(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
26 January 2012 (26.01.2012)

PCT

(10) International Publication Number
WO 2012/011891 A2

(51) International Patent Classification:
A61K 48/00 (2006.01)

(21) International Application Number:
PCT/US2010/042398

(22) International Filing Date:
19 July 2010 (19.07.2010)

(25) Filing Language: English

(26) Publication Language: English

(71) Applicant *(for all designated States except US)*: TREDEGAR FILM PRODUCTS CORPORATION [US/US]; 1100 Boulders Parkway, Richmond, VA 23225 (US).

(72) Inventor; and
(75) Inventor/Applicant *(for US only)*: DI CESARE, Ezio [IT/IT]; Viale Maiella 19, I-66023 Francavilla Al Mare (IT).

(74) Agent: TESSARI, Joseph, A.; 301 Lindenwood Drive, Suite 206, Malvern, PA 19355 (US).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— *of inventorship (Rule 4.17(iv))*

Published:

— *without international search report and to be republished upon receipt of that report (Rule 48.2(g))*

WO 2012/011891 A2

(54) **Title**: LAMINATES FOR CROP PROTECTION

(57) **Abstract**: Both food and non-food crops can be protected using a laminate made from a three-dimensional apertured film in combination with reinforcing scrim, a second three-dimensional apertured film, a nonwoven web and combinations thereof. The laminates provide the plants with diffused and/or reduced light and can effectively be used to control moisture on or near the plants, or to control weeds by applying the laminates to the soil surrounding the crop.

LAMINATES FOR CROP PROTECTION

Background

[0001] The disclosure is directed to laminates and to a method of protecting crops using such laminates.

[0002] In the agricultural industry, films are used to protect crops from environmental hazards. As used herein, the term "crops" is meant to include both the plant itself and any fruit or other product produced and/or harvested from a plant. Crops can include food crops, such as tomatoes, corn, grapes, etc. and non-food crops, such as flowers, plants for use in making biofuels, etc.

[0003] Certain crops fair best when protected from excessive rain, wind and sunlight. In addition, it is often desired to protect crops from insects, birds or other animals that may eat the fruits produced by the crops, or to cover the crops and protect them from temperature changes that may negatively affect the crop. For example, it is known in the art to manufacture a greenhouse structures applying a film to a supporting framework.

[0004] While it is important to protect the crops in these circumstances, it is also important that the covering not unnecessarily interfere with transmission of the essential amounts of light, moisture and most importantly air circulation. In particular, while covering a crop with a film may reduce the amount of light and/or moisture that can reach the crop, the temperature under the covering may reach 70°C or 80°C, which can result in death of the plant. Therefore, it is often necessary to prevent moisture from penetrating the covering in a first direction while simultaneously maximizing air flow through the covering in an opposite direction.

Summary

[0005] In one embodiment, the disclosure provides a process of protecting a growing crop comprising the step of covering the crop with a laminate, said laminate comprising a first apertured three-dimensional film bonded to a second apertured three-dimensional film.

[0006] In another embodiment, the disclosure provides a process of protecting a crop, comprising the step of covering the ground immediately surrounding the crop with a laminate, said laminate comprising a first apertured three-dimensional film bonded to a second apertured three-dimensional film.

[0007] In another embodiment, the laminate further comprises a nonwoven web laminated to at least one of the three-dimensional films.

[0008] In another embodiment, at least one of the apertured films comprises protuberances disposed at an obtuse angle relative to the base plane of the film.

[0009] In one embodiment, at least one of the apertured films comprises two sets of protuberances disposed at an obtuse angle relative to the base plane of the film, wherein one set of protuberances is oriented at a angle (such as 180 degrees) relative to the other.

[0010] In another embodiment, at least one of the apertured films contains a reinforced region to prevent tearing or punctures.

[0011] In one embodiment, the laminate comprises a three-dimensional apertured film bonded to a reinforcing mesh fabric.

[0012] A further understanding of the embodiments may be obtained upon reading of the following detailed description with reference to the accompanying drawings and the appended claims.

Brief Description of The Figures

[0013] Figure 1 is a cross-section of one embodiment of a laminate for use in protecting crops in accordance with the disclosure.

[0014] Figure 2 is a cross-section of one embodiment of a laminate for use in protecting crops in accordance with the disclosure.

[0015] Figure 3 is a cross-section of one embodiment of a laminate for use in protecting crops in accordance with the disclosure.

[0016] Figure 4 is a cross-section of one embodiment of a laminate for use in protecting crops in accordance with the disclosure.

[0017] Figure 5 is a cross-section of one embodiment of a laminate for use in protecting crops in accordance with the disclosure.

[0018] Figure 6 is a cross-section of one embodiment of a laminate for use in protecting crops in accordance with the disclosure.

[0019] Figure 7 is a cross-section of one embodiment of a laminate for use in protecting crops in accordance with the disclosure.

[0020] Figure 8 is a cross-section of one embodiment of a laminate for use in protecting crops in accordance with the disclosure.

[0021] Figure 9 is a cross-section of one embodiment of a laminate for use in protecting crops in accordance with the disclosure.

Description

[0022] The unique ability of three-dimensional films to manage the flow of liquids and gasses through the film make them ideal candidates for crop protection and other agricultural applications. Apertured or perforated plastic films are well known and essentially comprise a planar film with holes in it. Such films are generally divided in to two categories: two-dimensional films and three-dimensional films. While all films are three-dimensional in the sense that they have length, width and thickness, the term "three-dimensional films" as used herein refers to films that have a plurality of protuberances on their surface which provide the film with a thickness or loft that is greater than the nominal thickness of the film.

[0023] In three-dimensional apertured films, the protuberances terminate in an aperture at the end remote from their point of origin on the plane of the film. The apertures thus define a secondary film plane that is generally parallel to and spaced from the base plane of the film. Two-dimensional films lack the surface structures or protuberances that characterize three-dimensional films in the art.

[0024] Two-dimensional apertured films are generally prepared by die cutting, needle punching or otherwise mechanically forming a series of holes in the film. Three-dimensional films, however, require special techniques to produce the three-dimensional protuberances. Typically, three-dimensional films are produced using either a vacuum forming process or a hydroforming process.

[0025] In the vacuum forming process, a film is placed on a rotating screen having a plurality of holes. The film passes over a vacuum chamber as the screen rotates, creating a pressure differential on either side of the plastic film. The pressure differential causes the film to rupture at locations corresponding to the holes in the screen to form the apertures. The holes in the screen may be in a specific pattern or shape that transfers onto the film in the process.

[0026] The vacuum forming process may be practiced using a precursor film that is heated to a softening point prior to being subjected to vacuum (so-called reheat process) or is practiced using a molten sheet of polymer that is cast onto the screen immediately prior to the vacuum (so called direct cast process). In either case, the film is supported by the screen and a vacuum applied to the underside of the perforated screen. Film is pulled by the vacuum until it ruptures. In the process, the film is cooled as it is being pulled, such that the resulting product has a plurality of tapered, funnel-shaped protuberances with an aperture at the apex of the structure.

