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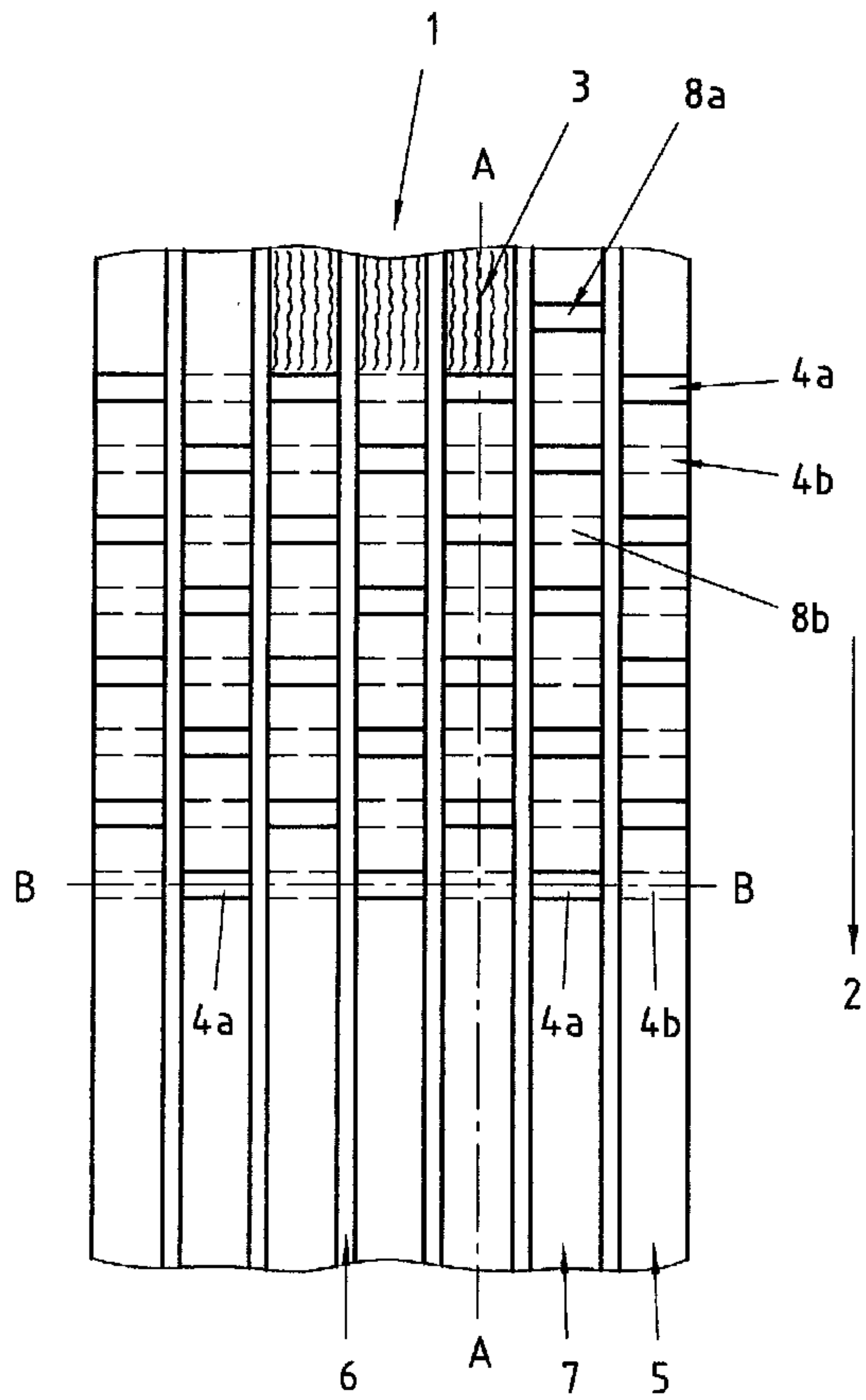
(54) Titre : ETOFFE NAPPEE GAUFREE A STRUCTURE TRIDIMENSIONNELLE

(54) Title: EMBOSSED NON-WOVEN FABRIC HAVING A THREE-DIMENSIONAL STRUCTURE



(57) Abrégé/Abstract:
The invention relates to a three-dimensionally embossed non-woven fabric, which is comprised of fibers and/or filaments (3) oriented primarily in the moving direction (2) of the machine, and has zones (5, 7) with regularly alternating elevations (4a, 8a)

(57) **Abrégé(suite)/Abstract(continued)**:
and indentations (4b, 8b), which are separated from one another by non-embossed areas (6) that are continuous in the moving direction (2) of the machine. These non-embossed areas constitute a proportion ranging from 5 % to 50 % with regard to the entire surface of the non-woven fabric (1) and the elevations (4a, 8a) and indentations (4b, 8b), when viewed from the opposite side, form indentations or elevations respectively, whereby the surfaces (10a, 10b) delimited by the elevations give the non-woven fabric an apparent thickness ranging from 0.5 mm to 5.5 mm.

Abstract

The invention relates to a three-dimensionally embossed non-woven fabric, which is comprised of fibers and/or filaments (3) oriented primarily in the moving direction (2) of the machine, and has zones (5, 7) with regularly alternating elevations (4a, 8a) and indentations (4b, 8b), which are separated from one another by non-embossed areas (6) that are continuous in the moving direction (2) of the machine. These non-embossed areas constitute a proportion ranging from 5 % to 50 % with regard to the entire surface of the non-woven fabric (1) and the elevations (4a, 8a) and indentations (4b, 8b), when viewed from the opposite side, form indentations or elevations respectively, whereby the surfaces (10a, 10b) delimited by the elevations give the non-woven fabric an apparent thickness ranging from 0.5 mm to 5.5 mm.

EMBOSSED NONWOVEN WITH THREE DIMENSIONAL STRUCTURE

Field of the Invention

The invention relates to an embossed open porous nonwoven material with three-dimensional structure, and a process and apparatus for its manufacture. The nonwoven consists of regularly alternating regions respectively having deep drawn weight-reduced 3D elevations and non-deep drawn, flat zones of unchanged weight.

The invention further relates to a special embossment process and the roller geometry necessary therefor in order to provide the nonwoven with a special 3D embossment structure after passing through the press nip of a pair of meshing positive and negative rollers.

Background Art

The absorbent core of baby diapers, incontinence products, and feminine hygiene products is these days covered on the carrier side, which means the body side, by at least two layers. An uptake and distribution layer (AVS) of nonwoven or reticulated foam material is positioned between the cover nonwoven or the perforated foil and the absorbent core, which layer, as the name indicates, quickly takes up the body fluid (urine, thin stool or menses) and distributes it as evenly as possible to the underlying absorbent core, generally consisting of cellulose and super absorbing powder. On the one hand, the human skin is thereby kept dry with the result of preventing skin irritations and on the other hand a leakage of the body fluid by lateral exit is prevented. On the backside, the absorbent hygiene product is sealed against body fluid passage by way of a watertight foil or a nonwoven-foil laminate.

For the AVS, nonwovens thermally bonded in a hot air oven or nonwovens bonded with polymer dispersions and made of crimped, relatively coarse titer fibers are known. The fibers have titers of more than 3.3 dtex and consist preferably of a polyester (polyethylene terephthalate) and/or polyolefins, whereby bi-component fibers with side by side or core/sheath structure are used for the purpose of a fiber bonding in the flow-through oven and one of the two fiber components melts significantly lower than the other component. Such nonwovens in relation to their low weight immediately after their manufacture have a relatively high volume (thickness). It is however known that this initial thickness is already reduced during the winding up of the ware under tension common in practice, and that compression conditions in the packaging further contribute to the reduction in thickness.

Solutions were therefore desired which achieve a thickness not only through more or less statistically distributed crimped fibers and their bonding, but by bringing such crimped nonwovens into the third dimension, referred to in the following as Z-direction, by ondulation or other geometrical re-orientations. It has been found that higher compression resistance can thereby be achieved than with so called high loft nonwovens with the result of a significantly lower thickness loss upon passage through the manufacturing steps of a diaper, including packaging and storage.

An embossment process for the manufacture of a structured, voluminous nonwoven is described in DE 197 25 749 A1. A pre-solidified spunbond nonwoven the endless filaments of which were stretched to only 50 to 70% of the maximum possible stretch are subjected to a special after-treatment. That consists of a passage of the nonwoven material between a positive roller with ribbed surface and a negative roller with lamella shape webs transverse to the machine direction, whereby the lamellae engage into the groves between the ribs. 3-D nonwoven materials are thereby generated with regions of conically shaped, weight-reduced protrusions which are surrounded by linear, un-deformed regions.

