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(54) **Front loading machine with hydrodynamic lifter**

(57) A drum type washing machine comprises a tub, a rotatable drum (D) provided in the tub and at least a V-shaped lifter (10) arranged on an inner peripheral surface (D1) of the rotatable drum (D). The lifter (10) presents two enlarged and rounded end portions (10b,10c) that reduce wearing of laundry during washing cycle.

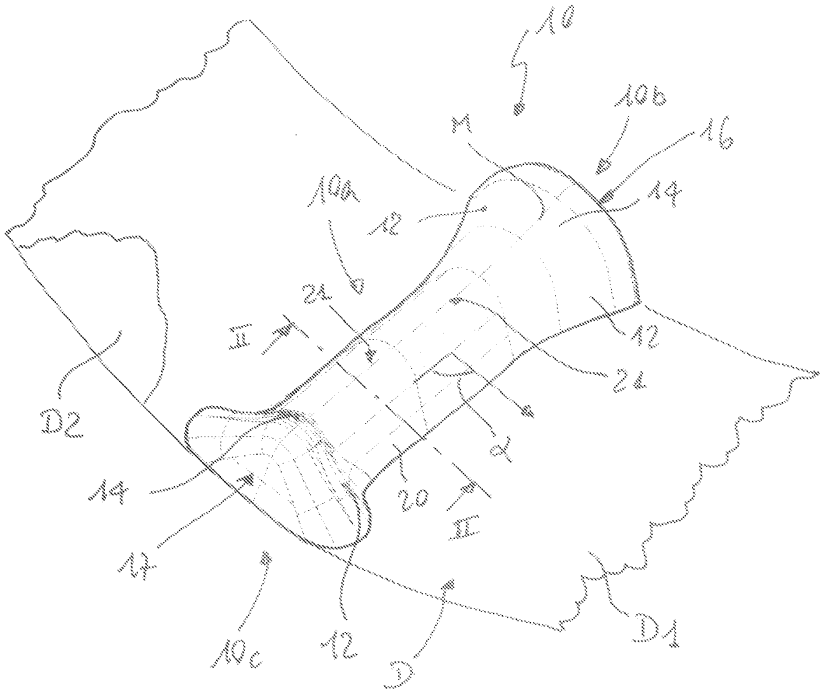

Fig. 1

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Description

[0001] The present invention relates to a drum type washing machine comprising a tub, a rotatable drum positioned in the tub and at least one V-shaped lifter arranged on an inner peripheral surface of the rotatable drum.

[0002] Automatic front-loading washing machines include a drum rotating inside the tub. Axis of rotation of the drum is horizontal or slanted to horizontal. Opening of the tub and drum is closed with a sealed door having a central frusto-conical portion made of glass. On inside surface of the drum one or more lifters are mounted. Laundry is loaded inside the drum and tub is filled with washing solution (water plus detergent). During washing of the laundry, drum periodically rotates around the axis of rotation in both directions (tumbling). During rotation of the drum, lifters in low position scoop the laundry and lift laundry up. Depending on the speed of the drum, shape, size and angle to axis of rotation of the lifters, laundry will be lift on different heights and then drop down to perform mechanical washing action. Besides the vertical movement, laundry will perform movement along axis of rotation.

[0003] The known hydrodynamic lifters have a V-shaped cross section; since the upper edge of the V-shaped lifter is rounded, the cross section of the lifter can be also defined as a isosceles trapezoid. Also the larger base of this isosceles trapezoid is convex, and such base is attached to the inner surface of the drum and it has radius equal to inner radius of the drum. Big enough radius at the top of the lifter and big enough angle between "legs" of this trapezoid provide sufficient transmission of energy to garments with less damage thereto.

[0004] A front loading washing machine is disclosed by US-A-2007/0017261 and US-A-2007/0022788 and it has lifters positioned parallel to the axis of rotation. During rotation of the drum in one direction, the lifters scoop the laundry in the drum and lift them. During lifting, laundry, under forces of the gravity, tries to escape from the lifter. Two sides are forbidden: laundry can't move against bottom, i.e. circular wall and end flat wall of the drum. An available alternative is to fall down from the lifter, or move along lifter towards the opening in the drum, i.e. towards the door. Part of the laundry that rotates with drum is moved into the opening of the drum and touches the stationary door. During contact of the laundry with stationary door, laundry is subjected to wear and tangling.

[0005] Another kind of washing machine is disclosed by US-A-2002/0083743 and it has lifters positioned obliquely. During rotation of the drum in one direction the lifters, which are disposed obliquely to the direction of rotation of the laundry drum, transport the laundry up and in a forward direction, for example, toward the door. Part of the laundry rotated with drum moves in the opening of the drum and touches stationary door. After laundry reaches maximum height, laundry is dropped down. Landing point of the laundry, along the drum axis, will be different from pick-up point of the laundry and this side of the laundry becomes twisted compared to the rest of the laundry. Each turn of the drum increases wear and taglines of the laundry. At rotation of the drum in the opposite direction, laundry will be forced to move in opposite direction towards to the bottom of the drum, but the effects in terms of wear and taglines of the laundry are similar.

[0006] Another kind of washing machine, disclosed by US-A-2005/0005651, has lifters having at least a part of the lifter taller than other parts. During washing of the laundry, each lifter scoops laundry in the drum and lifts it. Due to the different heights of different parts of the lifter laundry falls down from the lifter from different heights and at different moments, i.e. its "landing" on the drum circular wall is not simultaneous. Different positions of the laundry at scooping and landing points of the laundry lead to tangling of the laundry.

[0007] Another kind of washing machine is disclosed by US-A-2005/0097926 and has a lifter with constant height and a rear part of the lifter having width gradually decreasing from rear to front of the drum. Front part of the lifter has width gradually increasing in the direction of the opening. Rear part of the lifter is much longer than front part thereof. Side surfaces of the lifter have almost a constant angle of the attack pointed one against the other. With the term "angle of attack" we mean the angle between a line tangent to the working surface of the hydrodynamic lifter, and the flow line of the moving garments at point of interaction of the garment and direction of the hydrodynamic lifter movement. In the lifter disclosed by US-A-2005/0097926, the angle of the attack formed with front part of the lifter is much bigger than the angle of the attack formed with the rear part of the lifter. Ratio of the front angle of the attack to the rear angle of the attack is almost in inverse proportion to the length of the front and rear part of the lifter. During washing, side surface of the lifter forces garments to move up and in a direction along the lifter pointed with the angle of the attack of the lifter. From the rear of the drum garments are moving toward the front of the drum. From the front area of the drum garments are moving toward the rear of the drum. Due to the differences in the values of the front and rear angle of attack and differences in the length of the rear and front parts of the lifter, the most part of the garment will slowly move toward front of the drum, but lesser part of the garments with higher speed will move toward rear of the drum against a major flow of garments. Therefore the two garment flows will collide one with the other creating tangling and bunching of the garment.

