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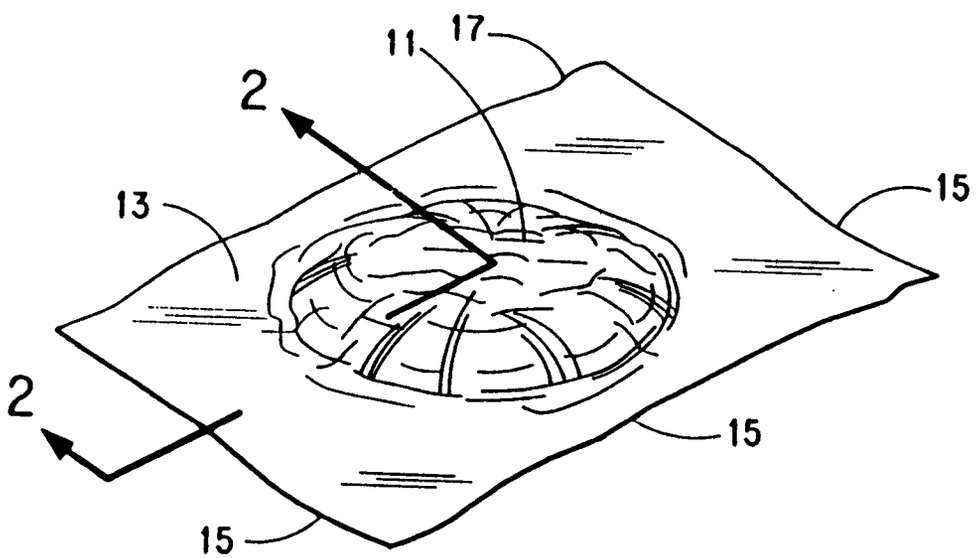
(54) Microwave package with easy open seal.

(57) An easy-to-open package for microwave cooking comprises a layer of non-melting cellulosic material, a support layer of polyethylene terephthalate film, a layer of vacuum deposited metal, and a layer of heat releasable thermoplastic material, used to seal the package in a wrapped conformation.

FIG. 1



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BACKGROUND OF THE INVENTION

This invention relates to packaging materials suitable for microwave cooking, particularly packages which have seams which are easy to open after microwave cooking.

There has been much interest recently in packaging materials which aid in browning and crisping of food items in a microwave oven. Such packages can take the form of a sheet which is wrapped about a food item and sealed in its wrapped conformation. One persistent problem with such packages, however, has been the difficulty with which such seals or seams are opened after cooking in order to remove the food contents of the package. In many such packages the sheet material itself is liable to melt or fuse together on heating,creating an unattractive or impenetrable seam. In other packages the adhesive used is such that the package, after heating, remains as firmly sealed as before. The present invention provides a package with a seam or seal which is easy to open after microwave cooking, thus avoiding the problems of the prior art packages.

U.S. Patent 4,911,938 discloses a package useful for cooking food in a microwave oven, comprising a thermally stable film wrapped about the food, a layer of heat releasable thermoplastic material located on the surface of the thermally stable film and forming a seal between at least two surface areas thereof, and a microwave susceptor material in close proximity to at least a part of said seal. The seal is selectively releasable upon exposure to microwave energy and resultant heating of the microwave susceptor material under microwave cooking conditions. The release of the seal permits venting of pressure or accommodation of growth of the food. Suitable thermally stable films include polyesters, polymethylpentene, polyarylates, polyamides, polyimides, polycarbonates, or cellophane.

U.S. Patent 4,640,838 discloses a vapor tight package which has a deposit comprising nonmetallic, microwave absorbing particles such as graphite dispersed in a polymeric binder. When heated in a microwave oven, heat built up in the particles may soften and weaken the underlying packaging material, thus venting the package. The package can be made with a heat-resistant plastic film such as cellophane. The deposit can be positioned over an opening, slit, or score in the package, and the heat can soften and weaken the deposit to vent the package. The deposit may be placed at a position to enhance the opening of the package to remove its contents.

European application 0 340 037 discloses a conformable multilayer laminated structure useful for packaging food for microwave cooking, comprising a layer of flexible, heat-resistant microwave transparent plastic film, a layer of flexible, heat resistant, heat stable, microwave transparent plastic film, and a layer of substantially continuous microwave susceptor material located on a surface of a film of the laminate. The layers of plastic film can be prepared from a number of materials, including as one option cellophane. The laminated structure can also include a layer of heat sealable thermoplastic resin, and applications are disclosed in which food is wrapped and sealed in the structure.