It is a disadvantage of the embossment process described in DE 197 25 749 A1, that it is limited to un-stretched or partially stretched endless filament nonwovens (spunnbond nonwovens). Such nonwovens consist of coarse titer, un-crimped endless fibers which, as is known, lead to hard, rough and non textile product and therefore are not used as AVS in diapers. Even endless filaments with side by side structure or isometric core/sheath structure lead in the partially stretched condition to no crimping. The latter is normally only trigged by a thermal after-treatment which again, as is known to the person skilled in the art, prevents a stretchability (or deformability) because of the occurring crystallization.

A fluid distribution material with improved fluid properties is described in EP-B 0.809.991 and EP-A 0.810.078. By passing it through a negative/positive roller pair, a plastically deformable web is deformed to a nonwoven with 3D structure. A deviation from the materials of the two abovementioned applications represents the embossed material and the manufacturing process therefor described in EP-B 0.499.942. The disclosed undulated cardboard type structure has however the disadvantage that it will not withstand continuous compression loads.

In the EP applications 1.047.824, 1.047.823, 1.047.822 and 1.047.821, nonwovens with protrusions and depressions are produced in an intermediate step in that the sheet structures are passed through two heated gear rollers. The ribbings have little compression resistance because of the fact that they are missing a non stabilizing flat sheet structure which is glued onto one side of the protrusions or depressions. It is rather the subject of the mentioned patent applications to mostly or partially pull out the undulations in order to achieve soft and slightly elastic products transverse to the undulation.

Absorbent disposable articles with a fecal management layer are known from EP-A 0.976.375, EP-A 0.976.374 and EP-A 0.976.373, whereby the latter layer consists of an undulated nonwoven material which is glued onto a flat nonwoven material carrier (EP-A 0.976.375). Instead of the nonwoven material carrier, thick polymer filaments (EP-A 0.976.374) or nets (EP-A 0.976.373) can be used. Such undulated nonwoven material laminates stabilized by a carrier have proven suitable as AVS for fecal management and improved urine management. The manufacture of such 3D laminate structures is however very expensive and requires two components and in some cases additional adhesive. The use of a thick monofilament (with a titer in a range of several thousand dtex) has however proven unsuitable, since such monofilaments are un-stretched (or exit a hole nozzle) and therefore stretch under the strong mechanical load in machine direction during the manufacture of diapers by thinning of the filament, therefore having a non-acceptable property in this respect.

Summary of the Invention

It is an object of the present invention to overcome at least one of the above described disadvantages of the state of the art and to provide an embossed nonwoven material which without the requirement of an additional stabilizing layer and after a preceding compression better returns to its original shape than the known types and is therefore better suited for the take up of liquids of different composition or for the transport of the liquids into an absorbent layer.

It is a further object of the invention to provide a process for the manufacture of a nonwoven material and an apparatus for carrying out this process. An embossment apparatus is to be provided, especially for diaper manufacture, as addition to a diaper manufacture line which allows the manufacturer to transfer an un-embossed, two dimensional nonwoven material in line with the diaper manufacture into the form of an embossed, three dimensional nonwoven material with improved liquid uptake and distribution function and to place it into a diaper or wound dressing. The nonwoven should thereby also be manufactureable independent of the diaper manufacture and exhibit the aforementioned properties more or less unchanged after an intermediate storage in the rolled up condition.

The invention describes a nonwoven material of staple fibers in which partial regions in machine direction have regularly alternating protrusions and depressions (peaks/valleys) and each protrusion/depression row is interrupted by a non-deformed linear region. The non-deformed linear regions are positioned symmetrically or asymmetrically to the protrusions and valleys of the respectably adjacent regions. In a preferred embodiment, the regions deformed to peaks and valleys extend symmetrically along the non-deformed linear region.

The row of respectively adjacent deformed regions transverse to the machine direction are arranged in machine direction in such away that they are respectively staggered to the adjacent row of undulations.

The undulations extend exactly in machine direction.

The preferred process in accordance with the invention for the manufacture of a nonwoven is carried out in that fibres and/or filaments are laid into a web mainly in machine direction, consolidated and deformed by treatment with embossment rollers at temperatures of 65° to 160° C into a 3-dimensional nonwoven material.

The staple fibers of the 2-dimentional nonwoven for the 3D embossment are therefor laid down in machine direction. The fiber web can additionally be reoriented along this preferred direction by a stunting arrangement.

The staple fibers of the staple fiber web laid down in machine direction are 2-dimentioanlly and/or 3-dimentioanlly crimped.

The fibres consist of such fiber polymers which have a high resetting force with respect to mechanical forces. Polyethylene terephthalate-fibers with a titer of 3.3 to 30 dtex, preferably 6.7 to 18 dtex have been shown especially suitable. Fibers of different titer can be mixed with each other.

The staple fibers webs are adapt adhesively bonded by use of aqueous polymer dispersions and in known processes, by thermal fiber-fiber bonding in a hot air oven or by heat and pressure application in a calendar roller pair. In the case of a hot air passage, bi-component fibers are added to the homophilic fibers as binder fibers.

The nonwoven material provided for the embossment deforming included a hydrophilic, well wetting surface active agent (surfactant), which either was already applied by the fiber manufacturer into or onto the fiber and/or subsequently applied onto the nonwoven material and/or applied into the nonwoven material with the polymer dispersion composition used. The surfactant can have differently strong bonding to the fibers and can thereby be washed out or can be semi permanent to fully permanent upon body fluid contact.

In the case of an adhesive bonding, an aqueous polymer dispersion on the basis of butadiene-copolymers, for example styrol butadiene or acrylonitrile-butadiene-copolymer, is used. The binder agent is preferably free of cross-linked components and remains after the application into the nonwoven material in a thermoplastically deformable condition. The shore hardness-A of the binder film cast from the dispersion is in the range of 70-100, preferably 75-95.

The cross section of the staple fibers can have the most different shapes, such as round, oval, trilobal, square, or rectangular. The fiber polymers can be distributed over the whole fiber cross section at the same density. The fiber can however also be hollow, whereby the hollow interior takes up to 10-30% of the total volume of the fiber.

All crimped single component synthetic fibers which do not shrink or even melt under the embossment conditions are suitable for the embossment process in accordance with the invention. Crimped synthetic fibers can also be mixed with un-stretched un-crimped fibers, but preferably in a proportion of ≤50%.

The base material to be deformed into a 3D-structure preferably includes polyester fibers, when the bonding of the fleece is carried out with an aqueous dispersion. The fiber: binder ratio is about 20 : 80 and up to 40 : 60. The binder agent can be applied with known application methods, such as foam impregnation, splatter or wet in wet printing. The binder agent can be distributed evenly over the cross section of the nonwoven material or can have a binder agent application amount gradient from one side to the other. The drying temperatures and residence times in the dryer must be selected so that a complete filming of the polymer occurs. This can be determined from the transparency (of the non pigmented binder agent) at the bonding points.

The staple fiber web of the precursor can consist of one or up to three layers. The three layers preferably have an average titer from one layer to the respectively adjacent layer. After the 3D deformation, the multi layer nonwoven material with the coarsest (highest titer) web side is oriented in the diaper as AVS towards the under side of the cover nonwoven, the top sheet. For embossed nonwovens with binder agent distribution gradient, the binder agent rich side has contact to the absorbing core or the hydrophilic melt blown nonwoven or tissue paper (core wrap) enclosing the core.

Brief Description of the Drawings

The invention will now be further described by way of example only and with reference to the enclosed drawings, wherein

Figure 1 is a top view of a 3-dimensionally deformed nonwoven in accordance with the invention;

Figure 2 is a cross section through a 3-dimensionally deformed nonwoven in accordance with the invention taken along line A-A in Figure 1;

Figure 3 is a cross section through a three dimensionally deformed nonwoven in accordance with the invention taken along line B-B in Figure 1;

Figure 4 is a schematic illustration of an embossment roller;

Figure 5 is a cross section through an embossment roller;

Figure 6 is schematic illustration of an apparatus in accordance with the invention;

Figure 7 is a cross section through a sprocket disk.

Detailed Description of the Preferred Embodiments

A 3D embossed nonwoven 1 is shown in top view in Figure 1. The machine direction is labeled with 2. The nonwoven material consists of fibres 3 oriented in machine direction 2 which are bonded to one another by known methods. In machine direction 2, the nonwoven material 1 has two continuously repeated zones 5, 7 and the region 6, whereby the zones 5 and 7 have a 3D embossment and the region 6 respectively positioned between the zones 5 and 7 is in the un-embossed condition. Elevations 4a of the zones 5 alternate with depressions (valleys) 4b. Within the zones 7, the elevations 8a and depressions 8b are positioned such that they are, for example, staggered with respect to the protrusions 4a and depressions 4b of the zones 5. The nonwoven 1 thus consist of two surfaces, where by the protrusions form one and the depressions the other surface. In accordance with the invention, the three dimensional embossed nonwoven consist of fibers and/or filaments 3 oriented mainly in machine direction 2 and zones 5,7 with regularly alternating protrusions 4a, 8a and depressions 4b, 8b which are separated from one another in machine direction by un-embossed, continuous regions 6, whereby they preferably make up a portion of 5% to 50% of the total surface of the nonwoven material 1 and wherein the elevations 4a, 8a and depressions 4b, 8b when observed from the opposite side respectively form depressions and elevations, whereby the surfaces delimited by the elevations provide the nonwoven material 1 with an apparent thickness in the range of 0.5 mm to 5.5 mm.