[0008] From the above known technical solution, it is clear that the present design of lifters to be used in washing machines is not satisfactory in terms of damage and tangling of garments.

[0009] It is one object of the present invention to provide a drum type washing machine which does not present the above problems and in which the clothes are properly washed with a reduced wear thereof. The above

object is reached thanks to the features listed in the appended claims.

[0010] According to the invention, the lifters present two enlarged ends each having a substantially rounded and smooth shape. Thanks to such feature, on both ends of the hydrodynamic lifter the inclined surfaces of the lifter are substantially concave and can be spiral or parabola shaped. The two inclined surfaces extending from one end of the lifter to another end of the lifter are forming working surfaces, i.e. surfaces acting on laundry during rotation of the drum. Each working surface defines a local draft angle that, according to the invention, varies from one to another end of the hydrodynamic lifter. The working surface is mainly a flat one, but it can be also concave or convex and, together with the enlarged ends, is configured to move the garments uniformly minimizing contact with static sealing and door and minimizing interference with bottom flat wall of the drum. This configuration does reduce damage and tangling of the garment and minimizes forces acting on the working surface at rotation of the drum with the hydrodynamic lifter at any directions.

[0011] According to a further embodiment of the invention, in order to increase positive influence of the hydrodynamic lifter on garments, the working surfaces between the two enlarged ends can be formed with crimps oriented perpendicularly or under a predetermined angle to the drum axis of rotation.

[0012] According to another embodiment of the invention, a sort of skirt can be attached to the lower surface of the hydrodynamic lifter in contact with the inside surface of the drum; this further feature increases concentration of the liquid solution in the garment during washing and increases wash performances. Low thickness of the skirt on the outside and higher thickness of the skirt in the middle of the hydrodynamic lifter contribute for better evacuation of the water solution from the canisters of the hydrodynamic lifter during spinning.

[0013] According to another embodiment of the invention, each lifter may be hollow with a longitudinal sealed wall going from one end of the hydrodynamic lifter to another in the middle of the body of the lifter in order to form two chambers inside the body. Each container has one or more rows of holes through the neighboring-working surface connecting this container with outside environment. Liquid solution collected and discharged through those holes from those chambers during rotation of the drum in any direction contribute to additional watering of the garment and increasing wash performance.

[0014] Further features and advantages of a washing machine according to the present invention will become clear from the following detailed description, provided by way of non limited example, with reference to the annexed drawings in which:

- figure 1 illustrates a perspective view of a first embodiment of a hydrodynamic lifter according to the present invention;
- figure 2 illustrates a cross-sectional view along line II-II of figure 1;
- figure 3 illustrates a top view of the hydrodynamic lifter of figure 1;
- figure 4 illustrates a second embodiment of the lifter according to the present invention;
- figure 5 illustrates a third embodiment of the lifter according to the present invention;
- figure 6 illustrates a fourth embodiment of the lifter according to the present invention;
- figure 7 shows a fifth embodiment of the lifter according to the present invention;
- figure 8 illustrates a cross sectional view along line VIII-VIII of figure 7;
- figure 9 illustrates another embodiment of the lifter according to the invention;
- figure 10 shows a schematic cross section of the drum illustrating the amount of the water inside of the lifter of the washing machine at different positions of the rotating drum; and
- figure 11 illustrates a cross-section of an assembled hydrodynamic lifter in accordance with another feature of the present invention.

[0015] The example of the invention described and illustrated herein comprises an automatic front loading machine having drum with hydrodynamic lifters that impart and optimize uniform movement to garments and other fabric items, such as sheets, towels, rugs and the like contained therein (hereinafter referred to collective as "garments"). During the oscillation-rotation of the drum with hydrodynamic lifters (in the movement of the laundry called "tumbling"), the working surfaces of each hydrodynamic lifter face the flow of the garments. The angle of attack as defined above is crucial in defining and optimizing the uniform flow and energy required for rotating the drum.

[0016] With straight lifters according to prior art, positioned parallel to the axis of rotation and having a constant angle of attack of 90°, uniform flow exists only in the middle of the lifters. Closer to the ends of the lifters flow interferes with bottom of the drum and with door in the opening of the drum and becomes non-uniform flow which contributes to the wear and tangling of the garment.

[0017] With a prior art obliquely positioned lifter having an angle of attack less then 90°, lifters at different directions of drum rotation transport garments in different directions increasing tangling of the garment.

[0018] With a prior art lifter with constant heights and rear part of the lifter having width gradually decreasing from rear to front of the drum and a front part of the lifter having width gradually increasing from rear to front, the difference in the values of the front and rear angle of the attack and differences in the length of the rear and front parts of the lifter causes the garments to have at least two different streams flowing one against the other, and this causes tangling and bunching of the garment. Additionally, during washing, shape of the lifter, heights, angle between working surfaces of the lifter and radius on the

top of the ridge also become critical in minimizing the resistance of the lifter to the movement of the garments and washing performance.

[0019] Referring to FIG. 1, a first embodiment of the invention is illustrated in which an automatic front loading washing machine for washing garments comprises a rotating wash drum D inside a static tub (not shown) with an opening to load and unload washing garments and a door (not shown) with a central glass portion closing this opening during washing. At least one hydrodynamic lifter 10 is attached to the inner surface D1 of the drum D. Each hydrodynamic lifter 10 has a body with three main functional portions, i.e. a central portion 10a and two enlarged end portions 10b and 10c respectively. This overall shape of the lifter 10 is somehow similar to a dickey bow. The enlarged end portions 10b and 10c have a substantially rounded shape.

[0020] The central V-shaped portion 10a comprises two flat and inclined side surfaces 20 and a curved top egde 21. Each of the two end portions 10b and 10c presents two curved slightly concave side surfaces 12 radiused to the inclined surfaces 20 and a curved convex top surface 14 which is also radiused to the curved top edge 21 of the lifter. Each curved convex surface 14, along the centerline of the lifter indicated in the drawings with reference M, has a height increasing towards the end of the lifter.

[0021] The cross section of the lifter is therefore V-shaped in the central portion 10a and substantially semicircular in the two end portions 10b and 10c. Moreover, the end 10b of the lifter, which is close to the door of the front-loading washing machine, has an end surface 16 which is slightly rounded and is radiused, as clearly shown in figure 3, to surfaces 12 and 14 of the end portion of the lifter. Also the end portion 10c of the lifter 10 close to the bottom wall D2 of the drum has an end surface 17 similar to the end surface 16 of the other end portion, even if this is lesser rounded (i.e. almost flat) since it lies against the bottom wall D2 of the drum D.