U.S. Patent 4,735,513 discloses a flexible, sheet structure comprising a base sheet of e.g. polyester, having a microwave coupling layer. The sheet may be laminated to a backing sheet of dimensionally stable flexible material transparent to microwaves. Examples of such backing sheets include a synthetic sheet formed from synthetic plastic fibers of a non-thermoplastic and dimensionally stable composition, or, preferably, paper. The microwave coupling layer can extend to the edge of the paper but is preferably present as an island covering selected areas of the sheet. The sheet may be formed into e.g. a bag.

U. S. Patent 4,734,288 discloses a package for an expandable food product including an outer container and an expandable plastic food pouch within the container. The expandable food pouch may contain a designed fault along its peripheral edge to facilitate the controlled release of pressure. One sidewall of the package (paperboard) may include a flap provided with a heat sensitive adhesive which is released when exposed to microwave energy.

U.S. Patent 4,267,420 discloses a plastic film or other dielectric substrate having a very thin coating thereon which controls the microwave conductivity when a package wrapped with such film is placed within a microwave oven.

U. S. Patent 4,571,337 discloses a bag and a mixture of edible popcorn ingredients suitable for use in microwave ovens. Portions of the panels of the bag contain a coating that is sensitive to pressure and heat, forming a seal along the top edge of the panels. The seal has sufficient strength to withstand the internal steam pressure generated by the moisture content of the kernels for at least one-half of the popping process. Preferably, the bag will vent at the top seam before the process is completed to allow steam to escape.

SUMMARY OF THE INVENTION

The present invention provides an easy-to-open package useful for cooking of food in a microwave oven, comprising a flexible multiple layer structure which comprises:

(a) a layer of non-melting cellulosic material;

(b) a support layer of polyethylene terephthalate film;

(c) a layer of microwave susceptor material comprising vacuum deposited metal located on said support layer in an amount suitable to supply heat

to an adjacent food item upon exposure to microwave energy and extending over at least about 50% of the surface area of said support layer; and (d) a layer of heat releasable thermoplastic material;

said multiple layer structure being wrapped about said food and being sealed in its wrapped conformation by means of the heat releasable thermoplastic material, the seal formed thereby being in close proximity to said layer of microwave susceptor material, whereby the strength of said seal is reduced after exposure to microwave energy, rendering said seal more easily openable after removal of said package from said microwave oven.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a view of a package of the present invention.

Figure 2 is a partial cross-sectional view of the package of Figure 1.

Figure 3 is an alternative package configuration of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

The packages of the present invention are prepared from multilayer film structures which are wrapped around or otherwise encompass a food item. The multilayer film structures comprise, first, at least one layer of non-melting cellulosic material. As used herein this term includes paper, paper board, and related products as well as cellophane (regenerated cellulose). Such materials are non-melting, thus providing resistance to gross melting or structural deformation of the package upon heating in a microwave oven. It is preferred that this layer is sufficiently thin that the final structure will have suitable flexibility to be wrapped around a foodstuff. Thus a layer of cellophane should preferably be about 13 to about 50 micrometers (1/2 to 2 mils) thick and most preferably about 20 to about 40 micrometers (3/4 to 1-1/2 mils) thick. Paper or paper products should preferably be about 25 to 250 micrometers (1 to 10 mils) thick, most preferably about 50 to about 150 micrometers (2 to 6 mils) thick. Certain materials, such as cellophane, are initially quite flexible in thin sheets, but after heating to e.g. 200°C and subsequent cooling they may exhibit an increase in stiffness. This behavior may actually be desirable since a package exhibiting an increase in stiffness after cooking may be easier to open.

Adjoined to the layer of non-melting cellulosic material is a layer of microwave susceptor material on a support layer of polyethylene terephthalate (PET) film. PET film is a staple item of commerce which can be readily treated with a microwave susceptor material. It is a reasonably temperature-stable material, having a melting point of about 260°C, and so is suitable for use in many microwave cooking applications. However, when used alone with an active, heat generating microwave susceptor material, as described below, it can be overheated and subject to melting; hence the requirement that a layer of non-melting cellulosic material be present. The thickness of the layer of PET is not particularly important, provided that it is thick enough to survive ordinary handling and thin enough not to unduly limit the flexibility of the final product. Common thicknesses of suitable PET films range from about 5 to about 130 micrometers, especially about 10 to about 50 micrometers.

