



INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

<p>(51) International Patent Classification<sup>6</sup> : <b>A61M 15/00, 16/00, B05D 7/14, B65D 83/06</b></p>	<p><b>A1</b></p>	<p>(11) International Publication Number: <b>WO 95/15190</b> (43) International Publication Date: 8 June 1995 (08.06.95)</p>
---	------------------	--

<p>(21) International Application Number: PCT/US94/10664 (22) International Filing Date: 21 September 1994 (21.09.94) (30) Priority Data: 08/161,230 2 December 1993 (02.12.93) US (71) Applicant: TENAX CORPORATION [US/US]; 4 Old Newtown Road, Danbury, CT 06810 (US). (72) Inventors: MULHAUSER, Paul; Apartment 15G, 69 Fifth Avenue, New York, NY 10003 (US). KARG, Jeffrey; 14 Highwood Avenue, Waldwick, NJ 07463 (US). (74) Agent: BRUFISKY, Allen, D.; Kramer, Brufsky &amp; Cifelli P.C., 181 Old Post Road, P.O. Box 59, Southport, CT 06490 (US).</p>	<p>(81) Designated States: AU, BR, CA, CN, FI, HU, JP, KR, NO, NZ, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE). <b>Published</b> <i>With international search report. With amended claims and statement.</i></p>
--	---

(54) Title: DRY POWDER INHALATOR MEDICAMENT CARRIER

(57) Abstract

A carrier (10) impregnated at spaced locations along its circumference with a dose (16) of powdered medicament. The powdered medicament is embedded in and across interstices (12) in the carrier formed by intersecting and sometimes offset depressions (32, 34, 36, 38) on each surface of the carrier.

**FOR THE PURPOSES OF INFORMATION ONLY**

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria	GB	United Kingdom	MR	Mauritania
AU	Australia	GE	Georgia	MW	Malawi
BB	Barbados	GN	Guinea	NE	Niger
BE	Belgium	GR	Greece	NL	Netherlands
BF	Burkina Faso	HU	Hungary	NO	Norway
BG	Bulgaria	IE	Ireland	NZ	New Zealand
BJ	Benin	IT	Italy	PL	Poland
BR	Brazil	JP	Japan	PT	Portugal
BY	Belarus	KE	Kenya	RO	Romania
CA	Canada	KG	Kyrgystan	RU	Russian Federation
CF	Central African Republic	KP	Democratic People's Republic of Korea	SD	Sudan
CG	Congo	KR	Republic of Korea	SE	Sweden
CH	Switzerland	KZ	Kazakhstan	SI	Slovenia
CI	Côte d'Ivoire	LI	Liechtenstein	SK	Slovakia
CM	Cameroon	LK	Sri Lanka	SN	Senegal
CN	China	LU	Luxembourg	TD	Chad
CS	Czechoslovakia	LV	Latvia	TG	Togo
CZ	Czech Republic	MC	Monaco	TJ	Tajikistan
DE	Germany	MD	Republic of Moldova	TT	Trinidad and Tobago
DK	Denmark	MG	Madagascar	UA	Ukraine
ES	Spain	ML	Mali	US	United States of America
FI	Finland	MN	Mongolia	UZ	Uzbekistan
FR	France			VN	Viet Nam
GA	Gabon				

## DRY POWDER INHALATOR MEDICAMENT CARRIER

BACKGROUND OF THE INVENTIONField of the Invention:

5 This invention relates to a medicament carrier,  
and more particularly, to a carrier containing a dry  
powder medicament adapted to be housed within an  
inhalator usable by asthmatics and the like. By  
inhaling on a mouthpiece, a prescribed dosage of the  
medicament is entrained in an air stream and inhaled  
10 by the user through the mouthpiece to coat the lungs  
of the user.

Description of the Prior Art:

15 Asthma and other respiratory diseases have long  
been treated by the inhalation of an appropriate  
medicament to coat the bronchial tubes in the lungs to  
ease breathing and increase air capacity. For many  
years the two most widely used and convenient choices  
of treatment have been the inhalation of a medicament  
from a drug solution or suspension in a metered dose  
20 aerosol, pressurized inhalator, or inhalation of a  
powdered drug generally admixed with an excipient,  
from a dry powder inhalator. With growing concern

being voiced over the strong link between depletion of the earth's atmospheric ozone layer and chlorofluorocarbon emissions, use of these materials in pressurized inhalators is being questioned, while  
5 an interest in dry powder inhalation systems has accordingly been stimulated.

