Señor
SUPERINTENDENTE DE INDUSTRIA Y COMERCIO
DIVISION DE NUEVAS CREACIONES
E. S. D.

Re: P1.-**THE GILLETTE COMPANY**.-Solicitud de Patente de Invención para **"SURTIDOR PARA APLICAR UN MATERIAL A UNA SUPERFICIE"**.-Clase B.21.-Expediente número **00-066.768.-**

1. Me refiero a mi solicitud de 5 de Septiembre de 2000 y al auto dictado por ese Despacho notificado por Estado el 21 de Septiembre del mismo año.

2. En relación con la objeción del señor Examinador según la cual **"Una aclaración respecto a la expresión baja energía superficial que aparece en la página 23, folio 29 y [con una modificación] en las reivindicaciones 48 y 49, porque, dado que se aplica sólidos, su empleo no es fácilmente comprensible"**, atentamente me permito llamar su atención a la patente U.S. 5,942,322, perteneciente a The Procter & Gamble Company en la cual se define la expresión "energía superficial" como así se observa en la Columna 5, líneas 65 a 67 y en la Columna 6 líneas 1 a 4 de dicho documento, del cual me permito anear copia.

De acuerdo con dicho documento, ***"la energía superficial** hace referencia a la cantidad de trabajo necesaria para incrementar el área de superficie de un líquido sobre una superficie sólida. Generalmente, para las superficies sólidas, el coseno del ángulo de contacto de un líquido sobre ellas es una función monotónica de la tensión superficial del líquido. A medida que el ángulo de contacto se acerca a cero, la superficie esta más húmeda. Si el ángulo de contacto llega a ser cero, la superficie sólida esta perfectamente húmeda. A medida que el ángulo de contacto se aproxime a 180 grados, la superficie se acerca a una condición no humectable. Se reconoce que ni el ángulo de contacto a cero grados ni el ángulo de contacto a 180 grados son observados con agua.... Como se emplea aquí, **la energía de superficie se refiere a la tensión superficial crítica de la superficie sólida, y puede ser empíricamente hallada a través de la extrapolación de la relación entre la tensión superficial de un líquido y su ángulo de contacto sobre una superficie particular de interés**. Por tanto, **la energía superficial de la superficie sólida es indirectamente medida a través***

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de la tensión superficial de un líquido sobre dicha superficie sólida. *Una discusión adicional sobre la energía superficial se encuentra en Adv. Chem Ser No. 43 (1964) por W. A. Zisman y en Physical Chemistry of Surfaces, 5ª Edición por Arthur W. Adamson (1990), ambas de las cuales son incorporadas aquí como referencia*".

En el mismo documento de patente, puede igualmente observarse que materiales sólidos que tienen una baja energía superficial como los empleados en la presente invención son también reconocidos por las personas versadas en la materia. En efecto, tal como se observa en la Columna 7, líneas 20 a 34, "*En vez de cubrir la superficie de una o más laminas 41-46 del medio 40 para reducir la energía superficial como se describe anteriormente, proféticamente el medio 40 podría ser hecho de un material que intrínsecamente tiene una baja energía superficial. Aunque los aceros inoxidables han sido descritos en las patentes incorporadas como materiales adecuados para las laminas 41-46, las laminas 41-46, particularmente la primera lámina 41, podría ser hecha de o impregnada con* ***un material de baja energía superficial tal como tetrafluoroetileno, comúnmente vendido por DuPont Corporation of Wilmington, Del. bajo el nombre comercial TEFLON o plásticos extruídos de baja energía superficial, tales como poliesteres o polipropilenos.*** *Será claro que los materiales que intrínsecamente tienen una energía superficial relativamente baja pueden ser cubiertos como se describe anteriormente, suministrando una energía superficial aún más baja*".

El TEFLON citado en el anterior documento de patente es uno de los materiales citados como ejemplo en la presente solicitud. Tal como se observa en la página 23 de la descripción de la presente solicitud, las cintas guía 270 y 274 indicadas en las figuras 7-7A, se forman preferentemente de un material de baja energía superficial, como por ejemplo, un politetrafluoroetileno (PTFE) conocido comercialmente como TEFLON. El Teflon®, tal como se describe en la página 66 del libro PLASTICS (Strong, A.B. *PLASTICS, Materials and Processing.* 2da Edición. Editorial Prentice Hall. New Jersey, 2000, copia adjunta de la página 66), es un polímero más inerte y más estable que el material hidrocarburo análogo, el polietileno. El polietileno tiene la misma estructura del PTFE con la excepción que todos los hidrógenos en el polietileno son reemplazados por átomos de flúor en el PTFE. Las diferencias en propiedades son debidas a la naturaleza de los enlaces carbono - flúor. El flúor es el más electronegativo de todos los átomos y por lo tanto, el enlace de carbono – flúor es altamente polar, con el extremo negativo hacia el flúor. De ahí que los electrones son retenidos muy estrechamente por la

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molécula de flúor. Los enlaces son muy fuertes y esto empuja a los átomos de flúor cerca de los carbonos a lo largo de la espina dorsal. Los átomos de flúor actúan como escudos para los carbonos y no permiten ni que los carbonos sean atacados por otros reactivos químicos ni que los átomos de flúor sean extraídos. De ahí que el polímero es inerte y posee una baja energía superficial.

De acuerdo con los hechos anteriormente expuestos, es claro que la expresión *baja energía superficial* al igual que los materiales que tienen una *baja energía superficial* son muy conocidos en el estado de la técnica. Dicha expresión es libremente aplicada por las personas versadas en la materia con referencia a materiales sólidos, como así se demostró en el documento de patente anteriormente citado y, por consiguiente, se solicita al señor Examinador que dicha expresión, permanezca como fue inicialmente presentada dada la claridad de la misma.

3. Anexas me permito presentar a usted:

(1) En (23) hojas de papel copia formal correspondiente a los dibujos de la solicitud;

(2) Nuevas páginas 27, 50 y 51 de la descripción y las reivindicaciones, **que reemplazan las originalmente presentadas bajo los mismos números,** en las cuales:

(a) Se ha modificado la página 27 de la descripción, con el objeto de corregir el texto "..., Le., ambos bordes de la cinta deben viajar la misma distancia sustancialmente a lo largo del trayecto de la cinta, para que la tensión en ambos los bordes serán sustancialmente el mismo, y la cinta no marchita experiencia carga del edgewise significante. ..." para reemplazarlo por el texto correcto **"..., es decir, ambos bordes de la cinta deben recorrer sustancialmente la misma distancia a lo largo del trayecto de la cinta, de manera tal que la tensión en ambos bordes será sustancialmente la misma, y la cinta no experimentará ninguna carga lateral significativa. ...".** La inclusión incorrecta de dicho texto fue debida a un error de traducción.

(b) Se ha modificado la reivindicación 54 con el fin de proteger "un surtidor de acuerdo con cualquiera de las reivindicaciones **11 a 53**, caracterizado porque el material es una cinta de corrección". Con dicha modificación se aclara al señor Examinador que la reivindicación 54 no abarca lo que se reclamó en la reivindicación 10.

(3) En original y dos copias, una de ellas de 6cm x 6cm, Arte Final de la Figura 1 del invento, para la publicación en la Gaceta de la Propiedad Industrial.

4. En relación con la objeción contestada en el punto 2 de este memorial atentamente me permito manifestar los siguientes hechos:

(a) No obstante el hecho de que el solicitante discrepa de las objeciones formuladas por el señor Examinador, tal y como se manifestó mediante los argumentos aquí expuestos, estos argumentos fueron **formulados de buena fe**.

(b) En virtud de la discrepancia del solicitante con la objeción del señor Examinador de conformidad con los argumentos debidamente presentados, es deseo del solicitante insistir en que estos argumentos sean aceptados como respuesta a las objeciones formuladas.

(c) En caso de que el señor Examinador considere que los argumentos desarrollados para estas objeciones no son satisfactorios, expresamente manifiesto a usted que es deseo del solicitante continuar con el trámite de la presente solicitud de patente.

(d) En consecuencia, si el señor Examinador considera que no es satisfactoria la respuesta dada por el solicitante, ruego muy comedidamente que los puntos respondidos y objeto de discrepancia por parte del señor Examinador sean notificados con ocasión del examen consagrado en el Artículo 27 de la decisión 344 del Acuerdo de Cartagena, con le fin de que el solicitante sea requerido para hacer las modificaciones o rectificaciones a que halla lugar.

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(e) Finalmente, tratándose de aspectos relativos a las reivindicaciones, solicito de la manera más atenta, que éstas sean examinadas de acuerdo con las disposiciones del Artículo 29 de la Decisión 344. Es decir, que después de ser estudiadas nuevamente, se otorgue el privilegio de patente para las reivindicaciones aceptadas, pero que en ningún momento la discrepancia que pueda hallarse entre la respuesta del solicitante y la objeción del señor Examinador conlleve el abandono de la solicitud, por considerar, de manera impropia que no se ha dado respuesta a las objeciones técnicas formuladas.

5. Llamo su atención al hecho de que las copias certificadas respecto de las cuales se reivindica prioridad en el presente caso a saber las solicitudes estadinenses números 09/390965 de 7 de Septiembre de 1999, 09/556598 de 21 de Abril de 2000 y 09/635,972 de 10 de Agosto de 2000 serán presentadas a ese Despacho dentro del plazo de tres meses contado a partir de la fecha de presentación de la solicitud, consagrado en el artículo 4D3 del Convenio de París el cual vence el 5 de Diciembre del presente año.

6. Finalmente, confirmo a usted que el tercer número de prioridad que se reivindica en el presente caso corresponde a la solicitud estadinense número 09/635.972 de 10 de Agosto de 2000.

Sobre este particular llamo su atención al hecho de que el solicitante se encuentra dentro del término que el artículo del Convenio de París otorga para reivindicar prioridad.

7. En relación con la objeción del señor Examinador de acuerdo con la cual **"Con el fin de reconocer personería al abogado que presenta la solicitud, es necesario que allegue la sustitución del poder, otorgada por quien aparece como apoderado principal. Lo anterior de conformidad con el artículo 66 del Código de Procedimiento Civil"**, atentamente me permito aclarar a usted que el documento que se encuentra protocolizado bajo el número 19.129, en ese Despacho, con el cual obro en el presente caso, tal como lo informé en el memorial de solicitud, es **un documento de Representación Legal**, mediante el cual la sociedad THE GILLETTE COMPANY, organizada y existente de conformidad con las leyes del Estado de Delaware, Estados Unidos de América y con domicilio en Boston, Estado de Massachusetts, nombró a los doctores JOSE LLOREDA CAMACHO y/o ALFONSO LLOREDA y/o al suscrito como sus **Representantes Legales** en Bogotá para todos los asuntos relacionados con la

Propiedad Industrial, en desarrollo del mandato legal contenido en el Artículo 543 del Código de Comercio.

Dicho Articulo establece:

> "Artículo 543. **Solicitantes de Patentes que residan fuera del país.-** En caso de que el solicitante resida fuera del país, designará un representante en Bogotá con facultades de recibir notificaciones y nombrar apoderados judiciales o extrajudiciales".

Teniendo en cuenta que en virtud de la disposición transcrita, los solicitantes extranjeros tienen la obligación de designar un representante en Bogotá, a continuación se establece en forma somera qué caracteriza dicha representación.

Existen dos clases de representación, a saber, la contractual y la legal.La representación que nos ocupa es una Representación Legal, por cuanto que **surge por Ministerio de la Ley** y no en razón de la voluntad del representado.

En el acto de designación de Representante Legal por parte de una sociedad, no se hace cosa distinta de elegir a la persona que debe cumplir con una función derivada de la existencia misma de la sociedad. Esta Representación está instituida para proteger un patrimonio, en este caso el de una sociedad sin domicilio en Colombia, es de orden público y no es susceptible de delegación o cambio por convenciones entre particulares.

Por el contrario, en la constitución de mandatario, ya sea con o sin representación, ha de concurrir la voluntad de las partes en un contrato por el cual una de ellas se obliga a celebrar o ejecutar uno o más actos, bajo las instrucciones de quien lo confiere y a su nombre.

Es importante además aclarar que la calidad de Representante Legal es diferente de la calidad de Apoderado. Como dice al respecto el doctrinante **José Ignacio Narváez García**, en su tratado "Teoría General de las Sociedades", Ediciones Doctrina y Ley, Bogotá, 1996, página 294, "La esencia de la función representativa de la persona jurídica es la de poner en juego su voluntad frente a terceros. Por ello su naturaleza se explica en que el representante está dotado de poderes que emanan en primer lugar de la ley, y en segundo término de los estatutos (ley suprema de los miembros o asociados y carta fundamental del ente asociativo), y no de fuente distinta. Esto no es óbice para que la persona jurídica eventualmente se valga de los servicios de apoderados a quienes confiere de conformidad con sus estatutos y dentro del ámbito permitido en la ley, poderes representantivos. Esos apoderamientos esporádicos son **especiales**, como cuando se encarga a un abogado de determinada gestión judicial, administrativa o policiva, o son **generales**, verbigracia cuando el representante legal celebra el contrato de preposición....De manera que en toda persona jurídica suelen concurrir: la **representación legal** --que surge de las reglas del derecho demarcadoras del modo de actuar del ente-- y la **representación voluntaria** cuando confiere a una persona la facultad de expresar su voluntad frente a terceros y recibir de éstos manifestaciones de voluntad, en ambos casos con efecto directo hacia la representada".

Visto lo anterior, es claro que para el caso en particular no es posible hacer una "sustitución del poder" como así lo requiere ese Despacho, debido a que la calidad de Representante Legal con la que obro, es **insustituible,** toda vez que **es una calidad que emana de la ley y de los estatutos legales** y ella estará siempre en cabeza de las personas designadas por la sociedad para tal fin. Por consiguiente, los Representantes Legales pueden actuar individualmente, en cualquier tiempo, sin que se requiera una sustitución de poder.

Cuando son varias personas las designadas como Representantes Legales, cualquiera de ellas puede, en cualquier momento, reemplazar a quien estaba ejerciendo la representación dentro de determinada actuación, ante sus faltas temporales o permanentes. Así ocurre respecto de la Representación Legal general establecida para las sociedades, según la cual, a pesar de que se hubieren designado primero y segundo o tercer suplentes, cualquiera de ellos puede en todo momento, sin que medie acto alguno por parte de quien estaba actuando, entrar a representar a la respectiva sociedad.

En cuanto a las facultades del Representante Legal de la sociedad que no tienen domicilio en Colombia y presentan solicitudes de patente, el Artículo 543 del Código de Comercio establece, de manera expresa, que el respectivo Representante Legal deberá tener facultades de "recibir notificaciones y nombrar apoderados judiciales o extrajudiciales". Los actos de representación pueden tener límites o abarcar de manera explícita facultades especiales. En el caso en cuestión, establece el Artículo 543 del Código de Comercio que dicha representación debe incluir unas facultades especiales, la de recibir notificaciones y la de nombrar apoderados judiciales o extrajudiciales.

No está la expresión "con facultades de recibir notificaciones y nombrar apoderados judiciales o extrajudiciales" limitando la representación que la norma en cuestión exige, sino estableciendo de manera explícita que dicha representación no puede excluir tales facultades.