There is a layer of microwave susceptor material deposited on the PET film. Susceptor materials are well known and are used to convert microwave energy into heat which can be used e.g. to brown and crisp the surface of a food item. In the present invention the base PET film is coated with a thin layer of susceptor metal by well-known vacuum deposition techniques. The susceptor material is a substantially continuous electrically conductive material which is present in sufficient thickness to cause the multilayer structure to heat under microwave cooking conditions to a temperature suitable for browning or crispening of food placed adjacent thereto, but not so thick as to completely prevent penetration of microwave energy to the interior of the food. The susceptor will cover a substantial part of the base sheet, preferably at least about 50% and most preferably nearly 100%, in order to assure utility for supplying heat to the food item.

A preferred susceptor material is vacuum metallized aluminum or stainless steel, which will preferably be present in sufficient amounts to impart an optical density, in the case of aluminum, of about 0.10 to about 0.35, preferably 0.16 to about 0.25, to the film. (Such film, as an additional benefit, will be substantially transparent to visible light if the cellulosic material is cellophane.) Other metals, of course, may be used, including gold, silver, mu-metal, stainless steel, nickel, antimony, copper, molybdenum, bronze, iron, tin, and zinc. Suitable films will generally have a surface resistivity of about 60-1000 ohms/square, preferably about 100-600 ohms/square.

The amount of susceptor material applied to the film may be varied within certain limits which will be apparent to one skilled in the art. The test to determine the correct amount of material is whether the coating will heat to the proper temperature and provide sufficient heat flux for browning or crispening of food items. The required temperature may depend on the particular food item used but for many applications is at least about 180°C.

Normally a layer of an adhesive material will be used to join the layer of cellulosic material to the vacuum metallized PET sheet. Any of a number of materials are suitable for this purpose, including crosslinking adhesives such as "Adcote" crosslink-

able copolyester from Morton chemical, ethylene acid copolymers and adhesives based thereon, acrylic adhesives, polymeric vinyl acetate or vinyl alcohol-based adhesives, and certain radiation crosslinked materials. Certain suitable adhesive materials are described in more detail in copending application WO-A-91/02440, published 21 February, 1991, the disclosure of which is incorporated herein by reference. The adhesive layer can be applied by conventional laminating techniques in general, such as extrusion coating, lamination, or printing processes. The joining together of the cellulosic layer and the metallized PET layer can be by conventional lamination followed by curing, as necessary.

On at least a part of one outer layer of the structure is applied a layer of heat releasable thermoplastic material. This is an adhesive type material which loses much of its strength upon heating, e.g. by heat generated by adjacent microwave susceptor material in a microwave oven. Suitable heat releasable thermoplastic materials include polyester copolymers, particularly copolymers of ethylene glycol, terephthalic acid and azelaic acid; copolymers of ethylene glycol, terephthalic acid, and isophthalic acid; and mixtures of these copolymers. An especially effective copolymer is that prepared by the condensation of ethylene glycol with terephthalic acid and azelaic acid in the mole ratio of about 50:50 to about 55:45. This resin composition can be applied as a solution of e.g. 15.8 parts solid in a mixture of toluene (25 parts) and tetrahydrofuran (58 parts). Small amounts of other materials such as erucamide and magnesium silicate can also be present in the mixture. After solvent removal, the heat releasable thermoplastic material can be heat sealed to itself or to another film surface by application of heat with e.g. an iron.

Figures 1 and 2 show a food item wrapped in such a multiple layer film. Figure 1 shows the food item 11 contained between two sheets or within a single folded sheet of the present invention. The sheet may be folded along a crease 17 providing contacting edges 15; or if two separate sheets are used all edges, 15 and 17 can be non-creased edges. In either arrangement the food item can be said to be "wrapped" in the multiple layer structure in the sense that it is enclosed therein. The structure is sealed in at least one seal 13 about the food item. Although Figure 1 illustrates a rectangular package, other geometrical arrangements are equally a part of the present invention. For instance, the seal need not completely surround the food item; vent areas can be remain unsealed or can be created by cutting off corners of the package if desired. However, the seal will generally extend along at least a considerable length of the food item.