[0027] In the hydroforming process, a precursor film is heated to above the softening point and columnar streams of high pressure water are directed against the surface of the film while the film is supported on a forming structure. The pressure from the water jets deforms the film and forces the film into holes in the forming structure until the film ruptures, forming an aperture. The film is quenched in the process, thereby resulting in three-dimensional apertured protuberances as in the vacuum forming process.

[0028] Many methods and apparatuses for preparing plastic films comprising apertures have been developed, examples include US Patent Nos. 4,155,693; 4,252,516; 3,709,647; 4,151,240; 4,319,868; 4,388,056; 4,950,511; 4,948,638; 5,614,283; 5,887,543, 5,897,543; 5,718,928;

5,591,510; and 5,562,932; 3,054,148; and 3,814,101, which are all hereby incorporated by reference.

[0029] Laminates of three-dimensional films are also known. For example, US 4,995,930 discloses a process in which a film is simultaneously apertured and bonded to a nonwoven web to form an apertured film laminate. Similarly, US 5,698,054 discloses a variety of laminates wherein an apertured film is bonded to another apertured film, a non-apertured (or "flat") film, and/or a nonwoven web. Both of these patents are incorporated herein by reference in their entirety.

[0030] One advantage of three-dimensional films is that the apertures tend to act as a one-way valve in that liquids tend to flow through the films better in one direction versus the other. However, air passes through the films equally in both directions.

[0031] With reference to Figure 1, a first embodiment of a laminate 10 for use in protecting crops is illustrated. The laminate 10 comprises a first film layer 11 and a second film layer 12. The first film layer 11 comprises a formed film having a plurality of three-dimensional protuberances 13 having sidewalls 14 that originate on the female side 15 of the film 11 and extend in the z-direction (as indicated by arrow Z in Figure 1). The sidewalls 14 terminate on the male side 16 of the film 11. The protuberances define an aperture 17 on the male side 16 of the film 11. The male side 16 of the film 11 defines a plane that is spaced from and generally parallel to the base plane defined by the female side 15 of the film 11.

[0032] The second film 12 is similar to the first film 11 and also comprises a three-dimensional formed film. Film 12 has a plurality of three-dimensional protuberances 22 having side walls 23 that originate on the female side 24 of the film 12 and extend in the z-direction. The side walls

23 terminate on the male side 25 of the film 12 and define an aperture 26. The male side 25 defines a plane that is spaced from and generally parallel to the plane defined by the female side 24 of the film 12.

[0033] As seen in Figure 1, the protuberances 13, 22 have a taper such that the opening 20, 27 on the female side 15, 24 has a greater diameter than the aperture 17, 26 on the male side 16, 25 of the films 11, 12, respectively. In this configuration, it is easier for liquids to pass from the female side 15, 24 to the male side 16, 25, but harder for liquids to pass in the opposite direction; i.e., from the male side 16, 25 to the female side 15, 24. Air, however, will pass freely through the film in both directions equally well.

[0034] Each of the films 11, 12 may be formed by the vacuum process or the hydroforming process described above. The laminate 10 of Figure 1 may be produced by laminating the first three-dimensional film 11 to the second three-dimensional film 12 in accordance with US 5,698,054, which is incorporated herein by reference.

[0035] With reference to Figure 2, an embodiment of the laminate 102 is illustrated therein. The laminate in this embodiment comprises a first film 11 and a second film 12, which are identical to those of the embodiment in Figure 1 and share the same reference numerals. In this embodiment, however, the laminate 102 further comprises a nonwoven web 30 laminated to the male side 25 of the second film 12.

[0036] The laminate 102 shown in Figure 2 may be formed by making the film/film laminate as in Figure 1 and then subsequently bonding the nonwoven web 30 to the film/film bilaminate. Bonding may be accomplished by any suitable process, including adhesive lamination and ultrasonic bonding, for example.

[0037] The laminate 102 of Figure 2 may be prepared in the same manner as the prior laminates. Alternatively, the laminate 102 may be prepared by depositing the nonwoven web 30 onto a forming screen, extruding a molten polymer film onto the nonwoven web, applying the three-dimensional film 11, then subjecting the resulting structure to vacuum to form the three-dimensional film 12 and simultaneously bond the film and nonwoven layers together.

[0038] Another embodiment of the laminate is shown in Figure 3. In this embodiment, the laminate 103 comprises a first film layer 11 and a second film layer 12 which are identical to those in the previous embodiments. In this embodiment, the laminate 103 further includes a nonwoven web 30. However, unlike the embodiment of Figure 2, the nonwoven web 30 is laminated to the female side 15 of the first film layer 11.

[0039] With reference to Figure 4, another embodiment of the laminate is illustrated therein. In this embodiment, the laminate 104 comprises a first film layer 411 and a second film layer 412. The first film layer 411 comprises a formed film having a plurality of three-dimensional protuberances 413 having sidewalls 414 that originate on the female side 415 of the film 411 and extend in the z-direction. The sidewalls 414 terminate on the male side 416 of the film 411. The protuberances define an aperture 417 on the male side 416 of the film 411. The male side 416 of the film 411 defines a plane that is spaced from and generally parallel to the base plane defined by the female side 415 of the film 411.

[0040] The second film 412 is similar to the first film 411 and also comprises a three-dimensional formed film. Film 412 has a plurality of three-dimensional protuberances 422 having side walls 423 that originate on the female side 424 of the film 412 and extend in the z-direction. The side walls 423 terminate on the male side 425 of the film 412 and define an aperture 426. The male side 425 defines a plane that is spaced from and generally parallel to the plane defined by the female side 424 of the film 412.

[0041] As seen in Figure 4, the protuberances 413, 422 are oriented at an angle 440 relative to the plane formed by the female side 415, 424 of the film 411, 412. The angle 440 is greater than 90 degrees relative to the plane formed by the female side 415, 424 of the film 411, 412, such that protuberances 413, 422 form an obtuse angle relative to the base plane of the film. The angle 440 is not particularly important, and may generally be in the range of 100-175° relative to the base plane. Films having such angular protrusions are known in the art and disclosed, for example, in EP 1040801; WO 1997/003818; and WO 2000/016726, each of which is incorporated herein by reference.

[0042] As seen in Figure 4, the protuberances 413, 422 have a taper such that the opening 420, 427 on the female side 415, 424 has a greater diameter than the aperture 417, 426 on the male side 416, 425 of the films 411, 412, respectively. In this configuration, it is easier for liquids to pass from the female side 415, 424 to the male side 416, 425, but harder for liquids to pass in the opposite direction; i.e., from the male side 416, 425 to the female side 415, 424. The angular orientation of the protuberances 413, 422 makes it more difficult for liquids to pass through from the male side 426, 425 of the films 411, 412 to the female side 415, 424. Air, however, will pass freely through the film in both directions equally well.

[0043] The embodiments of Figures 5 and 6 are similar to that of Figure 4 and the same reference numerals are used for identical features. In the embodiment of Figure 5, the laminate 105 further comprises a nonwoven web 530 bonded to the female side 415 of the first film 411.

In Figure 6, the laminate 106 further comprises a nonwoven web 530 bonded to the male side 425 of the second film 412.