Del tenor literal de la disposición citada no puede inferirse conclusión diferente, ya que si la ley hubiera querido que la representación en ella estatuida se limitase exclusivamente a recibir notificaciones y a nombrar apoderados judiciales o extrajudiciales, así lo habría dicho claramente en un texto que rezara: "Designará un representante en Bogotá para recibir notificaciones y nombrar apoderados judiciales o extrajudiciales". Esa es la fórmula aceptada en los documentos en que se quiere que el mandatario y/o representante sólo pueda realizar determinados actos jurídicos. Si designo una persona "para representarme" y le agrego la frase "con facultades para", ello implica que dicha persona podrá representarme y que entre los actos de representación que podrá ejecutar están incluidos algunos especiales que para efectos de claridad se mencionan expresamente.

Es una noción de carácter universal el que los Representantes Legales de las sociedades, encargados de ejercer su capacidad de obrar, pueden hacer cuanto no les esté vedado expresamente, siempre que no se contravenga el objeto social o los estatutos de la sociedad, sin que sea indispensable que todas sus atribuciones se encuentren enumeradas en el documento correspondiente. De donde se sigue que la amplitud de los poderes del representante es la regla, al paso que la limitación es la excepción y que, por tanto, cuando la limitación no aparece de manera expresa, debe aplicarse la regla. Así lo ha establecido la Corte Suprema de Justicia (G. J. LXXVII; 845).

Es factible que el Representante Legal designado para atender en Bogotá los asuntos de propiedad industrial de una persona residente en el extranjero tenga, simultáneamente, la calidad de abogado inscrito tal como ocurre en el caso en cuestión. En dicho evento no se requerirá la constitución de un tercero como mandatario para actuar a nombre de la sociedad correspondiente en materia de propiedad industrial. El Representante Legal en tal caso tendrá la facultad de actuar personalmente, sin intermediario alguno. Lógicamente, el Representante Legal podrá constituir un mandatario judicial o extrajudicial, si lo considera conveniente pero no está obligado a hacerlo.

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La aplicación del artículo 66 del Código de Procedimiento Civil, fundamento jurídico en el cual se basa la petición de sustitución de ese Despacho, no tiene lugar en el presente caso, ya que como anteriormente se dijo, en este caso se trata de la Representación Legal consagrada en el Artículo 543 del Código de Comercio, la cual tiene su propia regulación en dicho Código. La inaplicabilidad de la norma transcrita en el campo de la Representación Legal de los peticionarios de patentes residentes en el extranjero se origina en el hecho de que cuando la persona designada de conformidad con el Artículo 543 del Código de Comercio actúa personalmente , no lo hace en virtud de un contrato de mandato, sino en su calidad de Representante Legal, no obstante el hecho de que naturalmente, toda Representación Legal lleva implícito un apoderamiento, en el sentido de que ella envuelve el ejercicio de poderes que emanan de la ley para obrar a nombre de quien actúa.

A *contrario sensu,* tal como ya se dijo, un apoderado judicial o extrajudicial nombrado por un Representante Legal de la sociedad, deberá sustituir sus poderes, si no media prohibición al respecto, para que alguien diferente de alguno de los Representantes Legales pueda continuar la actuación.

En consecuencia, teniendo en cuenta el Artículo 543 del Código de Comercio, la naturaleza del documento de Representación Legal que obra en ese Despacho y las anteriores aclaraciones, queda claro que en el presente caso, la sociedad THE GILLETTE COMPANY, organizada y existente de conformidad con las leyes del Estado de Delaware, Estados Unidos de América y domiciliada en Boston, Massacusets,es una **sociedad extranjera** la cual obra por medio de sus **Representantes Legales** en Bogotá.

Por lo tanto, muy comedidamente solicito a ese Despacho proceder a reconocer mi personería respecto de la sociedad THE GILLETTE COMPANY en el presente caso, toda vez que se ha allegado a esa División el documento de Representación Legal necesario y se ha acreditado la existencia y representación de la sociedad dentro de los correspondientes términos legales (Artículo 14 y 22 de la Decisión 344 del Acuerdo de Cartagena y Artículo 4 del Decreto 117 de 14 de Enero de 1994).

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8. Ruego a usted tomar atenta nota de lo anterior y proceder de conformidad.

Señor Superintendente,

JOSE ANTONIO LLOREDA
T.P. 10.784
Código 231

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Industria y Comercio SUPERINTENDENCIA

FORMATO DE DIGITALIZACION RELACION DE ANEXOS

Royal Technologies S.A.

Item	Expediente No	No de unidades	No de Folio 97
1	CD		
2	DVD		
3	REVISTA		
4	LIBRO		
5	PERIODICO		
6	DISQUETES		
7	SOBRE DE MANILA	1	
8	SOBRE BLANCO TAMAÑO CARTA		
9	SOBRE BLANCO TAMAÑO OFICIO		
10	OTROS:		

Observaciones: Auto Final

la cinta se afloje o pueda ser estirado, es decir, ambos bordes de la cinta deben recorrer sustancialmente la misma distancia a lo largo del trayecto de la cinta, de manera tal que la tensión en ambos bordes será sustancialmente la misma, y la cinta no experimentará ninguna carga lateral significativa. Un trayecto de la cinta que se está de acuerdo con este criterio puede ser creado apoyando la cinta por lo menos en una porción mayor de su trayecto con una superficie que tiene una geometría que proveerá una igualación de longitudes del trayecto requerida.

La forma preferida de la carcasa 12 impone una restricción adicional en la distancia axial que la cinta puede viajar del borde de punta 165 antes que cambie su orientación. Para que el surtidor pueda agarrarse a una situación bastante cerca del borde 165, la carcasa debe encerrar la cinta hasta cerca del borde (ej., aproximadamente 15 mm del punto medio M del borde). También, la carcasa es preferentemente redonda en sección transversal en la región conmovedora y tiene un diámetro externo D de menos de 14mm al extremo delantero 191 de la región de empuñadura. Éstas consideraciones de diseño requieren que tanto cinta se mueva y también entre dentro de una abertura 190 de tamaño limitado (ej.; que posee 12 mm de diámetro interior) al extremo delantero 191 de la región de empuñadura.

Así, la compensación en longitud de trayecto de borde de cinta debe lograrse sobre una distancia D1 axial relativamente corta (es decir, la distancia axial entre la abertura 188 y el

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material de energía superficial inferior.

49. Un surtidor de acuerdo con la reivindicación 48, caracterizado por que dicho material de energía superficial inferior comprende politetrafluoroetileno (PTFE).

50. Un surtidor de acuerdo con la reivindicación 47, caracterizado por que las guías de cinta incluyen una superficie con una característica cóncava sobre la cual pasa el material.

51. Un surtidor para aplicar un material a una superficie, caracterizado por que comprende:

un carrete giratorio sobre un eje;

una cantidad de cinta almacenada en el carrete;

un cabezal aplicador alrededor del cual se traslada la cinta, oprimiento el cabezal a la cinta contra una superficie para depositar por lo menos una parte de la cinta en la superficie, en donde una línea de contacto entre la cinta y la superficie se extiende en una dirección que intersecta al eje.

52. Un surtidor de acuerdo con la reivindicación 51, caracterizado por que la línea de contacto entre la cinta y la superficie se extiende en una dirección que corta el eje en un ángulo agudo.

53. Un surtidor de acuerdo con la reivindicación 51, caracterizado por que la línea de contacto entre la cinta y la superficie se extiende en una dirección que intersecta el eje sustancialmente en un ángulo recto.

54. Un surtidor de acuerdo con cualquiera de las

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reivindicaciones 11 a 53, caracterizado por que el material es una cinta de corrección.

FIG. 1

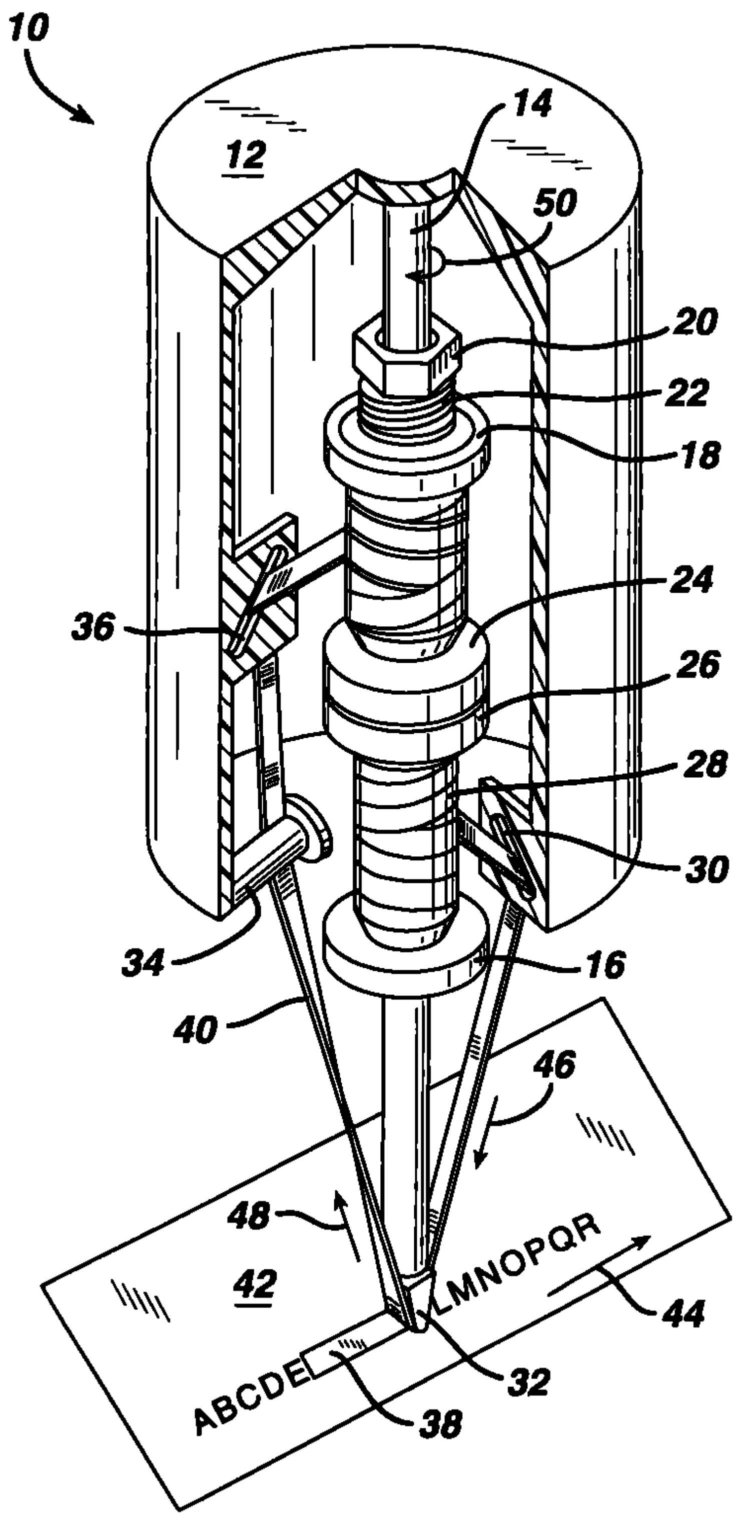
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FIG. 2

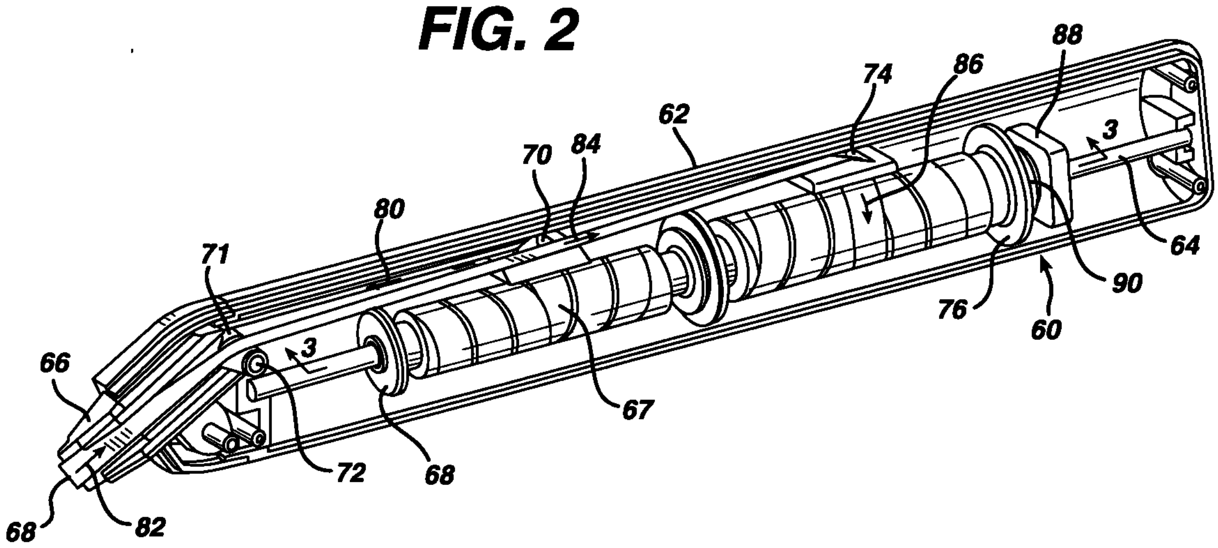
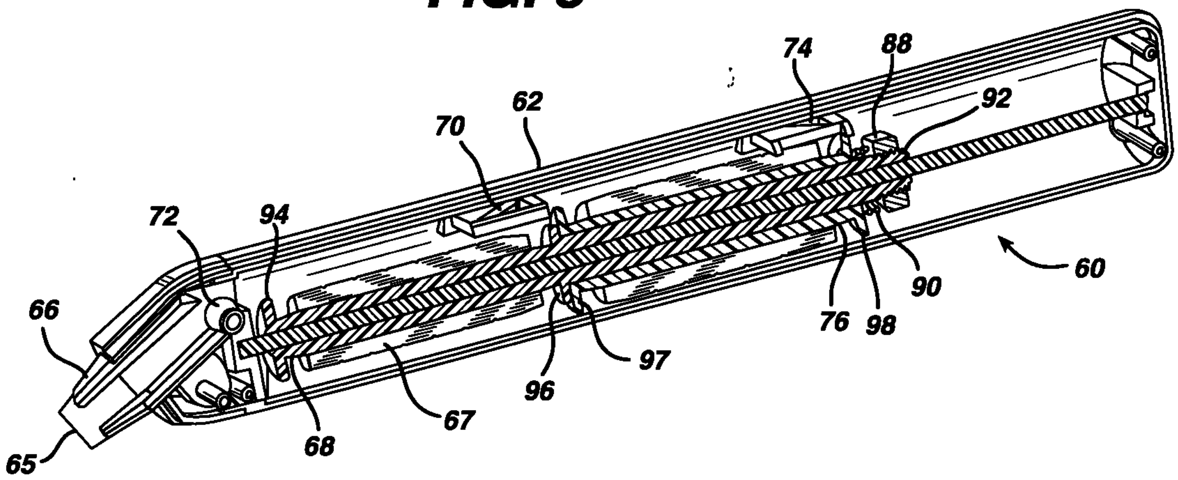


