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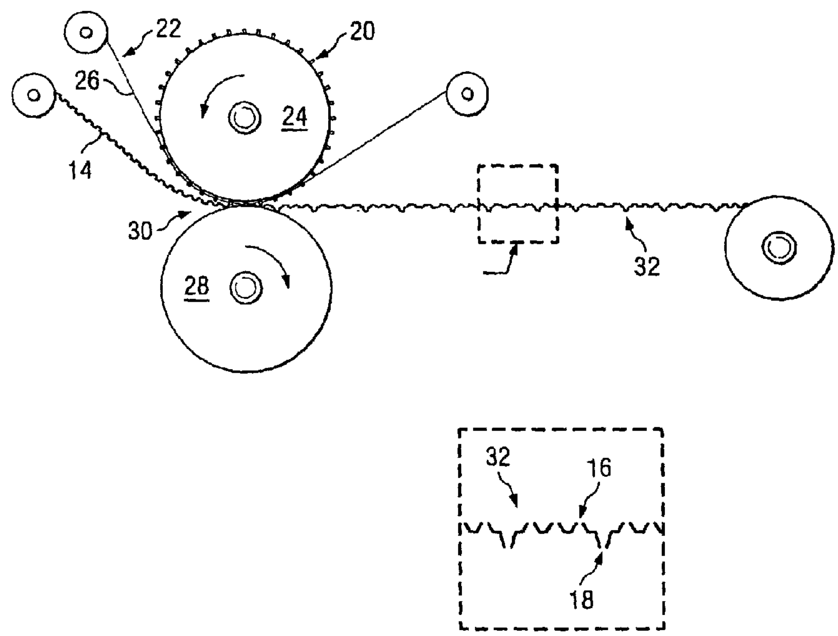
(54) **Title:** APERTURED MATERIAL FOR USE IN ABSORBENT ARTICLES AND METHOD OF MAKING SAME



(57) **Abstract:** A film (14) for use in absorbent articles is first microscopically textured (16) and then macroscopically apertured (18) while maintaining the microscopic texture (16). The micro-texturing (16) may be done by a variety of means including vacuum forming, and may include micro-apertures. The macroscopic texture (18) may be done by a variety of means including thermo-mechanical means with a heat shielding means (22). Where heated pins (20) are used, the heat shielding means (22) protects the micro-texture (16) from the heat so that the heat does not deform the micro-texture (16).

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APERTURED MATERIAL FOR USE IN ABSORBENT ARTICLES AND METHOD OF MAKING THE SAME

This application claims the benefit of U.S. Provisional Application No. 60/435,942, filed December 20, 2002. The disclosure of the prior application is considered part of (and is incorporated by reference in) the disclosure of this application.

TECHNICAL FIELD

This invention relates to the formation of three-dimensional thermoplastic films, and more particularly those with both micro-texture and macro-apertures.

BACKGROUND

Description of Related Art

There has always been a need to create cloth-like textures in poly-olefin films that can in turn become three-dimensionally apertured fluid transporting structures. In the past this texturing was achieved through the creation of a plurality of micro-apertures that stick out from the surface of film. This fragile micro-texture can be created through the use of water forming or vacuum forming as described in the prior art. However, once micro-texturing is completed, it is difficult to create the three-dimensional ("3D") funnel-shaped aperture that allows the fluid to pass through the film into the absorbent layer underneath without destroying the micro-texture. Water or needle perforation has been attempted, however, the water approach is not at a high enough temperature to create a permanently deformed and stress annealed aperture. Thus, a large 3D aperture formed using water perforation could have the tendency to become flat again if subjected to stress or to pressure at the time the aperture is formed. Use of a hot needle is not effective either, because the heat from the hot needle will melt the surrounding, very delicate micro-texture if the needle is hot enough to impart any permanent deformation into the cone. If the micro-texture is micro-apertures, the heat of the needle causes the edges of the micro-apertures to "crisp" or become very stiff as a result of the exposure to the heat. This sort of stiffening of the edges makes the final product rough to the touch.