[0044] In Figure 7, yet another embodiment of the laminate 107 is illustrated. In this embodiment, the laminate 107 comprises a first film layer 711 and a second film layer 712. The first film layer 711 comprises a formed film having a plurality of three-dimensional protuberances 713 having sidewalls 714 that originate on the female side 715 of the film 711 and extend in the z-direction. The sidewalls 714 terminate on the male side 716 of the film 711. The protuberances define an aperture 717 on the male side 716 of the film 711. The male side 716 of the film 711 defines a plane that is spaced from and generally parallel to the base plane defined by the female side 715 of the film 711.

[0045] The second film 712 is similar to the first film 711 and also comprises a three-dimensional formed film. Film 712 has a plurality of three-dimensional protuberances 722 having side walls 723 that originate on the female side 724 of the film 712 and extend in the z-direction. The side walls 723 terminate on the male side 725 of the film 712 and define an aperture 726. The male side 725 defines a plane that is spaced from and generally parallel to the plane defined by the female side 724 of the film 712.

[0046] As seen in Figure 7, the protuberances 713 are oriented at generally 90 degrees relative the plane formed by the female side 715 of the film 711. However, the protuberances 722 are oriented at an angle 740 relative to the plane formed by the female side 724 of the film 712 which angle 740 is greater than 90 degrees, such that protuberances 722 form an obtuse angle relative to the base plane of the film. The angle 740 is not particularly important, and may generally be in the range of 100-175° relative to the base plane.

[0047] In Figures 8 and 9, additional embodiments of the laminate are illustrated. In the embodiment of Figure 8, the laminate comprises a first film 711 and a second film 712 that are identical to that described in connection with Figure 7. In this embodiment, however, a nonwoven web 830 is bonded to the male side 725 of the second film 712. In the embodiment of Figure 9, again the same films 711, 712 from Figure 7 are employed, but the nonwoven web 830 is bonded to the female side 715 of the first film 711.

[0048] In another embodiment, not seen in the drawings, a three-dimensional film is bonded to a reinforcing mesh fabric. The mesh fabric may be on either or both sides of the film and is particularly useful in applications where increased strength is desired. The reinforcing mesh fabric may be of any type or description having the desired properties for the particular application. A wide variety of reinforcing mesh fabrics are commercially available, including woven mesh fabrics and nonwoven mesh fabrics (such as CLAF® mesh fabric from Atlanta Nisseki Claf, Inc.) and these can be elastomeric or non-elastomeric. All such fabrics may be used to advantage in the embodiments. In addition, the reinforcing fabric may also be used in other embodiments having the second three-dimensional apertured film and/ or a nonwoven web.

[0049] In use, the films of these embodiments may be applied to a growing crop or to a crop once it has been harvested. If the film is applied to a growing crop, it may be applied in direct contact with the plant or may be suspended above the plant. For example, the films may be supported on poles in a tent-like fashion above the plants. In such a use, air circulation around the plant and any fruits would be maximized. In addition, the sloped sides of the films would facilitate water run-off, keeping water off the plant and the fruits, and directing the water to the soil around the plants. In such use, it may be further advantageous if the embodiments of Figures 4-9, for example, had the angle apertures oriented to coincide with the slope of the tenting to further prevent water from entering the apertures and thus making direct contact with the crops.

[0050] Moreover, if the films are to be supported above the plants on poles or other structures, it may be advantageous to reinforce certain regions of the film webs to help prevent tearing or premature wearing of the film where it contacts the support member. Such a reinforced region can take many forms. For example, the reinforced region can comprise a lane in the film web that has no apertures. Or, the reinforced region may comprise a region where an additional piece of material, such as a strip of film, fabric (woven, knitted or nonwoven), scrim, or other material, is added to the film. In still another embodiment, the reinforced region may be a section of the film that has an increased thickness resulting from the extrusion profile.

[0051] The films are preferably made of polyolefin resins, such as polyethylene, polypropylene, low density polyethylene, high density polyethylene, ethylene-propylene copolymers, ethylene vinyl acetate (EVA copolymers) and other film forming resins known in the art. Blends and mixtures of these resins may also be used. Use of polypropylene resin (up to about 30% by weight), may be advantageous to promote bonding with the nonwoven web as taught in EP 0930861. Other suitable thermoplastic resins and blends are known in the apertured film art. Each of the films may be single layer or multi-layer construction. If a multi-layer construction is used, each layer may be formulated differently from the other.

[0052] The films may also contain additives, such as UV stabilizers, colorants, surfactants or other additives to control or enhance their weather resistance, light transmission, or other properties as desired for the particular application.

[0053] The nonwoven web used in the embodiments of Figures 2, 3, 5, 6, 8 and 9 may be of any standard construction known in the art. As is known in the art, nonwoven webs are fibrous webs comprised of polymeric fibers arranged in a random or non-repeating pattern. For most of the nonwoven webs, the fibers are formed into a coherent web by any one or more of a variety of processes, such as spunbonding, meltblowing, bonded carded web processes, hyrdoentangling, etc., and/or by bonding the fibers together at the points at which one fiber touches another fiber or crosses over itself. The fibers used to make the webs may be a single component or a bi-component fiber as is known in the art and furthermore may be continuous or staple fibers. Mixtures of different fibers may also be used for the fibrous nonwoven fabric webs.

[0054] The nonwoven web can be produced from any fiber-forming thermoplastic polymers including polyolefins, polyamides, polyesters, polyvinyl chloride, polyvinyl acetate and copolymers and blends thereof, as well as thermoplastic elastomers. Examples of specific polyolefins, polyamides, polyesters, polyvinyl chloride, and copolymers and blends thereof are illustrated above in conjunction with the polymers suitable for the film layer. Suitable thermoplastic elastomers for the fibrous layer include tri- and tetra-block styrenic block copolymers, polyamide and polyester based elastomers, and the like.

[0055] The thermoplastic fibers can be made from a variety of thermoplastic polymers, including polyolefins such as polyethylene and polypropylene, polyesters, copolyesters, polyvinyl acetate, polyamides, copolyamides, polystyrenes, polyurethanes and copolymers of any of the foregoing such as vinyl chloride/vinyl acetate, and the like. Suitable thermoplastic fibers can be made from a single polymer (monocomponent fibers), or can be made from more than one polymer (e.g., bicomponent fibers). For example, "bicomponent fibers" can refer to thermoplastic fibers that comprise a core fiber made from one polymer that is encased within a thermoplastic sheath made from a different polymer. The polymer comprising the sheath often melts at a different, typically lower, temperature than the polymer comprising the core. As a result, these bicomponent fibers provide thermal bonding due to melting of the sheath polymer, while retaining the desirable strength characteristics of the core polymer.

[0056] Bicomponent fibers can include sheath/core fibers having the following polymer combinations: polyethylene/polypropylene, polyethylvinyl acetate/polypropylene, poly-ethylene/polyester, polypropylene/polyester, copolyester/ polyester, and the like. The bicomponent fibers can be concentric or eccentric, referring to whether the sheath has a thickness that is even, or uneven, through the cross-sectional area of the bicomponent fiber. Eccentric bicomponent fibers can be desirable in providing more compressive strength at lower fiber thicknesses.