FIG. 3



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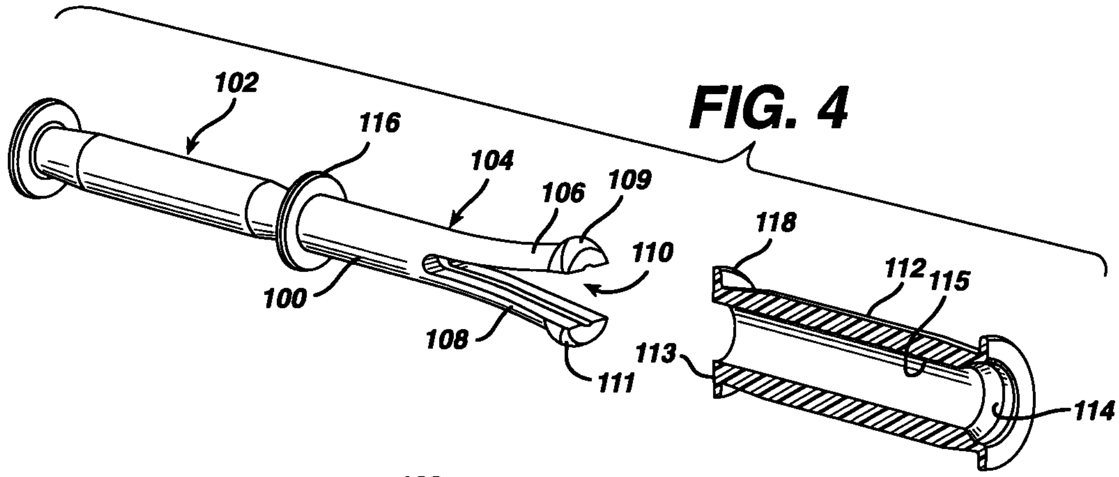
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FIG. 4

FIG. 5

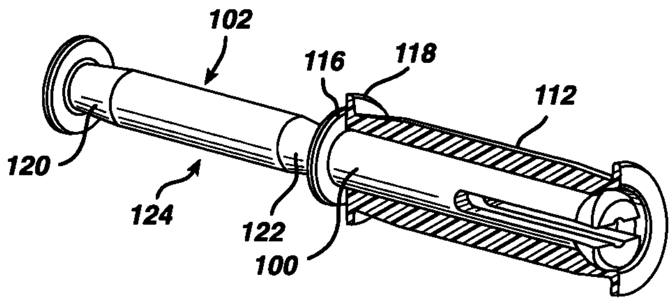
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FIG. 6(a)

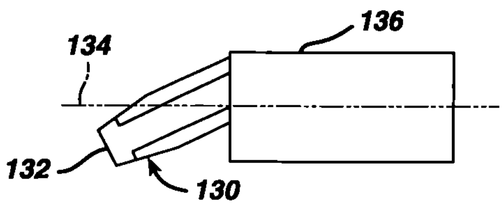


FIG. 6(b)

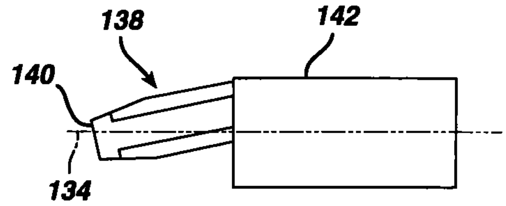


FIG. 6(c)

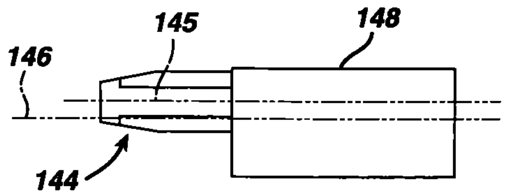


FIG. 6(d)

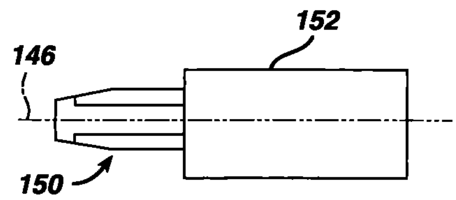


FIG. 7

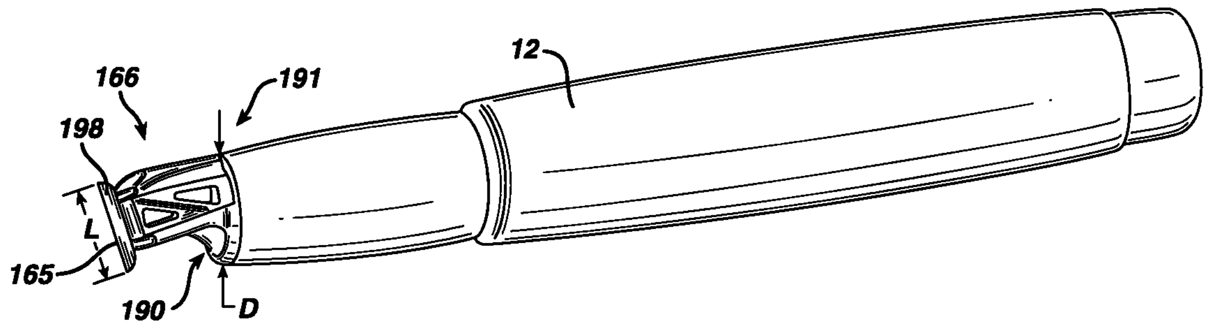

12
166
191
198
L
165
190
D

FIG. 7A

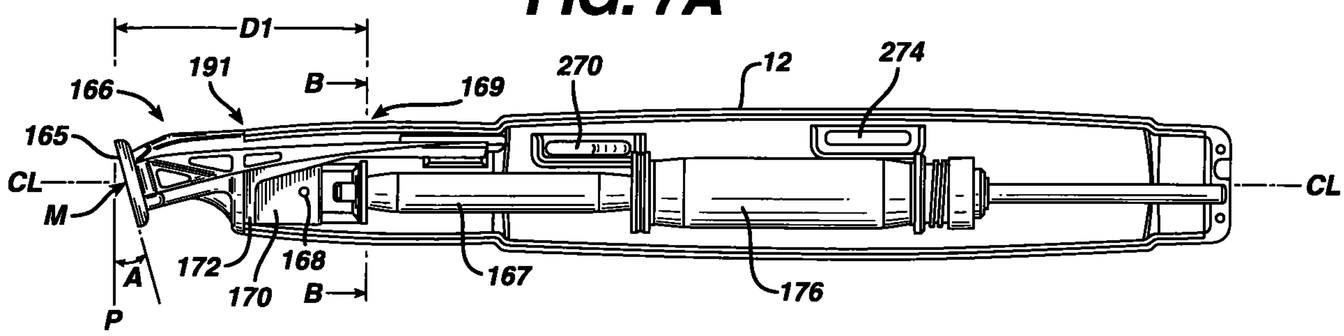

D1
191
166
B
169
270
12
274
165
CL
M
CL
A
P
172
168
170
B
167
176

FIG. 7B

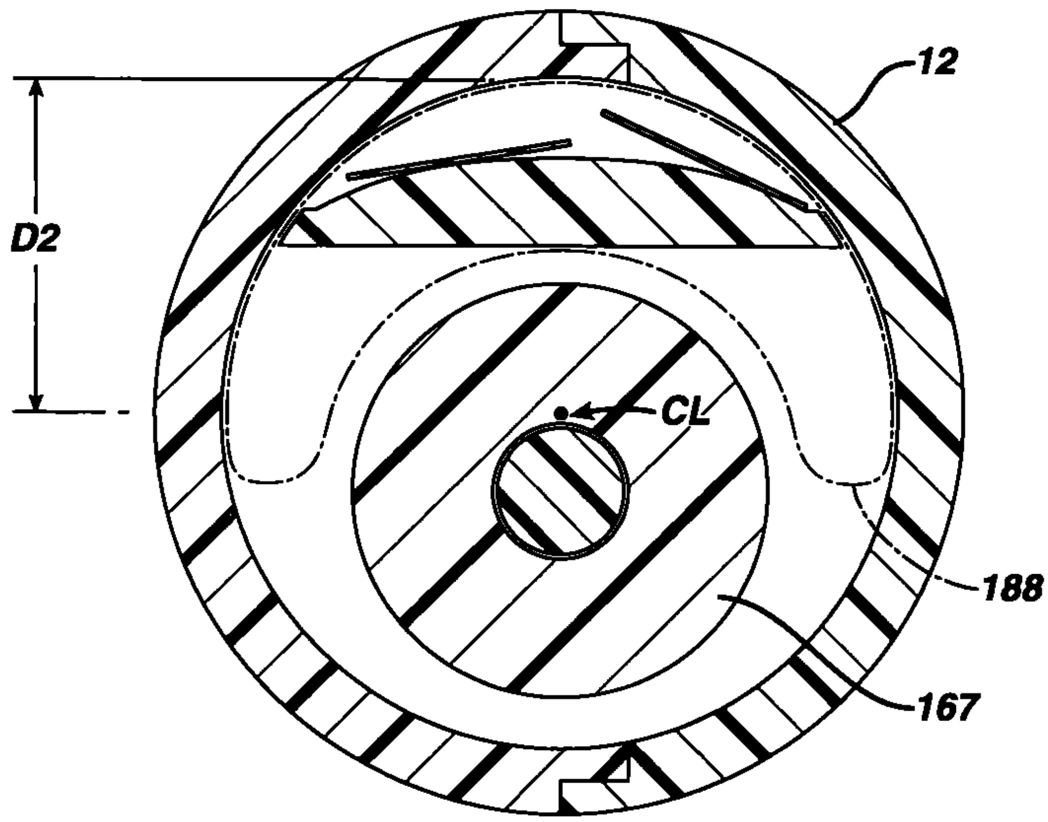


FIG. 8

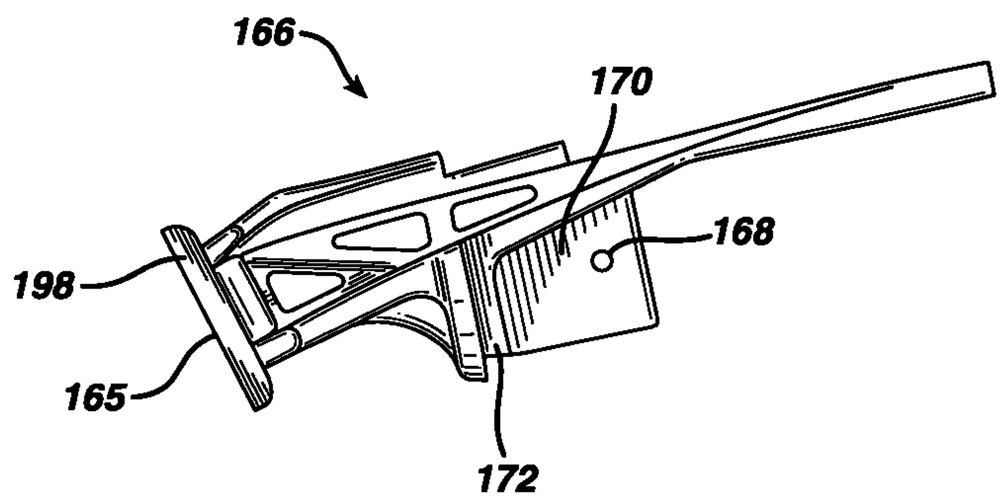


FIG. 9

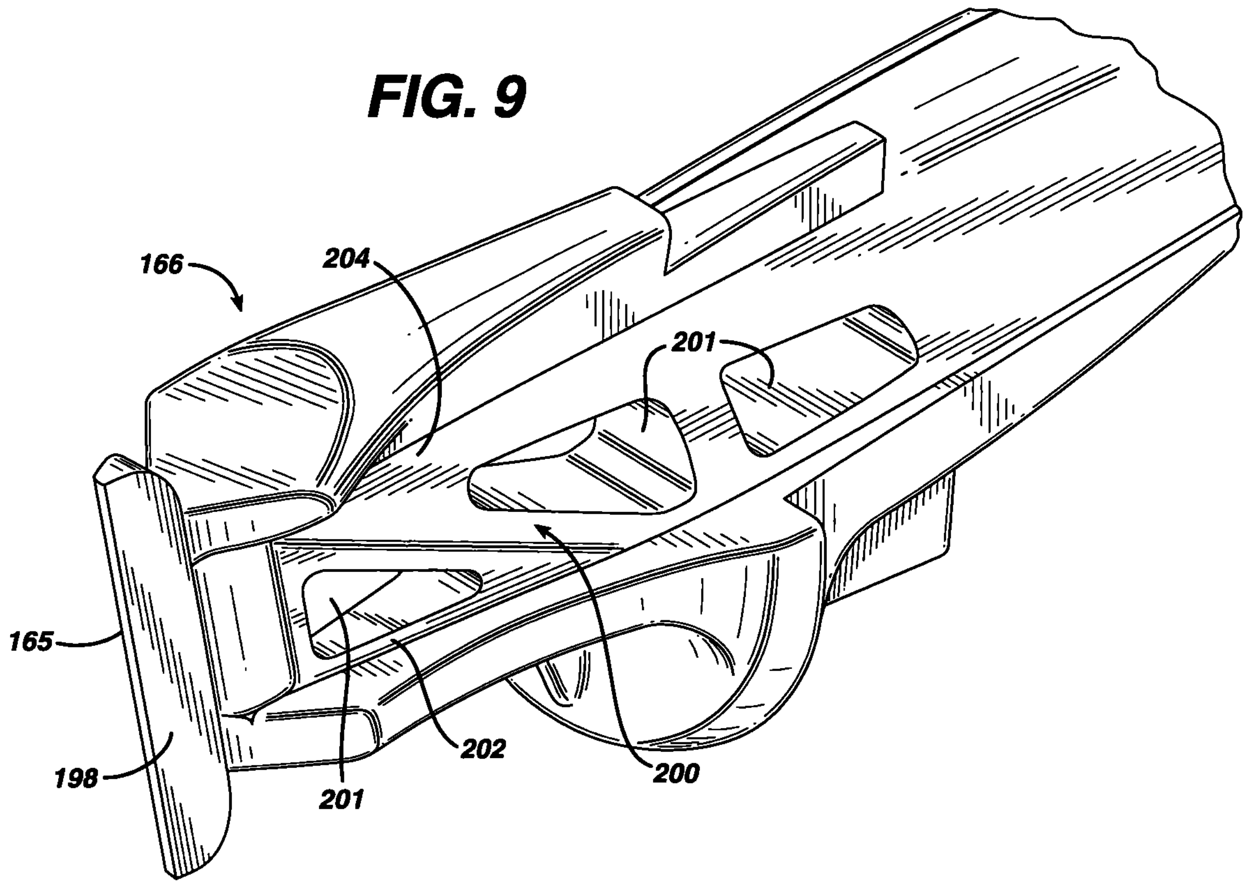
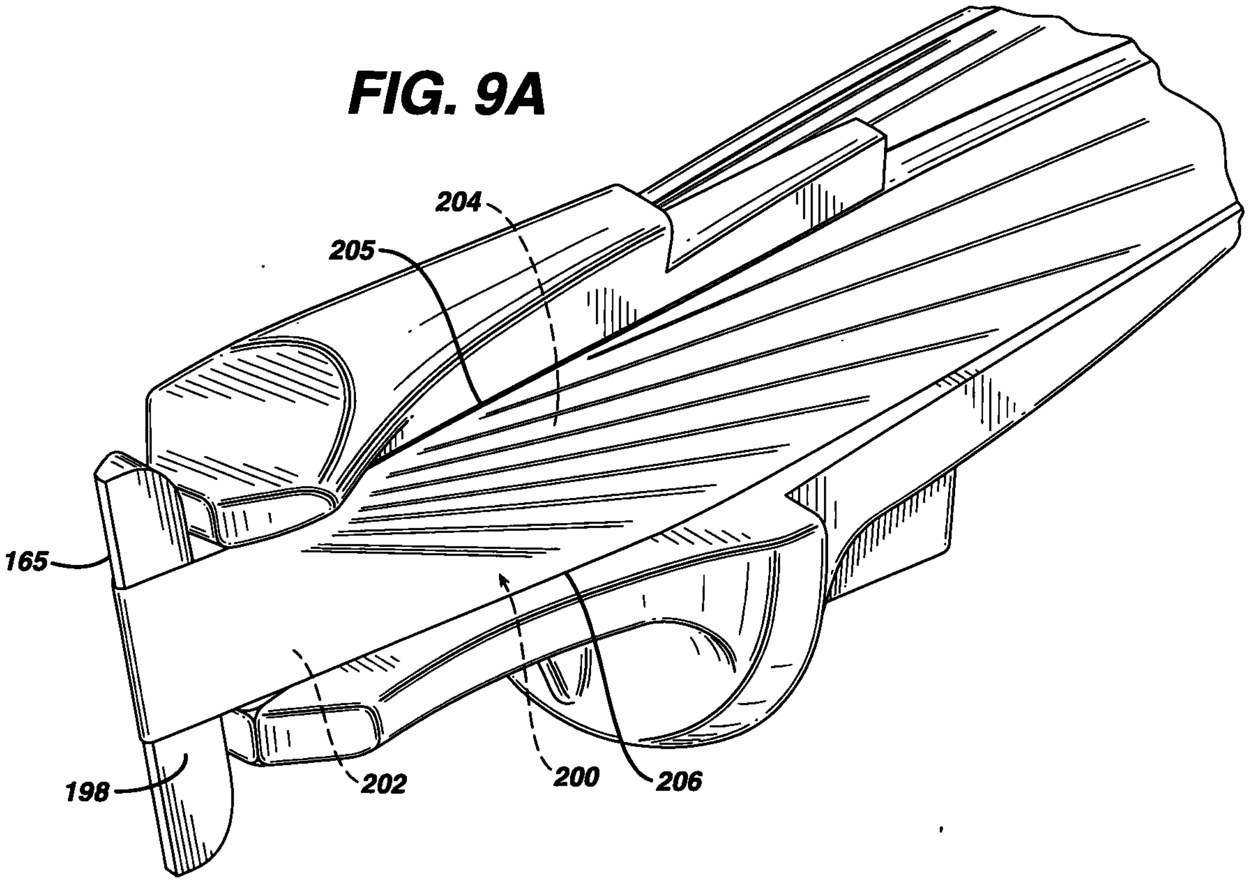