Small quantities of a fine particle, preferably micronized powder, are used mainly for therapeutic purposes in treating diseases of the respiratory tract. Powders of this type, such as salmeterol  
10 hydronapthoate, in quantities generally below 50 micrograms ( $\mu\text{g}$ ) are added to the respiratory air of the lung of the patient. It has been found that the particles of active materials should have a particle  
15 size of less than 5 microns ( $\mu$ ) in thickness to insure that they penetrate deep into the lung. Thus, the metered dose must be atomized, aerosolized, or sufficiently broken up for inhalation by the patient to achieve the desired effect in the required dosage.

20 In copending application serial numbers 08/025,964, filed March 3, 1993, to Mulhauser et al, entitled "Dry Powder Inhalator Medicament Carrier", and 08/143,182, filed on or about October 26, 1993, entitled "Dry Powder Medicament Inhalator", by  
25 inventors Mulhauser et al, and assigned to the same assignee as the present invention, a woven or nonwoven screen mesh disc or medicament carrier is disclosed which has perforations impregnated at spaced locations

along its circumference with a dose of powdered medicament, such as salmeterol hydronapthoate, which is useful in the treatment of asthma. The carrier is selectively indexed so as to present the impregnated doses of medicament seriatim between a pair of holes in an upper and lower pressure plate in an inhalator. Air is forced through the holes in the pressure plates and the perforations in the encapsulated carrier to entrain a dose of the powdered medicament, which is then inhaled through a mouthpiece, by the patient-user.

Because the powdered medicament is impregnated into the carrier and spans a number of perforations or interstices formed therein, the air impinging upon the carrier and the powdered medicament will cause the medicament to break up as it is pressed up against and passed through the infrastructure to aerosol or atomize the same so that the medicament is presented in appropriate particle sizes for maximum benefit when inhaled. Further, due to the porous nature of the carrier and the interstitial deposit of the medicament, turbulent air can completely surround each medicament dose and entrain it, to assure complete dispensing of the medicament dose from the carrier into the air stream. The turbulence can be created in the air flowing through the carrier by passing it through a nozzle and bottom pressure plate in such a manner to create pressure changes resulting in

turbulence of the air as it passes through the carrier to assist in breaking up the compressed dose.

This invention relates to such medicament carrier structures which lend themselves to mass production.

5

BRIEF DESCRIPTION OF THE DRAWINGS

Further objects and advantages of the invention will become apparent from the following description and claims, and from the accompanying drawings, wherein:

10

FIGURE 1 is a top plan view of the dry powder medicament carrier of the present invention;

FIGURE 2 is a perspective view of the carrier disc of FIGURE 1;

15

FIGURE 3 is an enlarged view of one of the medicament doses on the carrier of FIGURE 1 illustrating the structure of a medicament carrying portion of the carrier;

20

FIGURE 4 is a cross-sectional view taken substantially along the plane indicated by line 4-4 of FIGURE 3;

FIGURE 5 is a fragmentary view similar to FIGURE 3, but illustrating a different configuration of the perforations or interstices for holding the medicament on the carrier;

5           FIGURE 6 is a cross-sectional view taken substantially along the plane indicated by line 6-6 of FIGURE 5;

10           FIGURE 7 is a fragmentary view similar to FIGURE 3, but illustrating a further different configuration of the interstices which can be used for holding the medicament on the carrier;

FIGURE 8 is a cross-sectional view taken substantially along the plane indicated by line 8-8 of FIGURE 7;

15           FIGURE 9 is a fragmentary view similar to FIGURE 3, but illustrating yet another configuration of the interstices for holding the medicament on the carrier;

20           FIGURE 10 is a cross-sectional view taken substantially along the plane indicated by line 10-10 of FIGURE 9;

FIGURE 11 is a fragmentary view similar to FIGURE 3, but illustrating still a different configuration of the interstices for holding the medicament on the carrier;

FIGURE 12 is a cross-sectional view taken substantially along the plane indicated by line 12-12 of FIGURE 11.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

5 Referring now to the drawings in detail, wherein like numerals indicate like elements throughout the several views, a medicament carrier 10 in the shape of a ring or disc is illustrated in FIG. 1 which constitutes a medicament carrier forming the subject  
10 of the instant invention.