[0022] Referring also to FIG. 2, the hydrodynamic lifter 10 in cross-section view presents an isosceles trapezoid shape body attached to inside surface D1 of the drum D, extended along axis of rotation, between bottom D2 of the drum D to the front side of the drum with opening. Both bases 16 and 18 of this isosceles trapezoid are convex. One is attached to the inner surface D2 of the drum D and has a radius R equal to the inner radius of the drum. The other base 18 has radius "r" and mates both inclined sides of this isosceles trapezoid that forms the inclined surfaces 20. Big enough radius "r" and angle "a°" between "legs" of this isosceles trapezoid provide sufficient transmission of the energy to garments with less damage. Angle "a°" between side inclined surfaces 20 defines effectiveness of the lifter. Radius "r" on the top of the ridge 21 defines gentleness of the lifter. On both ends of the hydrodynamic lifter 10 the side curved surfaces 12 are slightly concave and their profile (intended as horizontal section of the lifter) can be preferably formed as a portion of spiral or parabola, even if other kind of profiles may be advantageously adopted as well. Even if the inclined surfaces 20 of the central portion 10a of the lifter 10 are shown as flat surfaces, nevertheless they can be also concave or convex, therefore giving a concave or convex profile to the top edge 21 of the central portion 10a. Accordingly, the working surfaces of the lifter 10 defined as combinations of side surfaces 20 and 12 and extending from one end of the lifter to another end, can be concave or convex and configured to move the garments uniformly without touching static sealing and door and minimize interference with bottom of the drum, in order to reduce damage and tangling of the garment and minimize force acting on the working surface at rotation of the drum in any directions. The working surface defines a local draft angle α (figure 1) that varies from one end to another end of the lifter.

[0023] Referring to FIG.3, an horizontal section12a (at a level close to the top 21 of the lifter 10) of the overall working surface composed by the central portion 20 and by the two end portions 12 has "b" and "c" angle of attack with garments. Angle of the attack "b" is closer to the end of the lifter then angle of the attack "c". Angle of the attack "c" is bigger then angle of the attack "b". On the working surfaces 12 the angle of the attack gradually increases from the ends towards the center from values close to 0° to values close to 90°. The angle of attack (α) of the lifter 10 is around 90° for more than 40% of the total length of the lifter, more preferably for more than 50% of said length. Good results have been obtained with lifters having an angle of attack of 90° for 60% or more of the total length of the lifter. The first end 10b of the lifter close to the front circular opening of the drum D has a decrease ratio of the angle of attack with lifter length towards the same end 10b of the lifter 10 which is lower than said decrease ratio of the second end 10c. This different decrease ratio can be seen in figure 3 where the enlarged end 10c is more "flat" than the enlarged end 10b close to the drum opening.

[0024] During washing, the garment working surfaces 12 of the moving hydrodynamic lifter force garments during washing to remain in a central zone of the drum, therefore avoid a contact with bottom and opening of the drum D.

[0025] FIG. 4 illustrates a second embodiment of the lifter 10, where the same reference numerals for identical or similar parts are maintained. The lifter 10, according to this embodiment, presents a shape similar to a saddle where the angle of attack is continuously decreasing from the middle portion to the two end portions 10b and 10c.

[0026] The embodiment shown in figure 5 relates to a lifter that, instead of having two flat inclined surfaces 20, has inclined surfaces 20' with a wave-shaped structure including grooves 24 and protrusions 22 with round surfaces alternately arranged. Crimped surfaces 20' will guide garments during washing.

[0027] FIG. 6 illustrates the lifter 10 in accordance with another feature of the present invention. The bottom of

the hydrodynamic lifter 10 according to this embodiment is covered with a skirt 26. During washing skirt 26 works as scoop and collects and discharges liquid solution at rotation from lowest position up. Thickness of the skirt 26 close to the center of the lifter is preferably thicker than thickness of the skirt on the outside of the skirt.

[0028] The lifter 10 according to the embodiment of figure 6 is hollow and it has a longitudinal wall 28 dividing inner space of the lifter 10 in to two independent chambers 30. Each chamber 30 is open through row of holes 34 and 36 with outside environment of the drum. Holes 34 and 36 have diameter d1 and d2. Distance "h" between two row of the holes 34 and 36 and their diameters "d1" and "d2" define at what position of the lifter 10 inside washing machine garments will be watered. Even if two rows of holes are shown in the drawings, it is clear that a single or a plurality of rows can be sued, with the proviso that the total number of holes and the diameter thereof is designed for giving the optimal watering performances (right amount of water at the right moment).

[0029] Referring to FIG. 7, it is shown another embodiment that can be defined as a combination of embodiments shown in figures 5 and 6. The central portion 10a has inclined surfaces 20" provided with protrusions 22 and grooves 24. Moreover each surface 20" has at least two rows of holes 34 and 36. First row of the holes 34 mates skirt 26 of the hydrodynamic lifter 10. The holes 34 and 36 are preferably located at the bottom of the grooves 24.

[0030] Referring to FIG. 9, another embodiment of the lifter 10 is quite similar to the embodiment of figure 6, with the difference that instead of rows of holes, the inclined surfaces 20''' are provided with slots 38 connecting the inside of chambers 30 of the lifter with outside environment of the drum D. The slots 38 are preferably located at the bottom of the valleys 24.

[0031] FIG. 10 illustrates how the amount of water in the chambers 30 of the lifter 10 is discharged at different position of the rotating drum. From figure 9 it is clear how the presence of a longitudinal wall 28 dividing the hollow space into two chambers 30 allows a watering of the laundry well above the position indicated with K in figure 9.

[0032] FIG. 11 illustrates a cross-section of the hydrodynamic lifter 10 in accordance with another feature of the present invention, particularly related to an easy assembly of the lifter to the wall D1 of the drum D. Hydrodynamic lifter 10 is composed by two parts, a first part 40 forming the curved base and skirt, and a second part 42 forming the working surfaces of the lifter. The first part 40 has through openings 40a adapted to cooperate with corresponding hooks 42a in the second part 42 of the lifter. During assembly hooks 42a of the second part 42 of the lifter body are snap-engaged into the openings 40a of the first part 40, and the central wall 28 of the lifter goes in a sealing slot 44. To install the whole assembly into the drum D of the washing machine it is possible to use the same slots in the drum of the washing machine as used today.

Claims

1. A drum type washing machine comprising a tub, a rotatable drum (D) provided in the tub and at least a V-shaped lifter (10) arranged on an inner peripheral surface (D1) of the rotatable drum (D), **characterized in that** the lifter (10) presents two enlarged end portions (10b, 10c) having a substantially rounded shape.