[0057] In the case of thermoplastic fibers for carded nonwoven fabrics, their length can vary depending upon the particular melt point and other properties desired for these fibers. Typically, these thermoplastic fibers have a length from about 0.3 to about 7.5 cm long, preferably from about 0.4 to about 3.0 cm long. The properties, including melt point, of these thermoplastic fibers can also be adjusted by varying the diameter (caliper) of the fibers. The diameter of these thermoplastic fibers is typically defined in terms of either denier (grams per 9000 meters) or decitex (grams per 10,000 meters). Depending on the specific arrangement within the structure, suitable thermoplastic fibers can have a decitex in the range from well below 1 decitex, such as 0.4 decitex, up to about 20 decitex.

[0058] Term "meltblown fibers" refers to fibers formed by extruding a molten thermoplastic material through a plurality of fine, usually circular, die capillaries as molten threads or filaments into a high velocity gas (e.g., air) stream that attenuates the filaments of molten thermoplastic material to reduce their diameter, which may be to a microfiber diameter. The term "microfibers" refers to small diameter fibers having an average diameter not greater than about 100 microns. Thereafter, the meltblown fibers are carried by the high velocity gas stream and are deposited on a collecting surface to form a web of randomly dispersed meltblown fibers.

[0059] The term "spunbonded fibers" refers to small diameter fibers that are formed by extruding a molten thermoplastic material as filaments from a plurality of fine, usually circular, capillaries of a spinneret with the diameter of the extruded filaments then being rapidly reduced as by, for example, eductive drawing or other well-known spunbonding mechanisms.

[0060] The size, shape and density of the protrusions and apertures in the films is of no critical importance. However, if the films are to be used to minimize the amount of rainwater that reaches the plant leaves or fruits, for example, it is advantageous for the apertures facing the environmental elements (i.e., the film side furthest away from the crop) to be small enough so that raindrops will not readily be able to pass through the aperture. In general, if the aperture on the male side is less than about 250 microns in diameter, it will offer adequate protection against water penetration. Of course, even if water were to penetrate the film layer 12 (Figure 1), film layer 11 would still offer an additional amount of protection against water contacting the crops.

[0061] In some embodiments it may be advantageous to use films having different sized apertures and different density or mesh count (i.e., the number of apertures per unit length or area). In particular, alignment of apertures between the two films will tend to maximize air flow, but may not offer the amount of water penetration desired. Using films with different mesh counts can help to balance good air permeability and good water resistance.

[0062] Numerous shapes of apertures are known from the prior art, including circular, pentagonal, elliptical, boat shaped, oblong, 'cat eye" and others, any of which may be used to advantage.

[0063] In use, the laminate can be applied to a supporting frame to form a greenhouse, or can be applied directly to the crops. If applied with the female side of the film closest to the crops, the laminate will substantially reduce the amount of liquids passing through the laminate to the crops. Orienting the laminate with the male side facing the crops will enable more liquids to pass through the laminate. The laminate will further diffuse the sunlight as it passes through the film and, depending on additives that may be used in the films, can also block, diffuse or reflect light reaching the crops. In another application, the laminate can be applied to the ground surrounding the crops to reduce the amount of weeds. In still another application, the laminates can be used to wrap flowers or other non-food crops, or for post-harvest storage of produce or other foodstuffs. The laminates in such applications can control the amount of moisture reaching the crop yet allow for the passage of air and thus prevent or reduce the occurrence of molds or fungus. For example, the shelf life of many crops after harvest can be increased by keeping the crop dry and well ventilated. In another embodiment, the laminate may be fashioned into a bag or sack and harvested crops or hanging fruits may be placed inside to maximize air circulation and/or controlled drying of the crops. The laminates disclosed herein are ideal for such applications because they allow air to pass through readily yet are resistant to passage of liquids.

[0064] A number of embodiments of the invention have been described. Nevertheless, it will be understood that various modifications may be made without departing from the scope of the invention. Accordingly, other embodiments are within the scope of the following claims.

Claims

1. A process comprising the step of protecting a crop with a laminate, said laminate comprising a first three-dimensional apertured film laminated to a second three-dimensional apertured film.

2. The process of claim 1, wherein the laminate further includes a nonwoven web.

3. The process of claim 2, wherein said nonwoven web is laminated to a male side of the second three-dimensional apertured film.

4. The process of claim 2 wherein said nonwoven web is laminated to a female side of the first three-dimensional apertured film.

5. The process of claim 1, wherein the first three-dimensional apertured film comprises protuberances oriented at an obtuse angle relative to a plane defined by a female side of the film.

6. The process of claim 5, wherein the second three-dimensional apertured film comprises protuberances oriented at an obtuse angle relative to a plane defined by a female side of the film.

7. The process of claim 5, wherein said laminate further comprises a nonwoven web.

8. The process of claim 7, wherein the nonwoven web is laminated to the female side of said first three-dimensional apertured film.

9. The process of claim 1, wherein said crop is a food crop.

10. The process of claim 1, wherein said crop is a non-food crop.

11. The process of claim 1, wherein said crop is harvested.

12. The process of claim 1 wherein the crop is a hanging fruit.

13. The process of claim 1, wherein the step of protecting the crop comprises applying the laminate to a support structure to suspend the laminate above the crops.

14. The process of claim 13, wherein the laminate is suspended in a tent-like fashion having a relatively higher center portion and angled side portions

15. The process of claim 1, wherein the step of protecting the crop comprises applying the laminate to a plant.

16. The process of claim 1, wherein the step of protecting a crop comprises applying the laminate to soil surrounding the crop.

17. The process of claim 1, wherein each of the three-dimensional apertured films comprises a polyolefin.

18. The process of claim 1, wherein at least one of the first and second three-dimensional apertured films comprises a UV stabilizer.