The medicament carrier 10 is of a size to be inserted within a breath-activated dry powder inhalator disclosed in detail in copending U.S. application, Serial No. 08/143,182, filed on or about  
15 October 26, 1993, to Mulhauser et al, entitled "Dry Powder Medicament Inhalator" and assigned to the same assignee as the present invention, which disclosure is incorporated by reference herein.

The carrier 10 can be stamped from a metal blank  
20 or even photo acid etched from stainless steel or ceramic to provide portions adjacent its periphery 14 containing a plurality of small interstices 12 (see e.g., FIGS. 3 and 4). Disposed across and impregnated within a number of the interstices 12 by adhesion at  
25 spaced locations along the periphery or circumference



14 of the carrier 10 is a prescribed dose 16 of a medicament. The size of the dose 16 depends upon the drug used. For example, a common drug used for asthmatics is salmeterol hydronapthoate which is to be dispensed in single doses of approximately 50 micrograms. Each medicament dose 16 of this drug could be approximately .030 to .250 inches in diameter with a thickness of about .002 - 0.1 inches to achieve the effective dosage.

10           The carrier 10 can be formed with interstices 12 of approximately .004 to .125 square inches and is positioned between a pair of pressure plates (not shown) each having an enlarged opening adapted to register with one of the medicament doses 16 upon indexing of the carrier 10, by suitable mechanical means, such as a pawl in contact with selected camming teeth 22 on the inner ring or circumference of the carrier. Indicia 24 adjacent teeth 22 will indicate to the user the number of doses 16 remaining on the carrier 10. The pressure plates distribute the pressure about the periphery of the carrier 10 to maintain the medicament dose 16 in its impregnated position compressed across the interstices or perforations 12 and the space therebetween adjacent the periphery 14. Air can then be forced through the pressure plate holes and the encapsulated carrier 10 to entrain the dose 16 of the powdered medicament, and the air stream with the entrained medicament is then inhaled through a mouthpiece by the patient-user.

Because the powdered medicament is impregnated into the carrier 10, across a plurality of the interstices 12, the air impinging upon the carrier disc and the powdered medicament will cause the medicament to break up as it is pressed up against and passed through the disc infrastructure or interstices 12 in the carrier 10 to aerosol or atomize the same so that the medicament is presented in appropriate particle sizes for maximum benefit when inhaled. Further, due to the porous nature of the carrier and the interstitial deposit of the medicament, air can completely surround each medicament dose and entrain it as shown e.g., in FIG. 3 to assure complete dispensing of the medicament dose from the mesh into the air stream.

As shown in FIGS. 3 and 4, the dose carrying portion 16 of the carrier disc 10 can be formed by photoetching or stamping of a metal or ceramic base 26 from opposite sides 28, 30 of the base with overlapping and offset, intersecting, cup-shaped depressions 32 for aiding in holding the medicament 13 on the surface of carrier 10. Three adjacent ones of cup-shaped depressions 32, e.g., 34, 36, and 38, form a set of the interstices 12, each of substantially ovoid shape in plan. The overlapping portions 40 of the cup-shaped depressions 32 form an air passage (or interstice 12) and provide corner surfaces 42 for contact with the medicament as it is entrained in the

air to aid in pressing against the medicament and breaking up the same to ensure complete entrainment and minimal agglomeration of the medicament particles.

5 FIGS. 5 and 6 illustrate that in lieu of forming cup-shaped depressions which overlap and are offset from each other, the cup-shaped depressions 44 formed on each surface or side 28, 30 of the base 26 can intersect along a common axis, still providing corner surfaces 46 for contact with the medicament to aid in  
10 breaking upon the medicament when entrained in an air stream through the aligned depressions.

15 FIGS. 7 and 8 show that the cup-shaped depressions 51 rather than being circular in plan, as in FIGS. 3 and 5, can be square in plan forming square overlapping and intersecting offset interstices 48. In FIGS. 9 and 10, the cup-shaped depressions 52 are hexagonal in plan on both surfaces 28 and 30 of base 26, providing diamond shaped interstices 54 at intersecting corners of the depressions. The  
20 interstices 48 and 54 have defined, sharp corners 53, along with the depressions 51 and 52 to increase contact with the medicament during air flow to ensure that the compressed dose 16 is broken up.

5           The cup-shaped depressions 56 may also be formed with different diameters, as illustrated in FIGS. 11 and 12 and need not be offset, as in FIGS. 5 and 6, as long as interfering surfaces 58 are formed for contact with the entrained medicament dose 16.