Figure 2 shows a cross section along line A-A, the view of this cross section being transverse to the machine direction 2. In the foreground is the wave shaped 3D structure which is represented by a string of arcuate elevations 4a and depressions 4b. Behind these undulations in the foreground, the un-embossed region 6 extends in machine direction 2. Behind the region 6, a second wave line extends which is characterized by elevations 8a and valleys 8b. The elevations 8a and 8b respectively are staggered to 4a and 4b.

Figure 3 shows the cross sectional view along line B-B (which means transverse to the machine direction 2) in the foreground and the view in machine direction 2 as background (broken lines). The surface weight of the non-deep drawn regions 6 is thereby significantly higher than the weight of the adjacent zones 5 and 7. The surface weight of the 3D embossed zones 5 and 7 is reduced by the factor which results from the division of the distance 28 with the circumference of location 29 after location 30. For example, when the surface weight of the un-embossed nonwoven material is 60 g/m^2, the distance 28 having a length of 6 mm and the circumference the of position 29 to 30 a length of 15 mm, a weight of 24 g/m^2 results for the 3D embossed zones along its surfaces, which corresponds to a significant material thinning within the embossed zones by about 60% fiber mass. The higher surface weight in the zones 6 in connection with their undamaged fiber bonds provides for the advantageous property of the nonwoven that it overall without the requirement of an additional stabilizing layer after a preceding compression returns better to its original shape than all previously known embodiments with the result that the nonwoven of the invention is better suited for the uptake of liquids of different composition or the transfer of the liquids to an absorbent layer.

The preferred embodiment of an apparatus in accordance with the invention for carrying out the process consists of at least two embossment rollers 21, 22 which mesh with one another in such a way that a nonwoven 20 is guided between them and deformed, whereby the embossment rollers 21, 22 consist of gears 11 which are mounted on a shaft 13 and separated by spacers 12.

Figure 4 shows an embossment roller 21. Gear disks 11 and un-toothed spacer disks 12 are alternately mounted on an axis 13, which is provided with a locking wedge 14. The diameter of the disk 12 corresponds to the diameter of the gear disk 11 at its deepest locations 17 (the valleys).

Figure 5 is a cross section of such an embossment roller 21. The teeth15 of the forward gear disk 11 has the elevations 16 and depressions 17. Behind the gear disk 11, an un-toothed disk 12 (not visible) with the diameter 19 is slid onto the axis 13 by way of a grove 18.

According to figure 6, an embossment work consists of at least two meshing embossment rollers 21 and 22. At least one of the two rollers can be heated. For the heating of the roller surface, an additional heat source 26 can be provided. The un-embossed nonwoven web 20 passes in the region 23 between the meshing teeth of the two embossment rollers 21 and 22 and is deformed, facilitated by heat, to a 3D embossed nonwoven material with new surface structure. The take off roller 24 has a rough surface 25 which facilitates the further transport of the sheet ware.

The embossment arrangement can be operated at a maximum width of up to 200 cm. In a smaller embodiment with roller widths between 55 to 125, preferably between 65 and 90 cm, it can be intergraded into diaper machines. This is a special embodiment of the process which has the advantage to deliver flat rolled up ware cut into disks and circumvent the logistical problem of the storage of the bands in cartons (festooning) or cost intensive cross wise spooling.

The process in accordance with the invention with the sole embodiment of an endorsement in the diaper machine has the further advantage that the un-embossed nonwoven with fluid uptake and distribution function can be more strongely compressed than one which is not subjected to a 3D embossment. An un-embossed rolled up ware is always associated with the problem that a stronger thickness compression occurs at the roll core in the vicinity of the spool than in the outer region, which compression even after placement in the diaper is not completely equalized. A master roll with a 3 inch core as inner diameter with binder bonded uptake and distribution nonwoven material loaned to an outer diameter of 114 cm provides about 2500 to 3000 linear meters per roll. Although the problem of compression at the winding core could be mostly solved by reducing the winding strength, that is associated with cost disadvantages, since fewer linear meters will be included in the roll. The process according to the present invention or the embossed, voluminous finished material resulting therefrom allows for a significantly stronger compression of the un-embossed half finished material with the advantage of alleviating the mentioned compression problem at the winding core and the logistical advantage to fit significantly more linear meter into the spool.

The un-embossed nonwoven material in the weight range of 30 to 100 g/m^2, preferably 40 to 80 g/m^2 has a thickness, measured at 0.5 kPA load of 0.2 to 1.5 mm, preferably 0.35 to 1.20 mm. The thickness after the embossment depends first of all on the height of the teeth, the distance between the teeth (degree of engagement = intensity of the meshing) and secondly from the surface weight of the unembossed nonwoven material. The thickness H (see Figure 2) of the embossed nonwoven measured between the imaginary planes defined by the elevations is in the range of about 0.5 to about 5.5 mm, preferably about 0.9 to about 4.5 mm.

The width of the zones 5 and 7 with gear embossment is in the range of about 3.0 to about 20 mm, preferably 6 to 12 mm. The zones 5 and 7 can respectively have the same width or different widths. Preferably, they have the same width. The regions 6 are generally ≤ half of the sum of the width of zone 5 and 7 and preferably only 5 to 25 % of the sum. For example if a width of 7 mm is selected for zone 5 and 7, the width of the regions 6 is only 0.7 mm to 3.5 mm. The regions 6 can have different widths, but cannot exceed a total surface portion of a maximum of 50 % and are preferably in the range of about 10 to about 33 % relative to the total surface of the embossed nonwoven. However, especially preferred is a 3D optic with regions 6 of equal width.

At the underside of the 3D embossed nonwoven useable as AVS, a hydrophilic binder agent (or an agent made absorbent by the addition of surfactants) can be subsequently applied. The term underside is understood to define that side the surface of which is delimited by the un-embossed regions 6 and the depressions 4b and 8b. Such a one-sided binder application can be advantageous for the purpose of the further 3D structure stabilization and can support a transfer of the fluid in direction of the absorbing core byway of increased hydrophilic properties.

Example 1

A laid web of crimped staple fibers of polyester with a titer of 6.7 dtex and a staple length of 51 mm is laid down in machine direction. The weight of the web is 45 g/m^2. The web is wetted with water in order to facilitate the subsequent one-sided printing with binder agent. An aqueous polymer dispersion on the basis of carboxylated copolymer styrol-butadiene is used as binder agent. The shore hardness –A of the film produced form this binder agent is about 90 to 95. Surfactant, some pigmented coloring and dilution water is added to the 50 % dispersion so that a watered down 40 % mixture is achieved. This mixture is one-sided applied to the fiber web with the help of a Raster roller the depressions of which are filled with this mixture. During drying at 180° C on drying cylinders, the binder agent migrates partially in direction of the binder agent free side. A concentration gradient is thereby generated from one side of the nonwoven to the other. After drying, the ware remains on the dryer until a total film forming of the binder points results. The application amount of this relatively hard corboxylated styrol-butadien-latex is 15 g/m^2. This results in a fiber : binder ratio of 75 : 25.

The properties (thickness; repeatability and the like) of this un-embossed ware are compared in Table 1 with those of an embossed ware.

This half finished material was subsequently subjected to the embossment in accordance with the invention, whereby an embossment device according to figures 4 to 6 was used.

The enlarged cross section of a gear disk is shown in Figure 7. The inner radius of the gear is defined with r_i and the outer radius of the gear is defined as r_a. The height h of the teeth is calculated as the difference between r_a and r_i. The (arcuate) distance t_i on the inside and t_a on the outside can be calculated from the formula for the circumference U = 2 r π. The circumference U_a and U_i can be calculated from the multiplication of the number of the teeth z on the gear with the spacing t_i or t_a as follows:

$$u_a = z\, t_a \text{ or } U_j = z\, t_j.$$

Embossment rollers with sprockets of the following dimensions and shape were used in examples 1 and 2:

$z = 28$

$r_i = 35$ mm

$r_a = 37.5$ mm

The following values can be calculated for t_i and t_a from the above mathematical formulas:

$t_i = 7.85$ mm and $t_a = 8.41$ mm

By the tapering of the teeth in direction of the other side of the roller and the circular cross section of the roller, the following relationship exists for the distances t_i and t_a:

$d_a > d_i$

In example 1, the ratio of $d_a : d_i$ is 2.88 : 1.0.