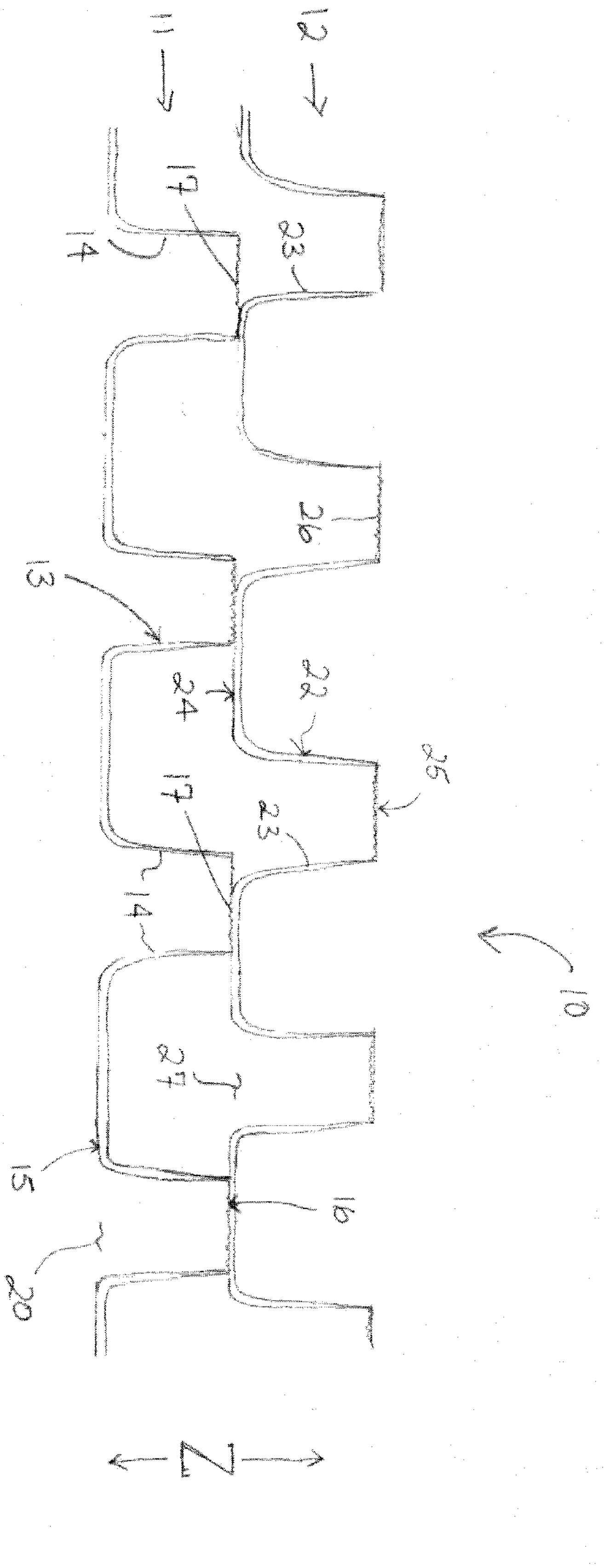

FIGURE 1

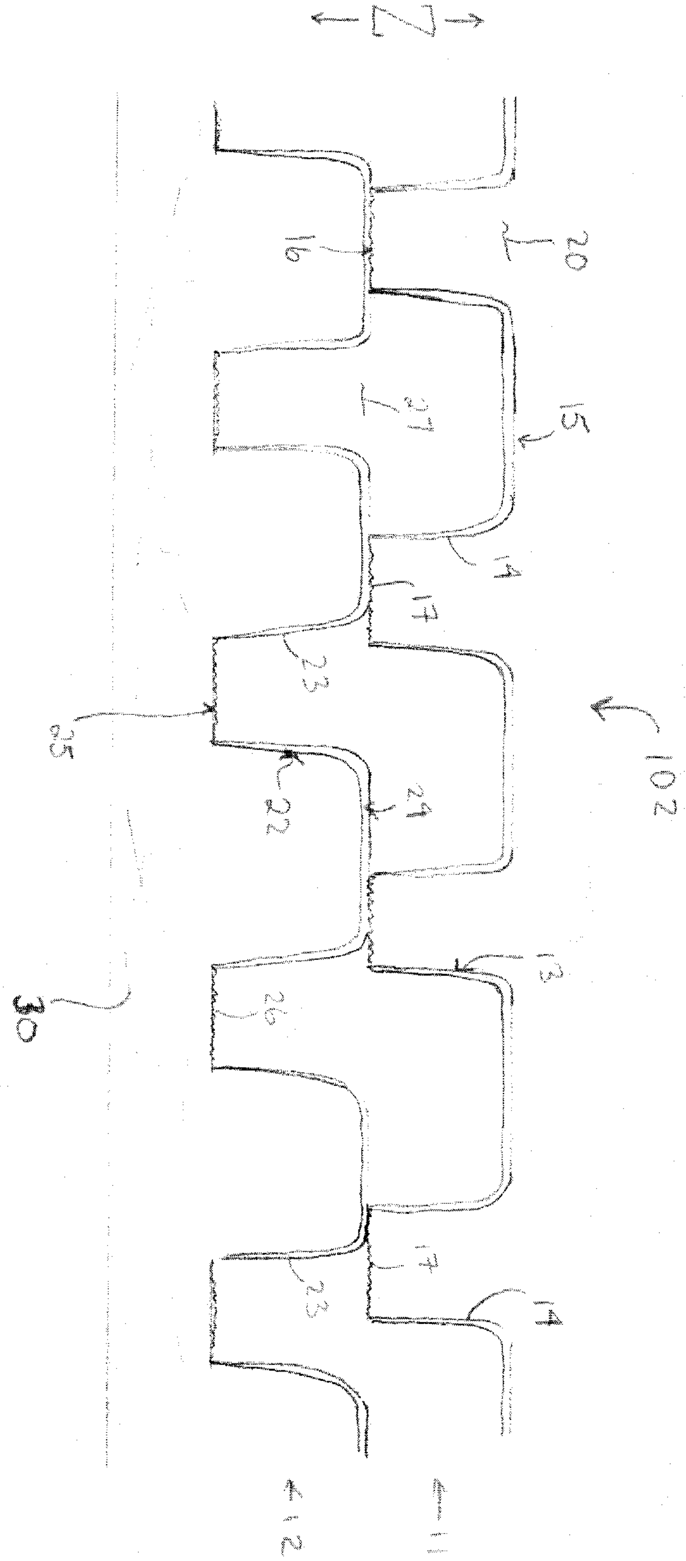

FIGURE 2

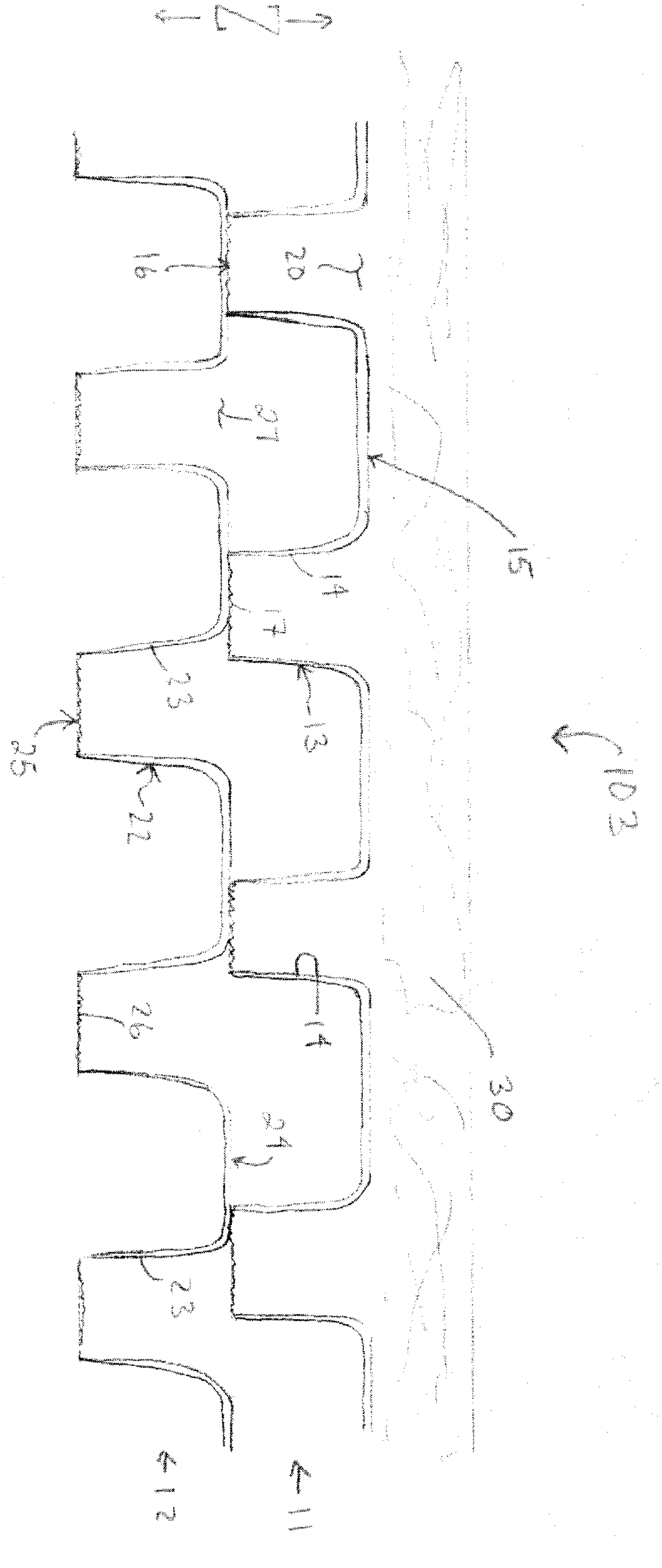

FIGURE 3

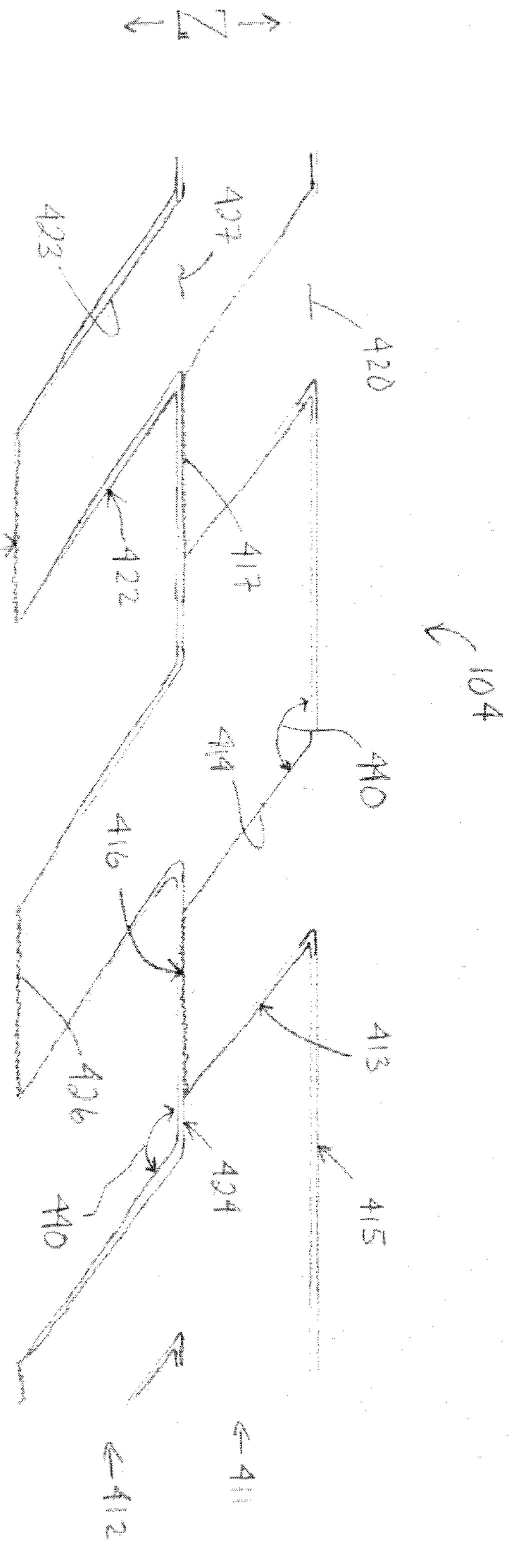