What is claimed is:

1. A medicament carrier having opposed surfaces for use in a dry powder breath-activated inhalator apparatus comprising at least one portion including a plurality of interstices in said carrier adapted to receive air flow therethrough to dispense a medicament disposed on said one portion of said carrier, at least one predetermined dose of a powdered medicament on said one portion of said carrier disposed across said portion and contained within depressions forming a plurality of said interstices and spanning the space therebetween for entrainment with a flow of air introduced into said depressions and through said interstices and said carrier portion, said interstices being formed from only a portion of overlapping, intersecting depressions formed in each of said opposed surfaces, the non-intersecting portions of said depressions holding said medicament and providing a sharp edge for atomizing said medicament in response to air flow through said interstices impinging thereon.

2. The medicament carrier of claim 1 wherein said depressions in each of said opposed surfaces have the same geometric shape in plan, but are offset from each other along a vertical axis through each of said intersecting depressions.

3. The medicament carrier of claim 1 wherein said depressions in each of said opposed surfaces have the same geometric shape in plan, and are formed along a common vertical axis through each of said intersecting depressions.

4. The medicament carrier of claim 3 wherein said depressions in each of said opposed surfaces have the same geometric shape in plan, but are of different sizes.

5. The medicament carrier of claim 2 wherein said geometric shape in plan is a circle.

6. The medicament carrier of claim 2 wherein said geometric shape in plan is a square.

7. The medicament carrier of claim 2 wherein said geometric shape in plan is a hexagon.

8. The medicament carrier of claim 1 wherein said carrier is formed from metal and said depressions are photo-etched in said metal.

9. The medicament carrier of claim 1 wherein said carrier is formed from metal and said depressions are stamped in said metal carrier.

10. The medicament carrier of claim 1 wherein said carrier is formed from a ceramic material.

11. The medicament carrier of claim 7 wherein said interstices are approximately .004 to .125 square inches in area.

12. The medicament carrier of claim 9 wherein each said medicament dose on said carrier is approximately .030 to .250 inches in diameter with a thickness of about .002 to 0.1 inches.

## AMENDED CLAIMS

[received by the International Bureau on 13 February 1995 (13.02.95);  
original claims 1-12 replaced by new claims 1-12 (3 pages) and statement]

1. A medicament carrier device for use in a  
dry powder breath-activated inhalator apparatus  
5 comprising  
a carrier having opposed surfaces comprising  
overlapping and intersecting depressions, with a  
plurality of said interstices formed from and joining  
portions of said overlapping, intersecting depressions  
10 formed in each of said opposed surfaces,  
at least one predetermined dose of a powdered  
medicament impregnated within said carrier, said  
powdered medicament dose disposed on at least one  
portion of said opposed surfaces of said carrier across  
15 said portion, said powdered medicament contained within  
said depressions forming said plurality of interstices  
and spanning the spaces between said depressions;  
non-intersecting portions of said depressions also  
holding said powdered medicament and providing sharp  
20 edges, said sharp edges atomizing said powdered  
medicament responsive to air flowing through said  
carrier, depressions, and interstices, and impinging on  
said sharp edges, said powdered medicament being  
entrained within this flow of air introduced into said  
25 carrier.
2. The medicament carrier device of claim 1  
wherein said depressions in each of said opposed  
surfaces have the same geometric shape in plan, but  
are offset from each other along a



vertical axis through each of said intersecting depressions.

3. The medicament carrier device of claim 1 wherein said depressions in each of said opposed  
5 surfaces have the same geometric shape in plan, and  
are formed along a common vertical axis through each of said intersecting depressions.

4. The medicament carrier device of claim 3 wherein said depressions in each of said opposed  
10 surfaces have the same geometric shape in plan, but are of different sizes.

5. The medicament carrier device of claim 2 wherein said geometric shape in plan is a circle.

6. The medicament carrier device of claim 2  
15 wherein said geometric shape in plan is a square.

7. The medicament carrier device of claim 2 wherein said geometric shape in plan is a hexagon.

8. The medicament carrier device of claim 1 wherein said carrier is formed from metal and said  
20 depressions are photo-etched in said metal.

9. The medicament carrier device of claim 1 wherein said carrier is formed from metal and said depressions are stamped in said metal carrier.

10. The medicament carrier device of claim 1  
25 wherein said carrier is formed from a ceramic material.

11. The medicament carrier device of claim 7 wherein said interstices are approximately .004 to .125 square inches in area.