FIG. 9A



11L

FIG. 10

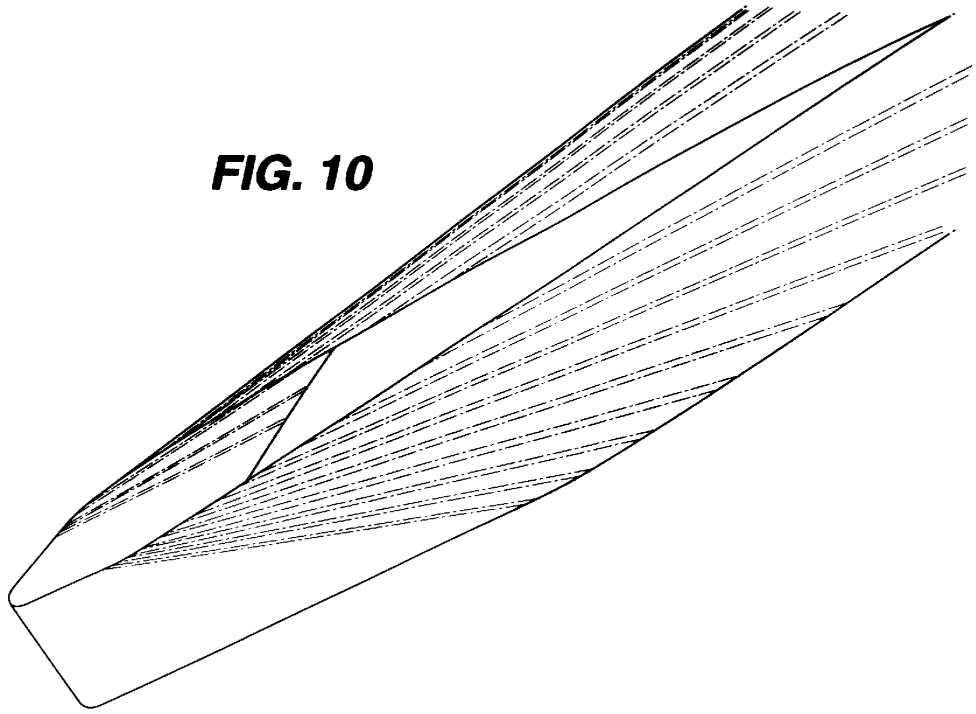


FIG. 10A

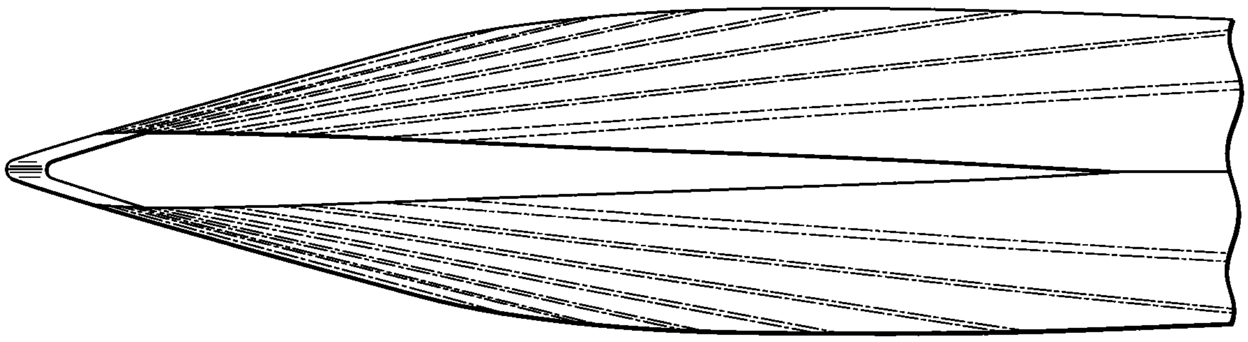
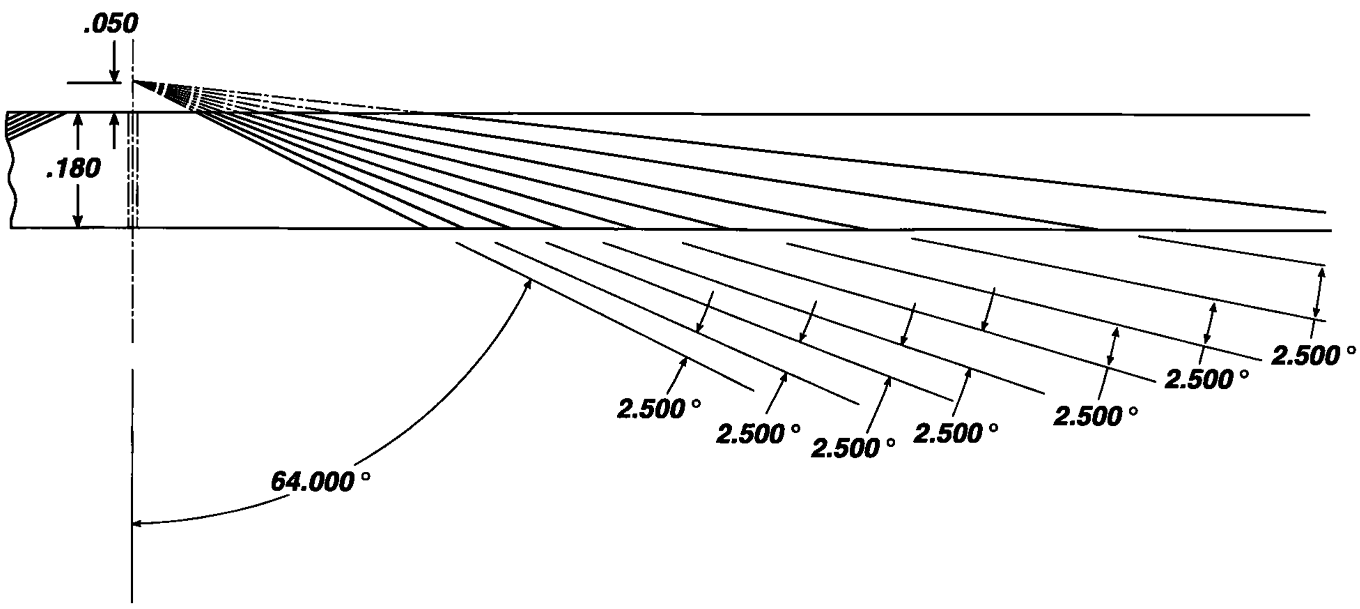