A novel method of using thermo-mechanical perforation with a matching set of needles, grooves and protective surface to create such product is disclosed herein. Further, this invention teaches how, in one pass, a product can have large 3D fluid transport holes imparted into a micro-textured film and how a fluid transport layer may be attached under the fluid transport sheets to direct the fluid away from the 3D funnel of the micro-textured film. The final product produced via such process is primarily intended for use as a body-contacting, textured formed film top sheet in an absorbent hygienic product or wound dressing. Further, this product can be used as a sub-layer in such an absorbent article or as a top layer in a baby diaper.

SUMMARY

A film is first microscopically textured and then macroscopically textured while maintaining the microscopic texture. The micro-texturing may be done by a variety of means including vacuum forming, and may include micro-apertures. The macroscopic texture may be done by a variety of means including thermo-mechanical means with a heat shielding means. Where heated pins are used, the heat shielding means protects the micro-texture from the heat so that the heat does not deform the micro-texture.

The details of one or more embodiments of the invention are set forth in the accompanying drawings and the description below. Other features, objects, and advantages of the invention will be apparent from the description and drawings, and from the claims.

DESCRIPTION OF DRAWINGS

Figure 1 is a schematic view of a method of forming a micro-texture in a film.

Figure 2 is a cross sectional view of a film with micro-texture formed by the process shown in Figure 1.

Figure 3 is a schematic view of a method of forming a macro-texture in a film.

Figure 4 is a cross sectional view of a film with both a micro-texture and a macro-texture as formed by the processes of Figure 1 and Figure 3.

Figure 5 is a schematic view of a method of forming a macro-texture in a film while combining a nonwoven layer with the film.

Figure 6 is a cross sectional view of a film adjacent to a nonwoven layer and with both a microtexture and a macro-texture as formed by the processes of Figure 1 and Figure 5.

Figure 7 is a schematic view of a method of forming a macro-texture in a film.

Figure 8 is a cross sectional view of a film with both a micro-texture and a macro-texture as formed by the processes of Figure 1 and Figure 7.

Figure 9 is a schematic view of a method of forming a macro-texture in a film while combining a nonwoven layer with the film.

Figure 10 is a cross sectional view of a film adjacent to a nonwoven layer and with both a microtexture and a macro-texture as formed by the processes of Figure 1 and Figure 9.

Like reference symbols in the various drawings indicate like elements.

DETAILED DESCRIPTION

As used herein, "micro" refers to individual features that are not individually discernable when viewed by the human eye from about 18 inches, although a change in texture on a whole may be discernable, while "macro" refers to features that are individually discernable when viewed by the human eye from about 18 inches. For example, micro-apertures with a mesh of between about 30 apertures per linear inch and 100 apertures per linear inch will change the surface texture of a film, but the individual apertures will not be individually discernable by the human eye from a distance of about 18 inches. Likewise, macro-apertures with a spacing of about 5 to about 11 holes per square centimeter will be individually discernable by the human eye from a distance of about 18 inches.

A film material 10, which is typically thermoplastic, is extruded onto a forming screen 12. Forming screen 12 contains a micro-texture. The forming screen 12 may have a variety of micro-texture patterns. The film material 10 is thereby formed into a microscopically three-dimensional film 14. The film material 10 may be apertured as part of the vacuum forming or may be allowed to stay intact.

The film material 10 may be a thin film consisting of a 50/50 blend of LDPE and LLDPE extruded from a cast die 16 or a blown die. While the film material 10 is still in a semi-molten, malleable state a pressure is applied by differential pressure means, such as a vacuum, blown air, etc., to the film material 10 to have the film material 10 form to a screen 12. The pressure may be applied by known vacuum forming techniques as shown in Figure 1, although other means may be acceptable. The screen 12 imparts a micro-texture 16 to the film material 10. The resultant micro-textured film 14 will have a micro-texture 16, which may include micro-apertures, micro-ridges, micro-dots, or other micro-textures known in the art, as it is removed from the screen 12 as shown in Figure 2. If the micro-texture 16 is micro-apertures, the micro-apertures may have a density of between about 30 holes per linear inch and about 100 holes per linear inch, also known as about 30 mesh to about 100 mesh, and preferably between about 40 mesh and about 60 mesh. Where micro-textures 16 are formed of micro-apertures, they may be three-dimensional micro-funnels to increase their effect on tactile response as well as fluid handling properties. Where micro-textures 16 are formed of micro-apertures they may be round, elongated, octagonal, oval, hexagonal, ellipsoid, rectangular, square, or any other shape or pattern depending on the preferred texture or fluid handling properties.