The width of the spacer 12 (see figure 4) is 0.2 mm and the width of the gears 0.75 mm, whereby a portion of the un-embossed region 6 of about 20 % of the total surface of the nonwoven results.

The 60 g/m^2 heavy nonwoven 20 is guided through the nip between the meshing embossment rollers 21 and 22 at a speed of 10 m/min (600 m/h). The surface temperature of the gear roller 11 of steel SAE 1045 is 125°C. The gear roller 22 of polyamide is unheated and somewhat warms during operation. A lowering of the temperature of the steel roller is prevented by the additional heat source 26. The take-off roller 24 is cooled. The ware is subsequently wound up at the lowest possible tension.

Example 2

One proceeds as an example 1, with the difference that the web weight was lowed to 31 g/m^2. The binder agent portion was 12 g/m^2 which corresponds to a fiber : binder ratio of about 73 : 27.

The 3D embossment was carried out according to the one in example 1.

Comparative Example 1

The heavy binder bonded nonwoven produced in example 1 having a surface weight of 60 g/m^2 is subjected to an embossment according to the prior art. For that purpose, a roller pair was manufactured in which no spacer disks 12 were inserted between the gears on the cone and in which the gear disks are all in the same position, which means not rotated to be staggered. The tooth depth is the same as in example 1.

The nonwoven binder bonded half finished material produced according to example 1 and having a surface weight of 60 g/m^2 was embossed under the conditions of example 1.

This conventionally embossed reference sample with a type of undulation which about corresponds to undulated cardboard was tested for thickness, repeatability and creep resistance. The results of the reference sample, the un-embossed half finished material and the sample according to example 1 are compared in table 1.

Test methods used

- Liquid Strike Through Time according to EDANA 150.3-96 (Lister-Tester)
- Coverstock Rewet (also called Wet Back) according to EDANA 151.1-96

Strike Through Time was measured after the 1 , 2 and 3rd liquid insult and the rewet was measured after the third insult.

The results of the examples 1and 2 of the un-embossed and embossed binder bonded nonwoven are assembled in table 1 as arithmetic averages from respectively 3 individual measurements.

Test Object	Liquid Strike Through Time (s) after 1st, 2nd and 3rd insult			Rewet
	1x	2x	3x	(g)
Example 1unembossed	0.91	1.92	2.21	0.07
Example 1 embossed	0.04	0.01	0.10	0.06
Example 2 unembossed	0.03	0.69	0.94	0.08
Example 2 embossed	0.00	0.02	0.02	0.04

Table 1: Liquid Strike Through and Rewet measured directly at the test object (outside the diaper) according to EDANA-Method with the Lister-Tester arrangement.

It is apparent from the results in table 1 that especially the liquid strike through time of the embossed nonwoven in accordance with the invention is significantly lower (better) than in the un-embossed condition. Even for the rewet, improvements can be seen, but they are less significant than those in relation to the liquid strike through time. In the Kanga-Test, carried out on a diaper (see table 2), the rewet results are however more significantly improved than with the EDANA-Lister-Test.

- Liquid Strike Through Time (seep through time) with the so called Kanga-Test of Stockhausen S.OSSE.204-3.0 measured on a diaper:

A commercially available diaper of the size maxi plus without take up and distribution layer was opened and the test body inserted as take up and distribution layer between the absorbent core and the cover layer (top sheet). The diaper was then once again closed and in this manner subjected to the Kanga-Test. 120 ml of a 0.90 % table salt solution (so called synthetic urine) was used as test liquid for each test. After the centered insertion of the diaper between the round shaped (corresponding to the body shape) plastic body and the woven band surrounding it, the plastic body is loaded with the weight of 12.5 kg. Subsequently 120 ml of the liquid are pored into the vertically oriented (for a girl, unisex) cylinder of the test apparatus and the time to the total seepage of the liquid into the diaper is measured (seep in time 1).

After awaiting time of respectively 20 minutes, a second (seep in time 2) and a third measurement (seep-in time 3) is carried out with the same amount of liquid (120 ml).

Rewet (rewetting with the so called Kanga-Test of Stockhausen S.OSSE.204-3.0) is measured on a diaper:

For the determination of the rewet behavior, one waits 20 minutes after the complete seeping in of the third liquid amount, removes the diaper from the measurement apparatus and spreads it out on a table. A weighed-in stack of 3 filter papers of respectively about 40 g/m^2 is placed on the liquid entry location of the diaper and loaded with 1270 g (which corresponds to a pressure load of about $20 g/cm^2$). After 20 minutes the filter paper stack is weighed out (once again weighed and the original weight subtracted). The lower the value the dryer the baby's skin remains.

Diaper size maxi plus	Kanga-Test			
	Seep in Time (s) after 1st, 2nd, 3rd insult with liquid			Rewet
	1x	2x	3x	(g)
Brand diaper No. 1- Original	13.5	27.5	34.0	37.2
Brand diaper No. 1- Opened	11.3	25.5	33.0	31.5
Brand diaper No. 2- Original	13.5	33.5	43.3	11.9
Brand diaper No. 2- Opened	14.0	52.3	60.0	0.44
Brand diaper No. 3- Original	22.2	30.3	53.5	16.1
Brand diaper No. 3- Opened	23.1	47.9	65.2	20.9
Diaper with embossed AVS of example 1	5.3	9.5	12.1	0.28

Table 2: Results of the Strike Through Time and the rewet determined according to the so called Kanga-Method

It is apparent from table 2 that the nonwoven in accordance with the invention when inserted into a diaper as AVS provides significantly improved properties.

- Creep Resistance KB

For the determination of the creep resistance KB, samples of the format 7 x 7 cm were stamped out and acclimatized in the lab for 25 hours. For determination of an arithmetic average, 3 measurements were respectively carried out.

The test sample was loaded for 72 hours at 45° C with 7.2 kPa. The location to be loaded was marked. Subsequently, the sample was removed from the oven and relaxed for 2 minutes. The thickness was subsequently measured at a contact pressure of 0.05 kPa and a contact pressure surface of 25 cm^2. After a relaxation time of 2 hours and 24 hours, the thickness was once again measured.

Test Sample	Initial thickness before loading at 45° C	After the loading of 72 hours at 45° C and 7.2 kPa and a relaxation time t of		
		t = 0	t =2 h	t = 24 h
	mm at 0.05 kPa	mm at 0.05 kPa	mm at 0.05 kPa	mm at 0.05 kPa
Example 1 unembossed	0.92	0.59	0.63	0.68
Example 1 3D-Embossed	2.56	0.67	0.72	0.91
Reference	1.87	0.51	0.54	0.60

Table 3: Thickness measurement after thermal storage (creep resistance KB) and after different load free recovery times

The original thickness of the reference sample with conventional embossing (undulation) shows even after a loading of 0.5 kPa a significantly lower thickness than example 1, 3D embossed according to the process of the invention.

- **Specific Volume (SV)**

The thicknesses d were measured under a load of 0.50 kPa and 6.2 kPa. The value for the specific volume in cm^3/g (the reciprocal value of the specific density) is obtained through the following calculation:

$$SV = (d / FG) \times 1000 \quad \text{in } (cm^3/g)$$

Whereby FG is the surface weight of the nonwoven in g/m^2 and d is the thickness in mm.

Test Sample	Specific Volume (cm^3/g)		Specific Volume Relative (%)	
	at 0.5 kPa	at 6.2 kPa	at 0.5 kPa	at 6.2 kPa
Example 1 unembossed	15.3	11.6	100	100
Example 1 3D-embossed	42.6	14.7	278	127

Table 4: Specific Volume

The values listed in table 4 for the specific volume also show that an improved nonwoven with significant fluid uptake function was generated with a 3D embossment in accordance with the invention.

CLAIMS:

1. Three dimensional sheet structure made of a nonwoven, characterized in that the nonwoven (1) consists of fibers and/or filaments (3) and is provided on both sides with zones (5, 7) of regularly or irregularly alternating elevations (4a, 8a) and depressions (4b, 8b) which are separated transverse to the machine direction (2) by un-embossed, continuous regions (6) which extended in machine direction and take up a portion of 5 % to 50 % of the total surface of the un-embossed nonwoven (1), whereby the elevations (4a, 8a) and the depressions (4b, 8b) when observed from the respectively opposite side respectively form depressions and elevations and that the elevations on both sides are shaped to protrude relative to surfaces (28) which are respectively formed by an imagined extension of the surfaces on both sides of the un-embossed, continuously formed regions (6).