Z
104
404
410
410
411
412
413
414
415
416
417
420
422
423
425
426
427

FIGURE 4

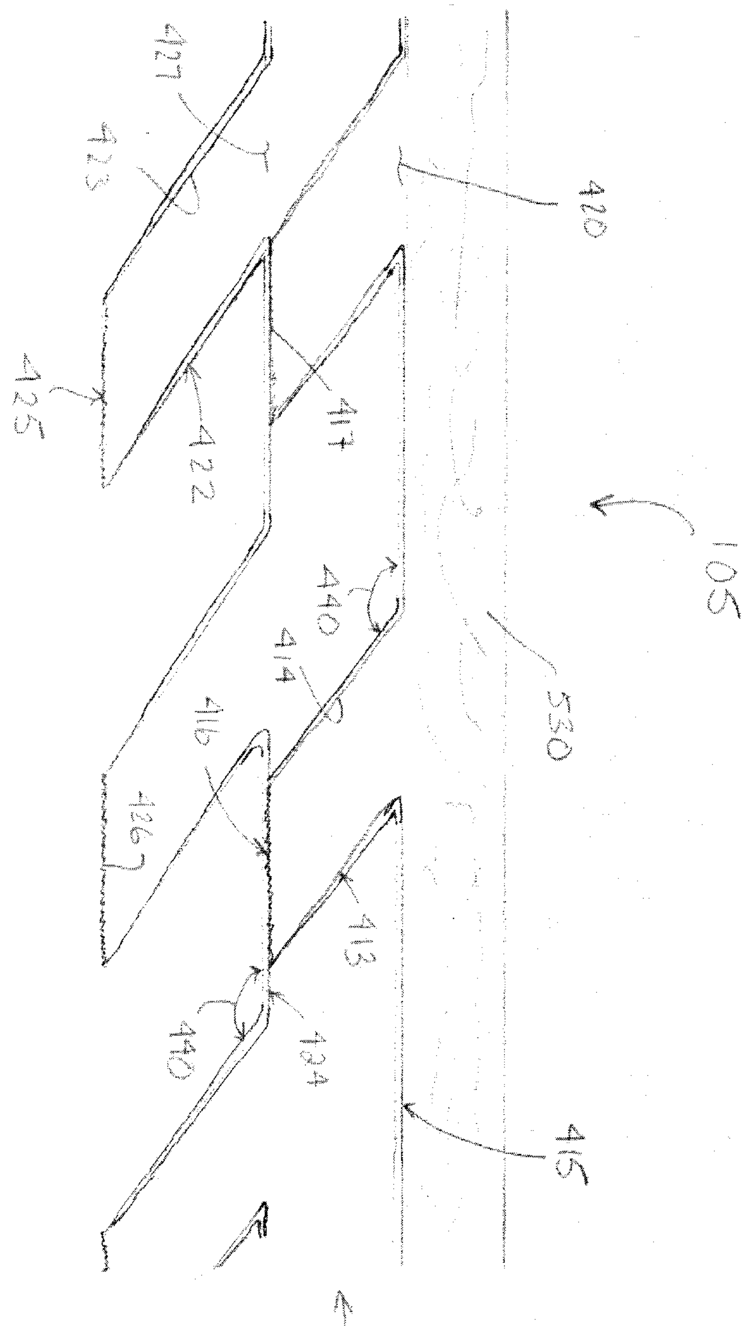
420
427
423
425
422
417
105
440
414
530
416
426
413
440
434
415
411
412