The film material 10 may contain surfactants in the resin, or surfactants may be added to the micro-textured film 14. Surfactants increase the philicity of the normally phobic film material 10 and may affect the performance of the finished product as discussed below. Alternatively, surfactants may not be added, resulting in a phobic film material 10.

In a preferred embodiment, the micro-textured film 14 is then thermo-mechanically perforated to produce a macroscopic three-dimensional aperture 18. The macro-aperture 18 forms a macroscopic texture on the film, and therefore the terms macro-texture and macro-aperture 18 are used throughout. Heat shielding 22 allows the use of heated pins 20 to perforate the micro-textured film 14 without destroying the micro-texture 16. Without heat shielding 22, the heated pins 20 may soften the material of film 14 such that micro-texture 16 is destroyed or the heated pins 20 may crisp the edges of the micro-texture 16 as described above. If micro-textured film 14 is sufficiently heated by heated pins 20, the micro-texture 16 will melt back to a film, thus losing the texture created by screen 12. The heat shield 22, shown in Figures 3, 5, 7, and 9, is a shielding material 26 having a higher melting point than the film, such as a nonwoven polypropylene, which passes through the perforating nip 30 between the micro-textured film 14 and a drum 24 carrying heated perforating pins 22. Two effective examples of shielding material 26 are nonwovens known in the art as Spun-Meltblown-Spun 19gsm and Thermo-bonded Carded 24gsm. The selection of an appropriate nonwoven material to be used as shielding material 26 should be based on finding a nonwoven that has a melting point higher than the film material 10. Other heat shields would include various other materials, which may be able to run on a continuous loop with a cooling cycle, a cooled drum/heated pin arrangement, and various fluid-cooling means.

The thermo-mechanical perforating unit shown in Figure 3 uses heated pins 20 mated into an unheated female roll 28 to form a nip 30. The micro-textured film 14 and above-mentioned shielding material 26 are fed into the nip 30 such that the heated pins 20 form macroscopic three-dimensional apertures 18 in the micro-textured film 14. The shape of the apertures is determined by the relationship between pins 20 and roll 28. The macro-apertures 18 of this preferred embodiment have a density of between about 4 holes per square centimeter and about 15 holes per square centimeter, and preferably between about 5 holes per square centimeter and about 12 holes per square centimeter. The macro-apertures 18 may be formed into a cone that extends from an upper surface of the film 14 to a lower surface spaced apart by a distance greater than the initial thickness of film 14. The taper of the cone will depend on the shape of female roll 28 and heated pins 20. Depending on the relative speed at which the film 14, heated pins 20, and female roll 28 are moving, the macro-apertures 18 may be round or elongated.

Female roll 28 may be temperature controlled to maintain a consistency to the macro-apertures 18 formed at the nip 30. The temperature control may include cooling or heating as needed for the desired results. For example, an operating temperature of 30 degrees Celsius may require cooling in some environments, heating in others.

The film 32 of the preferred embodiment will have a vacuum formed micro-texture 16 and a thermo-mechanically formed macro-texture 18, as shown in Figures

4 and 8. The micro-textured film 14 of Figure 2 has a caliper of about 25 microns while the caliper of the film 32 of Figures 4 and 6 is about 400 microns to about 1500 microns, preferably between about 800 microns and 1300 microns. The film 32 of this preferred embodiment will have a desirable texture provided by the micro-texture 16 and a resilient structure provided by the macro-texture 18.

As shown in Figures 5 and 9, a second material 34, such as a wicking nonwoven, may be fed into the nip 30 of the thermo-mechanical forming means to simultaneously bond the second material 34 to the film layer 14 thus creating a composite material 36. The second material 34 may be positioned between the film layer 14 and female roll 28 so that the micro-texture 16 is still exposed. Heated pins 20 would puncture second material 34 at macro-apertures 18. In this manner, a composite material 36 may be formed having the tactile impression and fluid handling abilities of a micro-apertured film backed by a wicking material and the fluid handling abilities of macro-apertures 18 unobstructed by the second material 34 as shown in Figure 6. The second material 34 is effective in wicking moisture away from the film layer 14, thus improving the wetback performance.