2. A washing machine according to claim 1, wherein each enlarged and portion (10b, 10c) presents two curved concave side surfaces (12) radiused to a curved convex top surface (14).

3. A washing machine according to claim 2, wherein the curved concave side surfaces (12) are radiused to substantially flat inclined surfaces (20) of a central portion (10a) of the lifter (10).

4. A washing machine according to claim 2 and 3, wherein the curved convex top surface (14) of each end (10b, 10c) of the lifter has an average height higher than the height of the central portion (10a) of the lifter.

5. A washing machine according to any of claims 2 to 4, wherein the horizontal profile of the curved concave side surfaces (12) is a portion of spiral or a portion of parabola.

6. A washing machine according to claim 1, wherein the lifter (10) is saddle-shaped.

7. A washing machine according to any of the preceding claims, wherein the lifter (10) presents an angle of attack (α) substantially decreasing from the center (10a) of the lift towards the end (10b, 10c), the angle of attack being the angle between a line tangent to the surface of the lifter and a line defining the movement direction of the lifter (10) when the drum (D) is rotated.

8. A washing machine according to claim 7, wherein the angle of attack (α) of the lifter is around 90° for more than 50% of the total length of the lifter, more preferably for more than 60% of said length.

9. A washing machine according to any of the preceding claims, wherein a first end (10b) of the lifter (10) has a shape different from that of a second end (10c).

10. A washing machine according to claims 7 and 9, particularly front loading machine in which the drum (D) presents a front circular opening facing a back circular wall (D2), wherein the first end (10b) of the lifter close to the front circular opening has a decrease ratio of the angle of attack with lifter length towards

the end (10b) of the lifter (10) which is lower than said decrease ratio of the second end (10c).

11. A washing machine according to any of the preceding claims, wherein the lifter (10) is hollow and present a longitudinal internal wall (28) dividing the inner part into two chambers (30), side walls (20) of the lifter being provided with holes (34, 36) or slots (38) allowing passage of liquid between the inside and outside of the lifter (10).

12. A washing machine according to any of the preceding claims, wherein a central portion (10a) of the lifter (10) presents two inclined surfaces (20) having a wave-shaped structure.