FIGURE 5

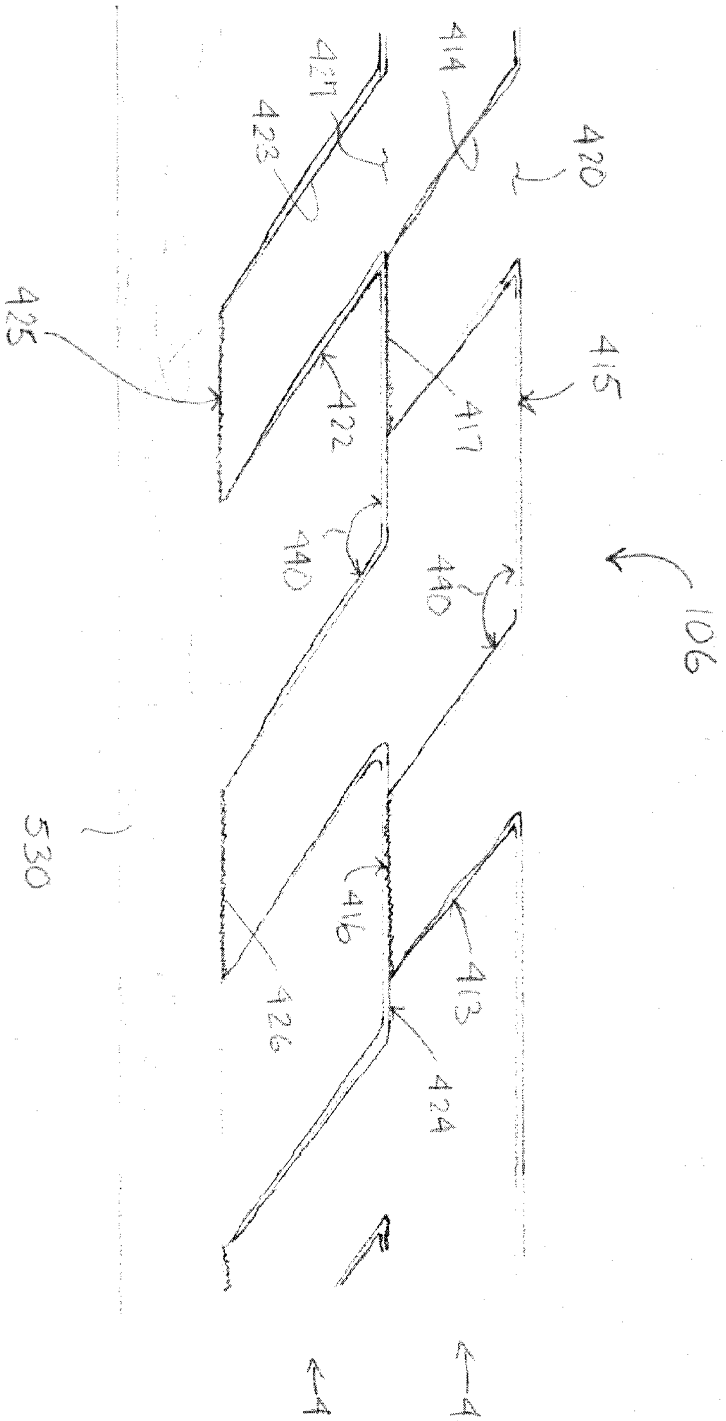
420
414
421
423
425
415
417
422
440
440
106
530
416
413
426
424
411
412