Figure 2 shows the seal or seam in greater detail. (In this figure the thicknesses of the various film layers are exaggerated for illustration.) Upper and lower sheets or leaves 21 and 21′ enclose the food item 11 and form a seal in region 13. Outer layers 23 and 23′ are the non-melting cellulosic material. Layers 25 and 25′ are the PET substrate layers on which vacuum deposited metal layers 27 and 27′ reside. Layers 31 and 31′ are adhesive layers. Layers 29 and 29′ are the layers of heat releasable thermoplastic material. Although Figure 2 shows the heat releasable thermoplastic material 29 adjacent to the PET sheet, it is understood that this need not be so; it could be adjacent to the cellulosic sheet. In addition, the microwave susceptor material 27 need not be located between the support layer 25 and the cellulosic material 23 as shown, although that arrangement may be desirable to protect the metal layer from the environment. Furthermore, the seal need not be a symmetrical face-to-face seal as shown. For instance, it is permissible to use only a single layer of the heat releasable thermoplastic material to make the seal. It is important, however, that the portion of the heat releasable thermoplastic material which provides the seal is adjacent to a heat generating layer of microwave susceptor material 27.

Figure 3 is an alternative package of the present invention which is sealed with two end seams 41 and 43 and a fin seam 45. The other edges 47 and 49 may be creased or uncreased (folded over without creasing). Any one or more of the seams can contain the heal releasable thermoplastic resin in close contact with the susceptor material and so be easily openable. Preferably all three seams will be releasable in this manner.

In practice the package such as shown in Figure 1 is placed into a microwave oven and cooked for a suitable time to cook and brown or crispen the food item contained therein. During this time the heat generated from the interaction of the microwave energy with the susceptor material not only serves to brown and crisp the food item but also softens the heat-releasable adhesive and tends to cause it to release. Even upon subsequent cooling the seal is weakened and is easy to open by manually pulling it apart. In some cases the seal releases completely upon heating and does not reform upon cooling, for example, when the leaves of the seal physically separate. Such behavior results in a package which is particularly easy to open after cooking. Certain materials such as cellophane, when used in the multiple layer structures of the present invention, tend to become somewhat more rigid after heating and may distort slightly during the heating process; such packages are more likely to automatically open in this fashion. The complete or partial release of the seal need not depend on any internal pressure generated by the cooking of the food.

Examples

For the Examples a piece of microwave active

sheet, described below for each example, is wrapped around a commercially available frozen burrito and heat sealed in its wrapped conformation using a seal formed between adjacent layers of heat releasable thermoplastic material (except as noted). Each wrapped burrito is cooked in a 700 watt microwave oven on full power for 3.5 minutes; the package removed from the oven and the seal evaluated for ease of opening.

Example 1

A multilayer film is prepared using a first layer of cellophane about 25 micrometers thick (about 1 mil, 175 gauge) and a substrate layer of PET film, 12 micrometers thick (0.48 mil, 48 gauge), vacuum metallized with aluminum to an optical density of about 0.26. These layers are joined together (aluminized surface of the PET facing inward) using an adhesive layer about 12 micrometers thick of ethylene methacrylic acid copolymer containing 9 weight percent methacrylic acid and having a melt index of 10 dg/min. The layers are joined by extrusion lamination, followed by irradiation crosslinking of the adhesive layer with 10 megarads of electron beam radiation. The outwardly facing surface of the PET is coated with a 3 g/m^2 layer of heat releasable thermoplastic material comprising the condensation product of 1.0 mol ethylene glycol with 0.53 mol terephthalic acid and 0.47 mol azelaic acid.

After cooking, the film has shrunk slightly and wrinkled, and the package is very easy to open. Some of the seal area has already spontaneously opened. The film is noticeably stiffer after cooking and has taken the shape of the contents, that is, it develops a memory of its configuration in the oven.

Example 2.

A similar structure similar to that of Example 1 is prepared replacing the acid copolymer adhesive with an acrylic adhesive (Hycar™ 26373 from B. F. Goodrich), applied at a thickness of about 2.3 g/m^2 (1.5 pounds per ream (1.5 lb/452,000 in^2)). The results are the same as in Example 1.

Comparative Example C1.