As can be seen by comparison of Figures 4 and 8 or Figures 6 and 10 where the micro-textures 16 are micro-apertures, the micro-apertures may extend in the same direction as the macro-apertures 18, Figures 8 and 10, or in the opposite direction as the macro-apertures 18, Figures 4 and 6.

Absorbent articles typically have a body facing topsheet, a backsheet opposite the topsheet, and an absorbent core between the topsheet and backsheet. Additionally, modern absorbent articles may contain an intermediate layer between the topsheet and the absorbent core. The film 32 or composite material 36 may be used as a topsheet or an intermediate layer in an absorbent article.

Performance Measures

Various materials were tested as topsheets against comparative topsheet materials. One of the comparative materials is a hydro-formed topsheet used in the Procter & Gamble sanitary napkin product "Lines Petalo Blu" and referred to herein as "HFF". Another of the comparative materials is the nonwoven phobic topsheet used in the SCA sanitary napkin product "Nuvenia Libresse" and referred to herein as "NW". The materials used for the different examples are as follows:

Example 1: A micro-texture 16 of 60 mesh micro-apertures in a philic film material 10 and macro-apertures 18 with a spacing of about 5.6 apertures per square centimeter.

Example 2: Similar to Example 1, but with a micro-texture 16 of 40 mesh micro-apertures.

Example 3: Similar to Example 1, but with a phobic film material 10.

Example 4: Similar to Example 2, but with a phobic film material 10.

Example 5: Similar to Example 1, but with a second material 34 of 25 gsm air through bonded nonwoven (ATB 25 RAM).

Example 6: Similar to Example 2, but with a second material 34 of 25 gsm air through bonded nonwoven (ATB 25 RAM).

Example 7: Similar to Example 5, but with macro-apertures 18 with a spacing of about 11 apertures per square centimeter.

Example 8: Similar to Example 6, but with macro-apertures 18 with a spacing of about 11 apertures per square centimeter.

Strikethrough is a measure of the rate of absorption through a topsheet into an absorbent article and was conducted on finished articles as indicated below. In order to test strikethrough the original topsheet material is removed from the article and replaced with the topsheet material to be tested, except when testing the sample of the original material. The article is then insulted with a 10ml sample of Menstrual Internal Synthetic Solution (MISS) and the strikethrough time is recorded using a Lister apparatus as described in EDANA Recommended Test Method ERT 150.5-02 Liquid Strike Through Time Test Method. Lower strikethrough numbers reflect a fast absorption and are desired in most absorbent articles.

Wetback is measured on the same samples used in the strikethrough test described above. After the strikethrough is measured the samples are carefully removed from the test apparatus and positioned on a flat surface. A 4 kg weight with a surface of 10cm by 10cm is placed on the insult area of the sample for three minutes. At three minutes the weight is removed and 5 pre-weighed pick up papers are placed over the insult area and the weight is placed over the pickup paper. At two minutes the weight is removed and the pickup paper is removed and reweighed. The weight gained by the pickup paper is reported as the wetback. This method is based on EDANA Recommended Test Method ERT 151.3-02 Wetback. Lower wetback numbers reflect more complete absorption and less leakage to the insult surface and are desired in most absorbent articles.

The following data refers to the tests performed on "Lines Petalo Blu" articles tested under the method described above:

Topsheet	Strikethrough (seconds)	Rewet (grams)
HFF	49.0	0.93
Example 1	38.7	0.72
Example 2	13.0	0.36
Example 5	54.8	0.43
Example 6	27.8	0.27
Example 7	47.0	0.42
Example 8	32.0	0.26

The following data refers to the tests performed on "Nuvenia" articles tested under the method described above:

Topsheet	Strikethrough (seconds)	Rewet (grams)
NW	>500	1.3
Example 1	143.6	1.2
Example 2	73.4	1.2
Example 3	325.3	1.1
Example 4	164.0	1.1
Example 7	91.78	0.465
Example 8	61.13	0.570

As can be seen from the above results, all of the Examples showed improvement over the original topsheet material used in the absorbent article.