12. The medicament carrier device of claim 9 wherein each said medicament dose on said carrier is approximately .030 to .250 inches in diameter with a  
5 thickness of about .002 to 0.1 inches.

## STATEMENT UNDER ARTICLE 19

In response to the Notification of Transmittal of the International Search Report or the Declaration under PCT Rule 44.1 dated 15 December 1994, applicant wishes to amend the claims of the  
5 above-identified international application. Kindly replace pages 11-13, containing claims 1 - 12, with the accompanying new pages 11 - 12, containing claims 1 - 12. Claims 1 - 12 replace claims 1 - 12 as filed, respectively. Page 13 is now deleted.

10 This amendment conforms the claims in the international application with those now allowed in the corresponding U.S. case, Serial No. 08/161,230, filed December 2, 1993. Claims 2 - 12 have been amended slightly to correct formal defects.

These amendments have no significant impact on the description and drawings, and do not go beyond the disclosure in the international application as filed.

FIG.1

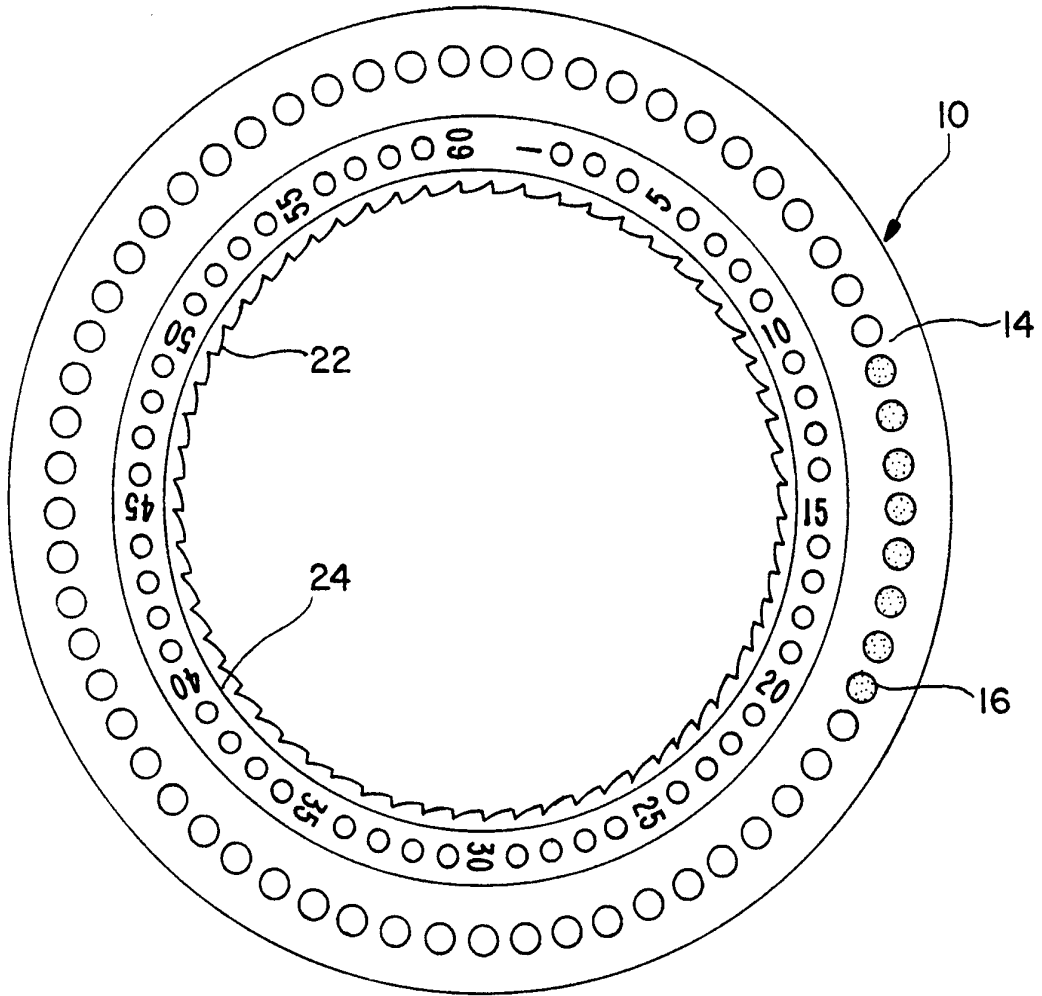


FIG.2

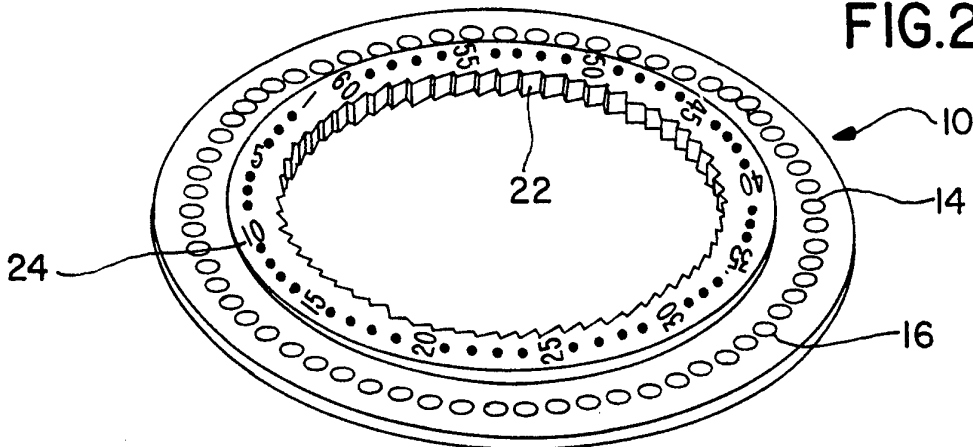


FIG.3

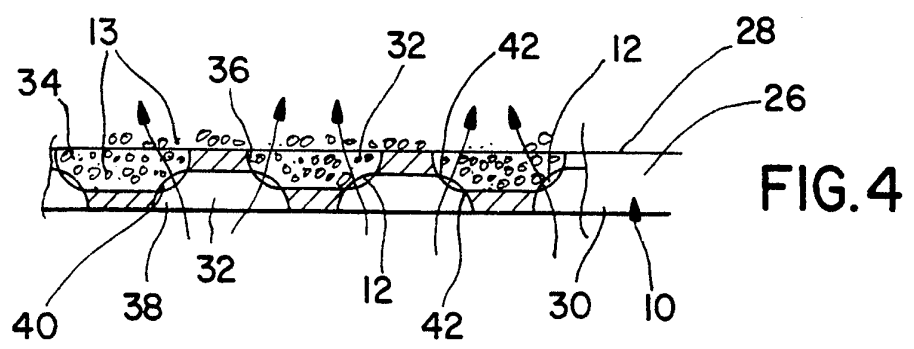
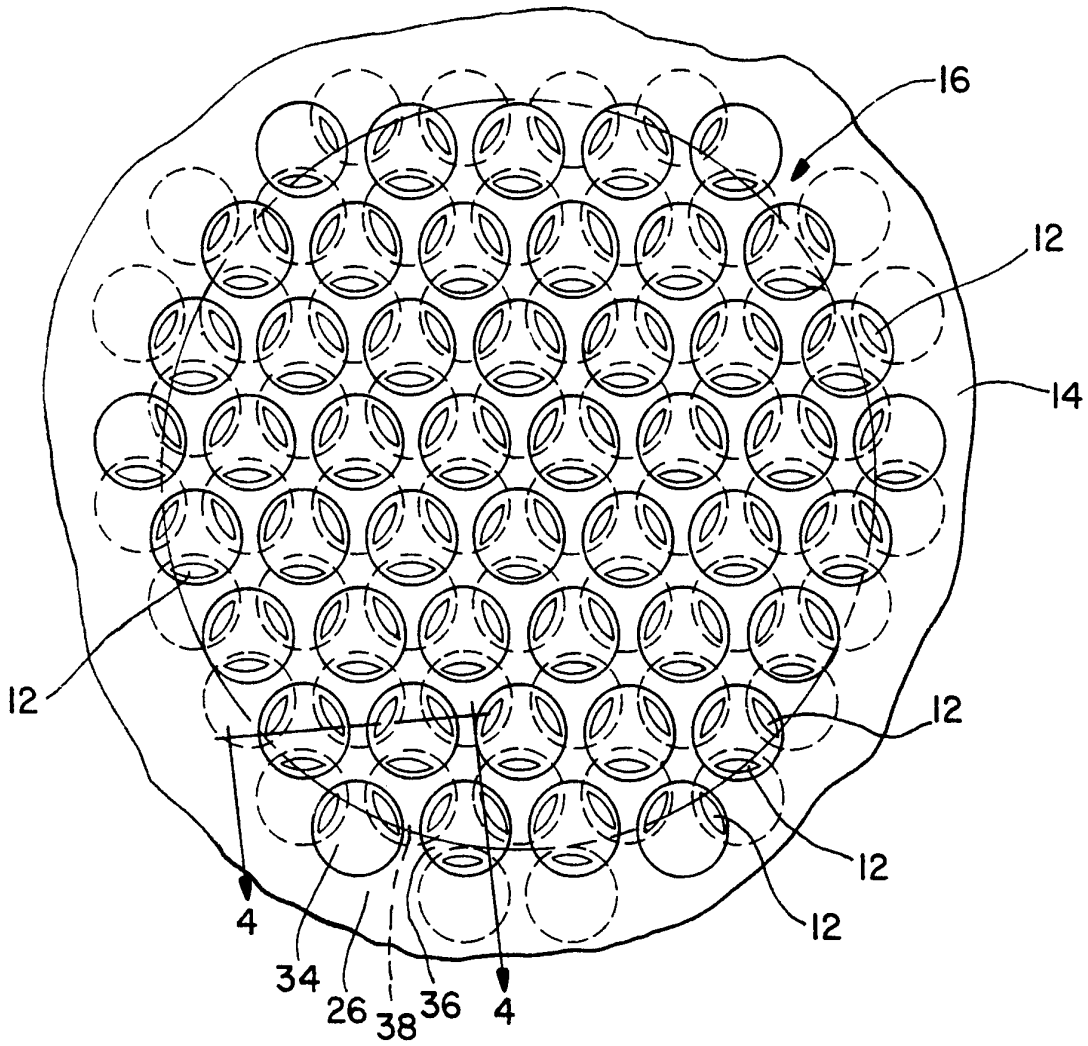