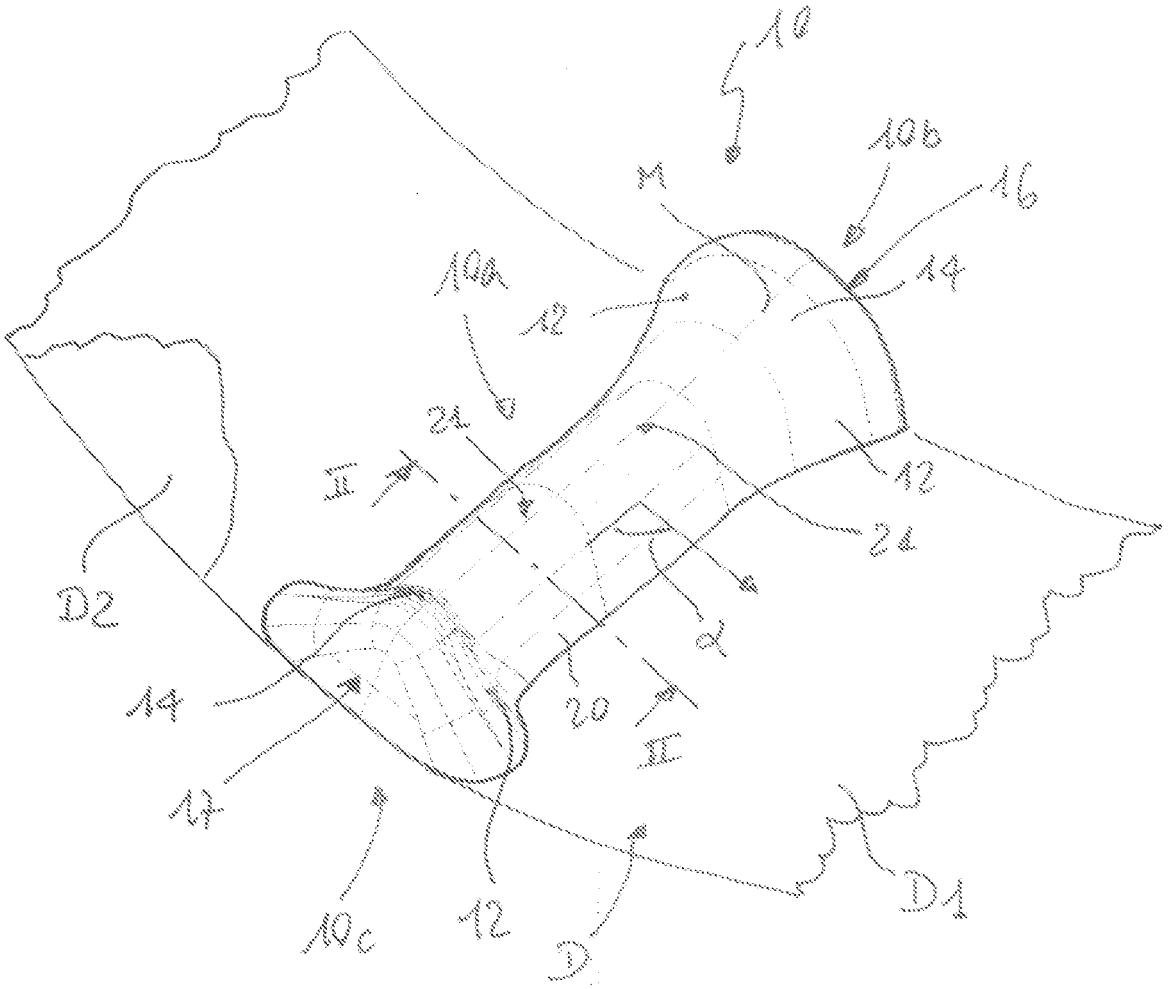

Fig. 1

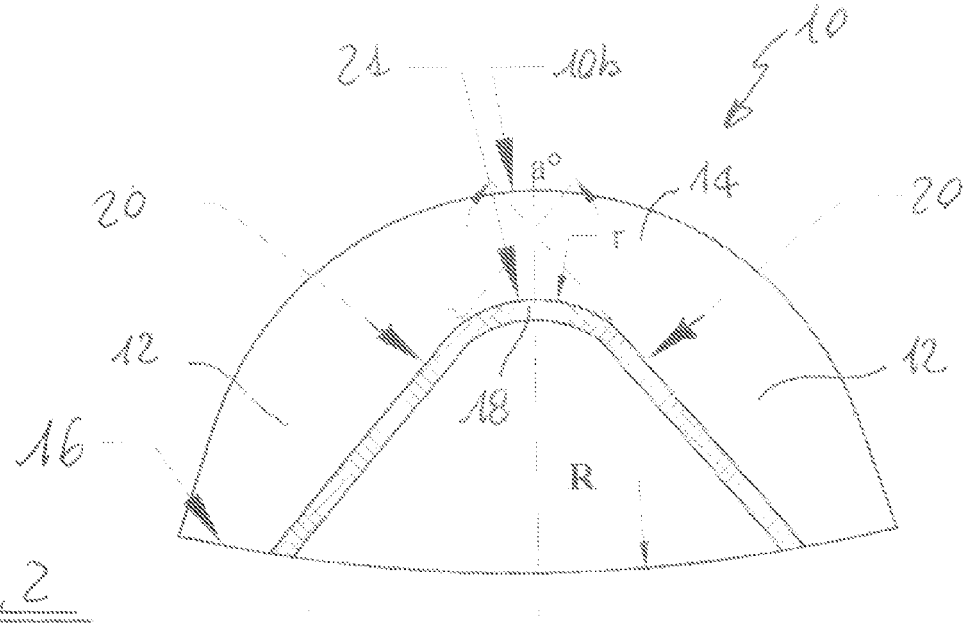
21
10b
10
a°
14
20
20
12
12
16
18
R

Fig. 2

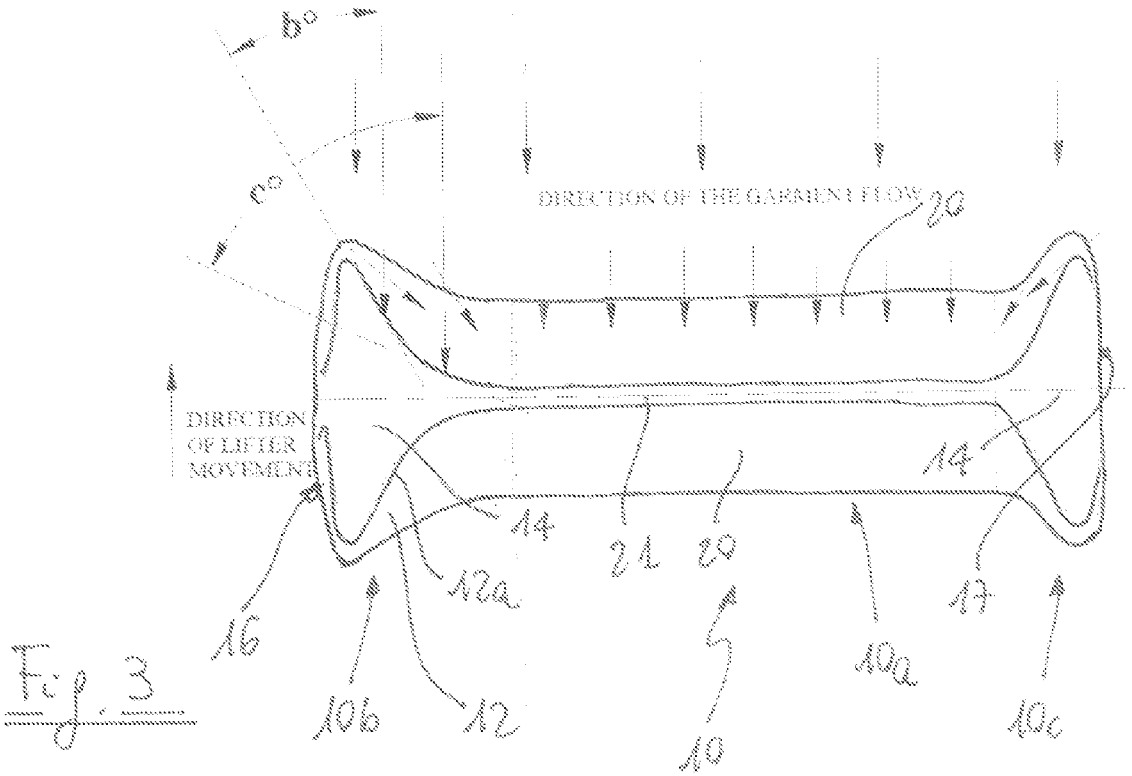
b°
c°
DIRECTION OF THE GARMENT FLOW
20
DIRECTION OF LIFTER MOVEMENT
14
14
21
20
12a
16
17
10b
12
10
10a
10c