While particular embodiments of the present invention have been illustrated and described, it would be obvious to those skilled in the art that various other changes and modifications can be made without departing from the spirit and scope of the invention. The appended claims are therefore intended to cover all such changes and modifications that are within the scope of this invention.

WHAT IS CLAIMED IS:

1. A method for manufacturing a formed film, the method comprising:

extruding a thermoplastic material to form a film;

forming micro-textures soon after extrusion, while the thermoplastic material is still in a maleable state; and

forming three-dimensional macro-apertures after micro-textures have been formed.

2. The method of claim 1 wherein the micro-textures are formed with a differential pressure means.

3. The method of claim 1 wherein the micro-textures are formed by pulling the thermoplastic material onto a screen with a vacuum.

4. The method of claim 1 wherein the macro-apertures are formed with a thermo-mechanical forming process.

5. The method of claim 4 wherein the thermo-mechanical forming process includes use of a heat shielding material to maintain the micro-textures in the film while the film is in a nip of the thermo-mechanical means.

6. The method of claim 4 wherein the thermo-mechanical forming process includes use of a layer of nonwoven fabric with a higher melting point than the film as the heat shielding material.

7. The method of claim 1 wherein a nonwoven material is bonded to the film concurrently with the forming of macro-textures.

8. An apertured thermoplastic film with a body facing surface and an absorbent core facing surface that comprises:

a micro-textured surface comprising a high density of elongated micro-funnels extending perpendicular to the surface's plane to form protrusions; and

three dimensional macro-apertures extending perpendicular to its plane to form protrusions on the film's absorbent core facing surface.

9. The film of claim 8 wherein the protrusions formed by the micro-funnels protrude from the same surface as the protrusions formed by the macro-apertures.

10. The film of claim 8 wherein the protrusions formed by the micro-funnels is in the opposite direction as the protrusions formed by the macro-apertures.

11. The film of claim 8 wherein the micro-funnels have a mesh of about 30 to about 100 micro funnels per linear inch.

12. The film of claim 8 wherein the micro-funnels have a mesh of about 40 to about 60 micro funnels per linear inch.

13. The film of claim 8 wherein the macro-apertures have a density of between 4 holes per square centimeter and 15 holes per square centimeter.

14. The film of claim 8 wherein the macro-apertures have a density of between 5 holes per square centimeter and 12 holes per square centimeter.

15. The film of claim 8 further comprising a nonwoven layer bonded to the absorbent facing side of the film with apertures aligned with the macro-protrusions on the absorbent facing side of the film.

16. An absorbent article comprising:

a topsheet; and

an absorbent core;

wherein the topsheet is a film with apertures forming lands on a surface, the apertures being three dimensional and extending perpendicular to the surface, the lands having micro-apertures, the micro-apertures being three dimensional and extending perpendicular to the surface.

17. The absorbent article of claim 16 wherein the apertures and the micro-apertures extend opposite one another.

18. The absorbent article of claim 16 wherein the apertures and the micro-apertures extend in the same direction.

19. The absorbent article of claim 16 wherein the film is bonded to a nonwoven layer having openings aligned with the apertures.

20. The film of claim 16 wherein the micro-apertures nave a mesh of about 30 to about 100 micro funnels per linear inch.

21. The film of claim 16 wherein the micro-apertures have a mesh of about 40 to about 60 micro funnels per linear inch.

22. The film of claim 16 wherein the apertures have a density of between 4 holes per square centimeter and 15 holes per square centimeter.

23. The film of claim 16 wherein the apertures have a density of between 5 holes per square centimeter and 12 holes per square centimeter.

24. An absorbent article comprising:

a topsheet; and

an absorbent core;

wherein the topsheet is a film with apertures forming lands on a surface, the apertures being three dimensional and extending perpendicular to the surface, the lands having micro-textures, the micro-textures being three dimensional and extending perpendicular to the surface.