2. The sheet structure according to claim 1, characterized in that the peaks of the elevations (4a, 8a) on both sides to the large part reach imaginary planes (27) which have a distance h of 0.5 mm to 5.5 mm from one another.

3. The sheet structure according to claim 1, characterized in that the peaks of the elevations (4a, 8a) on both sides to a large part reach imaginary planes (27) which have a spacing from one another of 0.9 mm to 4.5 mm.

4. The sheet structure according to one of claims 1 to 3, characterized in that the regions (6) take up a portion of 10 % to 33% relative to the total surface of the nonwoven.

5. The sheet structure according to one of claims 1 to 4, characterized in that the fibers or filaments are mainly oriented in machine direction (2) of the apparatus used during its manufacture.

6. The sheet structure according to one of claims 1 to 5, characterized in that the elevations (4a, 8a) and depressions (4b, 8b) of adjacent zones (5, 7) are arranged in a grid shaped pattern.

7. The sheet structure according to one of claims 1 to 5, characterized in that the elevations (4a, 8a) and depressions (4b, 8b) of adjacent zones (5, 7) are positioned such that the elevations (4a, 8a) and depressions (4b, 8b) are symmetrically positioned to both sides of the continuously formed regions (6) in machine direction (2) of the machine used for its manufacture,.

8. The sheet structure according to one of claims 1 to 5, characterized in that the elevations (4a, 8a) and depressions (4b, 8b) of adjacent zones (5, 7) to both sides of the continuously formed regions are staggered in machine direction (2) of the apparatus used for its manufacture.

9. The sheet structure according to one of claims 1 to 5, characterized in that the elevations (4a, 8a) and depressions (4b, 8b) of adjacent zones (5, 7) are asymmetrically positioned to both sides of the continuously formed regions (6) relative to one another in the machine direction of the apparatus used for its manufacture.

10. A process for the manufacture of a sheet structure according to one of claims 1 to 9, characterized in that a planar nonwoven of fibers and/or filaments (3) which are oriented mainly in machine direction(2) of the apparatus used for the manufacture is formed, that the fibers and/or filaments (3) of the nonwoven are bonded to one another and that the nonwoven obtained is subsequently subjected at a temperature of 65° C to 160° C to the action of at least one embossment roller for transforming the nonwoven into the form of a three dimensional nonwoven.

11. The process according to claim 10, characterized in that the fibers or filaments are bonded by a binder agent.

12. The process according to claim 11, characterized in that the binder agent is applied onto one side of the nonwoven.

13. The process according to claims 11 or 12, characterized in that a surfactant is added to the binder agent.

14. The process according to one of claims 10 to 13, characterized in that only the continuously formed regions (6) are strengthened by at least a second binder agent application before, doing or after the deformation.

15. The process according to claim 14, characterized in that the second binder application is carried out by spraying or printing onto the continuously formed regions (6).

16. The process according to claim 14 to 15 characterized in that a second binder agent application is applied to the continuously formed regions (6) from both sides.

17. An apparatus for carrying out the process according to one of claims 10 to 16, characterized in that at least 2 embossment rollers (21, 22) are provided which mesh with one another in such a way that a nonwoven (20) can be guided through their roller nip and deformed, whereby the embossment rollers (21, 22) consist of gears (11) which are mounted on a shaft (13) and separated from one another by spacers (12).

18. The apparatus according to claim 17, characterized in that the gears (11) have straight or oblique teeth.

19. Apparatus according to claim 17 or 18, characterized in that the gears (11) of the embossment rollers (21, 22) are made of the same or different materials selected from the group of iron, copper, aluminum, and their alloys, or polymers.

20. The apparatus according to claims 17 or 18, characterized in that the gears(11) of one of the embossment roller (21) are made of aluminum and the gears of the embossment roller (22) are made of polyamide.

21. Apparatus according to one of claims 17 to 20, characterized in that only one of the embossment rollers is heated.

22. Apparatus according to one of claims 17 to 21, characterized in that a radiant heat source (26) is used for the heating of the embossment roller.

