner layer of the first face, the first intermediate space and the second intermediate space being fluidly interconnected;

whereby a first filtering chamber is formed between the inner layer and the outer layer such that air in an interior of the bag may egress the bag by passing through the openings of the inner layer and through the openings of the outer layer, the air being at least partially filtered of particulate matter as it egresses the bag.

2. The plastic bag of claim **1**, wherein the bag is a 2-ply bag.

3. The plastic bag of claim 2, wherein the first face and the second face are different faces of the bag.

4. The plastic bag of claim 3, wherein no other layer of any other face of the bag has openings therein permitting air to pass therethrough.

5. The plastic bag of claim 2, wherein the first face and the second face are the same face of the bag.

6. The plastic bag of claim 5, wherein the first intermediate space and the second intermediate space are the same intermediate space.

7. The plastic bag of claim 6, wherein the openings of the outer layer of the second face are offset from the openings of the inner layer of the first face.

8. The plastic bag of claim 6, wherein in the absence of air and particulate matter in the filtering chamber, the outer layer of the second face and the inner layer of the first face lie flat against one another.

9. The plastic bag of claim 6, further comprising:

a third face, at least a portion thereof being 2-ply and having a third intermediate space therebetween, the 2-ply portion of the third face having an inner layer of air-impervious plastic material having openings therein permitting air to pass therethrough;

a fourth face, at least a portion thereof being 2-ply and having a fourth intermediate space therebetween, the 2-ply portion of the fourth face having an outer layer of air-impervious plastic material, the outer layer having openings therein permitting air to pass therethrough, the openings of the outer layer having a smaller average opening area than an average opening area of the openings of the inner layer of the third face, the third intermediate space and the fourth intermediate space being fluidly interconnected;

whereby a second filtering chamber is formed between the inner layer and the outer layer such that air in an interior of the bag may egress the bag by passing through the openings of the inner layer and through the openings of the outer layer, the air being at least partially filtered of particulate matter as it egresses the bag.

10. The plastic bag of claim 9, wherein the first intermediate space, the second intermediate space, the third intermediate space, and the fourth intermediate space are all fluidly interconnected forming such that the first filtering chamber and the second filtering chamber are the same filtering chamber.

11. The plastic bag of claim 10, wherein the third face and the fourth face are the same face of the bag.

12. The plastic bag of claim 11, wherein the third intermediate space and the fourth intermediate space are the same intermediate space.

13. The plastic bag of claim 12, wherein the openings of the outer layer of the fourth face are offset from the openings of the inner layer of the third face.

14. The plastic bag of claim 11, wherein in the absence of air and particulate matter in the filtering chamber, the outer layer of the fourth face and the inner layer of the third face lie flat against one another.

15. The plastic bag of claim 12, wherein the first face and the second face are a front face of the bag, and the third face and the fourth face are a rear face of the bag.

16. The plastic bag of claim 15, wherein only the front face and the rear face of the bag have a layer having openings therein.

17. The plastic bag of claim 15, wherein the openings in the outer layer of the second face and the openings in the outer layer of the fourth face are arranged with respect to each other such that the outer layer of the bag may be ripped apart along a tear line including such openings.

18. The plastic bag of claim 1, wherein the inner-layer openings have a jagged edge.

19. The plastic bag of claim 18, wherein the outer-layer openings have a non-jagged edge.

20. The plastic bag of claim 1, wherein a total opening area of the openings of the inner layer is greater than a total opening area of the openings of the outer layer.

21. A plastic bag comprising:

an inner layer of air-impervious plastic material, at least a portion of which has openings therein permitting air to pass therethrough;

an intermediate layer of air-impervious plastic material, at least a portion of which has openings therein permitting air to pass therethrough; and

an outer layer of air-impervious plastic material, at least a portion of which has openings therein permitting air to pass therethrough.

22. The plastic bag of claim 21, wherein:

the openings of the outer layer have an average opening area that is smaller than an average opening area of the openings of the intermediate layer; and

the average opening area of the openings of the intermediate layer is smaller than an average opening area of the openings of the inner layer

whereby a filtering chamber is formed such that air in an interior of the bag may egress the bag by passing through the openings of the inner layer, through the openings of the intermediate layer, and through the openings of the outer layer, the air being at least partially filtered of particulate matter as it egresses the bag.

23. The plastic bag of claim 22, wherein

the openings of the outer layer are offset from the openings of the intermediate layer; and

the openings of the intermediate layer are offset from the openings of the inner layer.

24. The plastic bag of claim 22, wherein in the absence of air and particulate matter in the filtering chamber, the outer layer, the intermediate layer and the inner layer lie flat against one another.

25. The plastic bag of claim 22, wherein the bag has a plurality of faces including a front face and a rear face, and the openings are located solely on the front face and the rear face of the bag.

26. The plastic bag of claim 22, wherein the inner-layer openings have a jagged edge.

27. The plastic bag of claim 26, wherein the outer-layer openings have a non-jagged edge.

28. A plastic bag comprising:

a front face;

a rear face;

at least a portion of the front and rear face being 2-ply and having a first intermediate space therebetween;

the 2-ply portion of the front and rear face each having an inner layer of air-impervious plastic material, the inner layers having openings therein permitting air to pass therethrough;

the 2-ply portion of the front and rear face each having an outer layer of air-impervious plastic material, each of the

outer layers having openings permitting air to pass therethrough, the openings of the outer layers arranged with respect to each other such that the outer layer made be removed from the bag by being ripped along a tear including the openings of the outer layer.

29. The plastic bag of claim **28**, wherein the openings of the outer layer are serrations at least a length of the bag.

30. The plastic bag of claim **29**, wherein the bag is one selected from a group consisting of open-mouth bags and valve bags.

31. The plastic bag of claim **29**, wherein:

the openings of the outer layer have an average opening area that is smaller than an average opening area of the openings of the inner layer;

whereby a filtering chamber is formed such that air in an interior of the bag may egress the bag by passing through the openings of the inner layer and through the openings of the outer layer, the air being at least partially filtered of particulate matter as it egresses the bag.

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