25. The absorbent article of claim 24 wherein the micro-textures extend opposite the apertures.

26. The absorbent article of claim 24 wherein the micro-textures are one of a group consisting of microdots, micro-ridges, random matte, and micro-apertures.

27. The absorbent article of claim 24 wherein the film is bonded to a nonwoven layer having openings aligned with the apertures.

28. The film of claim 24 wherein the apertures have a density of between 4 holes per square centimeter and 15 holes per square centimeter.

29. The film of claim 24 wherein the apertures have a density of between 5 holes per square centimeter and 12 holes per square centimeter.

30. A method for making a formed film comprising:

extruding a resin onto a forming screen imparted with a micro-texture so that the resin forms to the screen and forms a film with the micro-texture;

aperturing the film with heated pins to create three dimensional macro-apertures with lands between the macro-apertures; and

shielding the lands between the macro apertures during the aperturing process with a protective layer to prevent the heating of the lands to a point where the micro-texture loses its form.

31. The method of claim 30 wherein the protective layer is a nonwoven material with a melting point higher than the resin.

32. The method of claim 30 further comprising:

bonding a nonwoven layer to the film during the aperturing process such that the heated pins extend through the nonwoven layer so that the nonwoven layer does not obstruct fluid flow through the apertures.

33. The method of claim 32 wherein a vacuum is applied to the forming screen to create micro-apertures as the micro-texture in the film.

34. An absorbent article comprising:

a topsheet;

an absorbent core; and

an intermediate layer between the topsheet and the absorbent core;

wherein the intermediate layer is a film with apertures forming lands on a surface, the apertures being three dimensional and extending perpendicular to the surface, the lands having micro-textures, the micro-textures being three dimensional and extending perpendicular to the surface.

35. The absorbent article of claim 34 wherein the micro-textures extend opposite the apertures.

36. The absorbent article of claim 34 wherein the micro-textures are one of a group consisting of microdots, micro-ridges, random matte, and micro-apertures.

37. The absorbent article of claim 34 wherein the film is bonded to a nonwoven layer having openings aligned with the apertures.

38. The film of claim 34 wherein the apertures have a density of between 4 holes per square centimeter and 15 holes per square centimeter.

39. The film of claim 34 wherein the apertures have a density of between 5 holes per square centimeter and 12 holes per square centimeter.

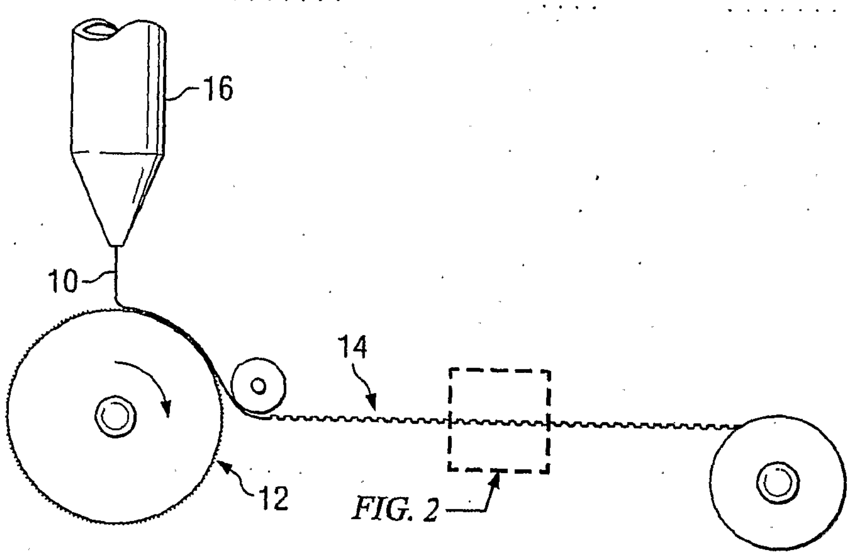
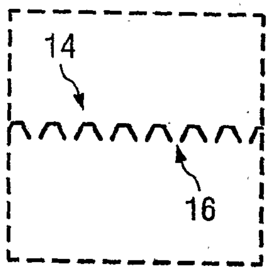