Fig.1

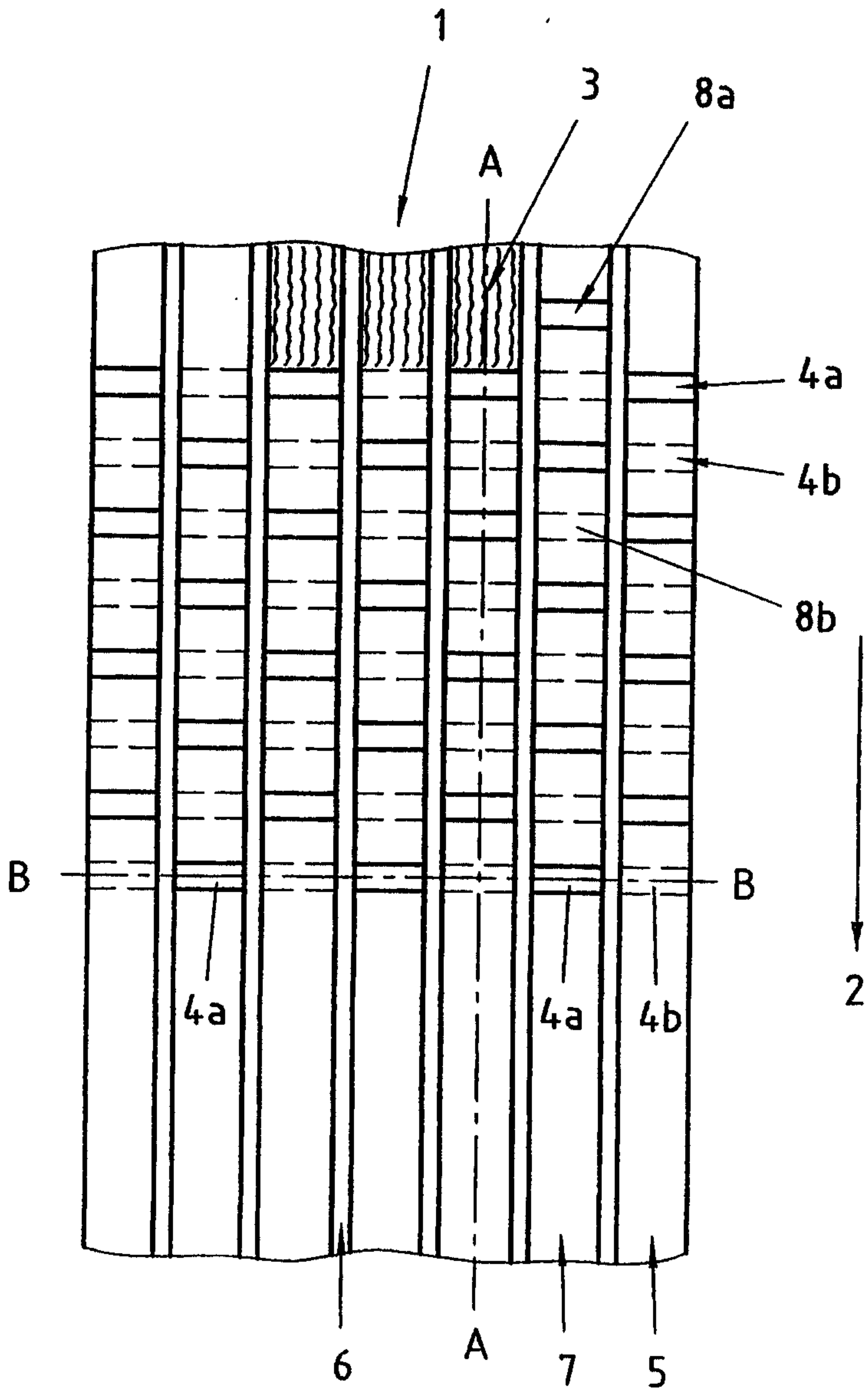


Fig.2

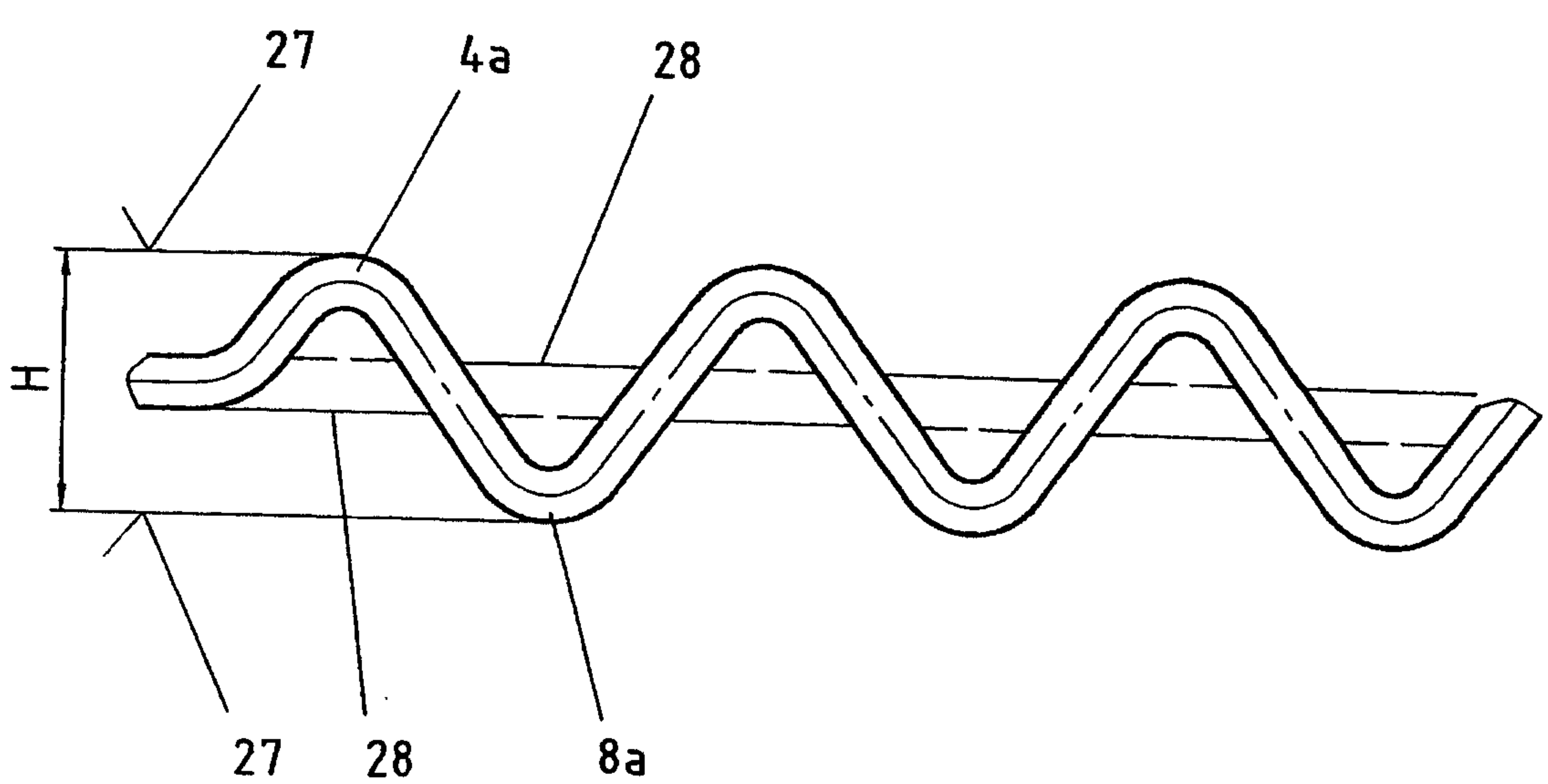


Fig.3

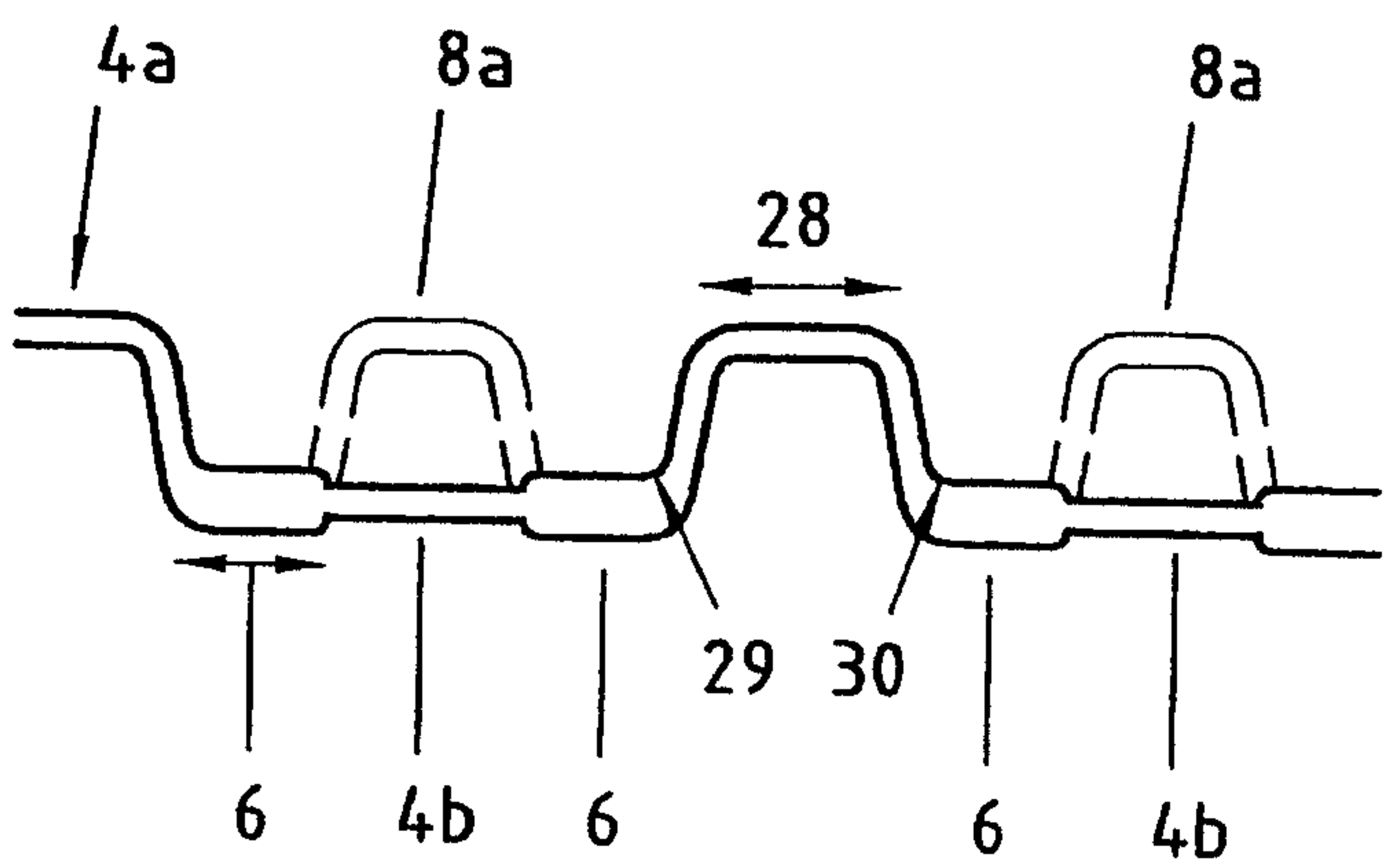