FIG. 11



128

114

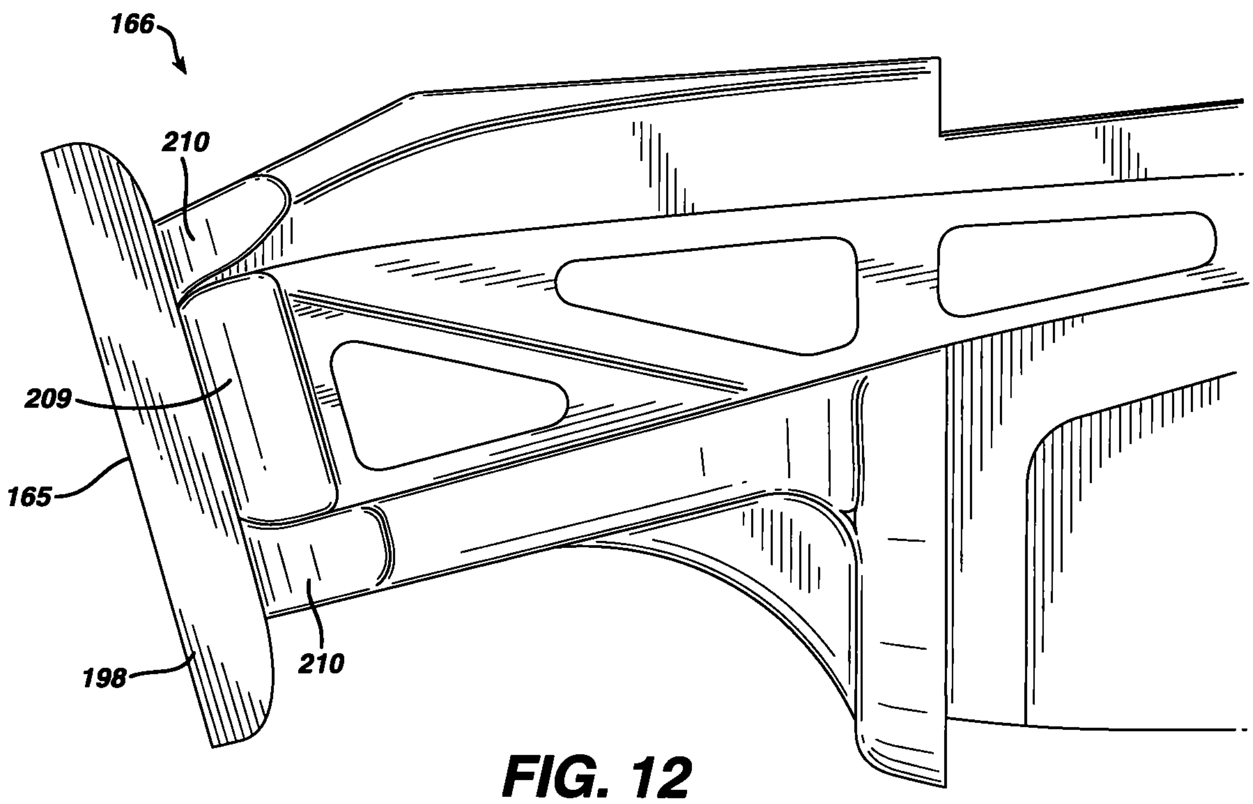


FIG. 12

170

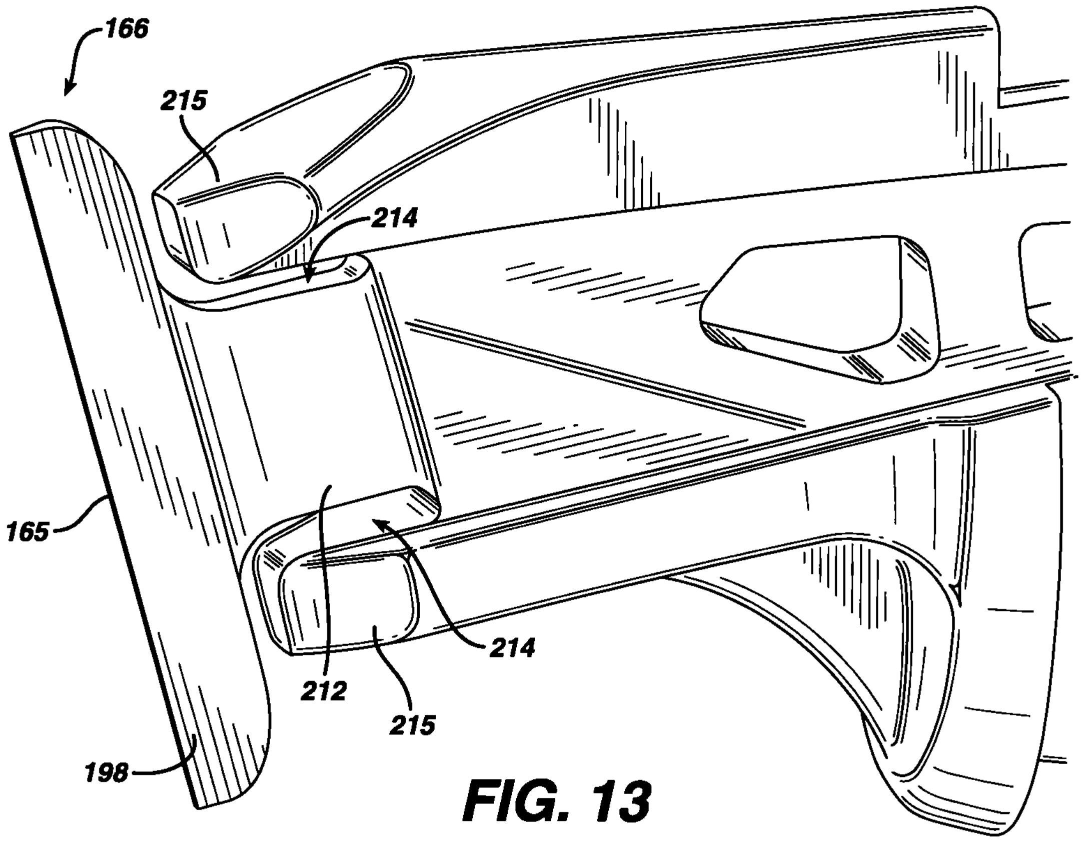
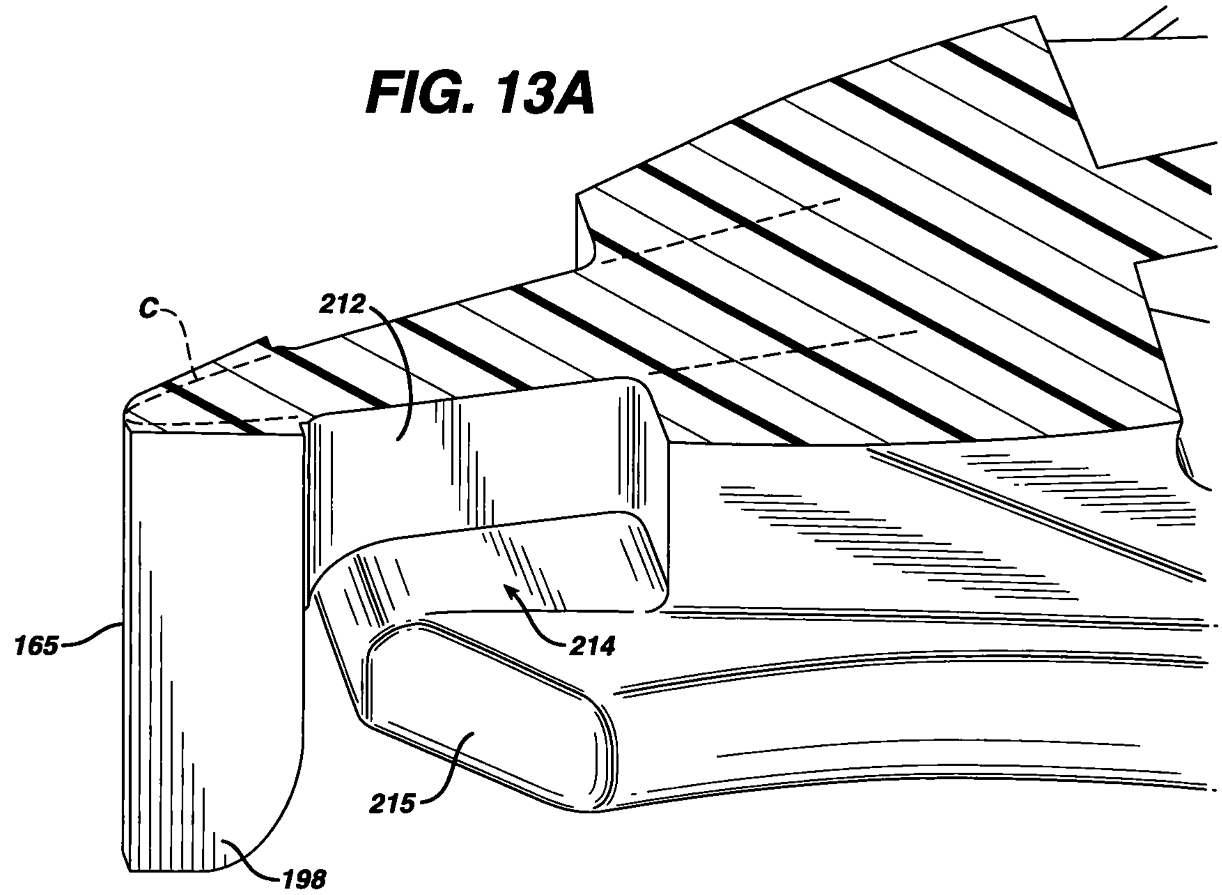


FIG. 13

FIG. 13A



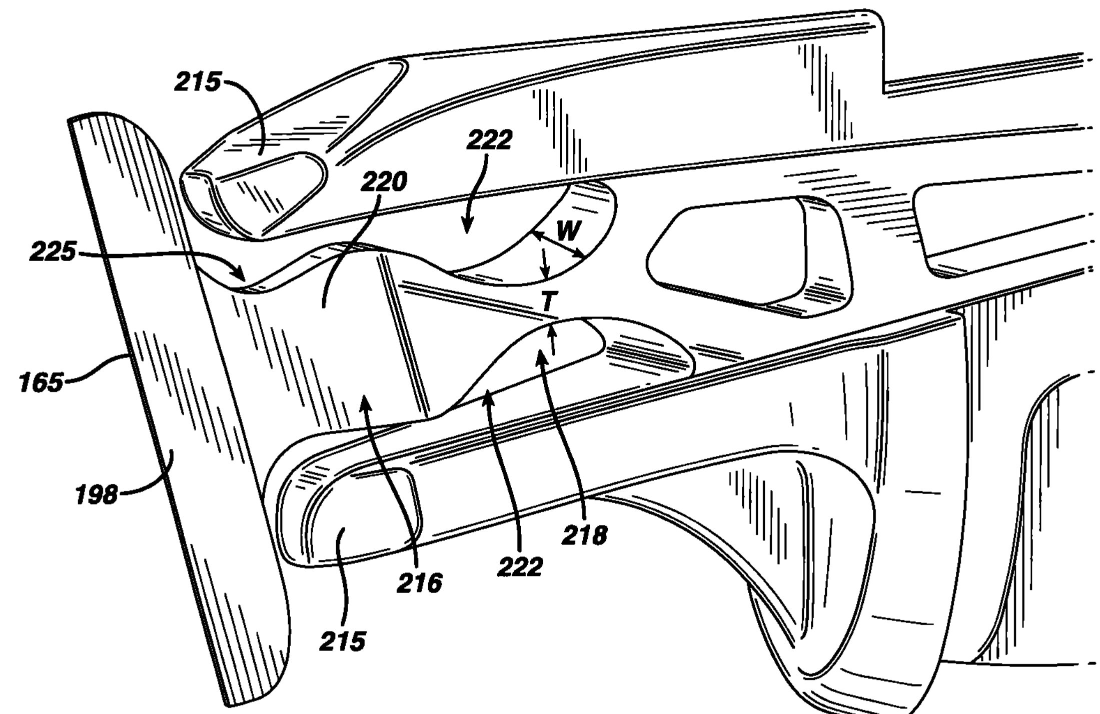


FIG. 14

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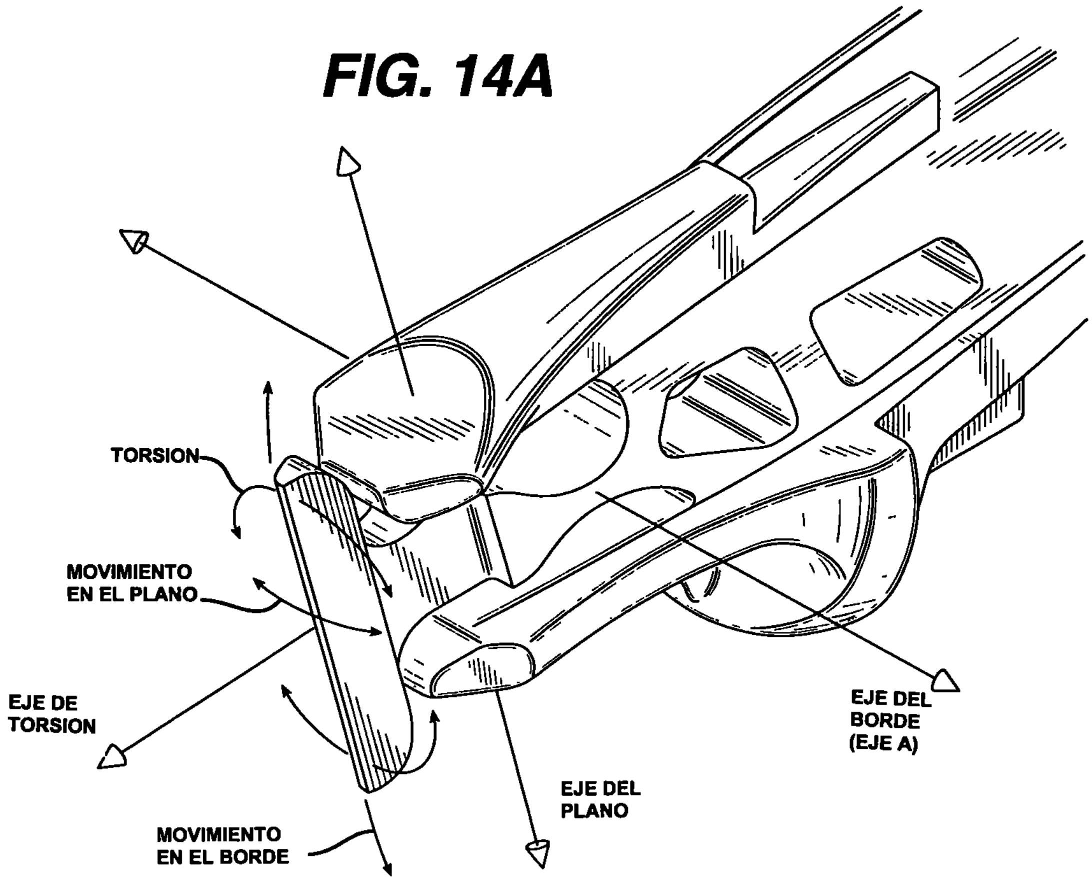
FIG. 14A


TORSION
MOVIMIENTO
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(EJE A)

119

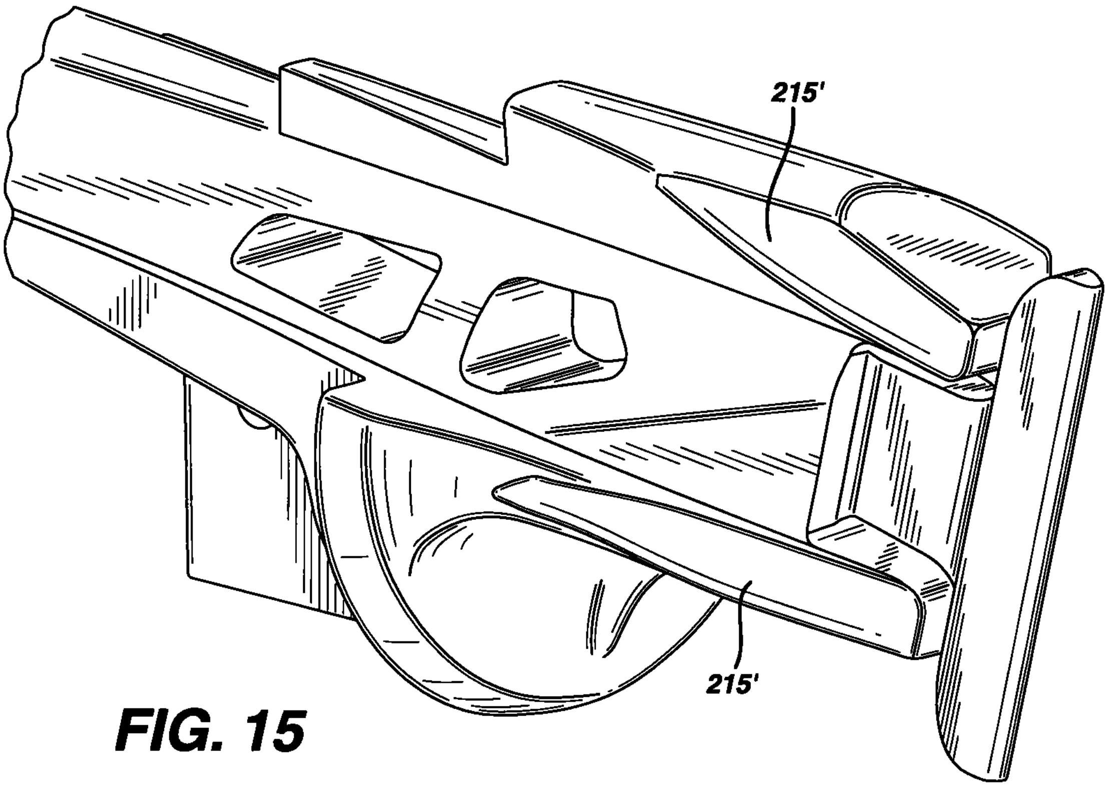
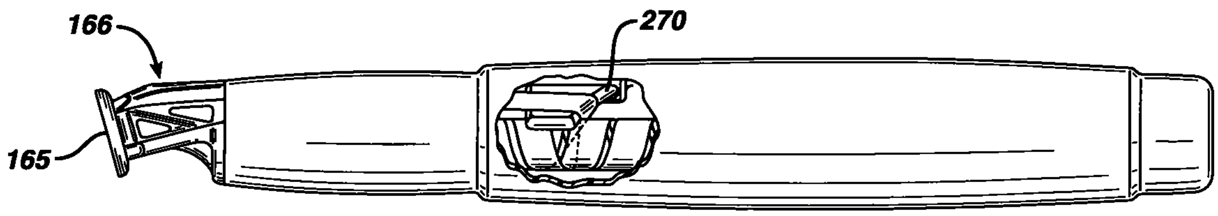