FIG.4

FIG.5

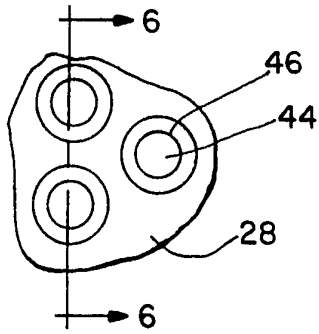


FIG.6

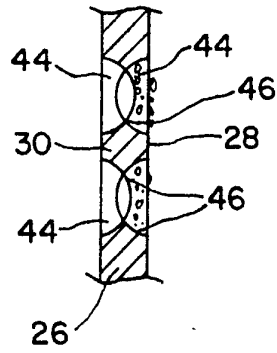


FIG.7

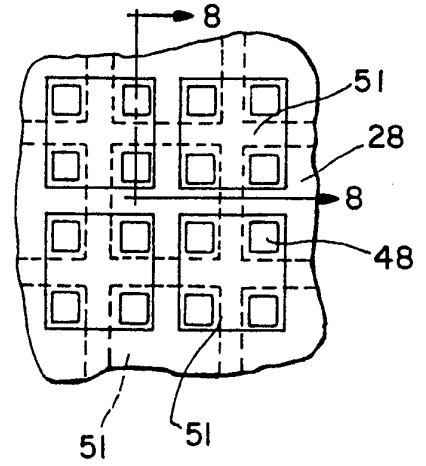


FIG.8

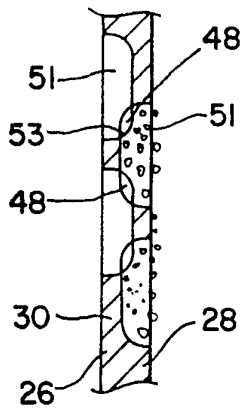


FIG.9

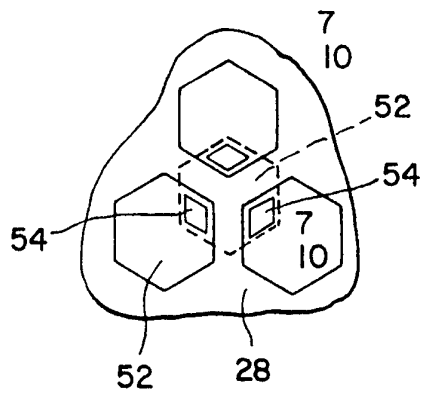


FIG.10

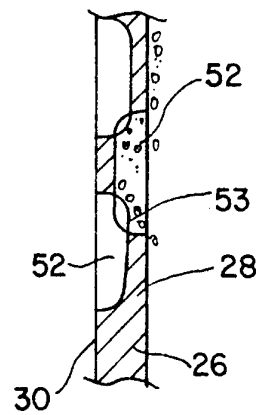


FIG.11

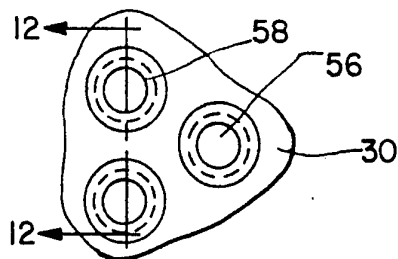
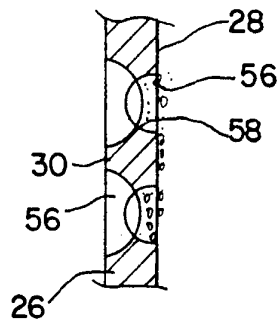


FIG.12



INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US94/10664

<p><b>A. CLASSIFICATION OF SUBJECT MATTER</b>                  :IPC (6): A61M 15/00, 16/00; B05D 7/14; B65D 83/06                  US CL :128/203.12, 203.15                  According to International Patent Classification (IPC) or to both national classification and IPC</p>																				
<p><b>B. FIELDS SEARCHED</b></p> <p>Minimum documentation searched (classification system followed by classification symbols)                  U.S. : 128/200.24, 203.12, 203.13, 203.19, 203.15, 203.21, 203.23, 204.13; 222/636; 604/58</p> <p>Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched                  NONE</p> <p>Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)                  NONE</p>																				
<p><b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b></p> <table border="1"> <thead> <tr> <th>Category*</th> <th>Citation of document, with indication, where appropriate, of the relevant passages</th> <th>Relevant to claim No.</th> </tr> </thead> <tbody> <tr> <td>A</td> <td>US, A, 4,534,345, (WETTERLIN), 13 August 1985. See entire document.</td> <td>1-12</td> </tr> <tr> <td>A</td> <td>WO, A, 93/12831, (ZIERENBERG ET AL), 08 JULY 1993. See the entire document.</td> <td>1-12</td> </tr> </tbody> </table>			Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.	A	US, A, 4,534,345, (WETTERLIN), 13 August 1985. See entire document.	1-12	A	WO, A, 93/12831, (ZIERENBERG ET AL), 08 JULY 1993. See the entire document.	1-12									
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.																		
A	US, A, 4,534,345, (WETTERLIN), 13 August 1985. See entire document.	1-12																		
A	WO, A, 93/12831, (ZIERENBERG ET AL), 08 JULY 1993. See the entire document.	1-12																		
<p><input type="checkbox"/> Further documents are listed in the continuation of Box C.      <input type="checkbox"/> See patent family annex.</p>																				