Fig.4

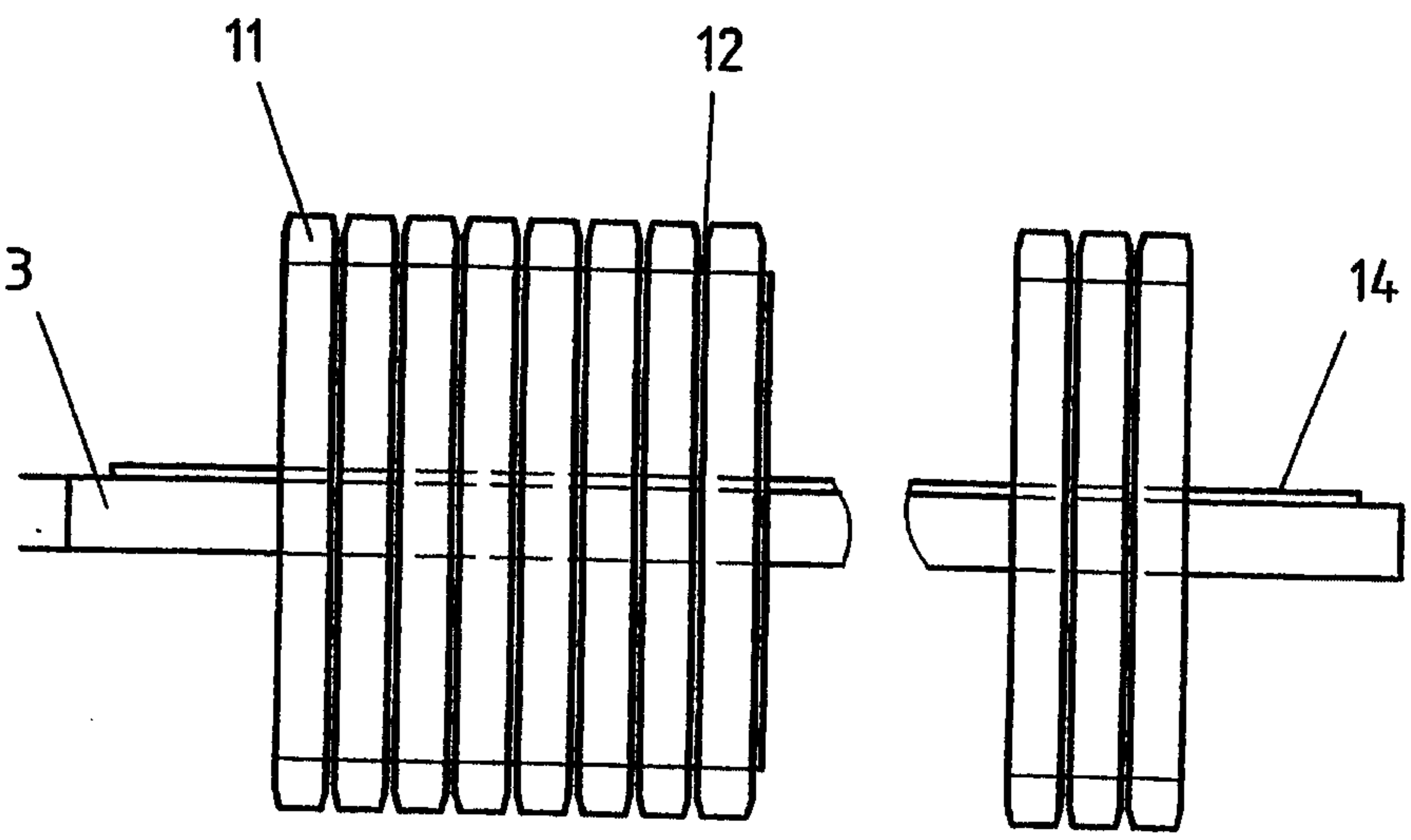


Fig.5

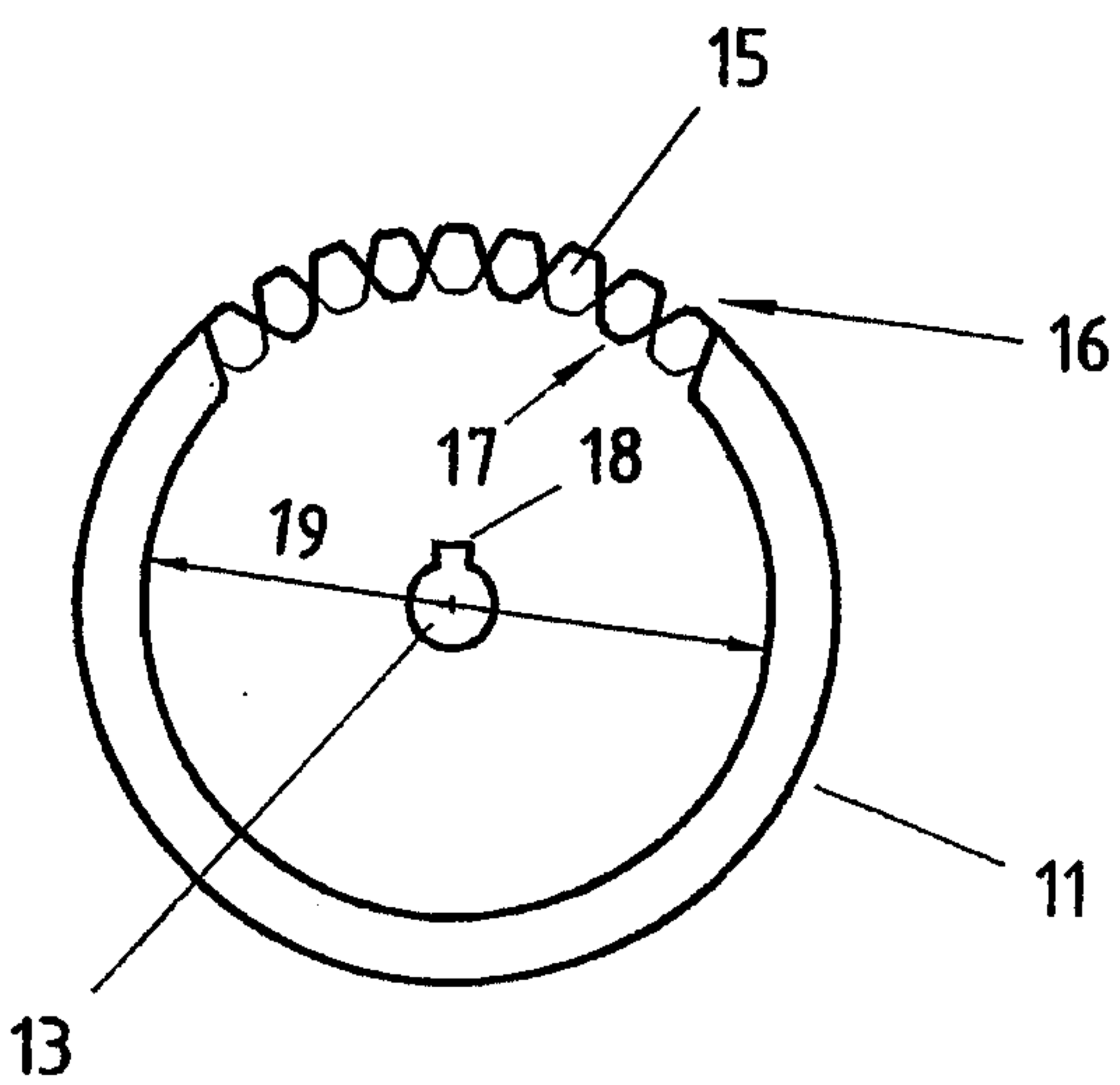


Fig.6

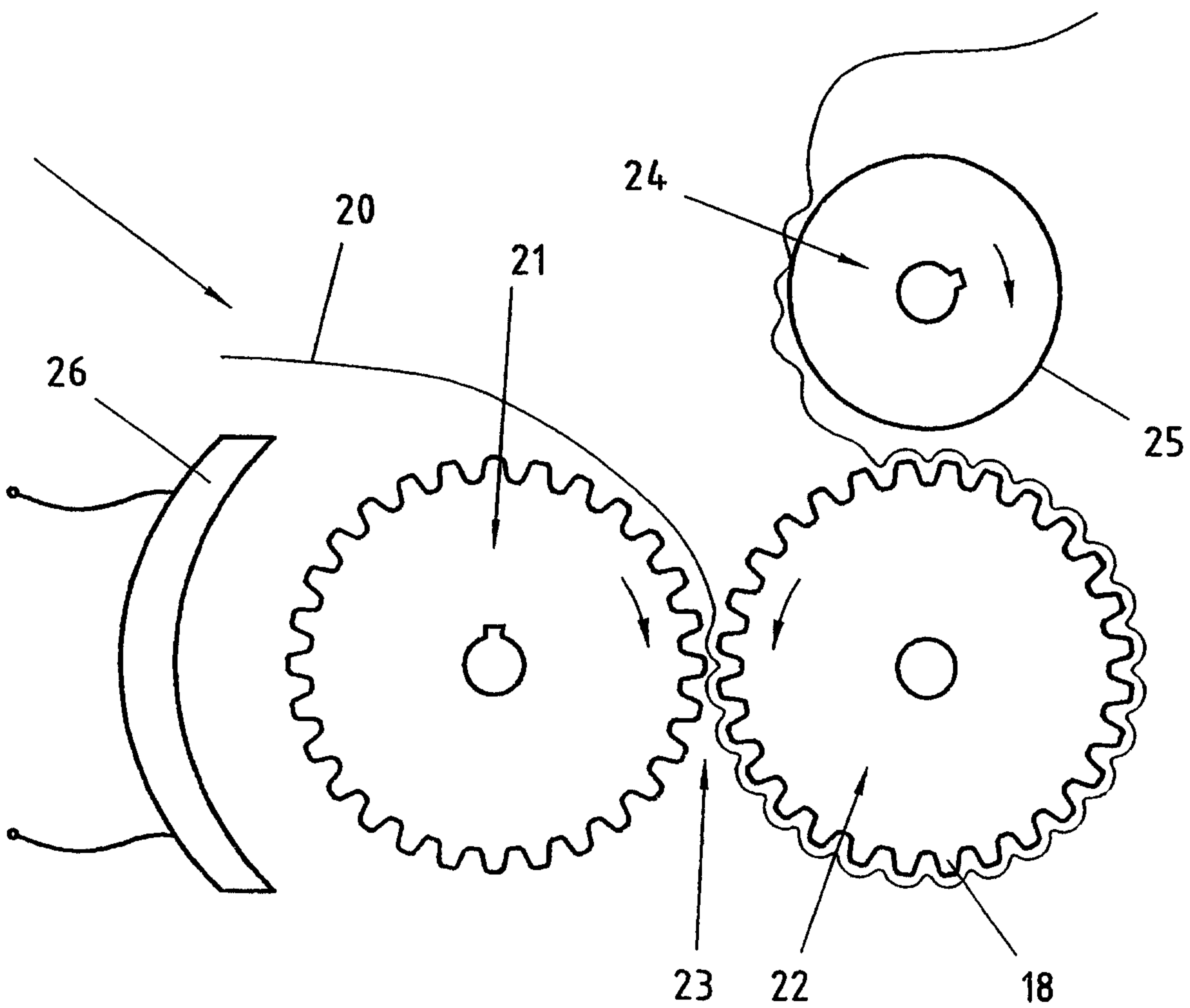