Fig. 3

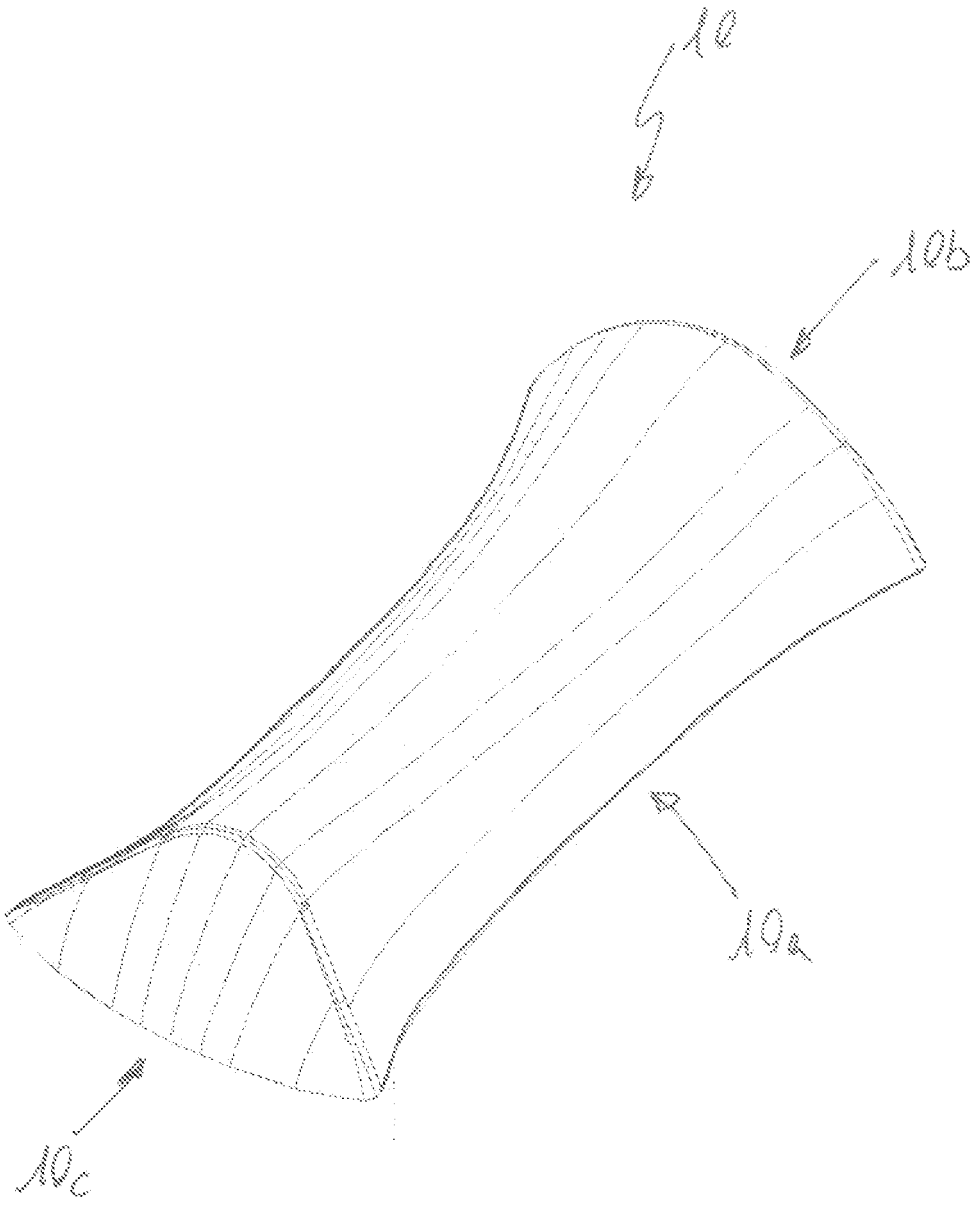

Fig. 4

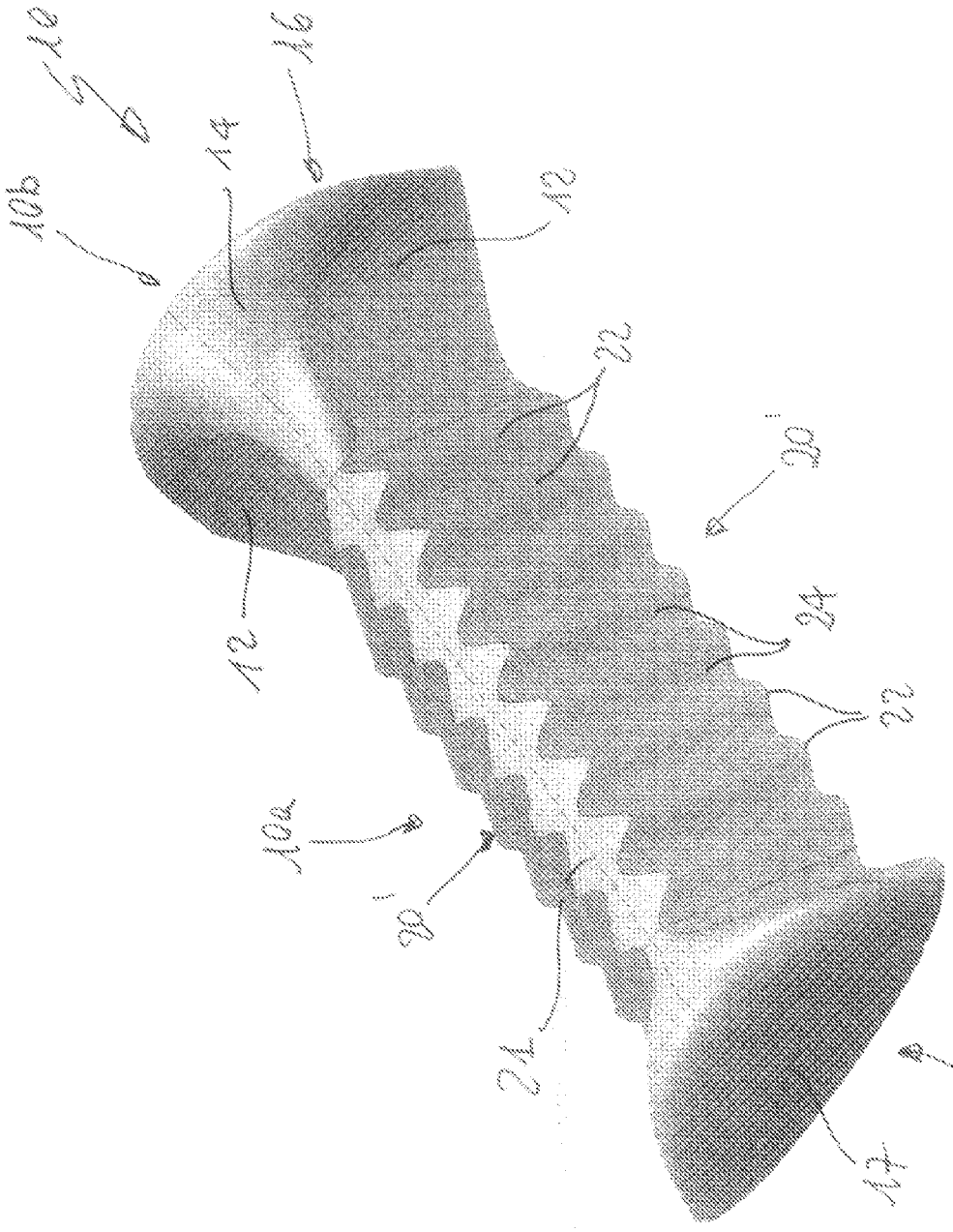

Fig. 5

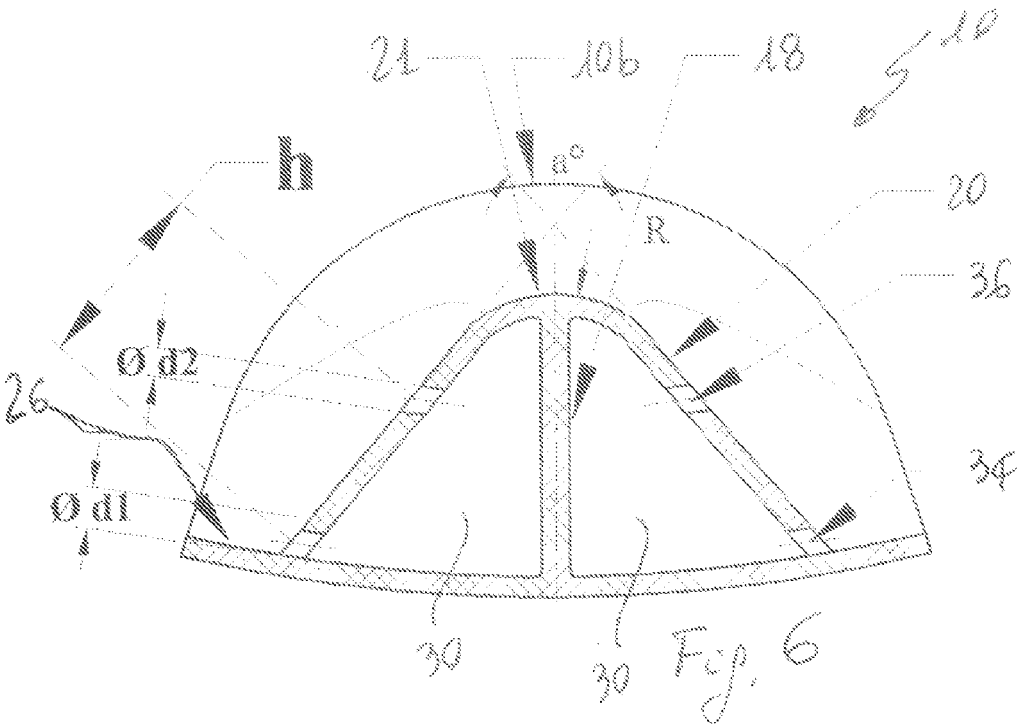
21
10b
18
10
h
α°
R
20
36
σa2
26
σa1
34
30
30