<table border="0"> <tr> <td>* Special categories of cited documents:</td> <td>"T"</td> <td>later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</td> </tr> <tr> <td>"A" document defining the general state of the art which is not considered to be part of particular relevance</td> <td>"X"</td> <td>document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone</td> </tr> <tr> <td>"E" earlier document published on or after the international filing date</td> <td>"Y"</td> <td>document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art</td> </tr> <tr> <td>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</td> <td>"&amp;"</td> <td>document member of the same patent family</td> </tr> <tr> <td>"O" document referring to an oral disclosure, use, exhibition or other means</td> <td></td> <td></td> </tr> <tr> <td>"P" document published prior to the international filing date but later than the priority date claimed</td> <td></td> <td></td> </tr> </table>			* Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention	"A" document defining the general state of the art which is not considered to be part of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone	"E" earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art	"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family	"O" document referring to an oral disclosure, use, exhibition or other means			"P" document published prior to the international filing date but later than the priority date claimed		
* Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention																		
"A" document defining the general state of the art which is not considered to be part of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone																		
"E" earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art																		
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family																		
"O" document referring to an oral disclosure, use, exhibition or other means																				
"P" document published prior to the international filing date but later than the priority date claimed																				
<p>Date of the actual completion of the international search 09 NOVEMBER 1994</p>		<p>Date of mailing of the international search report <b>15 DEC 1994</b></p>																		
<p>Name and mailing address of the ISA/US                  Commissioner of Patents and Trademarks                  Box PCT                  Washington, D.C. 20231                  Facsimile No. (703) 305-3230</p>		<p>Authorized officer <i>Kimberly Lynn Asher</i>                  KIMBERLY LYNN ASHER                  Telephone No. (703) 308-0332</p>																		