FIG. 15

120

FIG. 16



142

121 ~~144~~

FIG. 17

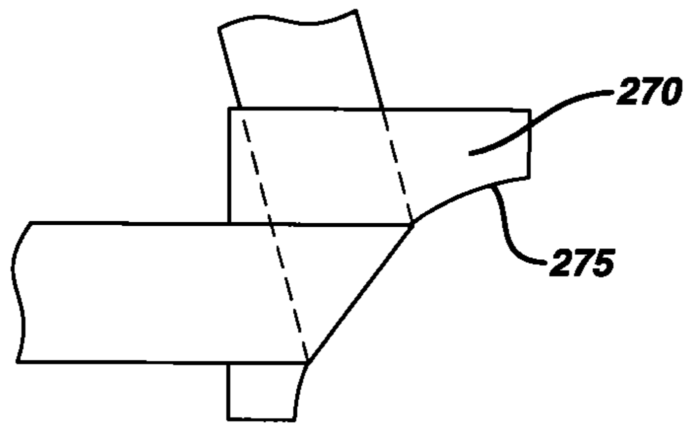


FIG. 18

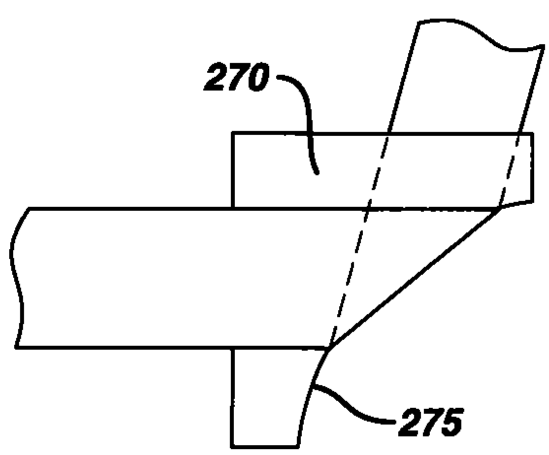


FIG. 19

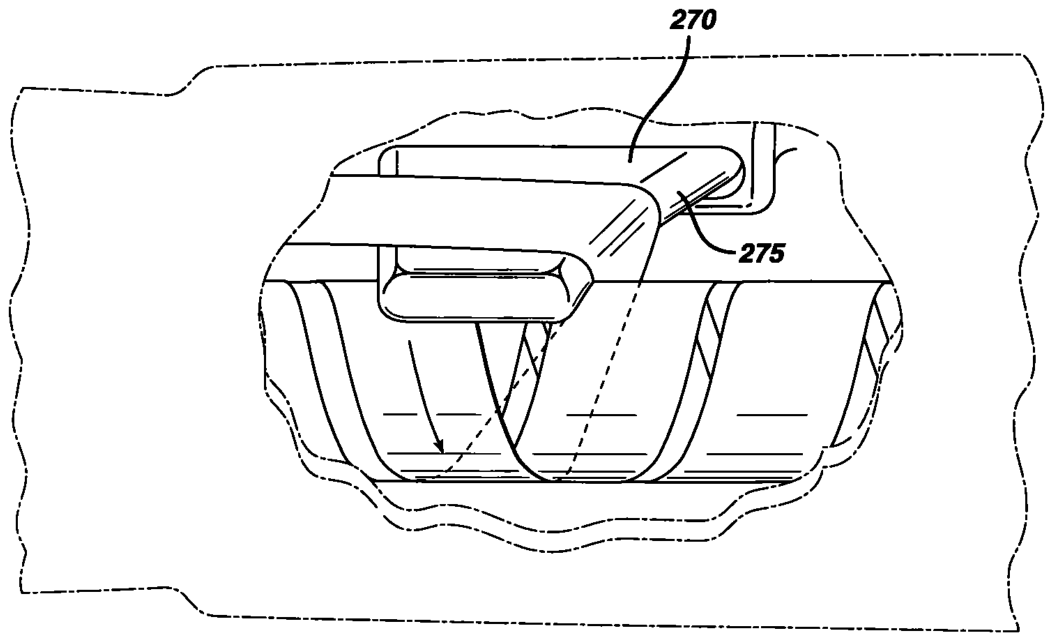
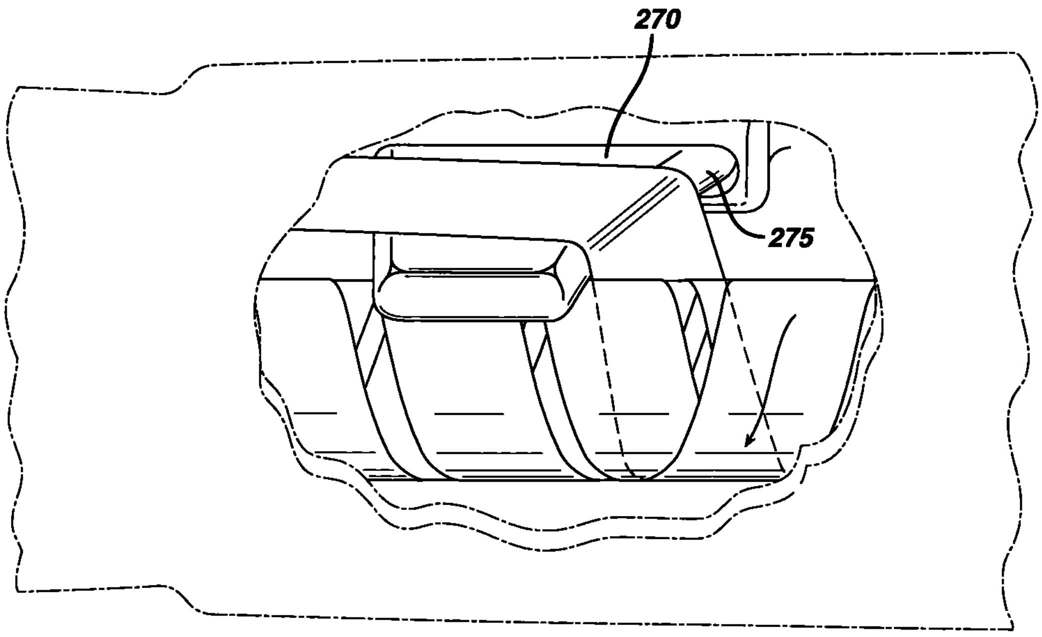


FIG. 20



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124

US005942322A

United States Patent [19]

Ensign et al.

[11] Patent Number: 5,942,322

[45] Date of Patent: *Aug. 24, 1999

[54] REDUCED SURFACE ENERGY LIMITING ORIFICE DRYING MEDIUM PROCESS OF MAKING AND PROCESS OF MAKING PAPER THEREWITH

[75] Inventors: Donald Eugene Ensign, Cincinnati; Paul Dennis Trokhan, Hamilton; Michael Gomer Stelljes, Jr., West Chester, all of Ohio

[73] Assignee: The Procter & Gamble Company, Cincinnati, Ohio

[*] Notice: This patent is subject to a terminal disclaimer.

[21] Appl. No.: 08/927,952

[22] Filed: Sep. 11, 1997

[51] Int. Cl.[6] D21F 11/14; F26B 3/00

[52] U.S. Cl. 428/315.5; 34/114; 34/116; 34/444; 162/361; 427/245; 427/421; 442/98; 442/99

[58] Field of Search 428/315.5; 442/76, 442/97, 98, 99; 34/114, 116, 444; 162/361; 427/244, 245, 421

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4,251,928	2/1981	Rotar et al.
4,329,201	5/1982	Bolton
4,528,239	7/1985	Trokhan
4,556,450	12/1985	Chuang et al.
4,583,302	4/1986	Smith
4,888,096	12/1989	Cowan et al.
4,921,750	5/1990	Todd
4,942,675	7/1990	Sundovist
4,973,385	11/1990	Jean et al.
5,274,930	1/1994	Ensign et al.
5,543,107	8/1996	Ensign et al.
5,584,126	12/1996	Ensign et al.
5,584,128	12/1996	Ensign et al.
5,598,643	2/1997	Chuang et al.
5,629,052	5/1997	Trokhan et al.

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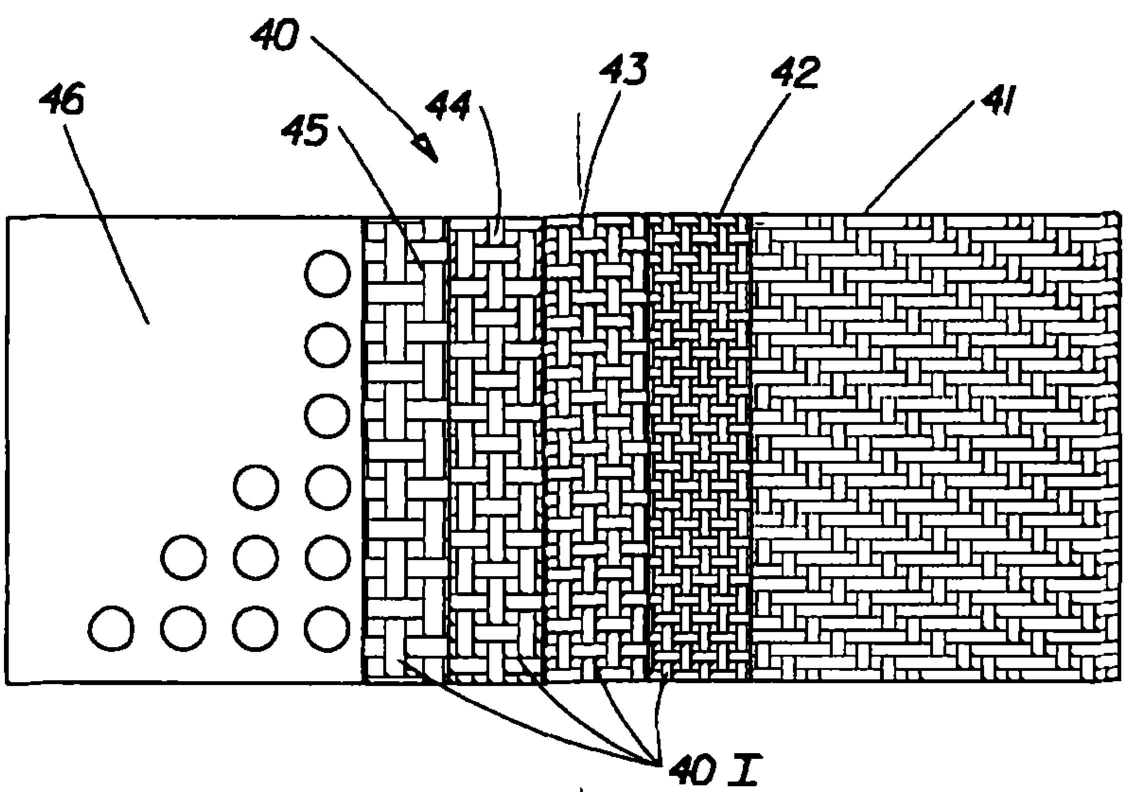
0 103 676	3/1984	European Pat. Off.
0 211 471	2/1987	European Pat. Off.
WO 94/00636	1/1994	WIPO

Primary Examiner—Blaine Copenheaver
Attorney, Agent, or Firm—Larry L. Huston; E. Kelly Linman; Donald E. Hasse

[57] ABSTRACT

An apparatus for drying an embryonic web. The apparatus comprises a micropore medium having pores therethrough. The pores are the limiting orifice in the air flow used in the drying process. The micropore medium has a surface oriented towards and preferably contacting the web to be dried. This surface has a relatively low surface energy, and preferably a surface energy of less than 46 dynes per centimeter.

16 Claims, 1 Drawing Sheet



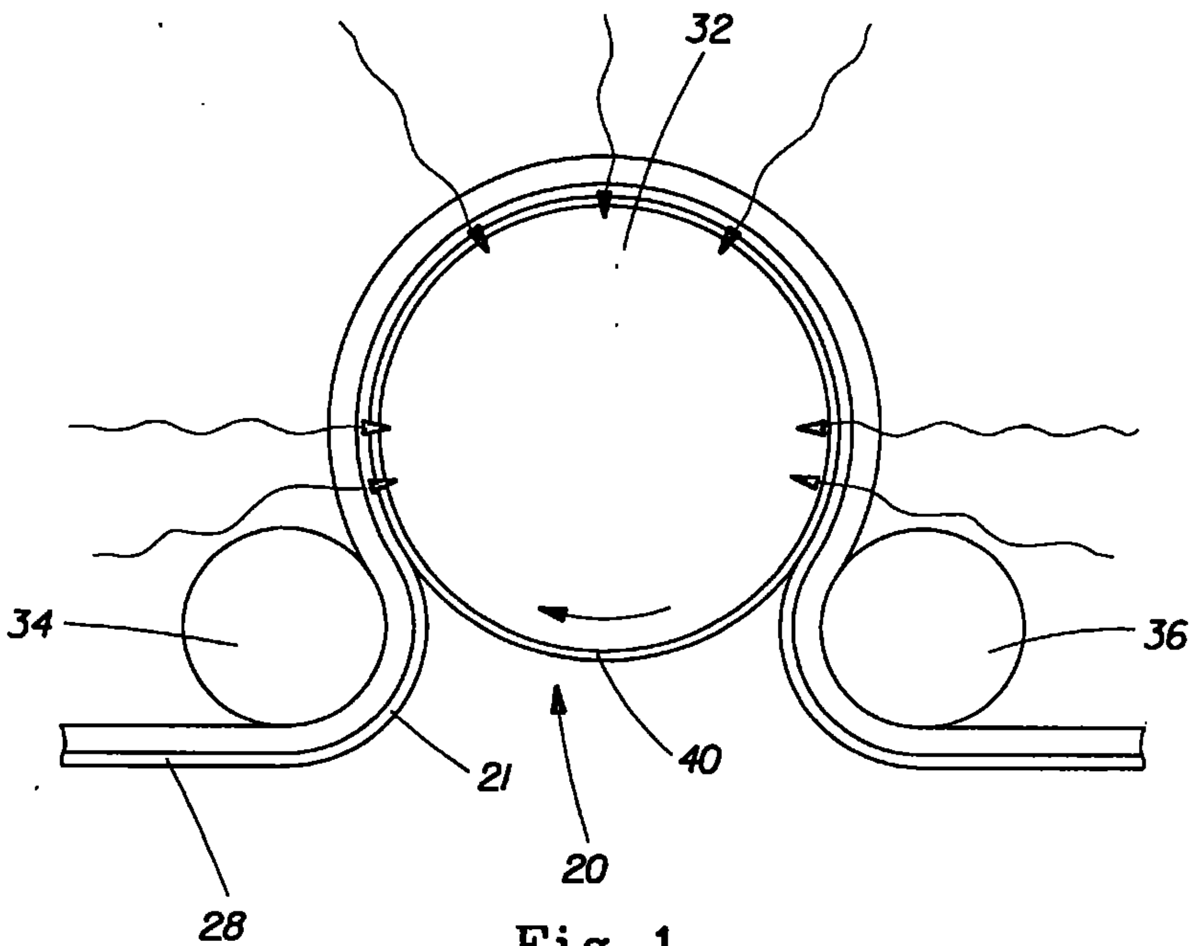


Fig. 1

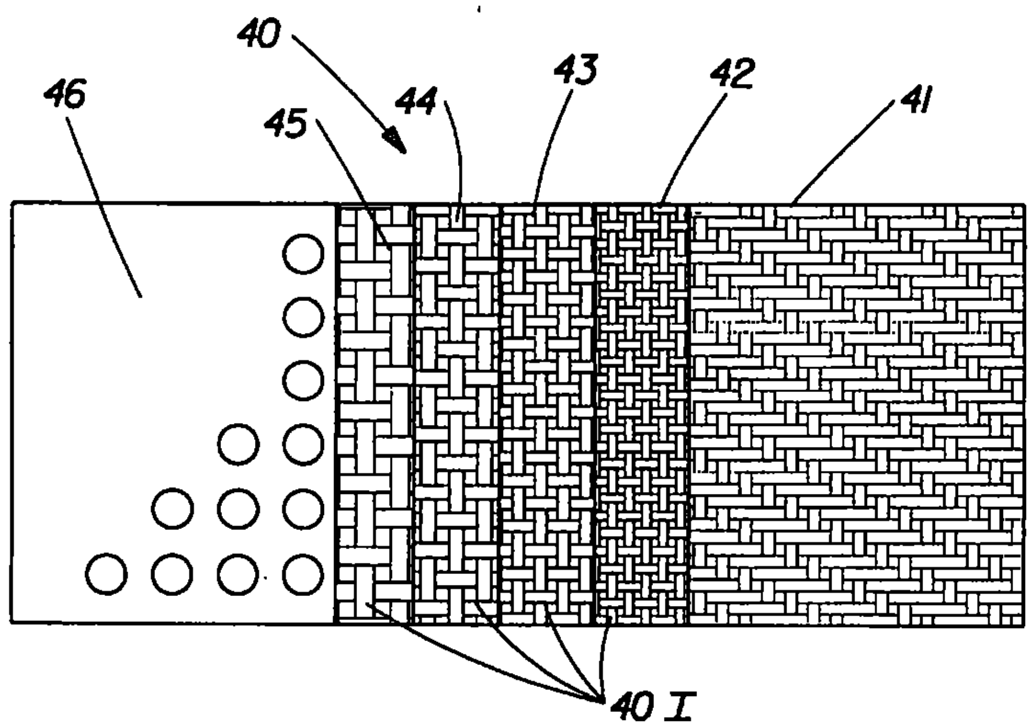


Fig. 2

REDUCED SURFACE ENERGY LIMITING ORIFICE DRYING MEDIUM PROCESS OF MAKING AND PROCESS OF MAKING PAPER THEREWITH

FIELD OF THE INVENTION

The present invention relates to an apparatus for absorbent embryonic webs which are through air dried to become a cellulosic fibrous structure and particularly to an apparatus which provides an energy savings during the through air drying process.