Fig. 6

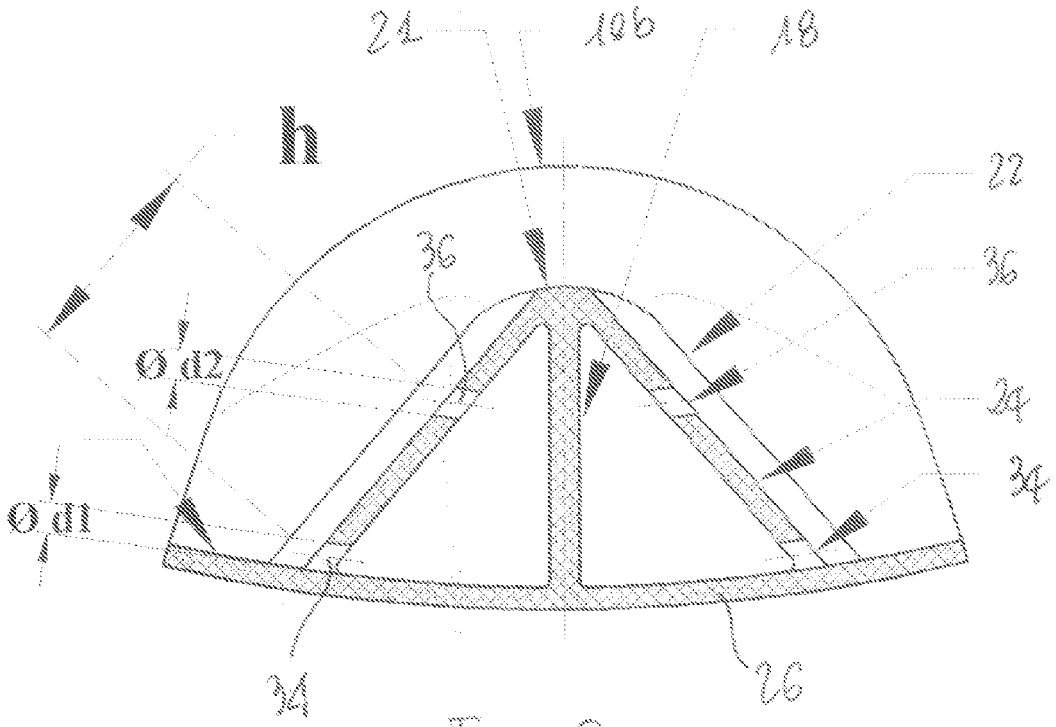
21
10b
18
h
22
36
36
σa2
24
34
σa1
34
26

Fig. 8

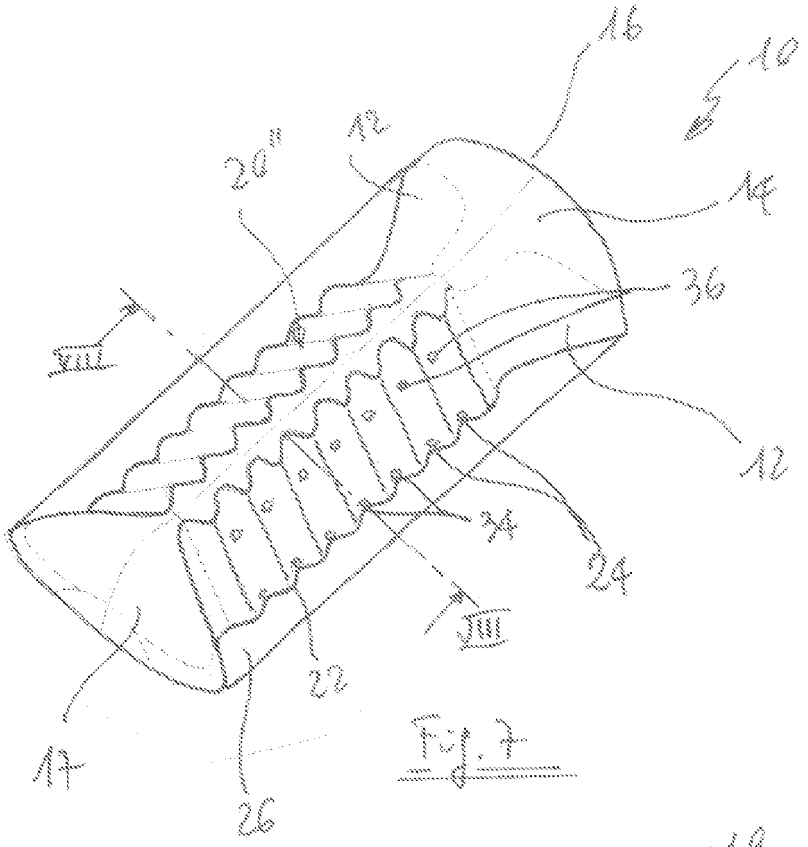
16
10
20"
12
14
36
VIII
12
34
24
VIII
22
17
26