A multilayer structure is prepared using as a core layer a film of PET 12 micrometers thick (48 gauge), vacuum metallized on one side with 304 stainless steel to a surface resistance of 515 ohms per square. A layer of PET 12 micrometers thick (48 gauge) is applied to each side of the metallized film layer using, for each such layer, a 3 g/m^2 adhesive layer of the heat releasable thermoplastic material described in Example 1. To one outer surface of the resulting structure is applied a 3 g/m^2 layer of the same heat releasable thermoplastic material.

After cooking, this material has shrunk slightly but shows less wrinkling than observed in Example 1. The film is somewhat stiffer than before cooking, but not markedly so. The seals of this package have fused and cannot be separated. (It appears that this film does not generate enough heat to adequately crisp the burrito; in addition, there is no venting of steam from the package through the seams.)

Comparative Example C2

A layer of aluminized PET films as in Example 1 is adhered to a layer of paper, aluminized side facing inward, using Adcote™ adhesive. No separate layer of heat releasable resin is used as external adhesive. The package is sealed by heating to fuse adjacent PET layers to form a seam. After cooking the paper shows little change in appearance and is not noticeably stiffer.

The seal in such a package, formed directly between two layers of high-melting PET, is more difficult to form than seals involving heat releasable thermoplastic resins. Such a seal is therefore more likely to be defective and to come open during handling, before cooking. To the extent that such a seal is well formed, it will not release readily during or after cooking.

Claims

1. An easy-to-open package useful for cooking of food in a microwave oven, comprising a flexible multiple layer structure which comprises:
   (a) a layer of non-melting cellulosic material;
   (b) a support layer of polyethylene terephthalate film;
   (c) a layer of microwave susceptor material comprising vacuum deposited metal located on said support layer in an amount suitable to supply heat to an adjacent food item upon exposure to microwave energy and extending over at least about 50% of the surface area of said support layer; and
   (d) a layer of heat releasable thermoplastic material;
   said multiple layer structure being wrapped about said food and being sealed in its wrapped conformation by means of the heat releasable thermoplastic material, the seal formed thereby being in close proximity to said layer of microwave susceptor material, whereby the strength of said seal is reduced after exposure to microwave energy, rendering said seal more easily openable after removal from said microwave oven.

2. The package of claim 1 wherein the non-melting

cellulosic material exhibits an increase in stiffness after heating to 200°C and subsequent cooling.

3. The package of claim 1 or claim 2 wherein the cellulosic material is cellophane.

4. The package of claim 1 or claim 2 wherein the cellulosic material is paper.

5. The package of any one of claims 1 to 4 in which the metal is aluminum or stainless steel.

6. The package of claim 1 in which the microwave susceptor material is vacuum deposited aluminum, and the cellulosic material is cellophane.

7. The package of any one of claims 1 to 6 further comprising a layer of adhesive between the support layer and the layer of non-melting cellulosic material.

8. The package of any one of claims 1 to 7 wherein the heat releasable thermoplastic material is a polyester copolymer.

9. The package of claim 8 wherein the polyester copolymer is prepared from polymers selected from the group consisting of copolymers of ethylene glycol, terephthalic acid and azelaic acid; copolymers of ethylene glycol, terephthalic acid, and isophthalic acid; and mixtures of these copolymers.

10. The package of claim 9 wherein the layer of heat-releasable thermoplastic material is made of a copolymer prepared by the condensation of ethylene glycol with terephthalic acid and azelaic acid, said acids being in the mole ratio of about 50:50 to about 55:45.