BACKGROUND OF THE INVENTION

Absorbent webs include cellulosic fibrous structures, absorbent foams, etc. Cellulosic fibrous structures have become a staple of everyday life. Cellulosic fibrous structures are found in facial tissues, toilet tissues and paper toweling.

In the manufacture of cellulosic fibrous structures, a slurry of cellulosic fibers dispersed in a liquid carrier is deposited onto a forming wire to form an embryonic web. The resulting wet embryonic web may be dried by any one of or combinations of several known means, each of which drying means will affect the properties of the resulting cellulosic fibrous structure. For example, the drying means and process can influence the softness, caliper, tensile strength, and absorbency of the resulting cellulosic fibrous structure. Also the means and process used to dry the cellulosic fibrous structure affects the rate at which it can be manufactured, without being rate limited by such drying means and process.

An example of one drying means is felt belts. Felt drying belts have long been used to dewater an embryonic cellulosic fibrous structure through capillary flow of the liquid carrier into a permeable felt medium held in contact with the embryonic web. However, dewatering a cellulosic fibrous structure into and by using a felt belt results in overall uniform compression and compaction of the embryonic cellulosic fibrous structure web to be dried. The resulting paper is often stiff and not soft to the touch.

Felt belt drying may be assisted by a vacuum, or may be assisted by opposed press rolls. The press rolls maximize the mechanical compression of the felt against the cellulosic fibrous structure. Examples of felt belt drying are illustrated in U.S. Pat. No. 4,329,201 issued May 11, 1982 to Bolton and U.S. Pat. No. 4,888,096 issued Dec. 19, 1989 to Cowan et al.

Drying cellulosic fibrous structures through vacuum dewatering, without the aid of felt belts is known in the art. Vacuum dewatering of the cellulosic fibrous structure mechanically removes moisture from the cellulosic fibrous structure while the moisture is in the liquid form. Furthermore, if used in conjunction with a molding template-type belt, the vacuum deflects discrete regions of the cellulosic fibrous structure into the deflection conduits of the drying belts and strongly contributes to having different amounts of moisture in the various regions of the cellulosic fibrous structure. Similarly, drying a cellulosic fibrous structure through vacuum assisted capillary flow, using a porous cylinder having preferential pore sizes is known in the art as well. Examples of such vacuum driven drying techniques are illustrated in commonly assigned U.S. Pat. No. 4,556,450 issued Dec. 3, 1985 to Chuang et al. and U.S. Pat. No. 4,973,385 issued Nov. 27, 1990 to Jean et al.

In yet another drying process, considerable success has been achieved drying the embryonic web of a cellulosic

fibrous structure by through-air drying. In a typical through-air drying process, a foraminous air permeable belt supports the embryonic web to be dried. Hot air flow passes through the cellulosic fibrous structure, then through the permeable belt or vice versa. The air flow principally dries the embryonic web by evaporation. Regions coincident with and deflected into the foramina in the air permeable belt are preferentially dried. Regions coincident the knuckles in the air permeable belt are dried to a lesser extent by the airflow.

Several improvements to the air permeable belts used in through-air drying have been accomplished in the art. For example, the air permeable belt may be made with a high open area, i.e., at least forty percent. Or, the belt may be made to have reduced air permeability. Reduced air permeability may be accomplished by applying a resinous mixture to obturate the interstices between woven yarns in the belt. The drying belt may be impregnated with metallic particles to increase its thermal conductivity and reduce its emissivity or, alternatively, the drying belt may be constructed from a photosensitive resin comprising a continuous network. The drying belt may be specially adapted for high temperature airflows, of up to about 815 degrees C. (1500 degrees F.). Examples of such through-air drying technology are found in U.S. Pat. No. Re. 28,459 reissued Jul. 1, 1975 to Cole et al.; U.S. Pat. No. 4,172,910 issued Oct. 30, 1979 to Rotar; U.S. Pat. No. 4,251,928 issued Feb. 24, 1981 to Rotar et al.; commonly assigned U.S. Pat. No. 4,528,239 issued Jul. 9, 1985 to Trokhan, incorporated herein by reference; and U.S. Pat. No. 4,921,750 issued May 1, 1990 to Todd. Additionally, several attempts have been made in the art to regulate the drying profile of the cellulosic fibrous structure while it is still an embryonic web to be dried. Such attempts may use either the drying belt, or an infrared dryer in combination with a Yankee hood. Examples of profiled drying are illustrated in U.S. Pat. No. 4,583,302 issued Apr. 22, 1986 to Smith and U.S. Pat. No. 4,942,675 issued Jul. 24, 1990 to Sundovist.

The foregoing art, even that specifically addressed to through-air drying, does not address the problems encountered when drying a multi-region cellulosic fibrous structure. For example, a first region of the cellulosic fibrous structure, having a lesser absolute moisture, density or basis weight than a second region, will typically have relatively greater airflow therethrough than the second region. This relatively greater airflow occurs because the first region of lesser absolute moisture, density or basis weight presents a proportionately lesser flow resistance to the air passing through such region.

This problem is exacerbated when a multi-region, multi-elevational cellulosic fibrous structure to be dried is transferred to a Yankee drying drum. On a Yankee drying drum, isolated discrete regions of the cellulosic fibrous structure are in intimate contact with the circumference of a heated cylinder and hot air from a hood is introduced to the surface of the cellulosic fibrous structure opposite the heated cylinder. However, typically the most intimate contact with the Yankee drying drum occurs at the high density or high basis weight regions. After some moisture is removed from the cellulosic fibrous structure, the high density or high basis weight regions are not as dry as the low density or low basis weight regions. Preferential drying of the low density regions occurs by convective transfer of the heat from the airflow in the Yankee drying drum hood. Accordingly, the production rate of the cellulosic fibrous structure must be slowed, to compensate for the greater moisture in the high density or high basis weight region. To allow complete drying of the high density and high basis weight regions of the cellulosic fibrous structure to occur and to prevent scorching or burning of the already dried low density or low basis weight regions by the air from the hood, the Yankee hood air temperature must be decreased and the residence time of the cellulosic fibrous structure in the Yankee hood must be increased, slowing the production rate.

Another drawback to the approaches in the prior art (except those that use mechanical compression, such as felt belts) is that each relies upon supporting the cellulosic fibrous structure to be dried. Airflow is directed towards the cellulosic fibrous structure and is transferred through the supporting belt, or, alternatively, flows through the drying belt to the cellulosic fibrous structure. Differences in flow resistance through the belt or through the cellulosic fibrous structure, amplify differences in moisture distribution within the cellulosic fibrous structure, and/or creates differences in moisture distribution where none previously existed.

One improvement in the art which addresses this problem is illustrated by commonly assigned U.S. Pat. No. 5,274,930 issued Jan. 4, 1994 to Ensign et al. and disclosing limiting orifice drying of cellulosic fibrous structures in conjunction with through-air drying, which patent is incorporated herein by reference. This patent teaches an apparatus utilizing a micropore drying medium which has a greater flow resistance than the interstices between the fibers of the cellulosic fibrous structure. The micropore medium is therefore the limiting orifice in the through-air drying process so that an equal, or at least a more uniform, moisture distribution is achieved in the drying process.

Yet other improvements in the art which address the drying problems are illustrated by commonly assigned U.S. Pat. Nos. 5,543,107 issued Aug. 1, 1995 to Ensign et al.; 5,584,126 issued Dec. 19, 1996 to Ensign et al.; and 5,584,128 issued Dec. 17, 1996 to Ensign et al., the disclosures of which patents are incorporated herein by reference. The Ensign et al. '126 and Ensign et al. '128 patents teach multiple zone limiting orifice apparatuses for through air drying cellulosic fibrous structures. However, Ensign et al. '126, Ensign et al. '128, and Ensign et al. '930 do not teach how to minimize pressure drop through the micropore drying medium when encountering liquid or two phase flow. The magnitude of the pressure drop is important. As the pressure drop, at a given flow rate, through the medium decreases, less horsepower is necessary to run the fan(s) which draw air through the apparatus. Reducing fan horsepower is an important source of energy savings. Conversely, at equivalent horsepower and pressure drop, additional air-flow can be drawn through the cellulosic fibrous structure, thereby improving the drying rate. The improved drying rate allows for increased throughput in the papermaking machine.

The limiting orifice through-air-drying apparatus of the Ensign et al. '107 patent teaches having one or more zones with either a subatmospheric pressure or a positive pressure to promote flow in either direction.

Applicants have unexpectedly found a way to treat the micropore drying media of the prior art apparatuses to reduce pressure drop at a constant liquid or two phase flow, or, alternatively, increase liquid or two phase flow at constant pressure drop. Furthermore, it has unexpectedly been found that this invention can be retrofitted to the micropore drying apparatus of the prior art without significant rebuilding.

The apparatus of the present invention may be used to make paper. The paper may be conventionally dried or through air dried. If the paper is to be through air dried, it may be through air dried as described in commonly assigned U.S. Pat. Nos. 4,191,609, issued Mar. 4, 1980 to Trokhan; or the aforementioned U.S. Pat. No. 4,528,239, the disclosures of which patents are incorporated herein by reference. If the paper is conventionally dried, it may be conventionally dried as described in commonly assigned U.S. Pat. No. 5,629,052, issued May 13, 1997 to Trokhan et al., the disclosure of which patent is incorporated herein by reference.

Accordingly, it is an object of this invention to provide a limiting orifice through-air drying apparatus having a micropore medium which can be used to produce cellulosic fibrous structures. It is, furthermore, an object of this invention to provide a limiting orifice through-air drying apparatus which reduces the necessary residence time of the embryonic web thereon and/or requires less energy than had previously been thought in the prior art. Finally, it is an object of this invention to provide a limiting orifice through-air drying apparatus having a micropore medium which is usable with a relevant prior art apparatus, which apparatus preferably is or has at least one zone with a differential pressure greater than the breakthrough pressure.

SUMMARY OF THE INVENTION

The invention comprises a micropore medium for use with papermaking. The papermaking process may comprise through air drying. The micropore medium provides a limiting orifice for air flow through the embryonic web in the drying process. The micropore medium has at least one lamina having a surface contacting the embryonic web. The lamina has pores therethrough.

The surface of the lamina in contact with the embryonic web and/or the pores in the micropore medium have a surface energy of less than 46, preferably less than 36, and more preferably less than 26 dynes per centimeter. The lamina of the micropore media may be coated to provide such a surface energy, or, alternatively, may be made of a material intrinsically having such surface energy.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic side elevational view of a micropore medium according to the present invention embodied on a pervious cylinder, the thickness being exaggerated for clarity.

FIG. 2 is a fragmentary top plan view of a micropore medium according to the present invention showing the various laminae.

DETAILED DESCRIPTION OF THE INVENTION

Referring to FIG. 1, the present invention comprises a limiting orifice though-air-drying apparatus 20 in conjunction with a micropore medium 40. The apparatus 20 and medium 40 may be made, according to the aforementioned U.S. Pat. Nos. 5,274,930; 5,543,107; 5,584,126; 5,584,128; and commonly assigned U.S. patent application Ser. No. 08/878,794, filed Jun. 16, 1997 in the names of Ensign et al., the disclosures of which are incorporated herein by reference. The apparatus 20 comprises a pervious cylinder 32. The micropore medium 40 may circumscribe the pervious cylinder 32. A support member 28, such as a through-air-drying belt or press felt, wraps the pervious cylinder 32 from an inlet roll 34 to a takeoff roll 36, subtending an arc defining a circular segment. This circular segment may be subdivided into multiple zones having mutually different differential pressures relative to the atmospheric pressure. Alternatively, the apparatus 20 may comprise a partitioned vacuum slot, flat or arcuate plates, or an endless belt. The apparatus 20 removes moisture from an embryonic web 21.

Referring to FIG. 2, the micropore drying media according to the present invention comprises a plurality of laminae 41–46. The micropore media 40 according to the present invention may have a first lamina 41 which is closest to and contacts the embryonic web 21. Subjacent the first lamina 41 may be one or a plurality of other laminae 42–46. The subjacent laminae 42–46 provide support for the laminae 41–45 and fatigue strength. The laminae 41–46 may have an increasing pore size for the removal of water therethrough, as the subjacent laminae 42–46 are approached. At least the first lamina 41 and more particularly, the surface thereof which contacts the embryonic web 21, has the low surface energy described below. Alternatively, other and all of the laminae 41–46, comprising the medium 40 according to the present invention may be treated to have the low surface energy described below.

The laminae 41–46 each have two surfaces, a first surface and a second surface opposed thereto. The first and second surfaces are in fluid communication with each other by pores therebetween. The first surface, i.e., that which is oriented towards the high pressure or upstream side of the air flow or water flow therethrough, should have a low surface energy according to the present invention and as described below. Also, the pores between the first and second surfaces, particularly those pores which provide limiting orifices in the flow path, should also be provided with a low surface energy surface as described below.

The low surface energy may be accomplished with a surface coating. The coating may be applied after the laminae 41–46 are joined together and sintered, to prevent the deleterious effects of the manufacturing operation on the coating or deleterious effects of the coating on the manufacturing operation.

According to the present invention, the medium 40 is coated in order to reduce pressure drop therethrough for liquid or two phase flow. Particularly, the coating reduces the surface energy of the medium 40, making it more hydrophobic. Any coating or other treatment which reduces the surface energy of the micropore medium 40 is suitable for use with the present invention, although coating the first lamina 41 of the micropore drying medium 40 has been found to be a particularly effective way to reduce the surface energy. Preferably, the surface energy is reduced to less than 46, preferably to less than 36, and more preferably to less than 26 dynes per centimeter.

The surface energy refers to the amount of work necessary to increase the surface area of a liquid on a solid surface. Generally, for solid surfaces, the cosine of the contact angle of a liquid thereon is a monotonic function of the surface tension of the liquid. As the contact angle approaches zero, the surface is more wetted. If the contact angle becomes zero, the solid surface is perfectly wetted. As the contact angle approaches 180 degrees, the surface approaches a non-wettable condition. It is to be recognized that neither zero nor 180 degree contact angles are observed with water, as may be used in the liquid slurry with the present invention. As used herein surface energy refers to the critical surface tension of the solid surface, and may be empirically found through extrapolation of the relationship between the surface tension of a liquid and its contact angle on a particular surface of interest. Thus, the surface energy of the solid surface is indirectly measured through the surface tension of a liquid thereon. Further discussion of surface energy is found in the Adv. Chem Ser No. 43 (1964) by W. A. Zisman and in Physical Chemistry of Surfaces, Fifth Edition, by Arthur W. Adamson (1990), both of which are incorporated herein by reference.