FIG. 1

FIG. 2



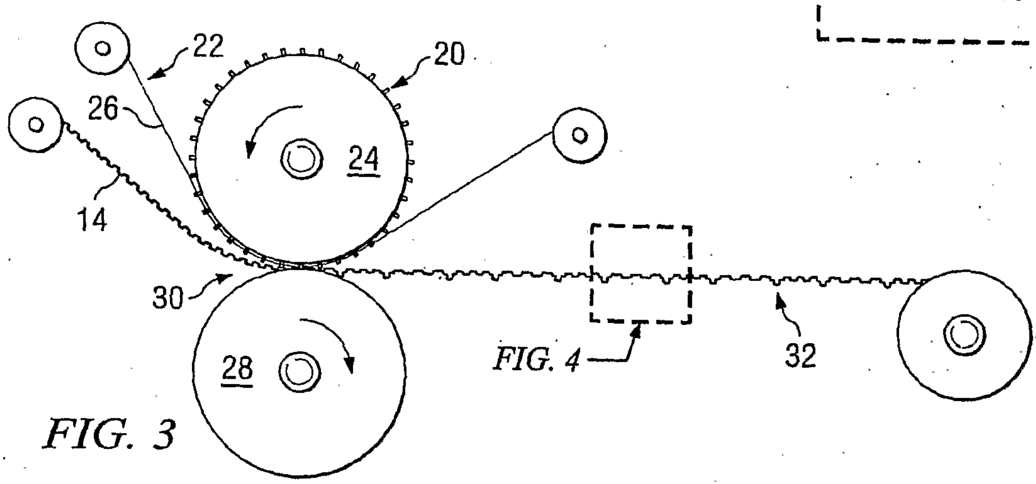
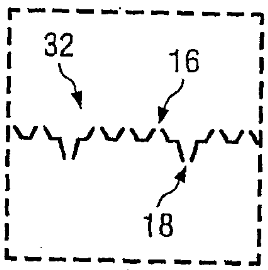


FIG. 3

FIG. 4



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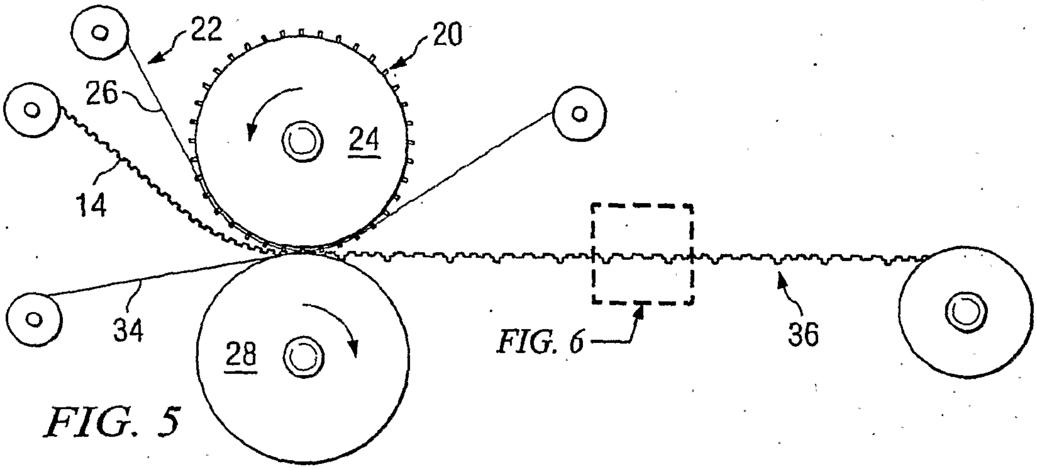
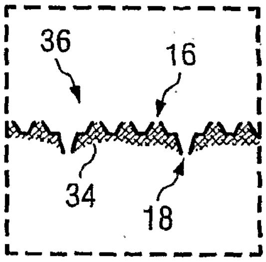