FIG.1

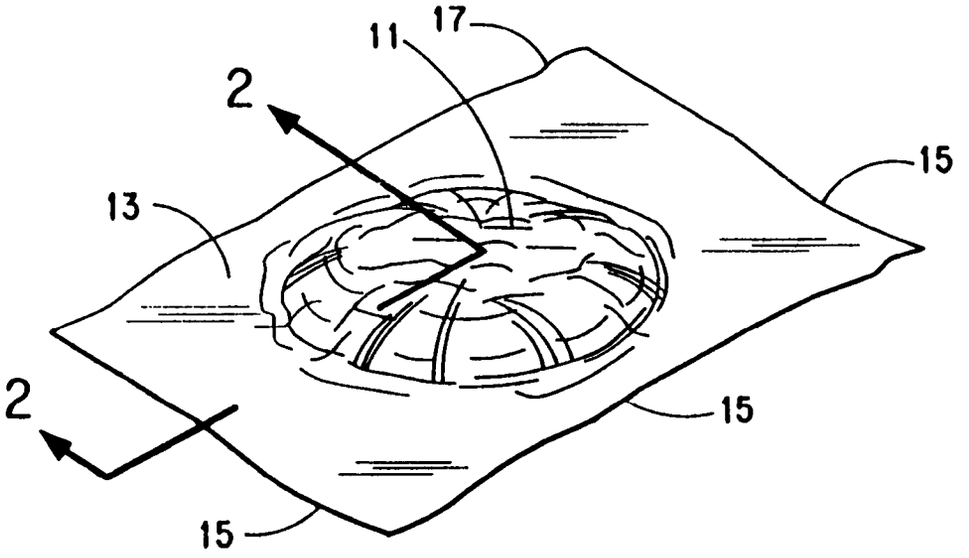

FIG.2

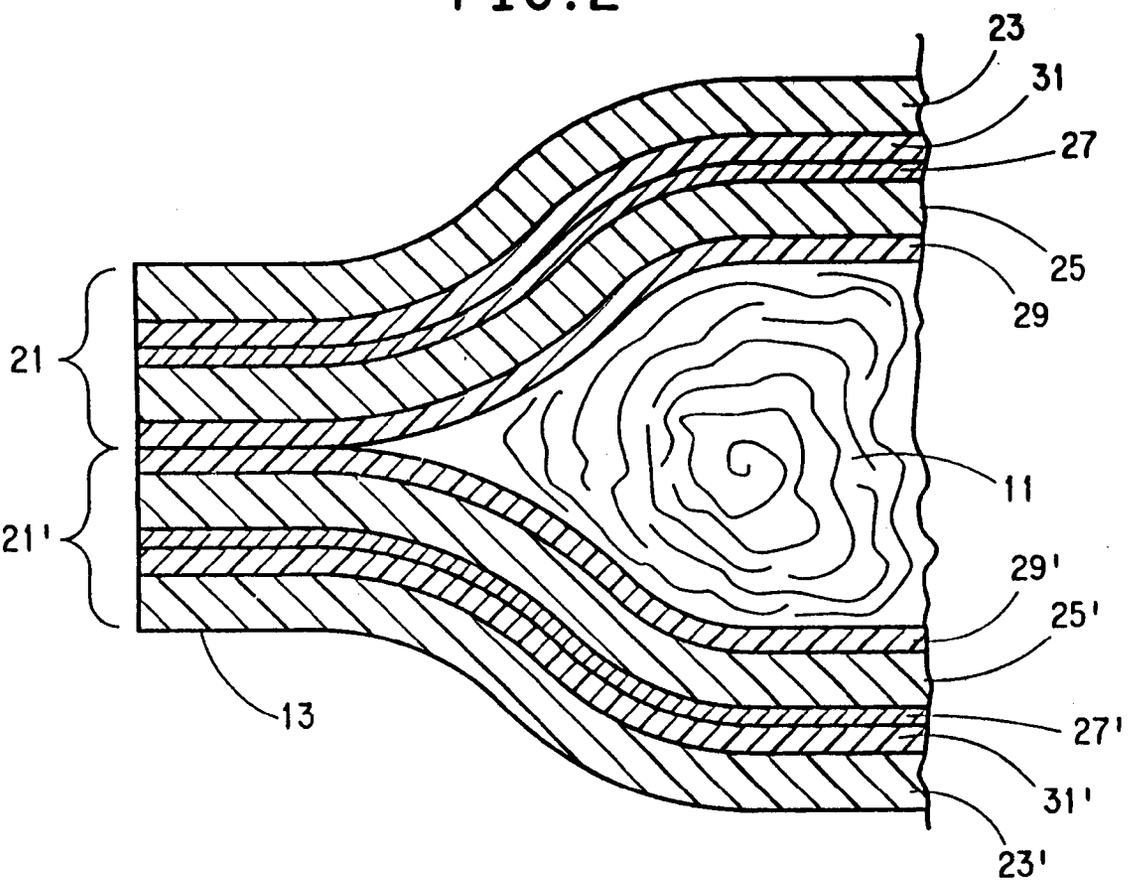

FIG.3