The surface energy is measured by low surface tension solutions (e.g., isopropanol/water or methanol/water mixtures). Particularly, the surface energy may be measured by applying a calibrated dyne pen to the surface of the medium 40 under consideration. The application should be at least one inch long to ensure a proper reading is obtained. The surface is tested at a temperature of 70°±5° F. Suitable dyne pens are available from the Control-Cure Company of Chicago, Ill.

Alternatively, a goniometer may be used, provided that one corrects the results for the surface topography of the laminae 41–46. Generally, as the surface becomes rougher, the apparent contact angle will be less than the true contact angle. If the surface becomes porous, such as occurs with the laminae 41–46 of the present invention, the apparent contact angle is larger than the true contact angle due to the increased liquid-air contact surface.

Nonlimiting and illustrative examples of suitable coatings useful to reduce the surface energy include both fluids and dry film lubricants. Suitable dry film lubricants include fluorotelomers, such as KRYTOX DF made by the DuPont Corporation of Wilmington, Del. The dry film lubricant may be dispersed in fluorinated solvents from the freon family, such as 1,1-dicholoro-1-fluoroethane, or 1,1,2-trichloro-1,2,2-trifluoroethane, or isopropyl alcohol, etc. The KRYTOX DF lubricant is preferably heat cured in order to melt the KRYTOX DF lubricant. Heat curing at 600 degrees for a period of 30 minutes has been found suitable for the medium 40 according to the present invention.

Alternatively, the coating material may comprise other low surface energy particles suspended in a liquid carrier. Prophetically, suitable particles include graphite and molybdenum disulfide.

Alternatively, the coating material may comprise a fluid. A polydimethylsiloxane fluid, such as GE Silicones DF 581 available from The General Electric Corporation of Fairfield, Conn. at one weight percent is a suitable fluid coating material. The polydimethylsiloxane fluid may be dispersed in isopropyl alcohol or hexane. Also, 2-ethyl-1-hexanol has also been found to be a carrier suitable for use with the present invention. After application to the medium 40, the polydimethylsiloxane is heat cured to increase its molecular weight via crosslinking and to evaporate the carrier. Curing for one hour at 500° F. has been found suitable for the medium 40 according to the present invention.

The coating materials, dry film or fluid, may be sprayed, printed, brushed, or rolled onto the medium 40. Alternatively, the medium 40 may be immersed in the coating material. A relatively uniform coating is preferred. The dry film coating material is preferably applied in relatively low concentrations, such as 0.5 to 2.0 weight percent. The low concentrations are believed to be important to prevent plugging of the small pores of the laminae 41–46 of the micropore medium 40. Silicone fluid coatings may be applied in concentrations of approximately 0.5 to 10 weight percent, and preferably 1 to 2 weight percent.

Prophetically, organically modified ceramic materials known as ormocers may be used to reduce the surface energy of the medium 40. Ormocers may be made according to the teachings of U.S. Pat. No. 5,508,095, issued Apr. 16, 1996, to Allum et al., and incorporated herein by reference.

It will be apparent that various dry film lubricants, various fluid coatings, various ormocers, and combinations thereof may be used to reduce the surface energy of the medium 40.

If coatings are used to render the micropore drying medium 40 more hydrophobic and reduce its surface energy, it is important that the coatings do not plug the fine pores of the laminae 41–46, and particularly the first lamina 41 of the medium 40. The laminae 41–46, particularly the first lamina 41, may have pores with dimensions in any one direction smaller than 20 microns and even smaller than 10 microns. The laminae 41–46 may have pores which successively increase in size from the first lamina 41 to the last lamina 46, the last lamina 46 being disposed furthest from the first lamina 41. The aforementioned dry film and fluid coatings have been successfully used without causing plugging of the laminae 41–46. A coating which significantly plugs the pores of the medium 40 is unsuitable. For example, a coating may be unsuitable, if the coating thickness and/or concentration is too great.

Rather than coating the surface of one or more laminae 41–46 of the medium 40 to reduce the surface energy as described above, prophetically the medium 40 could be made of a material intrinsically having a low surface energy. Although stainless steels have been described in the incorporated patents as suitable materials for the laminae 41–46, the laminae 41–46, particularly the first lamina 41, could be made of or impregnated with a low surface energy material such as tetrafluoroethylene, commonly sold by DuPont Corporation of Wilmington, Del. under the tradename TEFLON or low surface energy extruded plastics, such as polyesters or polypropylenes. It will be apparent that materials intrinsically having a relatively low surface energy may be coated as described above, to provide an even lower surface energy.

In yet another alternative embodiment, the apparatus 20 needs only to have a through-air drying zone and may eliminate the capillary drying zone. Such an apparatus 20 is believed useful in conjunction with the present invention

In another variation, one of the intermediate laminae 42–45 may have the smallest pores therethrough. In this embodiment, the intermediate lamina 42–45 having the smallest pores will determine the flow resistance of the medium 40, rather than the first lamina 41. In such an embodiment, it is important that the intermediate laminae 42–45 having the greatest flow resistance be provided with the low surface energy described above. It will be recognized that, similar to the embodiments described above, the low surface energy surface need only be disposed on the high pressure (i.e., upstream) side and in the limiting orifice of the pores of that lamina 41–45.

The apparatus 20 according to the present invention may be used in conjuction with a papermaking belt which yields a cellulosic fibrous structure having plural densities and/or plural basis weights. The papermaking belt and cellulosic fibrous structure may be made according to any of commonly assigned U. S. Pat. Nos. 4,191,609, issued Mar. 4, 1980 to Trokhan; 4,514,345, issued Apr. 30, 1985 to Johnson et al.; 4,528,239, issued Jul. 9, 1985 to Trokhan; 4,529,480, issued Jul. 16, 1985 to Trokhan; 5,245,025, issued Sep. 14, 1993 to Trokhan et al.; 5,275,700, issued Jan. 4, 1994 to Trokhan; 5,328,565, issued Jul. 12, 1994 to Rasch et al.; 5,334,289, issued Aug. 2, 1994 to Trokhan et al.; 5,364,504, issued Nov. 15, 1995 to Smurkoski et al.; 5,527,428, issued Jun. 18, 1996 to Trokhan et al.; 5,554,467, issued Sep. 18, 1996 to Trokhan et al.; and 5,628,879, issued May 13, 1997 to Ayers et al.

In another embodiment, the papermaking belt may be a felt, also referred to as a press felt as is known in the art, and as taught by commonly assigned U.S. Pat. No. 5,556,509, issued Sep. 17, 1996 to Trokhan et al. and PCT Application WO 96/00812, published Jan. 11, 1996 in the names of Trokhan et al., the disclosures of which patent and application are incorporated herein by reference.

Additionally, the paper dried on the micropore medium 40 according to the present invention may have multiple basis weights, as disclosed in commonly assigned U.S. Pat. Nos. 5,534,326, issued Jul. 9, 1996 to Trokhan et al. and 5,503,715, issued Apr. 2, 1996 to Trokhan et al., the disclosures of which are incorporated herein by reference, or according to European Patent Application WO 96/35018, published Nov. 7, 1996 in the names of Kamps et al. The paper dried on the micropore medium 40 according to the present invention may be made using other papermaking belts as well. For example, prophetically, the belts disclosed in European Patent Application WO 97/24487, published Jul. 10, 1997 in the names of Kaufman et al. and European Patent Application 0 677 612 A2, published Oct. 18, 1995 in the names of Wendt et al. may be utilized. As well, other papermaking technologies may be utilized in conjunction with the papermaking machinery supporting and the paper made according to the micropore medium 40 of the present invention. Prophetically, suitable additional papermaking technologies include those disclosed in U.S. Pat. Nos. 5,411,636, issued May 2, 1995 to Hermans et al.; 5,601,871, issued Feb. 11, 1997 to Krzysik et al.; 5,607,551, issued Mar. 4, 1997 to Farrington, Jr. et al.; and European Patent Application 0 617 164, published Sep. 28, 1994, in the names of Hyland et al.

The embryonic web may be completely dried on the apparatus 20 according to the present invention. Alternatively, the embryonic web may be finally dried on a Yankee drying drum as is known in the art. Alternatively, the cellulosic fibrous structure may be finally dried without using a Yankee drying drum.

The cellulosic fibrous structure may also be foreshortened as is known in the art. Foreshortening can be accomplished with a Yankee drying drum, or other cylinder, via creping with a doctor blade as is well known in the art. Creping may be accomplished according to commonly assigned U.S. Pat. No. 4,919,756, issued Apr. 24, 1992 to Sawdai, the disclosure of which is incorporated herein by reference. Alternatively or additionally, foreshortening may be accomplished via wet microcontraction as taught in commonly assigned U.S. Pat. No. 4,440,597, issued Apr. 3, 1984 to Wells et al., the disclosure of which is incorporated herein by reference.

What is claimed is:

1. A micropore medium for use with a limiting orifice through air drying papermaking apparatus, said micropore medium comprising a limiting orifice for air flow through an embryonic web, said micropore medium having at least one lamina, said lamina having first and second opposed surfaces and pores therebetween, said first surface being oriented towards said embryonic web and a second surface opposed thereto, said first surface of said lamina and said pores having a surface energy of less than 46 dynes per centimeter.

2. A medium according to claim 1 wherein said first surface and said pores have a surface energy of less than 36 dynes per centimeter.

3. A medium according to claim 2 wherein said first surface and said pores have a surface energy of less than 26 dynes per centimeter.

4. A medium according to claim 1 wherein said first surface of said lamina comprises a coating, wherein said

coating provides said surface energy of less than 46 dynes per centimeter.

5. A medium according to claim 4 wherein said coating is selected from the group consisting of fluorotelomers, polysiloxanes, ormocers, and combinations thereof.

6. A medium according to claim 5 wherein said first lamina of said micropore medium comprises stainless steel.

7. A medium according to claim 1 wherein said first lamina comprises a material intrinsically having a surface energy of less than 46 dynes per centimeter.

8. A medium according to claim 1 wherein said apparatus comprises a pervious cylinder and said first surface of said first lamina contacts said embryonic web.

9. A medium according to claim 8 comprising a plurality of laminae, each said lamina having pores therethrough, said pores of said laminae successively increasing in size from said first lamina having said first surface which contacts said web to the last of said laminae, said last of said laminae being disposed furthest from said first lamina.

10. A process for making a micropore medium, said process comprising the steps of:

providing a limiting orifice through air drying lamina having two surfaces and pores therebetween, a first surface and a second surface opposed thereto; and

coating said first surface and said pores of said lamina with a coating, said coating having a surface energy of less than 46 dynes per centimeter.

11. A process according to claim 10 wherein said coating is applied by spraying.

12. A process according to claim 10 further comprising the step of joining said first lamina in face-to-face relationship with at least one other lamina, said step of joining said laminae being performed prior to said step of coating said first surface and said pores of said first lamina.

13. A process according to claim 12 wherein said second lamina has two surfaces, a first surface oriented towards said first lamina and a second surface opposed thereto, and further comprising the step of coating said first surface and said pores of said second lamina.

14. A process for making a tissue paper, said process comprising the steps of:

providing an embryonic web;

providing a micropore medium, said micropore medium having a pore size which provides a limiting orifice for air flow through said embryonic web, said medium having a surface energy of less than 46 dynes per centimeter;

disposing said embryonic web on said micropore medium;

passing air through said embryonic web and said micropore medium, whereby said micropore medium is the limiting orifice for air flow through said embryonic web to thereby remove water from said embryonic web; and

removing said embryonic web from said micropore medium.

15. A process according to claim 14 wherein said embryonic web is substantially dry upon removal from said micropore medium.

16. A process according to claim 14 further comprising the steps of:

providing a Yankee drying drum;

drying said embryonic web on said Yankee drying drum; and

creping said embryonic web from said Yankee drying drum.

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polymerized to PTFE, the resulting solid material. Because TFE had a carbon-carbon double bond, the addition polymerization method was suspected, and was later confirmed.

The DuPont Company named the new polymer material Teflon® and began to explore its properties. The polymer was found to be more inert and stable than the analog hydrogen-carbon material, polyethylene. (Polyethylene is the same structure as PTFE except that all the hydrogens in polyethylene are replaced by fluorines in PTFE). The differences in properties are because of the nature of the carbon-fluorine bonds.

Fluorine is the most electronegative of all the atoms. Therefore, the carbon-fluorine bond is highly polar, with the negative end toward the fluorine. Hence, the electrons are held very tightly by the fluorine molecule. The bonds are very strong and this pulls the fluorine atoms close to the carbons along the backbone. The fluorines act as shields to the carbons and do not allow the carbons to be attacked by other chemicals, nor will the fluorines be extracted. Hence, the polymer is very inert.

This inertness contributes to other characteristic properties of PTFE. For instance, PTFE will not combine with oxygen and so it will not burn nor can it be corroded. Because the electrons are held so tightly, it will not conduct electricity. Because PTFE resists forming bonds with other materials, very few things stick to it and it has been used extensively in making nonstick surfaces for cooking pans. (The PTFE flows around the roughened edges of the pan surface during manufacture to give a mechanical bond. No chemical bond is formed; hence, the PTFE can be removed by scraping.)

PTFE chains are very long, straight, and stiff, allowing PTFE molecules to pack together tightly. PTFE has the highest density of any plastic. Furthermore, temperatures have little effect. PTFE is unaffected by cold, remaining unchanged at temperatures as low as −268°C, only a few degrees above absolute zero. Likewise, it resists high temperatures. PTFE does not begin to melt until 327°C and then does not become a liquid, but a translucent gel. At temperatures above this point, PTFE decomposes. This resistance to elevated temperature has been both a benefit and a detriment for the use of PTFE. While it allows PTFE to be used in many high-temperature applications, it also means that PTFE is difficult to process by normal thermoplastic processing techniques that require melting of the polymer.

Originally PTFE was made into useful parts by packing the powder into a mold and then heating the mold, under pressure, to just below the melting point. This treatment caused the polymer particles to fuse together into a solid mass, a common process in metals and ceramics called *sintering*. The fabrication of large parts was therefore difficult. Also, the time required to make a part was very long compared with the traditional thermoplastic manufacturing processes.

Therefore, the DuPont Company sought a way to make a polymer that had the beneficial properties of PTFE but would be easier to process by traditional plastic manufacturing methods. The key to success was the discovery of polyhexafluoropropylene (PHFP), a polymer related to PTFE. As seen in Figure 2.28b, the PHFP is based on propylene (a three-carbon group) rather than on ethylene. The resultant polymer has a pendent carbon atom and fluorines at all possible bonding locations. This pendent group means that the chain has far more flexibility and will, therefore, melt at a lower temperature. The pendent group also means that the material loses some of the beneficial properties characteristic of PTFE. PHFP has greater adhesion for other materials, is more electrically conductive, and is slowly attacked by some chemicals.