FIG. 5

FIG. 6



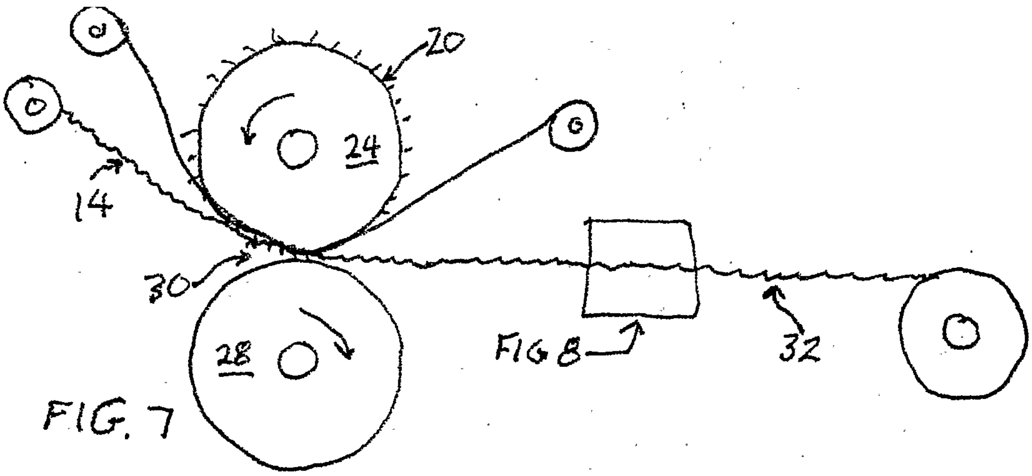


FIG. 7

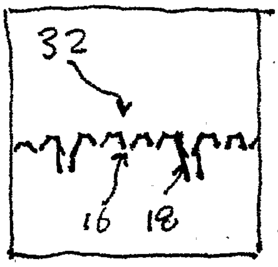


FIG 8

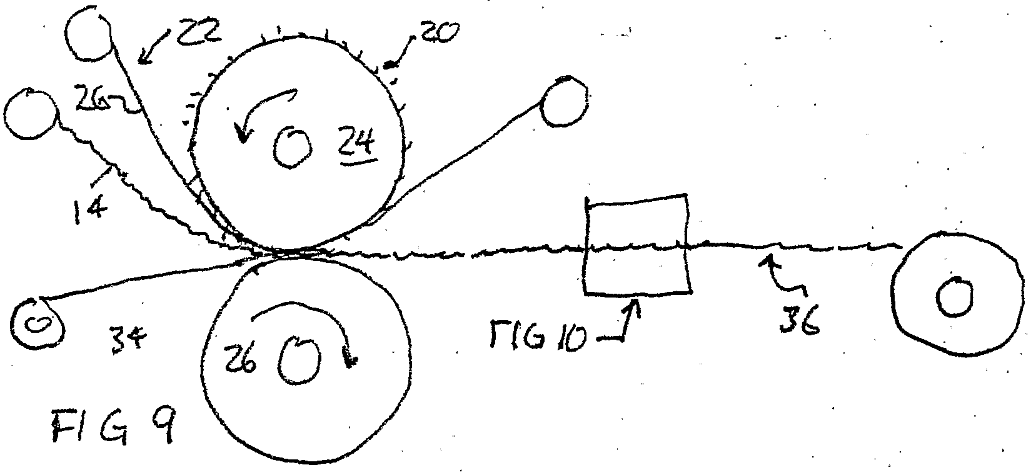


FIG 9

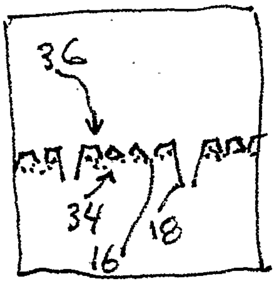


FIG. 10

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 03/40850

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 A61F13/15 B32B3/26 B29C51/22

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 A61F B29C B32B

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

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

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 99/30658 A (GRAY BRIAN FRANCIS ; PROCTER & GAMBLE (US)) 24 June 1999 (1999-06-24)	1-5,8,9, 16,18, 24,26
Y	the whole document	6,7, 10-15, 17, 19-23, 25,27-39
X	US 4 629 643 A (CURRO JOHN J ET AL) 16 December 1986 (1986-12-16)	1-3,8,9, 16,18, 24,26
Y	the whole document	4-7, 10-15, 17, 19-23, 25, 27-30,39

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
28 April 2004	07/05/2004

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Kopp, C

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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