Fig. 7

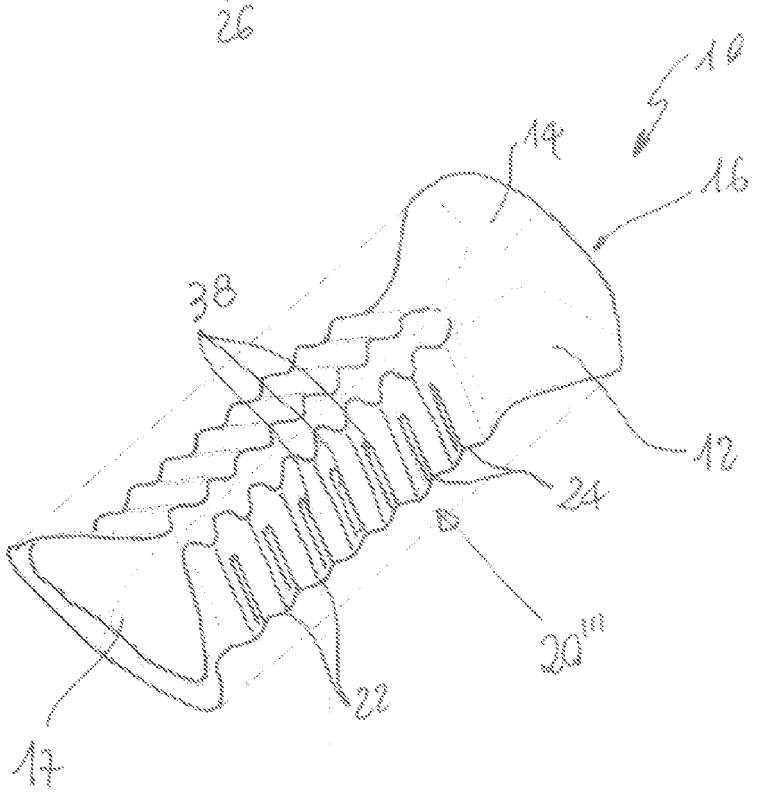
10
19
16
38
12
24
20"
22
17

Fig. 9

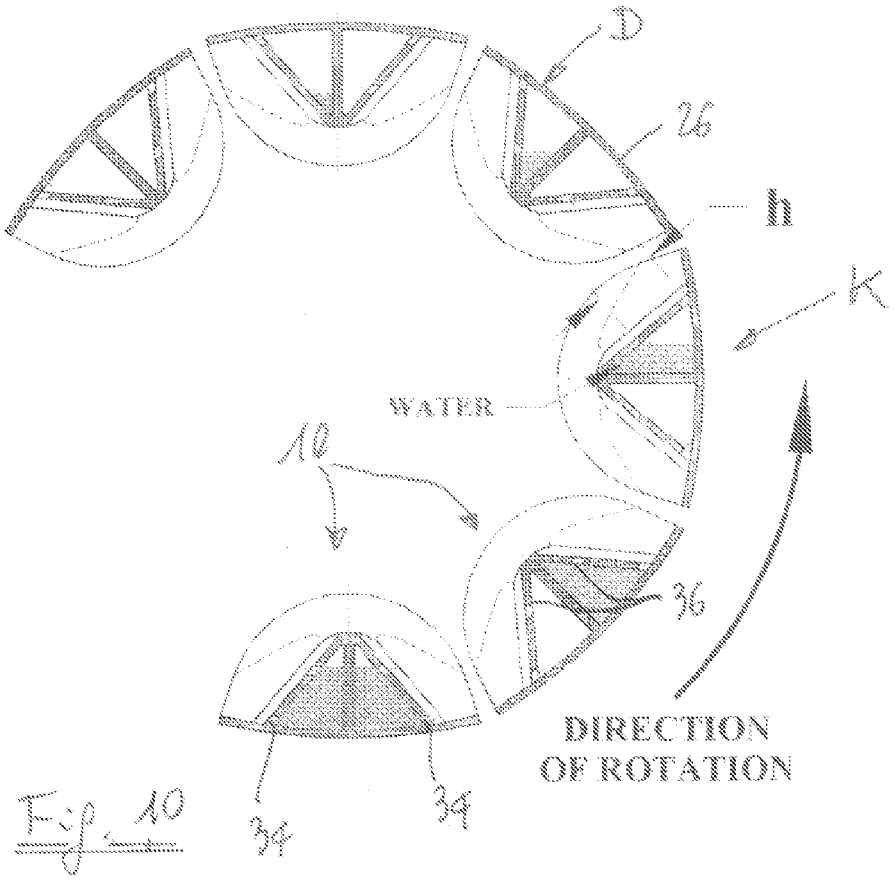
D
26
h
K
WATER
10
36
DIRECTION
OF ROTATION
34
34

Fig. 10

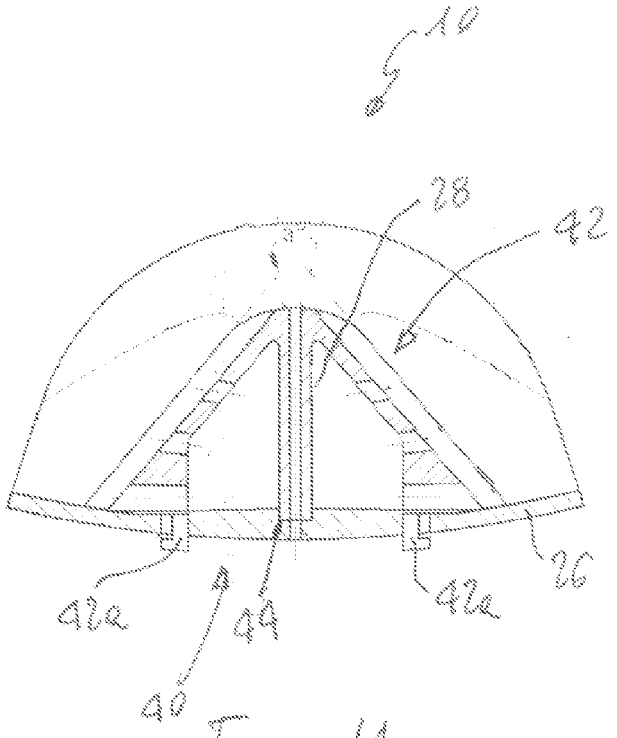
10
28
42
42a
40
44
42a
26

Fig. 11

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 07 11 6910

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 3 997 292 A (LUTES CHARLES T ET AL) 14 December 1976 (1976-12-14) * figures 4-8 *	1,7-9	INV. D06F37/06
A,D	US 2005/097926 A1 (KIM HYUN S [KR] ET AL) 12 May 2005 (2005-05-12) * figures 2,3 *	1	
A,D	US 2005/005651 A1 (KIM KWANG SOO [KR] ET AL) 13 January 2005 (2005-01-13) * figures 2a,2b,3,4a,4b *	1	
A,D	US 2002/083743 A1 (USZKUREIT DETLEF [DE] ET AL UZKUREIT DETLEF [DE] ET AL) 4 July 2002 (2002-07-04) * figures *	1	

TECHNICAL FIELDS SEARCHED (IPC)

D06F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	18 February 2008	Courrier, Gilles

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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A : technological background
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