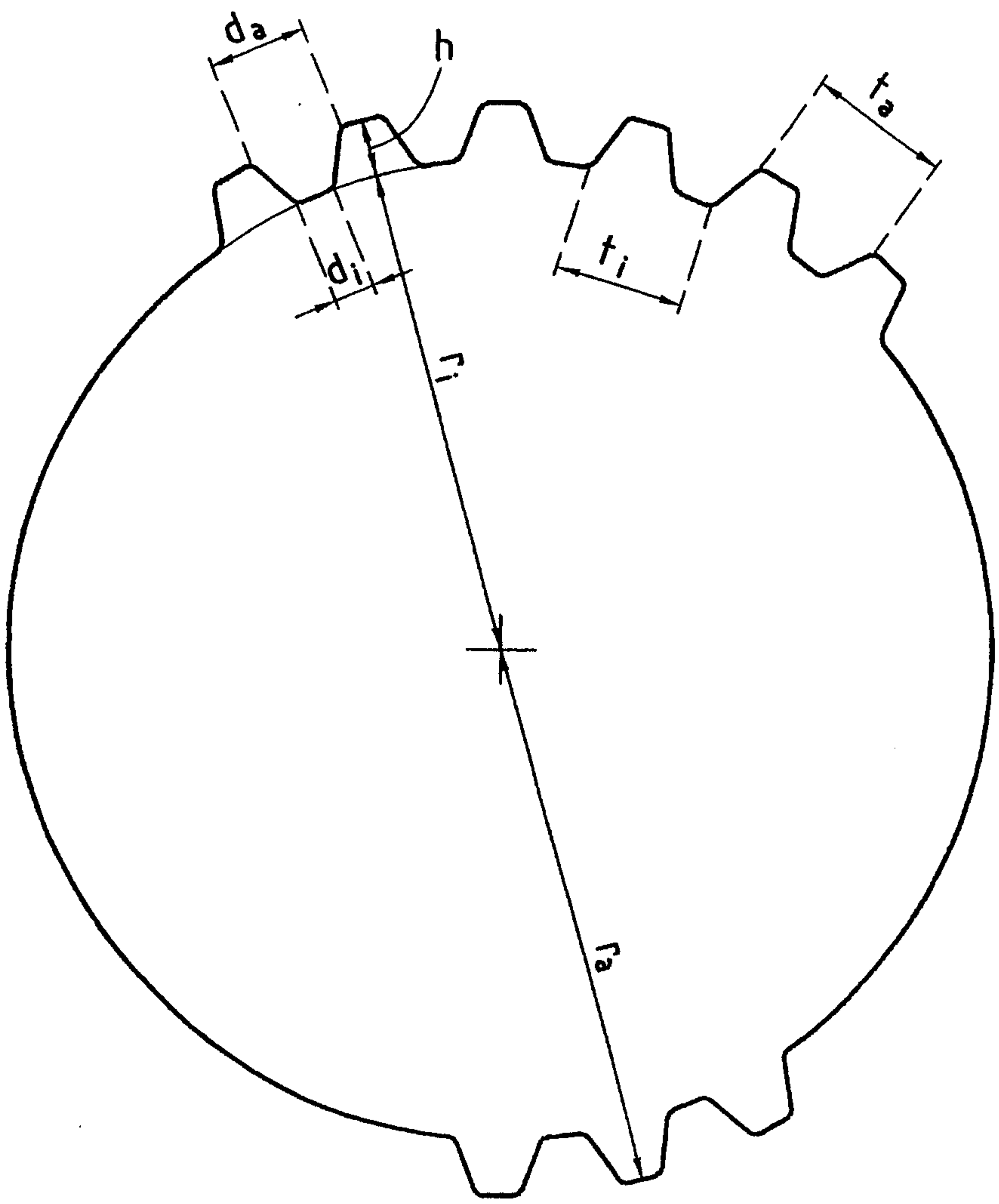
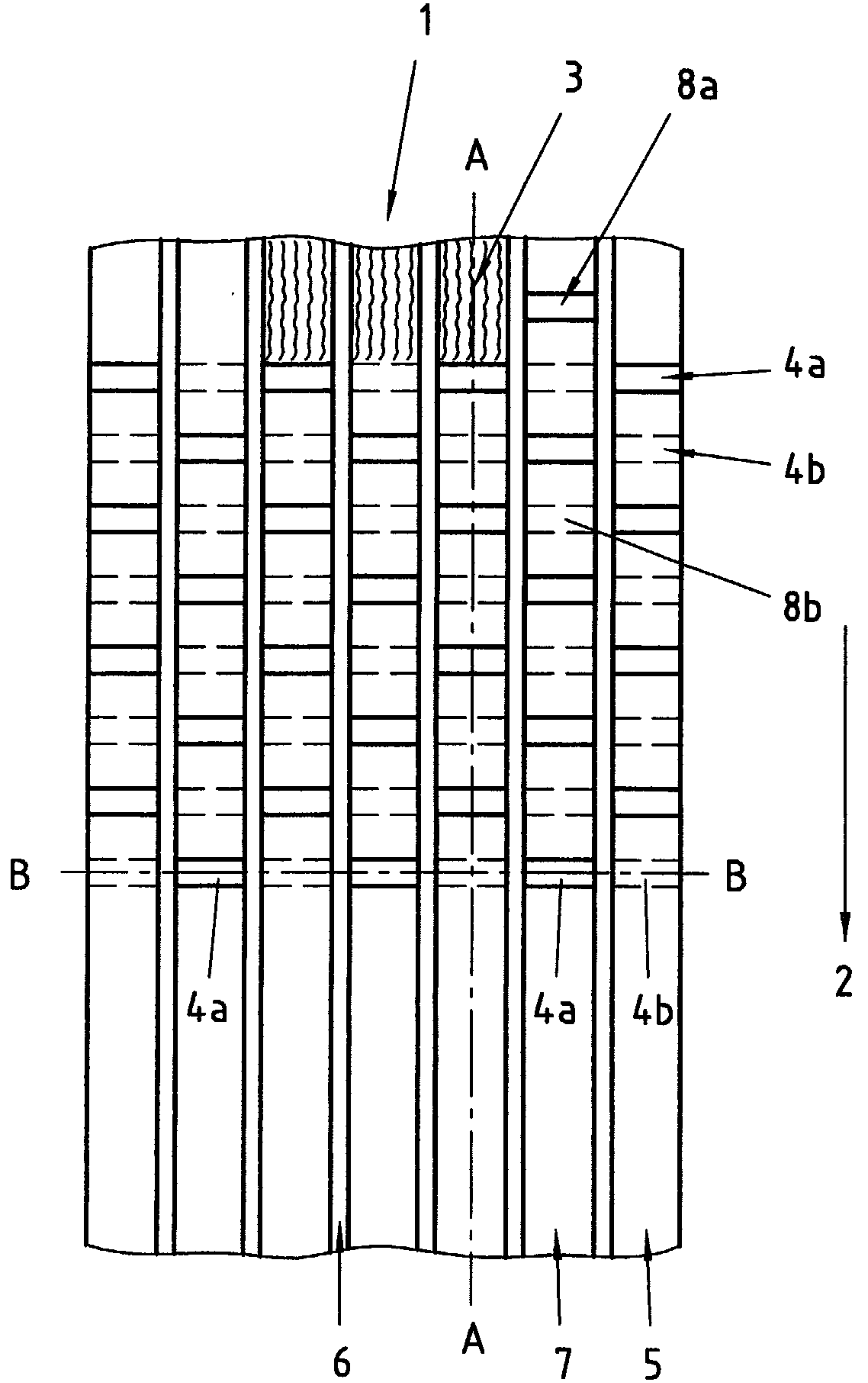


Fig.7




1
3
8a
A
4a
4b
8b
2
B
B
4a
4a
4b
6
A
7
5