FIGURE 6

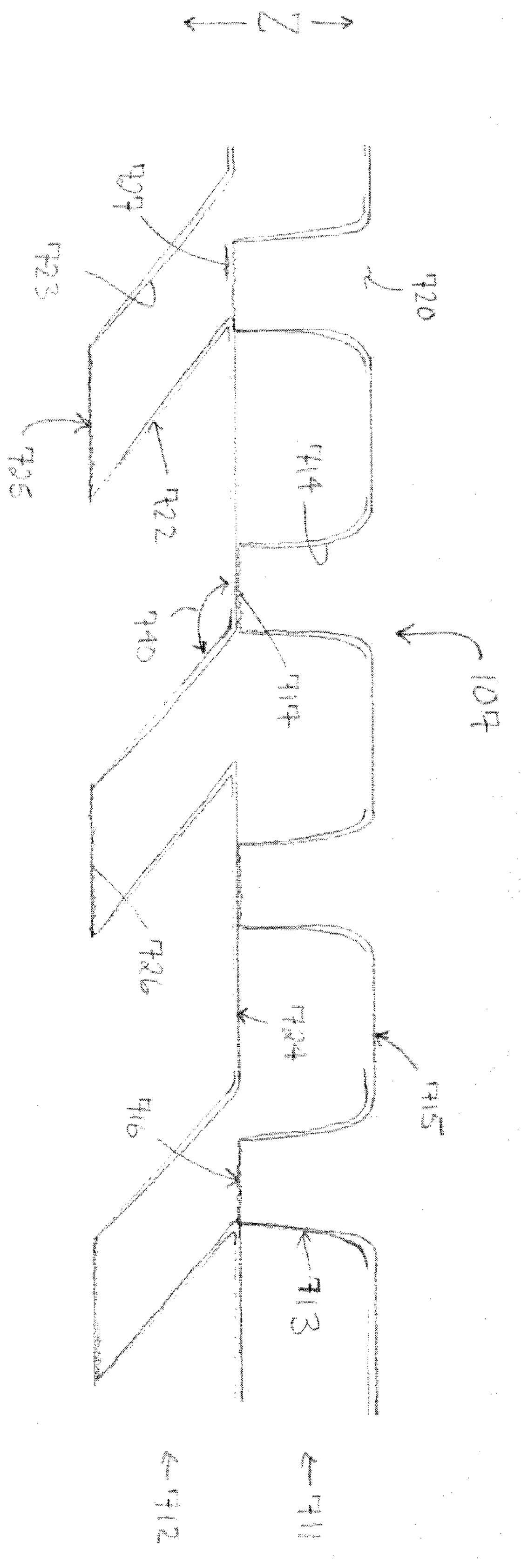

FIGURE 7

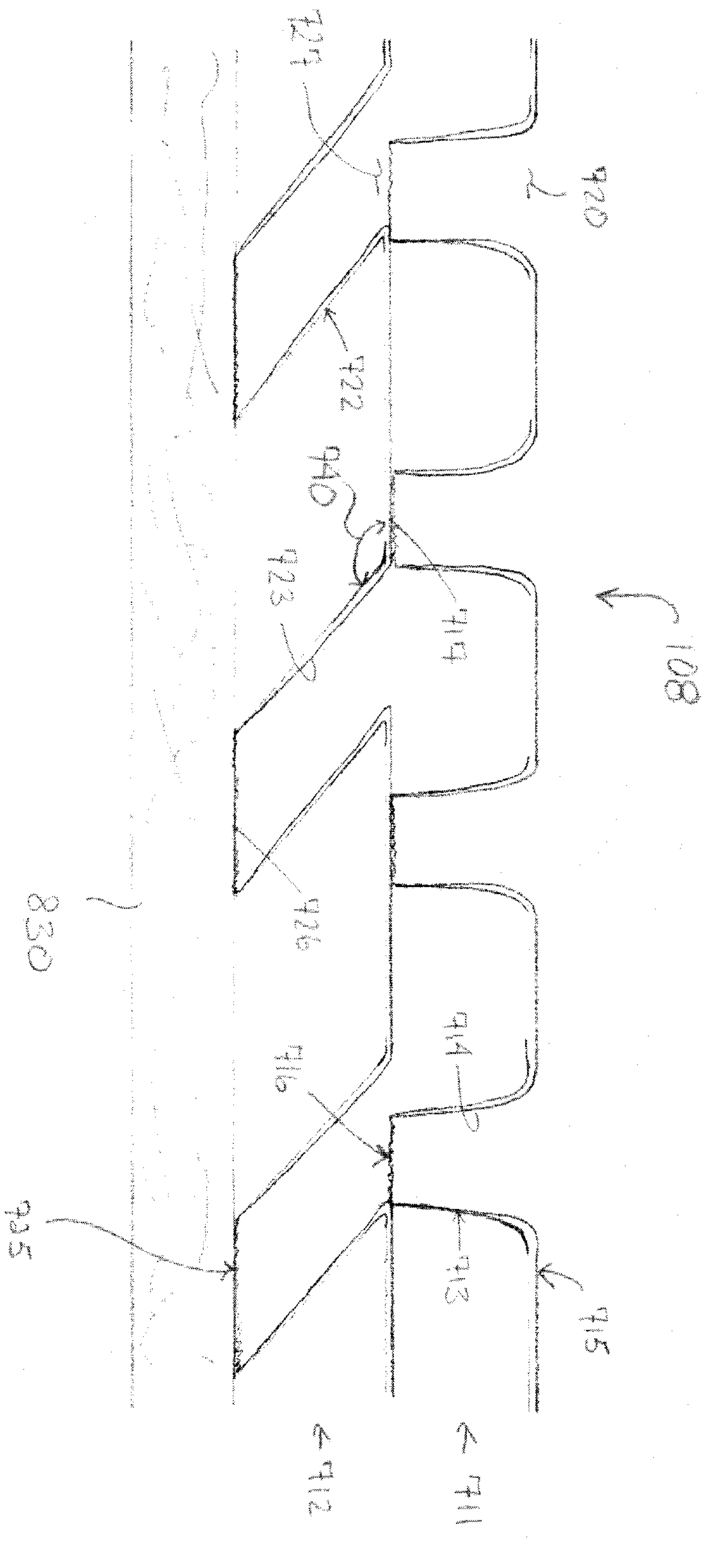

FIGURE 8

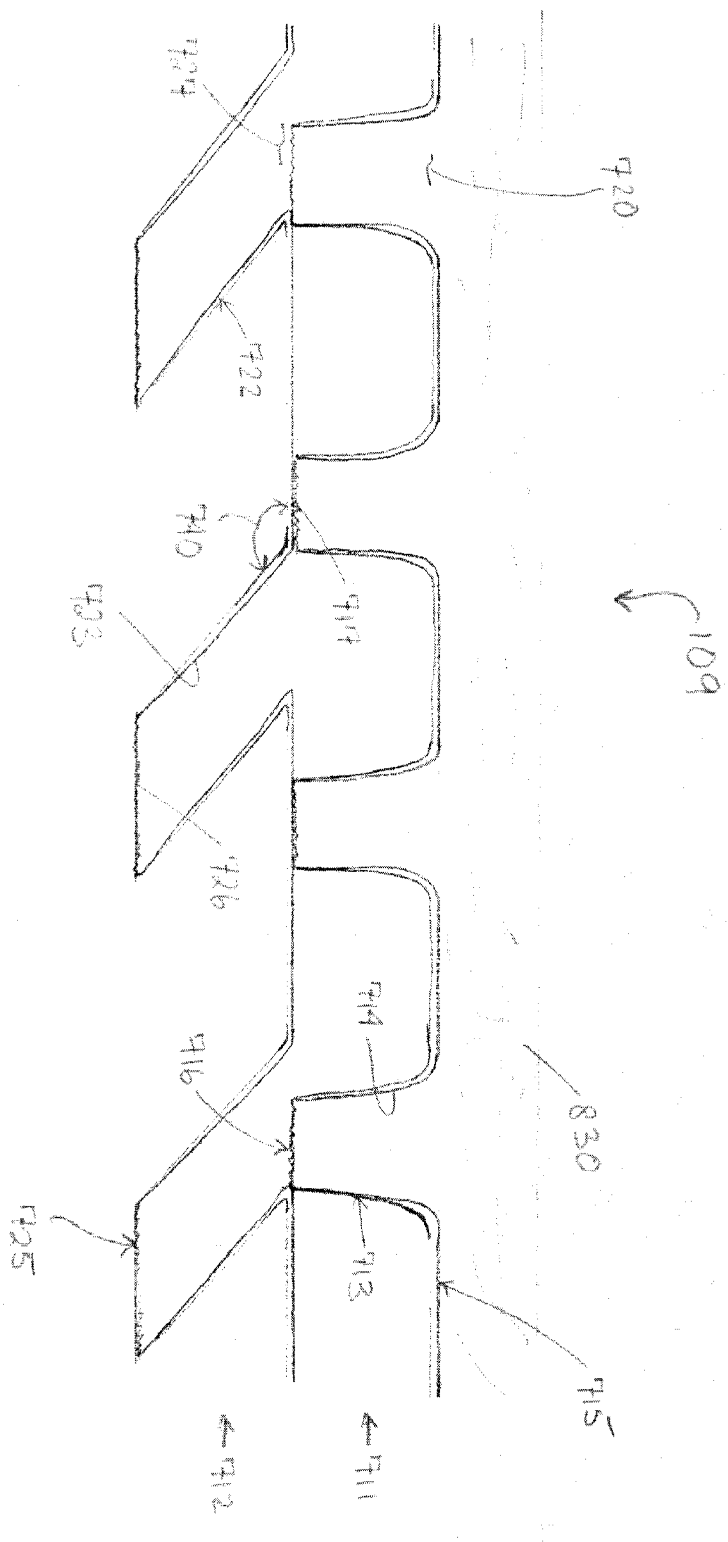

FIGURE 9